ALPINE AREA

Land Conservation Council Victoria

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REPORT

on the

ALPINE STUDY AREA

Land Conservation Council, Victoria

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FOREWORD

The Land Conservation Council, Victoria, established by the *Land Conservation Act* 1970, carries out investigations and makes recommendations to the Minister for Conservation on the balanced use of public land throughout the State. Such an investigation was commenced in the alpine area in 1973, and final recommendations for the area presented to the Minister for Conservation in June, 1979.

In May 1982, the Council was directed by the government to carry out an investigation of public land within the alpine area and to make recommendations on those areas that may be added to the alpine park system.

The original alpine area report (published in July 1977) set out to describe and assess the natural resources of the public land in the alpine area, and provided a factual basis on which members of the community based their submissions to Council. That report is now out of print.

The Council has now produced an abridged version of the report, which contains the original text and maps but, because of time and cost, does not include more recent information or the photographs. However, a supplementary report has been prepared, which brings up to date information on the tenure and use of land in the area and sets out to assess the values of public land outside the existing system of parks.

The alpine area report and the supplement enable interested members of the community to obtain and study the basic information on the area, which the Council itself will study, and so make informed and constructive suggestions to the Council for its consideration in the new investigation.

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

S.G.McL. DIMMICK
Chairman

Land Conservation Council
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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 National Museum, the Fisheries and Wildlife Division; the Forests Commission; the National Parks Service; and 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 governments, universities, industries, apiarists, mountain-district cattlemen, members of fauna and flora study organizations, and many individuals with expert knowledge in fields such as botany or zoology. Their assistance is gratefully acknowledged.

This Council is indebted to the many Government Departments mentioned above that made photographs available for the report, and to the following organizations and individuals for the use of their photographs:

The Melbourne Walking Club, Australian Paper Manufacturers Ltd, and *The Bairnsdale Advertizer;* Mrs. A.I. Wakefield, and Messrs. F. Balkau, R.P. Dunbar, James Flett, A.E. Howard, D. Hutton, K.G. McInnes, G. Moore, G. Parr, T.W. Pescott, P.A. Rawlinson, W. Ryder, G. Stoney, K. Tarrant, T. Tierney, L. Jackson, and W.R. Wheeler.

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 4 of the *Crown Land (Reserves) Act* 1978 and State forest and parks within the meaning of the *National Parks Act* 1975;

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

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

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

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

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

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

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

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

Functions of the Council

Section 5.

(1) The Council shall -

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Investigations, notices and reports

Section 9.

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

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

(a) the Council of any municipality in the municipal district of which any part of the area or 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 submissions 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.

Government departments and authorities to give effect to recommendations

(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 be given to 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 Sales Office, 7a Parliament Place, Melbourne, 3002.

PART I

INTRODUCTION

1. AIMS AND METHODS

This report brings together information that is relevant to decisions regarding the future use of public land in the study area. It describes the physical nature of the land, examines the existing and 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 plants, animals, and potential areas for possible future alpine resorts.

Although public land has been emphasized, the report considers relevant aspects of all land in the study area to place public land in perspective.

The text is divided into four main sections. Part I, an introductory section, outlines the conservation 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 area in most cases. Maps accompanying this report show physiography, topography, geology, rainfall and water resources, vegetation on public land, and land systems.

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. Recreation, primary production, and mineral maps are also included. An indication of wood resources may be obtained from the vegetation map.

Part IV provides more detailed information and, for convenience, the study area has been divided into 20 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 include lists of climatic data, fauna, and flora for the study area.

2. CONSERVATION PRINCIPLES

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 must be aware of long-term needs and recognize that a community requires land for recreation, 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. In the last century the expansion of Victoria's economy 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 may increase or decrease with time. Animal and plant communities and landscape fall within this category. 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 development of sound management techniques based on those principles. An ecosystem typically contains many interrelated components. 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 techniques 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 techniques and only emerge in the long term - for example, the use of insecticides can increase production of food or fibre dramatically, but may also reduce the population of predatory birds and insects and so encourage the build-up of populations of other insect pests.

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 picnicking 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, determining other uses compatible with these, and specifying 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 usually been given prime importance when deciding the use of natural resources. The present pattern of land use is, of course, a result of these past decisions.

Recently there has been greater public demand for a shift in emphasis towards nature conservation and recreation as the economic welfare of the bulk of society has improved, the need and opportunities for outdoor recreation have grown, and an appreciation of nature has become more apparent.

The concept of balance is fundamental to land use and is directly related to the values that society puts on the goods and services that the land can provide. It also involves consideration of the needs of all sections of society, on both regional and State bases, as well as those of this and future generations.

These needs should be clearly stated as aims.

The intangible values of recreation, aesthetics, and preservation should be recognized by providing land for these purposes, and by considering the impact of other land uses upon them. The preservation of outstanding natural features should be considered.

Where several land uses are compatible, land should be available for the most beneficial combination of such uses. To achieve this, 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.

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

3. THE STUDY AREA

The Alpine study area occupies a large part of the Victorian Eastern Highlands - extending from Mansfield and Licola eastwards to the Snowy River and Murray River headwaters, as indicated on the locality plan (page 8).

This region comprises parts of the Shires of Mansfield, Oxley, Myrtleford, Bright, Tallangatta (formerly Towong), and Upper Murray in north-eastern Victoria.

In Gippsland, about 80% of Omeo Shire lies within the study area and also portions of Maffra, Avon, Bairnsdale, and Tambo Shires.

With the exception of Omeo, the bulk of the population of each Shire is outside the study area. Public land covers approximately 14,250 sq km and private land 1,840 sq km.

Most of the public land (as defined in the *Land Conservation Act* - see page x) is unreserved Crown land or reserved forest. Private land is mainly concentrated in the Omeo and Tambo Shires.

Although it includes all the alpine and most of the sub-alpine environments in Victoria, the area contains a wide range of natural environments. Physiography, climate, soils, and vegetation all show a marked variation over comparatively short distances in some places.

Dry "rain-shadow" valleys contrast markedly with adjacent mountains characterized by wet montane forests and, at higher elevations, sub-alpine woodlands and alpine herbfields. The mountains are a highly important source of water for Victoria and contribute about one-quarter of the flow in the State's river systems - the highest elevations being the most productive. Water quality in streams in the study area is high, and most of them flow relatively reliably throughout the year.

Streams contribute water to a number of storages (used mainly for irrigation purposes) outside the study area. The Dartmouth Dam project when completed will be the largest water storage in Victoria. This is completely within the study area. It will supply water for irrigation and for hydro-electric power generation.

Most of the public land is in one large contiguous area that has high nature conservation values. It is highly important for the conservation of animals that are characteristic of and common in the mountains as well as for the vegetation that forms their habitat. Moreover many plants are endemic to the study area. The rare mountain pigmy possum is only found at a few locations at the highest elevations in the study area and in the adjacent Kosciusko area. These elevations also contain a characteristic insect fauna found only in alpine and sub-alpine regions.

Some land types are fragile and prone to damage. The alpine and low-rainfall zones are the most vulnerable.

The forests of the study area support an important segment of the Victorian wood-products industry. At present they provide 32% of all hardwood sawlogs produced in Victoria. This represents 85% of Victorian seasoning-quality sawn timber and nearly one-quarter of framing timber for house construction. Australian Paper Manufacturers draws part of its hardwood pulpwood supply from the study area.

Agricultural land produces beef cattle and sheep for wool or meat. Some of the property-owners integrate their home-property pastures with grazing blocks on public land, thereby running higher numbers of beef cattle than their property alone could support. Most of the suitable agricultural land has been cleared and developed. Apiarists make some use of native flora to produce honey, but another significant use is to build up the vigour of the bee colonies for later harvesting of nectar flows elsewhere.

Recreation is a major use of the study area, which contains the three largest ski resorts in the State. The region is very important for cross-country skiing, bushwalking, and adventure driving - all rapidly increasing activities. Some areas still have wilderness values - a dwindling resource in Victoria.

The Kiewa hydro-electric scheme is a small but important producer of electricity, used mainly for peak-load supply.

Mining has dwindled in importance since the gold-mining era, but significant reserves of construction materials and of several minerals exist at various scattered localities.

While some uses are non-competitive, there are also a number of competitive uses of the study area. Careful allocation of land areas and control of use in space and time as well as in terms of activity levels can achieve a balance of land use.

Population

The permanent population of the Shires plus the town of Bairnsdale in 1976 comprised only 1.6% of the total Victorian population (see Table 1). This percentage has decreased steadily from a level of 2.2% in 1954. Only in the Shire of Myrtleford has the population growth rate exceeded the Victorian average.

The actual study area, which comprises only part of each Shire, has a correspondingly much smaller population than the preliminary regional total of 59,429 persons in 1976.

The region shows a small but definite trend towards urbanization. The largest town within the study area is Mount Beauty, which had a population of 1,570 in 1971.

There is, however, an increasing influx of visitors to the study area throughout the year. In summer a high proportion of visitors use the areas closer to Melbourne, but are more dispersed generally than in winter. In the season, the ski resorts of Mount Buller, Falls Creek, and Mount Hotham are well patronized and many day visitors to snowfields come from Melbourne and other areas of Victoria, or stay at nearby centres such as Harrietville and Mount Beauty.

Visitor use is expected to continue to increase as urban centres become larger and the leisure time, disposable income, and mobility of their populations increase. The demand for goods and services by visitors is likely to support the trend towards urbanization.

Employment

While the tourist industry is increasing in importance, the timber and agricultural industries are the main ones that have continued to sustain local populations. There are no manufacturing industries within the study area. The Kiewa hydro-electric scheme provides employment in the Mount Beauty region.

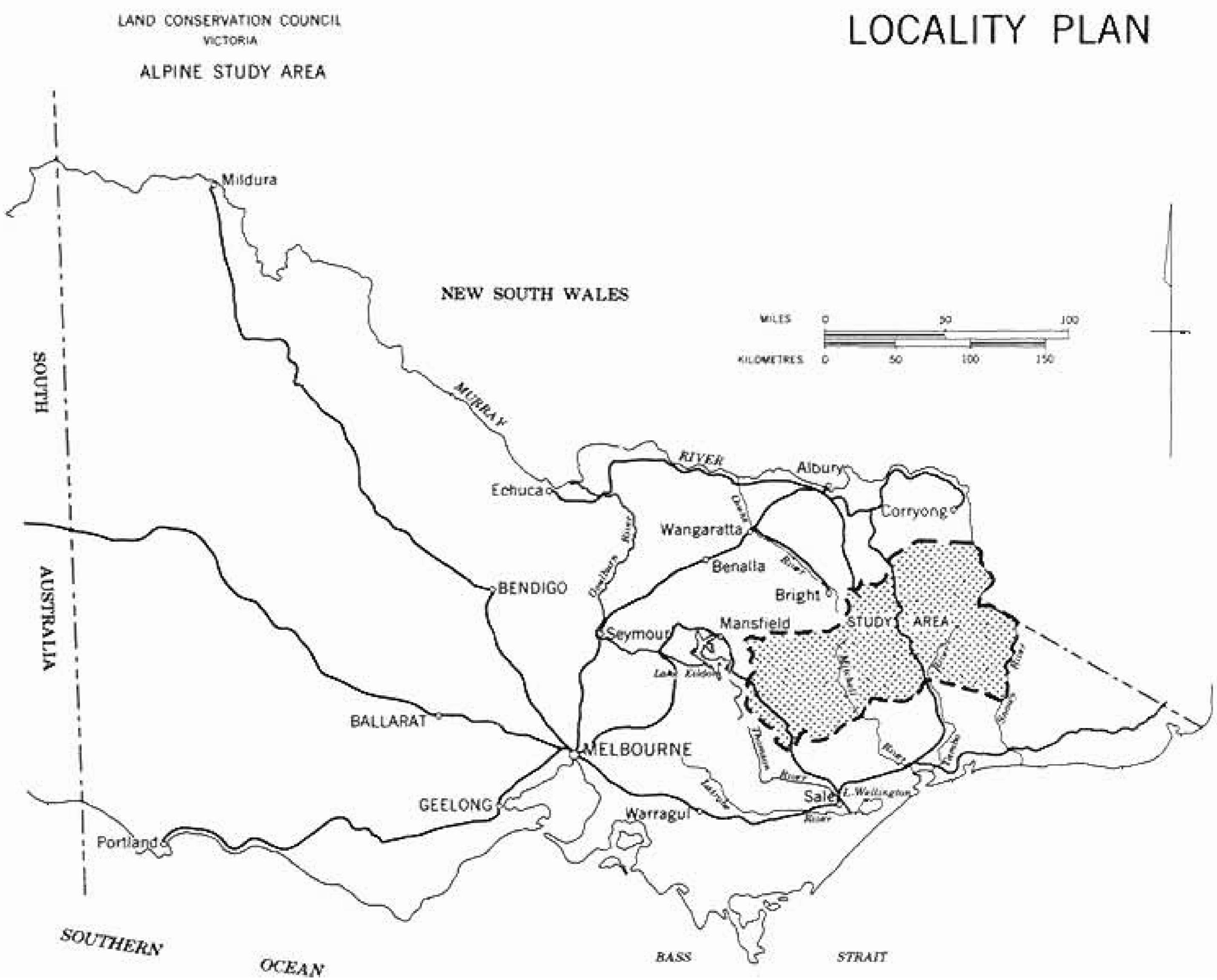
The timber industry is an important factor contributing to the stability of population centres both within and outside the area. Heyfield, Mansfield, and Swifts Creek are among a number of towns that rely on it to a varying extent.

The pattern of employment based on the industry is likely to change in future as the mature hardwood forests are cut out. Alternative hardwood sawlog supplies will be increasingly sought from fire-regrowth forests as these reach maturity. More than 64% of these regrowth forests are outside the study area, mainly closer to Melbourne. In some centres that currently draw supplies from the study area, employment opportunities may decrease as a result of the shift from one source of sawlog supplies to another.

The agricultural industry is based on production of beef cattle, although the Benambra, Omeo, and Swifts Creek districts support sheep for wool. Sheep are grown for meat in the Merrijig area, and beans are produced around Dargo.

Transport

The transport system is influenced by topography and the main industries of agriculture, timber, and tourism. The main agricultural areas of Omeo, Benambra, Swifts Creek, Wulgulmerang, and Gelantipy are well served by roads. Timber-extraction tracks also provide an important form of access and in some cases have been upgraded into tourist roads.



LAND CONSERVATION COUNCIL
VICTORIA
ALPINE STUDY AREA
LOCALITY PLAN
NEW SOUTH WALES
SOUTH AUSTRALIA
MILES 0 50 100
KILOMETRES 0 50 100 150
MURRAY RIVER
Mildura
Echuca
Albury
Corryong
Wangaratta
Benalla
Bright
BENDIGO
Seymour
Mansfield
STUDY AREA
Lake Eildon
BALLARAT
MELBOURNE
GEELONG
Warragul
Sale
L. Wellington
Portland
SOUTHERN OCEAN
BASS STRAIT

Table 1

POPULATION STATISTICS FOR LOCAL-GOVERNMENT AREAS

	Population at Census June 30				
	1954	1961	1966	1971	1976 (preliminary)
Avon Shire	3,223	3,230	3,171	3,090	2,999
Bairnsdale Shire	4,119	3,551	3,606	3,741	4,477
Bairnsdale (town)	5,912	7,647	7,960	8,552	9,131
Bright Shire	5,402	4,331	4,526	4,659	5,274
Maffra Shire	8,554	8,758	8,510	8,515	8,479
Mansfield Shire	5,023	4,423	4,275	4,260	4,355
Myrtleford Shire	2,658	3,770	4,374	4,434	4,147
Omeo Shire	2,072	2,145	2,026	1,858	1,605
Oxley Shire	4,356	5,185	5,318	5,595	4,973
Tambo Shire	5,085	5,431	5,558	5,888	6,335
Tallangatta (formerly Towong) Shire	4,385	4,207	4,079	3,768	5,097
Upper Murray Shire	2,521	2,938	3,337	2,676	2,557
Total	53,310	55,616	56,740	57,083	59,429
Victoria	2,452,341	2,930,113	3,220,217	3,502,351	3,646,301
Melbourne Statistical Division	1,589,185	1,984,815	2,230,793	2,503,022	2,603,578

Access between north-eastern Victoria and Gippsland is difficult during winter. The road between Omeo and Harrietville via Mount Hotham is cleared of snow regularly and the Omeo Highway and Corryong--Omeo road may also be used.

References

Bowden, N. Population. *Australian Year Book* No. 89, 1975.

Commonwealth Bureau of Census and Statistics, Victorian Office. 'Victoria - Population of Local Government Areas, 1947 to 1971.' (Government Printer: Melbourne 1972.)

4. HISTORY

An understanding of present land-use patterns and the condition of the land in the study area is assisted by an appreciation of when and how its resources were used in the past. Aborigines made few demands on land resources, but the advent of Europeans early last century heralded a series of changes in resource use. These had varying impact on the land, according to the type of use, its intensity and duration, and the particular characteristics of that land.

Settlers introduced domestic grazing animals wherever suitable forage occurred. The best land was appropriated and cleared for pastures during the late 1800s and the early 1900s. Such land tended to be where the climate was not too severe and slopes were moderate, for example in the Omeo and Gelantipy areas. Grazing of alpine meadows and woodlands and forests was practised from the beginnings of settlement.

An added land use was the mining boom that expanded and then collapsed during the period from the 1850s to the 1920s. This greatly added to the wealth of the developing State and left a legacy of numerous access tracks, alluvial workings along many streams, and mine tailings at various gold-reefing localities.

The combined effects of grazing and mining assisted the establishment of blackberries and other weeds, which thrived on river flats and beside water-courses. Blackberries were probably introduced in many cases by miners and settlers to provide a ready source of fruit.

After the Second World War significant demands for timber and recreation were made on the study area and these have continued unabated to the present. Many miles of logging roads and fire access tracks have been constructed, and many timber stands harvested.

The most obvious features associated with recreation are the alpine tourist roads over Mount Hotham and Mount Skene, which were opened in 1936 and 1969 respectively, and the alpine villages at Mount Buller, Falls Creek, and Mount Hotham. Development at these localities gained momentum in the 1950s and 1960s and is continuing.

Apart from a bushwalking boom during the 1930s, the use of the study area for various recreation activities has increased greatly since the 1940s. The main activities are skiing, bushwalking, recreation driving, and fishing. The main usage has been in the western and north-eastern sections of the alps.

Aborigines

Aborigines lived in the study area for many thousands of years. They had attained a state of harmony with the land, as their numbers were small and their wants few. Probably the most significant effects on the land were changes in vegetation brought about by their use of fire in hunting animals and attracting herbivores to the succulent herbaceous regrowth.

Possums provided a ready source of food, but the Bogong moth is perhaps the best-known part of their diet. During the summer, up to 700 Aborigines from local tribes and friendly neighbouring tribes would gather on high plateaux to catch and roast great numbers of these insects.

Several tribes inhabited the study area. Chief among these was the Jaitmathang. One section - the Kandagora-mittung - lived around the Lake Omeo plain and the rolling hills of the Livingstone Creek, Limestone Creek, and Tambo headwater localities. The other section - the Theddora-mittung - occupied a more extensive area that included the headwaters of the Ovens, Kiewa, and Mitta Mitta Rivers and extended north-east to the Murray River at Tom Groggin. The tribes occupied the lower areas most of the year, but visited the high plateaux during the spring and summer.

The group of tribes known as the Kurnai included in their territories practically all of the study area south of the Great Dividing Range. These territories extended south to the coastal plain, where the tribes were mostly located. Journeys into the forested mountains were few.

It is difficult to determine which tribes occupied particular localities in the area enclosing Mounts Buller and Cobbler, as the boundaries of four different tribes converge here - the Taungurong in the west, the Pangerang in the north, the Jaitmathang in the east, and the Kurnai in the south.

Routes for trade or war between tribes included the Macalister River to Mount Howitt and thence down the King or Howqua Rivers and the route along the Tambo and Mitta Mitta Rivers.

With the advent of Europeans, Aborigines dwindled in numbers and the tribes virtually disappeared by the 1860s. The only present evidence of their long occupation includes an axe quarry at Howqua, camp sites around Omeo, and implements found on the Bogong High Plains and at Mount Buller.

European discovery

The first recorded sighting of the Victorian Alps is that of a peak, now known as Mount Buller, noted by Hume and Hovell as they passed through the Mansfield area in 1824. It was, however, the search for grazing land that motivated much of the exploration and Mount Buller was not climbed until 1853, when Dr. von Mueller, the botanist and explorer, made the first recorded ascent.

Pressure for new grazing areas came as settlement extended on the Monaro plains. The extensive grazing lands of the Omeo plains were reached from the Monaro by McKillop, Livingstone, and McFarlane in 1835. Edmund Buckley is said to have explored the Bindi and Tongio areas by 1837, but the mountains to the south of Omeo still formed an impenetrable barrier and it was left to Angus McMillan to open a route from the Monaro to Corner Inlet in 1839/40.

McMillan set out from Currawong station on the Monaro in May 1839 accompanied by an Aboriginal guide. They traversed the Wulgulmerang plateau as far south as Mount Macleod in an unsuccessful attempt to reach the Gippsland plains. The two returned to the Monaro via the Omeo plains, and in August McMillan set out again with a larger party. They travelled via Omeo and the Tambo River and, after much hardship, reached and named Lake Victoria in January 1840.

McMillan's route from Omeo to Gippsland was followed in that same year by Count Strzelecki, who had climbed and named Mount Kosciusko before trekking to Omeo via the vicinity of present-day Corryong. Strzelecki then continued, suffering extreme hardship, through the South Gippsland hills that now bear his name, to Westernport Bay. McMillan attempted to set up a station at Bushy Park on the Avon River, but when this venture failed and gold was discovered he returned to the mountains. He then pioneered tracks between the goldfields and was eventually killed by a fall from his horse near Iguana Creek in 1865.

The Bogong High Plains were first visited by John Mitchell, who climbed from the Kiewa valley in 1843, and in 1851 they were approached and traversed from the Buckety Plain Spur by Brown and Wells. These two remained in the area as stockmen for some years and pioneered the route from Omeo to the Ovens valley via Mount Hotham.

Early settlement

Pastoralists moved their stock into the east of the study area from the Monaro region. The Omeo district was among the first to be used for grazing, and the runs occupied by the squatters were some of the earliest in the then Port Phillip district of New South Wales. The Limestone--Omeo region and the Upper Tambo valley became the gateway to the extensive grazing areas of Gippsland in these early days. A track had been cleared from Omeo to the Gippsland Lakes by 1841 but access remained poor for many years.

Grazing began on the Omeo plains and Benambra Creek valley in 1836 and extended east to Mount Leinster in 1837, south to Bindi and Tongio by 1839, and west to Cobungra before 1842. By the early 1840s runs had been taken up at Gelantipy and Suggan Buggan in the eastern part of the study area, the Nariel and Mitta Mitta valleys in the north-east, Merrijig and Howqua in the west, and Glenfalloch on the Macalister River.

For many years the settlers had no legal claims to ownership so improvements were few and properties often changed hands. Fencing of stock - as an alternative to shepherding of sheep and periodic mustering of cattle - began as the selection legislation of the 1860s came into effect. During the 1870s the large runs were broken up, with the better grazing land being selected first. This pattern of selection has resulted in most of the freehold land and present population being concentrated in the Shire of Omeo and on the Wulgulmerang plateau in Tambo Shire.

Other scattered selections, such as on the Dargo High Plains and in the Wonnangatta valley, have also remained freehold but their owners have used them as outstations, preferring to live closer to population centres.

The early settlers cleared the land of timber by ringbarking, felling, and burning. In some areas the removal of tree cover combined with overgrazing caused erosion. This was aggravated by the depredations of rabbits, which had built up from small numbers in the late 1890s to plague proportions from the 1900s to 1920s.

Grazing

Grazing of public land by domestic livestock has continued from the time of the first pastoralists. The history of grazing on the Bogong High Plains has been well documented. Grazing licences were first taken out for this area as early as 1851, when Jim Brown and Jack Wells brought cattle up. Since then, stock have been taken each year from the dry lower country in summer, or during times of drought, to graze the mountain meadows and the grassy floors of the surrounding woodlands and forests.

During autumn the mustered stock were returned to their home pastures along established routes like Dungeys track. In drought years, large numbers of sheep were added to the cattle and horses that normally grazed the high country.

Overgrazing and burning contributed to opening up the previously continuous ground cover of grass and herbs, and wind and water erosion resulted. Because the alpine environment is so harsh, revegetation was extremely slow. The mossbeds and peat soils of drainage lines also suffered damage and increased stream entrenchment, which further extended deterioration by allowing faster drainage of these hydrologically sensitive areas.

The seriousness of the deterioration was recognized during the 1940s, and government departments concerned with soil conservation and land met with a committee of cattlemen. The meeting initiated a continuing relationship, which has resulted in a ban on burning and sheep-grazing and in the introduction of the present controls on the numbers of cattle grazed and the dates of their entry and removal from the Bogong High Plains. Areas such as the summits of Mount Bogong, Mount Hotham, Mount Loch, and Mount Feathertop, where restoration of ground cover has been slow or where deterioration has continued, have been withdrawn from grazing.

Similar controls have been extended to other alpine areas where the environment is highly sensitive to grazing pressure.

As a result of these controls, restoration of ground cover has occurred over much of the high country, but in some areas recovery is very slow.

Similar grazing practices were used in other high-country areas such as the Bennison, Dargo, and Nunniong plateaux. In some instances cattle spent the winter grazing in sheltered gullies below the snowline. Grazing of the lower valleys was more common in earlier years than it is today. Its reduction has been due to several factors, beginning with the rabbit plague in the early 1900s, when forage was eaten out or fouled by rabbit droppings. The spread of weeds by various agencies and the growth of scrub following cessation of regular burning have continued to limit the use of these areas.

The mining boom

The discovery of gold followed, and exceeded grazing as an economic incentive for the opening up of the alpine area. The rush for alluvial gold in the mountains began in the early 1850s with its discovery at Omeo, Cobungra, Harrietville, Shady Creek (near Mount Pinnibar), and Mitta Mitta. Other discoveries came rapidly and, by the end of the 1850s, additional goldfields were located at Swifts Creek, Tongio West, Granite Flat, Lightning Creek, Cassilis, Powers Creek, and the upper Livingstone Creek.

During the next 30 years gold was found successively at Crooked River, Big River, Buenba Flat, Howqua River, Saltpetre and Sassafras Creeks, Tom Groggin, Upper Buckwong River, Dart River, Zulu Creek, Dead Horse Creek (near Limestone Creek), Mount Wills, and Sunnyside.

Gold exploration followed a pattern. After the first discoveries by pastoralists came haphazard prospecting by miners, then systematic prospecting by government-sponsored expeditions resulting in discoveries such as that made by Alfred Howitt at Crooked River. Prospecting was further encouraged by a government-financed programme of trackcutting and maintenance.

Angus McMillan was invited to lead an expedition to locate and clear tracks between the various goldfields. In 1864/65 his party cut a track from the Crooked River to Omeo via the Dargo High Plains and to the Jordan via the Bennison High Plains. The cutting and maintenance of access tracks was financed by the Mines Department until 1925, although few additional tracks were cut after 1909.

Exploitation of the gold deposits, like their discovery, followed a pattern.

The initial workings of alluvial gold were in many cases succeeded by the working of the associated gold-bearing reefs.

Shallow reef mining commenced in the decade 1860--70; then came deep-lead mining on the Dargo High Plains, where high-level terrace gravels had been traced under the basalts.

By the late 1880s, large reef mines such as Cassilis and Glen Wills were being worked and large-scale alluvial mining was being carried out. This included dredging on Livingstone Creek and the Upper Ovens with sluicing on Livingstone Creek and the Ovens, Mitta Mitta, Dargo, and Crooked Rivers.

Small villages and townships sprang up with the inflow of the miners and some goldfields supported a few thousand people in their heyday while others attracted only a few score. The numbers of diggers on a field varied greatly, depending on the chances of success and the advent of rushes to new discoveries.

Gold production was at a maximum from 1902 to 1912, but has declined since for various reasons. In the first instance the easily won gold was becoming scarcer. The lack of manpower during the First World War, the lack of finance during the great depression, and the increase in labour costs relative to the price of gold all added to this.

Other minerals, notably tin, were often found and extracted along with the gold, and by 1890 extensive tin lodes had been located on the Mitta Mitta and Glen Wills fields.

Mining activities had a considerable impact on the land at many remote areas during the mining boom. Many kilometres of stream beds and terraces were sluiced. Water races were cut in the hills, river flats were dredged, and forests were cut to produce timber for dwellings, mine construction, and firewood.

In addition, roads and mining tracks were cut to facilitate both the prospecting and the subsequent mining and by the time the gold yield dwindled there were several thousand kilometres of roads and tracks throughout the study area. Those that fell into disuse, however, are barely traceable today, although the scars left by the dredging and sluicing are evident in some areas.

Mining machinery such as water wheels, steam engines, and stamping batteries still remain in some localities.

Timber-harvesting

Following the decline of gold-mining about 1914, the utilization of forests for timber was limited to providing timber for fencing and farm buildings. It was not until the 1930s that any significant sawlog-harvesting commenced in the study area.

In 1930 a sawmill was established near Mount Baldhead, south-west of Swifts Creek, and in 1935 logging commenced at Mirimbah in the Delatite watershed below Mount Buller. Shortly afterwards logging commenced in the Mount Wills area.

Features of pre-war logging in the alpine forests, as in the mountain ash forests nearer Melbourne, were the use of steam-powered winches to haul logs directly into the sawmill yards where possible, and the use of tramlines and lowering gear to extend operations further into the forest. Horse teams were still used extensively to bring logs to the winch lines until about 1939, after which they were progressively replaced by crawler tractors. Tree-felling was by axe and crosscut saw until chainsaws were introduced about 1950.

After the Second World War there was a great boom in demand for timber from the study area. This was due both to the increased community requirements and to the loss in the 1939 fires of hugh areas of mature mountain ash forest closer to Melbourne.

Much of the alpine ash forests of the study area escaped the worst of the fires and, following the massive salvage of the fire-killed timber in central Victoria, many sawmills were transferred to these forests in the late 1940s. In '46 mills were built at Swifts Creek and Omeo. Others were built at Mansfield during 1947 and 1948 and timber supplies were drawn from the forests of the King, Howqua, and Jamieson watersheds. In 1949 Heyfield was established as an important sawmilling centre, with log allocations being granted in the Connors Plain area.

Post-war expansion of operations was accompanied by an increasing mechanization and sophistication of milling, with developments in accurate band-sawing and mechanical handling of logs. The introduction of large diesel trucks improved log haulage from remote areas, and the increasing reliability of larger and more powerful crawler tractors and chainsaws increased the efficiency of forest operations.

The Forests Commission has undertaken or supervised the construction of many hundreds of kilometres of access roads, and almost all of the large areas of mature alpine ash have now been opened up. Some of these roads, notably the Jamieson--Licola road, have been developed into major tourist routes, and many others are used by fishermen and bushwalkers to gain access to their recreation areas.

Recreation

Alpine recreation on an organized basis began with the establishment of a resort on Mount Buffalo in the late 1880s. Bright served as a centre for alpine activities in those days as it does now. The Bright Alpine Club made the first winter ascent of Mount Feathertop in 1889 and used a form of snowshoe for their winter excursions in the alps.

Skiing began as an organized sport in the early 1920s. Enthusiasts began to search for snowfields that promised good opportunities for cross-country and also downhill skiing. The Bogong High Plains and nearby mountains were used for ski-touring. Cattlemen's huts were used for refuge and overnight accommodation. Later, huts such as the Cleve Cole and Summit huts were built for cross-country skiers and bushwalkers. The snow-pole lines originally established by mining prospectors were renewed by ski-tourers.

The increase of downhill skiing was linked with the development of suitable accommodation centres. The Bungalow spur west of Mount Feathertop was popular for skiing as early as 1923. This activity ceased when the Feathertop Bungalow was destroyed during the 1939 fires. In 1924 Mount Buller was investigated for its skiing potential. By the next year a road had been built to the foot of the mountain and a hut constructed near the summit, but Mount Buller did not develop greatly as a resort until 1946.

The Mount Hotham snowfields have provided enjoyment for skiers from about 1925. Accommodation was available at Mount St. Bernard and Hotham Heights and subsequent development has been at Hotham Heights. The development of Falls Creek village was initiated during the 1940s, but it was not until the late 1950s that major development occurred.

Organized bushwalking in the study area began in the late 1890s. Large parties often used packhorses, particularly for walks lasting several days. The pastime had become well established by the 1920s and boomed in the early 1930s, only to lose many participants prior to the war.

Membership of clubs increased greatly after the war, however, and some clubs offered a range of other associated activities such as camping, orienteering, rock-climbing, and cross-country skiing.

The use of four-wheel-drive vehicles and trail bikes has increased rapidly within the last few years.

Fishing in the mountain streams has long been popular as a form of recreation. Trout acclimatization societies were active in Victoria in the 1870s. They introduced trout into various waters and these sporting fish spread rapidly into mountain streams. The use of streams in the study area for fishing is steadily increasing with easier access to the rivers and increased leisure time.

The development of some adventure sports such as canoeing is difficult to trace because those who value this type of recreation often do not seek any association with clubs.

Hydro-electric power

In 1911 the Victorian Hydro-electric Company was formed with the intention of harnessing the potential energy of water draining off the Bogong High Plains.

The development of the Yallourn power station took precedence, however, and it was not until 1938 that work began on the Kiewa Hydro-electric Scheme. After a delay during the war, the project was completed in 1961. Works include dwellings, roads and tracks, racelines, water storages, tunnels, power stations, and transmission lines.

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PART II

NATURE OF THE LAND

5. CLIMATE

Climate is the aggregation of atmospheric conditions involving heat, moisture, and air movement and may be described in terms of precipitation, temperature, humidity, wind, cloud, and fog. The study area is subject to the patterns of air mass movement and the succession of passing or locally generated pressure systems that influence eastern Victoria's weather. The interaction of these conditions with the topographic features of the alpine area modifies the prevailing conditions and results in a great diversity of climate within short distances.

Most of the study area is characterized by high precipitation, much of it falling as snow during winter. Some areas at low elevations, however, have relatively low annual rainfall.

Temperatures are usually lower than in most other parts of the State. Frosts may occur at any time of the year at the highest elevations, and the area is more subject to cloud and fog than surrounding lowlands. Relative humidities are generally higher than those of the inland and coastal plains. The study area contains only three recording stations for temperature and relatively few for rainfall. Rainfall data are especially lacking for the higher elevations.

Precipitation

Precipitation over the mountains may take the form of rain, mist, snow, or hail. This form depends on the level in the atmosphere at which the air temperature reaches freezing point. This level is generally 3,300--4,300 m in summer and therefore rain is the usual form of summer precipitation. In winter, however, the usual elevation range is between 1,500 and 2,500 m. Thus the higher parts of the alps receive much of their annual precipitation as snow, and in a normal winter snow accumulates from June until September. Regular falls occur down to 1,000 m, but at this elevation snow persists for a few days only.

The timing of snowfalls varies considerably, but two basic weather patterns may give the necessary low temperatures and precipitating cloud.

The first is a "southerly outbreak", which occurs when a large "high" centred south of the Great Australian Bight brings a cold southerly airstream from the Antarctic across the area. These southerly outbreaks occur irregularly, and may bring snow at any time of year. They are most important in early and late winter, when they may bring drastic weather changes.

The main winter snow, however, usually falls when a cold front moves in from the west. This westerly airstream may bring snow or rain - depending on elevation, temperature, and the activity of the front.

Snow usually falls faster than the snowfields melt until about the end of September, when the combined effects of high temperatures, wind, and increased sunshine begin the spring thaw. Sheltered sites sometimes carry snow until well into the summer.

Rainfall-recording stations in or near the study area are few, but Map 5 attempts to indicate rainfall distribution. This has been based on information presented in Appendix 1A, other records, and estimates using topography and vegetatiion as guides.

In winter, moist west to north-westerly airstreams, lifted by the north-western face of the highlands, deposit most of their moisture on the lower slopes to windward and on the higher elevations. Rain-shadows therefore occur on the lee side, such as around Benambra. Similar conditions apply in the south-west, where south-westerly airstreams are the main source of moisture in winter. In the south-east, the winds from that quarter associated with low-pressure systems located off the East Gippsland coast often bring rain, and these conditions may occur at any time throughout the year.

In summer, warm, moist, tropical air may sometimes penetrate as far south as Victoria and can bring heavy summer rains when atmospheric conditions are favourable. Thunderstorms caused by convection are another source of rain in summer. These occur erratically, but falls are often heavy and occasionally contribute to rainfall in rain-shadow areas.

Highest annual rainfalls occur around the Bogong uplands, averaging more than 2,000 mm. The higher elevations generally have rainfalls in excess of 1,200 mm. Rain-shadow areas at Benambra/Swifts Creek, at Wulgulmerang/Suggan Buggan, and in the main river valleys south of the Divide have annual averages of less than 700 mm. Appendix 1A presents records for selected stations.

Figures 1A and 1B depict average rainfall distribution throughout the year for ten stations. Relatively narrow valleys north of the Divide - represented by Jamieson, Harrietville, and Mitta Mitta - have rainfall peaks in winter with secondary peaks in spring. River valleys south of the Divide tend to have higher rainfalls in spring than during the rest of the year, as do the rain-shadow areas at Omeo and Wulgulmerang.

Appendix 1A tabulates the average annual rainfall for stations in and adjacent to the study area.

Rainfall variability is illustrated by Appendix 1B, which shows the 30, 50 (median), and 70 percentile ranges. This indicates for example, that Wulgulmerang has a low median rainfall with high variability, whereas Bindi has more reliable rainfalls although it normally receives a similar annual total.

FIGURE 1A

AVERAGE MONTHLY RAINFALL

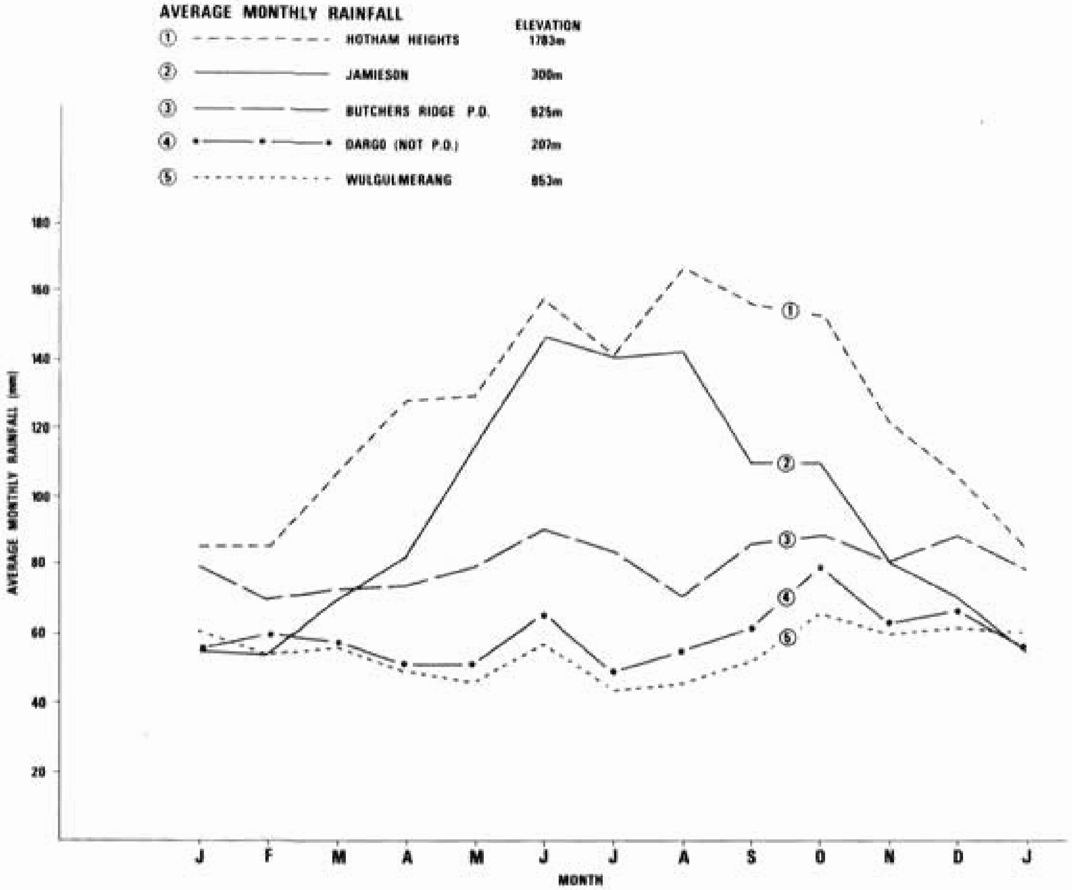


FIGURE 1B

AVERAGE MONTHLY RAINFALL

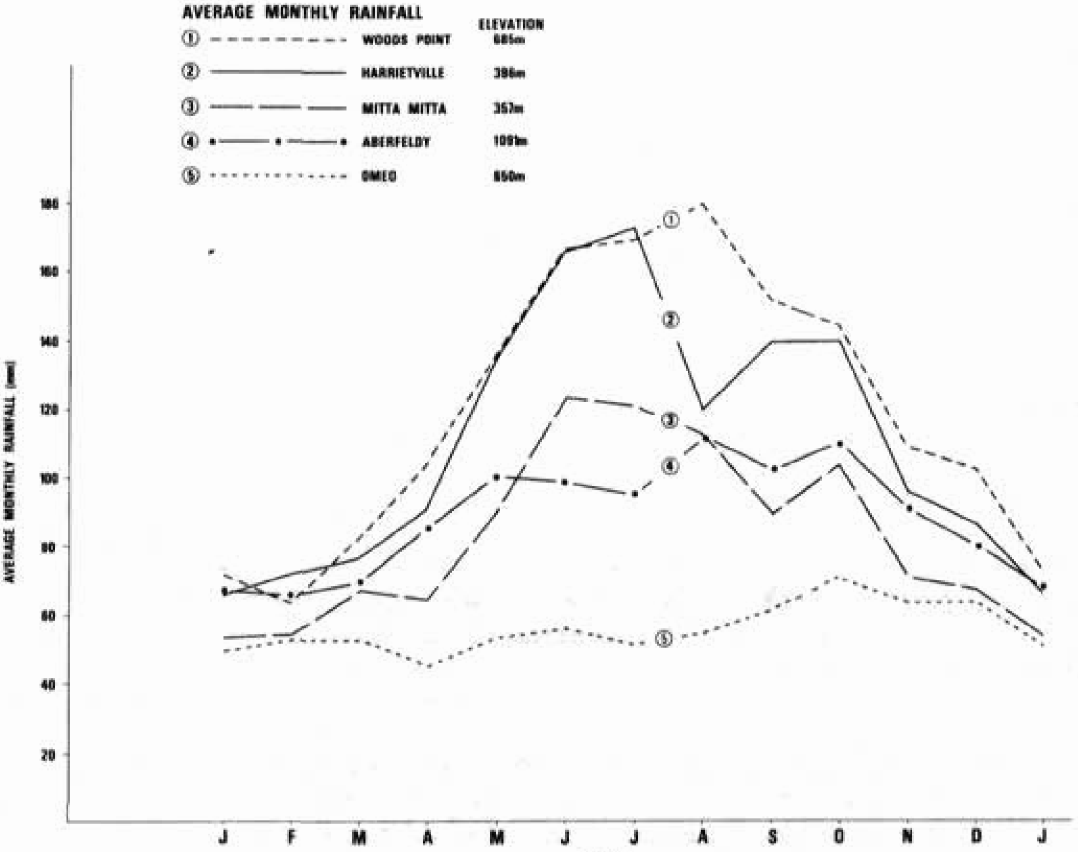
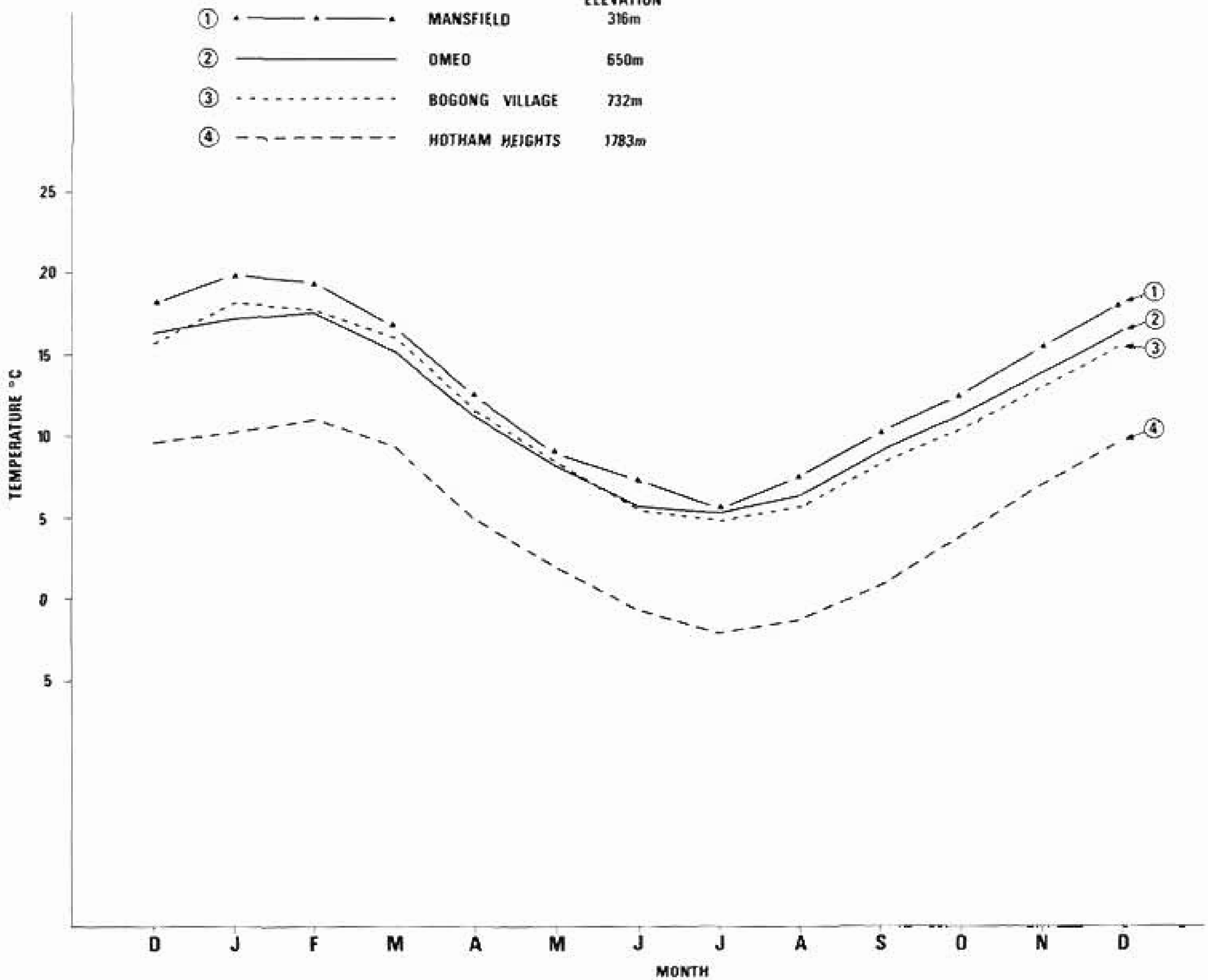


FIGURE 2

AVERAGE MONTHLY TEMPERATURE



Appendix 1C shows the average rain per wet day, which indicates the incidence of high-intensity storms during the year. Most stations have their highest values in February, or during the autumn. High-intensity storms when combined with snow-melt on already saturated catchments contribute to flooding.

Temperature

Temperatures recorded in and near the area are shown in Appendix 1D and illustrated in Figure 2.

Mean monthly temperatures are highest in January or February and lowest in July. In summer, they vary from about 19°C at the low elevations to about 10°C at the highest. During winter they vary from about 6°C at the lowest elevations to -2°C at the highest.

The decrease in maximum temperatures with elevation is not obvious below about 600 m, but above this there is a steady decrease of about 1°C per 100 m for unsaturated air. In summer, average day temperatures follow this trend. Available records indicate, however, that average summer night temperatures do not differ markedly with altitude change.

Extreme minimum temperatures in summer are much lower at high altitudes (for example -5.5°C in January at Hotham Heights), and even in the warmest months frost may occur at stations above 300 m. Frosts are common throughout the area, with average frost-free periods (i.e. the number of days between the first and last average dates on which temperatures of 2.2°C are recorded) of only 62 days at Omeo and as few as 13 days at Hotham Heights. July has the highest incidence of frost at these two stations.

Heavy frosts are most likely when the atmosphere is cool and dry with clear night skies and little or no wind.

Severe frosts may freeze the top layers of the soil unless it is protected by tall dense ground vegetation or an insulating layer of snow.

Local topography, as well as elevation, may affect minimum temperatures. For any given altitude, exposed places generally have higher minimum temperatures than enclosed valleys and basins, gullies, and saddles where cold air collects in "frost hollows". A minimum temperature of -10°C has been recorded at Omeo, which is situated in an enclosed basin at 650 m elevation.

In the cooler months of the year, blizzard conditions may bring sub-zero maximum daily temperatures for several days at a time and even as early as April extremely cold conditions may prevail for a few days.

In summer, monthly maxima vary from about 30°C at the lowest elevation to 15°C at the highest. Daily maxima may rise to about 40°C at low or mid elevations and less than 30°C at the highest. Days that are hot and dry at lower elevations are usually experienced as cooler but windier at high elevations. Appendix 1E shows meteorological data at 15.00 hours on selected days to illustrate the variation between adjacent high- and low-altitude stations - Mount Buller and Mansfield respectively.

In winter, monthly maxima vary from about 11°C at the lower elevations to 0°C at the highest. Daily maxima are generally experienced as cool to cold conditions, but mild day temperatures sometimes occur in the Omeo--Ensay region due to the Föhn effect, when northerly winds (after releasing rain in the north-eastern highlands) become warmer as they descend.

Humidity

During summer the relative humidity at 9.00 a.m. probably averages about 60--70% for much of the study area. Recordings for Omeo and Hotham Heights are 60% and 65% respectively. During winter it is considerably higher, averaging 86% and 90% respectively at these two stations.

Wind

The prevailing winds vary from north-westerlies to south-westerlies. Northerlies and southerlies become more common from spring through summer. Easterlies are rare.

Local topography can greatly affect wind direction and speed near the ground, where air may be funnelled through gaps or along narrow valleys. Down-valley winds can occur at night when skies are clear, due to the effects of radiational cooling and gravity. Up-valley winds can occur during the day, due to differential heating of the land surface. Wind velocities tend to be greater on the steeper slopes and ridges at the higher elevations where no protection by adjacent topography is afforded.

Clouds and fog

The mountain region is more subject to cloud and fog than the surrounding lowlands. Low cloud and fog can obscure peaks and upper valley slopes for a number of consecutive days. Valley fogs may develop from fairly calm moist air that is cooled by night-time radiation.

On some occasions cloudy conditions or fogs may prevail on one side of the Divide but not on the other. For example, air flow from the south may produce wet conditions south of the Divide yet fine clear conditions may prevail to the north. This happens because the conditions necessary for cloud formation are removed when the air, having lost some of its moisture, becomes warmer as it descends after crossing the Divide.

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6. PHYSIOGRAPHY

The study area lies in the Eastern Highlands, which form part of the Great Divide. The Divide is highest around the Cobberas range in the east, Mount Hotham in the central section, and Mount Howitt in the west. Its lowest points are at Tongio, Cassilis, and Jirnkee gaps near Omeo, the Barry Mountains east of the Viking, and a low gap to the east of Mount Sunday. Mount Bogong, the highest point in Victoria, is situated about 30 km to the north of the Divide.

Streams drain into the Murray system to the north and into the Gippsland Lakes to the south, with the exception of the Buchan and Snowy Rivers, which join and flow directly into the sea at Marlo. The drainage pattern in general reflects underlying rock structure - for example bedding strike in sedimentary rocks, jointing in volcanics and intrusive rocks, and foliation in schists and gneisses. In some cases faulting has influenced the stream pattern, as demonstrated by straight courses along sections of the West Kiewa Thrust, Indi, Haunted Stream, and Livingstone faults.

The land forms of the area may be divided into three main types: mountainous tracts, tablelands or plateaux, and basins. These are shown on Map 2. Elevations are indicated on Map 3.

Mountainous tracts

Mountainous tracts are the dominant land form of the area. They are typified by sharp-crested ridges and spurs that rise between deeply incised valleys. Relief between ridge tops and adjacent valleys commonly exceeds 500 m and may exceed 900 m. High isolated peaks are few, the best example being Mount Feathertop (altitude 1,922 m). Most summits are rounded and often form part of a high ridge.

Tablelands and plateaux

These are typically areas of gentle to moderate relief that are limited on at least one side by an abrupt descent to lower land.

Tablelands comprise a number of distinct plateau surfaces contained within the one unit - such as the Paw Paw Tablelands, named after Paw Paw plain, situated to the east of Mount Hotham.

Some tablelands and plateaux in the study area are surrounded by steep escarpments that descend to lower topography. Others, such as the Wulgulmerang Tablelands, have higher ranges rising from portions of their edges.

Tableland surfaces vary from undulating topography with a few protruding hills - such as Mounts Jim, Bundara, and Cope on the Bogong Tablelands and Mounts Reynard and Arbuckle on the Bennison Tablelands - to relatively flat topography such as occurs on the Dargo and Wulgulmerang Tablelands.

Some plateaux are capped by relicts of basalt, which at the time of extrusion filled broad flat valleys and undulating lowlands. The basalts may form tabular hills (such as Mount Tabletop), or stepped topography due either to differential erosion or to successive flows of basalt such as on the Nunniong Tablelands.

The most extensive surfaces are the Bennison, Dargo, Paw Paw, Bogong, Native Cat, Nunniong, and Wulgulmerang Tablelands. Some plateaux are little more than broad flat ridges such as the Hooker plateau at Mount Bogong and the plateau along Davies Plain Ridge.

The various tablelands and plateaux differ considerably in elevation. The highest have been referred to as high plains by geomorphologists, and these are mostly above 1,400 m.

Basins

A number of flat to undulating land forms have been collectively termed basins for convenience. They usually occur at the lower elevations and include alluviated valleys such as at Wonnangatta station and Tawonga or small intermontane basins as at Tom Groggin, Granite Flat, and Bindi.

Large basins around Omeo, Benambra, and Swifts Creek have been named the Livingstone, Morass, and Tambo basins respectively. The topography of the Livingstone basin consists mainly of rolling hills, whereas the Morass basin is relatively flat (particularly around Lake Omeo, near Benambra, and the river flats of Morass Creek). Both of these basins are in the Mitta Mitta catchment at an elevation of about 600--700 m, compared with the Tambo basin at Swifts Creek at an elevation of about 400--500 m.

The Moroka basin, at about 1,100--1,200 m, is the most extensive elevated basin.

Physiographic Evolution

The evolution of the present-day land surface can be traced back to the Mesozoic era, or perhaps even to the Permian, when prolonged erosion had reduced Victoria to an extensive tract of low relief, called the Baw Baw Surface.

Uplift, followed by prolonged erosion, occurred during the Mesozoic, and this cycle formed another extensive area of low relief, called the Kinglake Surface.

Remnants of the Baw Baw Surface stood above this as large plateaux and isolated hills, at elevations of more than 600 m above the general level of the Kinglake Surface. These remnants form the highest tracts of the study area and include the region around Mounts Buller and Howitt, the Feathertop--Hotham area, Mount Cobberas, and Bennison, Bogong, Paw Paw, and Nunniong Tablelands.

In the late Mesozoic, another period of uplift initiated a third cycle of erosion. This was interrupted in the Early

Tertiary period by extrusion of volcanic lavas. These lavas, termed Older Volcanics, flowed down many of the valleys cut into the Baw Baw and Kinglake Surfaces and have been preserved.

They provide a valuable insight into the Early Tertiary topography. We know, for instance, that the Bogong, Dargo, Paw Paw, and Wulgulmerang Tablelands all had a mature topography with wide, flat valleys. The basalt remnants in the ancestral Macalister, Buchan, and Snowy River valleys show that these streams were youthful in contrast to the previous regions, and were deeply incised into the Kinglake Surface.

Block faulting during the Middle Tertiary had a profound effect on the evolution of the modern drainage system. Before the faulting, the Great Divide followed a more-or-less straight course from the highlands of the Mount Buller--Mount Howitt area through to the Mount Hotham--Mount Bogong area, and thence probably to the Kosciusko region via Mount Gibbo. Streams draining the eastern slope of the Mount Hotham--Mount Bogong area formerly flowed into the south-flowing Tambo River via the Tongio and Cassilis gaps. Similarly, the Gibbo River--Morass Creek system flowed south into the Tambo via Lake Omeo and the Tongio gap.

This drainage pattern was interrupted by gradual faulting, accompanied by slight westward tilting, along the Livingstone fault. A complex series of stream captures took place towards the close of the faulting, and the entire northern and northwestern headwaters of the Tambo were captured by the Mitta Mitta River, which flowed north as it does now. As a result, the modern Great Divide does not follow the highest parts of the area, but crosses the floor of the former Tambo River valley at the Cassilis and Tongio gaps, both of which have elevations of less than 800 m.

Large-scale block faulting also occurred in the Mount Kosciusko area at some time in the Tertiary, but it is not known whether this has significantly altered the drainage pattern near the Cobberas.

Within the study area, erosion has continued without interruption from the Cretaceous period to the present day.

Remnants of the Baw Baw Surface form the highest tracts, and are in some cases preserved as extensive tablelands.

The resistant Older Volcanics form tablelands or plateaux with surfaces that steadily decrease in altitude along the line of the valleys that the lavas flowed down and filled. The Paw Paw, Dargo and Wulgulmerang Tablelands are good examples of this, but the slope of the former two has been accentuated by tilting. In other cases, basalt occurs as isolated hill-cappings; for instance at Mounts Loch, Higginbotham, Tabletop, and Useful.

Most of the basins have resulted from differential erosion and are situated in relatively soft, often deeply weathered, rocks.

The best examples of this are the Morass, Livingstone, and Tambo basins, all of which lie in relatively soft metamorphic rocks, and the small basin at Tom Groggin situated on granite.

Some basins are partly formed by faults or other deformation of the earth's crust. The Morass and Livingstone basins are partly of this tectonic origin, with the Livingstone fault scarp forming their western margins.

The Mount Beauty basin similarly is partly of tectonic origin, lying at the foot of the Tawonga fault scarp.

The very extensive flats at Benambra are due, at least in part, to the damming of Morass Creek by Late Tertiary basalts. Lake Omeo itself appears to have a tectonic origin, for its outlet at Benambra is blocked by a low ridge formed by uplift during faulting.

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7. GEOLOGY

The study area contains a number of major geological features. The Omeo metamorphics, which were formed more than 430 million years ago by the effects of heat and pressure on deeply buried Ordovician sediments, have been exposed in the central section of it after prolonged erosion (see Map 4).

These metamorphics extend between Ensay and Tawonga in a belt 35 km wide and have been intruded by younger granitic rocks.

To the west, they are flanked by a large area of Ordovician sediments that extends from north to south through the study area.

The outstanding feature to the west of the metamorphic belt and resting on these Ordovician sediments is a thick sequence of sedimentary rocks overlying basal volcanic rocks. Volcanic flows and pebbles, sands, silts, and muds deposited in fresh water filled a deep trough created by downfaulting more than 345 million years ago. These formed the rock sequence, which extends in a wide belt from the headwaters of the King River south to the Valencia Creek and Avon River watersheds.

East of the Omeo metamorphic belt, the main geological features have originated from igneous activity ranging from the time of metamorphism through to the Triassic period (220 million years ago). This has resulted in numerous granitic intrusions as well as thick piles of acid volcanics with associated sediments, which now outcrop in the Mitta Mitta River valley and from north of Mount Cobberas to far south of Gelantipy.

Table 2 sets out the geological history of the study area.

Geological History and Stratigraphy

The Cambrian and Ordovician rocks outcropping in the study area were deposited in an elongated sedimentary basin known as the Tasman Geosyncline, which extended down the eastern side of Australia.

Cambrian

The oldest rocks in the study area, the Howqua greenstones, outcrop in two thin belts near its western boundary, extending from the Howqua River to near Licola. The greenstones represent a phase of submarine igneous activity, in which dark green basi lavas were extruded onto the ocean floor. Associated with the lavas are fragmental volcanic rocks (tuffs, agglomerates), marin cherts, shales, and limestone.

A Cambrian age has been assigned to these greenstones, based on the presence within them of Middle Cambrian fossils preserved i a limestone lense at Dolodrook River.

Table 2

GEOLOGICAL HISTORY ALPINE STUDY AREA					
PERIOD OR EPOCH (Age - millions of years)			WESTERN SIDE	OMEO METAMORPHIC BELT	EASTERN SIDE
Quaternary	Recent Pleistocene	1.8 my	river captures and shift of main divide several phases of alluvial deposition		
				Newer Volcanics	
Tertiary	Pliocene	5 my	minor alluvial deposits		
	Miocene	22 my	further uplift and dissection		
	Oligocene	36 my	Older Volcanics		
	Eocene	65 my	lignite, deep-lead gravels, sand, brown coal, tuff		
			uplift and peneplanation		
Lower Triassic		210 my 225 my			Syenite intrusions at Benambra
			major unconformity		
			further folding movement		
Lower Carboniferous		320 my 345 my	AVON RIVER GROUP terrigenous siltstone, sandstone, conglomerate interbedded with acid volcanics and basalt		Mount Tambo beds terrigenous sediments, minor acid volcanics
Devonian	Upper		major unconformity		
			intrusion of granite, block-faulting, and folding		
	Lower--Middle		WENTWORTH GROUP siltstone, sandstone, conglomerate, limestone		BUCHAN GROUP marine limestone
					SNOWY RIVER VOLCANICS acid volcanics, terrigenous and marine sediments
			non deposition	strong folding movement - unconformity	
		359 my		intrusion of granite	
Silurian					WOMBAT CREEK GROUP conglomerate and sandstone, grading east to sandstone, shale, limestone, tuff
					Mitta Mitta Volcanics terrigenous acid volcanics
			strong folding movement		
				intrusion of granite	
		435 my		metamorphism to schist and gniess	
Ordovician		500 my	Wonnangatta beds trough sediments (includes Mount Useful beds in west)		
Cambrian		570 my	Howqua Greenstones, submarine basic volcanics and sediments		

In common with similar belts in other parts of Victoria, the greenstone belt is associated with major faulting and stratigraphic displacements. These movements, together with mild metamorphism, have altered some of the rocks to talcose schists and serpentine. The greenstones are strongly folded and usually bounded by faults.

Ordovician

For convenience, the Ordovician rocks outcropping in the study area are informally named the Wonnangatta beds. They are several thousand metres thick and consist of marine siltstone and silty shale with feldspathic sandstone, minor black shale, and rare chert bands.

The fossils preserved in these sediments indicate a Middle to Upper Ordovician age over most of the area of outcrop, with some Lower Ordovician in the Howqua--Licola area.

Intense earth movements towards the end of the Ordovician tightly folded and faulted these sediments. In the central part of the study area, immediately succeeding the folding, deeply buried Ordovician sediments were subjected to rising temperatures and pressures that resulted in the complete or partial reconstitution (regional metamorphism) of some of the sediments to form the *Omeo metamorphics*.

The metamorphism, where most intense, caused complete recrystallization of sediment to light-coloured crystalline gniess. Where it was less intense, the original rocks were altered to metamorphic rocks varying from low-grade phyllites through to high-grade schists.

On the eastern side of the metamorphic belt, Ordovician sediments grade into metamorphic rocks. On the western side, a massive shear zone exists, separating high-grade gniesses from normal Ordovician sediments to the west.

The area of the metamorphic belt is intruded by granitic rocks of various ages. Some granites contain foliations parallel to that in the main metamorphic belt, indicating intrusion before the effects of the regional metamorphism had completely waned. Other granites are structureless and thus younger, imposing thin contact aureoles on the regionally metamorphosed rocks.

Silurian

During the Silurian, the area east of the metamorphic belt began to react to earth movements quite differently from other parts of Victoria.

In this area, earth movements were expressed in the form of large faults that divided the area into a series of blocks. These blocks probably controlled Silurian sedimentation and were certainly active at the end of the Silurian.

Variations in both thickness of deposit and lithology suggest that various blocks behaved differently, sinking rapidly or slowly.

In the Mitta Mitta valley, a narrow graben (down-faulted block) contains thick Mitta Mitta volcanics, which were extruded over the land surface. These are unconformably overlain near Wombat Creek by marine sediments consisting of conglomerate, shale, sandstone, and limestone of the Wombat Creek group.

At Limestone Creek the Silurian is represented by marine siltstone, mudstone, minor limestone, and quartz sandstone.

The Mount Useful beds outcrop in the Howqua River--Licola area. They are shown as Silurian on Map 4, but are now believed to be Lower Ordovician in age. Lithogically and structurally they resemble the Middle to Upper Ordovician over most of the study area.

At the end of the Silurian, another period of deformation affected eastern Victoria. In contrast to that at the end of the Ordovician, this later deformation was largely expressed by major faulting. The thick Limestone Creek sequence was strongly folded, whereas the Wombat Creek sediments escaped strong folding because of the underlying massive rhyolites and conglomerates and instead were steeply tilted.

The presence of granite inclusions in the Mitta Mitta volcanics and that of granite pebbles in the Wombat Creek beds establish the presence of Lower Silurian granites in the study area. The Silurian sediments at Limestone Creek have been intruded and weakly metamorphosed by the Kosciusko granite, which also establishes the presence of Upper Silurian--Lower Devonian granites in the study area. Generally such direct age relations are not so clear and, in the absence of radiometric dating, the precise ages of many of the granites are unknown.

Lower--Middle Devonian

East of the metamorphic belt a cycle similar to that in the Silurian followed in the Lower to Middle Devonian.

At Limestone Creek the Silurian sediments and later granodiorite are unconformably overlain by the thick Snowy River volcanics that stretch from the Cobberas to the southern edge of the study area and beyond to Nowa Nowa. They consist of up to 3,000 m of rhyodacites and pyroclastic rock, with local interbedded non-marine conglomerate and sandstone.

Conformably overlying the Snowy River volcanics - in remnants preserved from erosion at Butchers Ridge, Bindi, and Limestone Creek - is the Buchan group, which consists of highly fossiliferous limestone, dolomite, and calcareous shale.

The Wentworth group occupies only a limited area of outcrop in the upper Wentworth River in the southern part of the study area. It is Lower Devonian in age - equivalent to the Buchan group - and consists of 1,300 metres of marine siltstone and sandstone with conglomerate, limestone and dolomite.

Upper Devonian--Lower Carboniferous

In the late Middle to early Upper Devonian, eastern and central Victoria were subjected to their last major deformation. In eastern Victoria, movement was largely absorbed by major fault lines, and in the thick Snowy River volcanics the major structures are broad open folds with strike faulting predominating.

Upper Devonian granites were emplaced in the Omeo metamorphics and Ordovician sedimentary rocks in the upper Mitta Mitta valley, and in Ordovician sedimentary rocks at Mirimbah and Mount Stirling.

With the whole of Victoria largely stabilized, thick non-marine sedimentation was initiated in and restricted to graben structures.

The Avon River group outcrops over a major portion of the western part of the study area, largely in the Macalister, Moroka, and Avon River watersheds. It consists mainly of fresh-water sediments concentrated in a sinking graben or cauldron structure. Relatively thin acid lavas and minor basalt were first extruded, to be followed by flood extrusions of rhyolite and rhyodacite, with local interbedded sediment, infilling the cauldron in stages to a thickness of 600 m. Conformably overlying the volcanics are 4,000 m of fluviatile conglomerates and characteristic finer-grained red beds, containing plant fossils and occasional fish remains.

North of Bindi the Buchan group is conformably overlain by the Mount Tambo beds, consisting of 3,500 metres of reddish shale and sandstone with one inter-bedded rhyolite flow. The Mount Tambo beds are believed to be Upper Devonian and equivalent in age to the basal section of the Avon River group in the west.

All these Upper Devonian-Lower Carboniferous rocks are gently deformed into broad open folds except at their margins in the western part of the study area, where faulting may cause locally steep dips.

Younger rocks

Apart from deep lead gravels (which are probably Eocene in age), and Recent, Pleistocene, and some Pliocene river gravels and lake deposits, no sediments in the study area are younger than Lower Carboniferous.

North and north-west of Benambra, trachyte lavas were extruded over the land surface during the Lower Triassic. These were later intruded by Lower Triassic granite porphyry and quartz syenite.

Basalt cappings up to 120 metres thick at various locations are Oligocene in age and are remnants of Older Volcanic flows. These may cover a layer of lignite, probably Eocene in age, up to 10 metres thick. The lignite overlies a basal section consisting of alluvial gravels and sands. These gravels and sands were gold-bearing where they thickened into a former river channel cut in the underlying Wonnangatta beds.

There is also a remnant of Newer Volcanics along Morass Creek north of Benambra.

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8. SOILS

The wide range of environments in the study area gives rise to great variation in soils. The soil-forming factors of climate, geology, topography, vegetation, and age of land surface all cover a wide range. Some indication of the distribution of soils and their relation to soil-forming factors is given in the Land Systems chapter.

Most of the soils covered in this section have been described in more detail in other Land Conservation Council reports (North-east District 1, North-east District 2, and North-east Districts 3, 4 and 5), or in bulletins published by the Soil Conservation Authority. The present terminology is that used in the soils information that accompanies the State Land System map.

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 their development is, in the main, 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 a sandy clay.

Duplex soils, on the other hand, change sharply to a clayey subsoil. The main distinguishing features of such soil groups are described in Table 3.

The text briefly describes soils of each group and indicates their pattern of distribution. Chapter 12 (Land Systems) relates soils to other features of the land. The glossary on page explains some of the terms in the descriptions.

Organic Soils

Peats

Peat soils consist of undecomposed and partly decomposed remains of bog and fen vegetation that accumulate under conditions of low temperatures and a consistently high water table. They may be a metre or more thick in well-developed bogs.

The upper horizons of bog peats are dominated by yellow to brown spongy remains of mosses. Fen peats, which are mainly formed from sedges, usually have brown and fibrous upper horizons. The underlying horizons, where decomposition is well advanced, are usually dark and greasy.

Peats can absorb a large quantity of water and release it slowly. They are acid to very acid, and the organic-matter content commonly exceeds 60% and may be up to 80% by weight.

Bog and fen peat soils commonly occur in wet depressions and are particularly common in gently sloping drainage lines in the alpine and sub-alpine tracts throughout the study area. Associated soils on better-drained areas are organic loams.

Dry peats

These soils occur as shallow accumulations of plant material derived from heathland vegetation. They are usually less than 30 cm deep and may overlie a thin layer of coarse non-organic material; shelving rock is usually present within about 30 cm.

Although not extensive, dry peats are important in such areas where shelving rock is common, as they absorb water during rain-storms and thus retard run-off.

Humified peats

These peats are black, friable, loamy, organic soils, generally still containing some fibrous material. Usually they have well-developed crumb structure, and may contain coarse sedimentary material. They may rest on gleyed sedimentary material or unweathered rock.

Humified peat soils are most common near entrenched streams in alpine and sub-alpine areas. The humification of the true peats to form these soils has apparently followed the lowering of the valley water table, which has resulted from entrenchment of the streams. In some areas there are also indications that humification may have resulted from climatic change. In these areas mature snow gums are growing in the humified peat soil.

Soil with Uniform Texture Profile

Stony loams

Rock fragments constitute a major part of the profile in this type. The small quantity of soil between the rock fragments has probably developed from the accumulation of wind-borne dust, minimal weathering of soft rock particles, and the decomposition of plant remains.

Although the soil may be relatively fertile, it has a low available-water capacity because of its shallowness and the high proportion of stones. During prolonged dry periods, moisture would be inadequate to support shallow-rooted plants. Trees and shrubs may be able to persist on the stony loam soils, because they develop extensive root systems in rock fissures and obtain moisture from well below the surface.

Table 3

SOIL GROUPS OF THE ALPINE STUDY AREA

Primary profile form (Northcote)	Other distinguishing features	Soil group	Synonyms and included soil types
I ORGANIC SOILS	Accumulation of plant debris below bog and fen vegetation	Peat soils (bog and fen peats)	peats
	Accumulation of plant debris from heathland vegetation	Dry peat soils	peats
	Decomposing bog, fen, or heathland peats; black, highly structured soil	Humified peat soils	humified peat
II UNIFORM SOILS UNIFORM TEXTURE THROUGHOUT	Coarse-textured:		
	- Predominantly stone fragments	Stony loam soils	lithosols, skeletal soil
	- Loams and clay loams with a high proportion of gravel	Gravelly loam soils	red earths
	- Coarse sandy loams on coarse-grained rocks	Coarse sand soils	granitic sandy loams
	- Sandy, often variably bedded alluvial deposits	Undifferentiated sand soils and undifferentiated loam soils	alluvial soils; regosols
	Medium-textured:		
	- Brown or grey loams and fine sandy loams on alluvium	Grey-brown loam soils	minimal prairie soils; meadow soils; alluvial brown earths
	- Highly organic well-structured soils from high areas	Shallow organic loam soils	alpine humus soils
		Organic loam soils	transitional alpine humus soils
	Fine-textured:		
	- Dark clays with well-developed structure; lime present in sub-soil	Dark, calcareous clay soils	black earths; chernozems
	- Dark clays with well-developed structure; lime absent	Dark cracking clay soils	prairie soils
	- Friable red clays on limestone	Red calcareous clay soils, fine structure	terra rossas

Table 3

SOIL GROUPS OF THE ALPINE STUDY AREA

Primary profile form (Northcote)	Other distinguishing features	Soil group	Synonyms and included soil types
III			
GRADATIONAL SOILS	Soils on stream alluvium:		
GRADUAL INCREASE IN CLAY WITH DEPTH	- Red	Red gradational soils, weak structure	red earths
	- Yellow-brown	Yellow gradational soils	alluvial brown earth; brown earth
	Soils with bleached sub-surface (A2) horizon:		
	- Red	Red gradational soils; stony red gradational soils	leptopodzols; minimal red podzolic soils
	- Yellow-brown	Yellow-brown gradational soils	Leptopodzols; minimal yellow podzolic soils
	Brown soils:		
	- Massive, hard	Massive gradational soils	leptopodzols; minimal podzolic soils
	- Strongly coloured; weakly to moderately structured, friable	Friable brown gradational soils	acid brown earths; cryptopodzols; brown mountain soils
	Red soils:		
	- On basalt	Red gradational soils on basalt	chocolate soils
	- On non-basaltic material, strongly structured; hard consistency	Red gradational soils, fine structure	red amphipodzols; krasnozemic soils
	- Moderately structured; friable	Friable red gradational soils	krasnozems; red amphipodzols
IV			
DUPLEX SOILS	Red subsoil, bleached subsurface horizon; acid throughout	Red duplex soils	red podzolic soils, red solodic soils; red-brown earths
SHARP INCREASE IN CLAY AT DEPTH	Yellow-brown subsoil, bleached subsurface horizon; acid or alkaline subsoils	Yellow sodic duplex soils, coarse structure; yellow duplex soils	yellow solodic soils; yellow podzolic soils

Stony loam soils are common on ridge tops and steep exposed slopes.

Gravelly loams

Although dominated by the gravel fraction, these soils have a binding matrix of loam or clay loam. They may have structure, but the abundance of gravel makes it difficult to see. The loamy matrix is usually porous.

Colours are commonly brown or red-brown, particularly in soils from well-drained sites in moderately high-rainfall areas.

Some pale brown or even grey-brown forms may be found where the site tends to be poorly drained, but these are not as common.

Gravelly loam soils are formed in colluvial deposits usually at the base of long steep slopes - for example where mountain slopes intersect or where steep slopes meet gentle valley-floor slopes. They may be very deep. Although not extensive in area, they are relatively common in the situations described above.

Because of the mixture of abundant gravel with some binding fine material, these soils are sought-after for roadmaking or surfacing material.

Coarse sands

These are common soils on the slopes of granitic areas. They have a uniform texture profile that is dominated by the coarse-textured material, mainly quartz, but felspar may also be an important constituent. Although a slight increase in clay content may be revealed by particle-size analysis, this is usually masked by the dominance of the coarse components in field textures.

A typical coarse sand would have about 10 cm of brown to dark-brown coarse sandy loam with weak coherence, which lacks structure. This gradually changes to a lighter-coloured but otherwise similar horizon that may extend to 30 cm.

Below this depth the colour may gradually change to strong brown or yellow-brown, but with no appreciable change in texture, structure, or consistence. Weathered rock usually occurs at less than 1.5 m depth on slope soils, but profile depths of greater than 2 metres occur in deposits at the base of steep slopes.

They are moderately acid soils and, although they contain abundant primary minerals, their lack of colloidal material probably gives them a relatively low nutrient status. Furthermore, their coarse texture also results in a low availability of moisture, and this is the dominant factor affecting their suitability for plant growth.

Coarse sands have a high ability to absorb run-off, but drain rapidly. They may play an important part in the hydrologic cycle of granitic areas that typically produce prolonged seepage, often in the form of highly reliable springs.

Undifferentiated sands and loams

Such soils consist of the relatively recent sediments that accumulate at the margins of most streams. They may also occur as alluvial fans of recent origin. They typically lack any profile development, except for darkening by organic material near the surface.

Textures may vary from silty loam to sand, or even include clays and gravels. Within a single profile, abrupt changes in texture may exist as a result of current-bedding, but texture variation produced by other soil-forming processes has not occurred.

Grey-brown loams

Soils of this group usually have a dark and strongly structured surface. Below about 10 cm, however, colours are lighter and the soils usually have a weakly developed prismatic structure. They become hard as they dry out.

They are formed on alluvium and generally have a uniform texture profile. Nevertheless, as they are relatively young soils, there may be changes in texture related to the sedimentary bedding, particularly in the lower part of the profile. Because they occur in a relatively low topographic setting, they are often associated with a fluctuating water table, which causes gleying of the subsoil.

Organic loams; shallow organic loams

These soils predominate in alpine and sub-alpine environments, sometimes descending into montane tracts where annual precipitation is greater than 1,500 mm, winter snow is persistent or lies for several days after snowfalls, and average annual temperatures range from about 4.5° to $6.5^{\circ}C$. They are typical of moist but well-drained slopes.

Two forms are recognized. Shallow organic loam soils have a thick organo-mineral surface horizon directly overlying weathered parent material or bedrock, usually at depths of less than 1 m. The organic loams have a similar surface horizon, but also have a well-weathered, non-organic loam or clay loam subsoil. These soils may be a metre or more deep above the weathered parent material.

The shallow forms are commonly associated with tussock grassland, heathland, herbfield, and snow gum woodland. The deeper forms are found under snow gum woodland, snow gum--mountain gum forests, and the upper range of the alpine ash forests.

Organic loam soils have a strongly developed crumb to granular structure, loose to friable consistence, and high porosity in the upper horizon. The organic matter content may be up to 25% in the surface 15 cm. These soils are very acid with low fertility and much of the nutrient content is associated with the surface few centimentres. They have high macroporosity and generally high infiltration capacity.

When dry, topsoils become very light and friable. If a complete vegetative cover is not maintained, they are readily eroded, particularly by the strong winds that are common in the high mountains where these soils occur.

Dark calcareous clays

These black or dark brown clay soils have a self-mulching surface and lime in the subsoil. They have usually formed on fine-textured alluvium, and are often quite deep. In the study area, their main occurrences are on the Lake Omeo flats and parts of the Morass Creek flats, both of which are areas of restricted drainage. A brown variant occurs on the lunette of Lake Omeo.

Dark cracking clays

This group comprises dark brown or black friable clays or clay loams that have a well-developed fine structure in the surface but become grey, more plastic, and coarser-structured with depth. They are typical of creek flats and low terraces.

Red calcareous clays, fine structure

These are generally relatively shallow soils, formed on limestone, with rock at less than about half a metre. Their characteristic features are strong red-brown colour, well-developed fine structure, and friable consistence. Because these soils occur only on limestone, they are of limited extent within the study area.

Soils with Gradational Texture Profile

Red gradational soils, weak structure

These soils of the alluvial deposits are red-brown loams to clay loams with little structural organization. A typical profile shows a few centimetres of brown fine sandy loam, grading into a red-brown loam to sandy loam that becomes a little more strongly coloured, and of slightly heavier texture, with depth.

The whole profile is friable and porous, and there is little development of secondary organization.

They are mildly leached and appear to be moderately fertile, but are more notable for their good physical properties.

They may be slightly superior to the red gradational soils in their ability to retain moisture available for plant growth.

These soils are typical of the outflow areas from small catchments and alluvial fans. They also occur in the terrace sequence and sporadically on the plains.

Yellow gradational soils

The gradational texture profile of these soils is usually well developed, although on the coarser sediments it may not be as obvious. The texture ranges from loam or sandy loam in the surface to light clay in the subsoil at between about 30 and 80 cm, where moderate structure may be developed. Below this, the texture becomes less clayey and the structure becomes less well developed.

The subsurface horizon is usually moderately bleached and the colour in the subsoil may be strong brown, although more yellow colours are usual.

These are moderately acid soils with fairly high natural fertility. They are relatively common on mid-level stream terraces. This land form is limited in extent in the study area, however.

Red and stony red gradational soils

Soils of this group and those of the next combine some of the features of the friable red gradational soils and the massive gradational soils. They have a weakly structured subsoil, which has a hard consistency when dry. The sub-surface horizon is weakly bleached. Profiles are seldom deep, and may overlie well-structured red clay, which appears to be a truncated relic of an earlier soil, or weathered rock.

Stony red gradational soils are typical of the alluvial fans of intermediate size on the valley-side slopes, and may also occur on the steeper slopes of residual hills or lower-elevation montane slopes.

Both groups are moderately acid throughout and of moderate natural fertility.

Yellow-brown gradational soils

While similar to those of the previous group, soils of this type have subsoils in which the dominant colour is yellow-brown. They are less well-drained and are usually less acid than the red forms. Because they occur in the lower topographic positions on the alluvial fans of the valley-floor slopes, they may be more fertile than the red more-freely draining group.

Massive gradational soils

Texture in these soils gradually increases from loam or sandy loam in the surface, to clay loam, sandy clay loam, or light clay in the subsoil at about half a metre, below which the clay content decreases fairly rapidly. Colours range from dark brown in the surface to yellow-brown or pale brown in the sub-surface horizon, to brown, yellow-brown, or yellow-red in the subsoil. The colour and texture changes are usually gradual, but may not coincide.

Except for the surface few centimentres, where concentrated biological activity maintains moderate structure, the profile has poor structure or none at all, and sets hard when dry. The soils have abundant visible pores resembling pinholes.

Wide variations from the typical profile occur, particularly in colour and texture. On poorly drained sites, subsoil colours are mottled and there may even be a gley horizon. On better-drained sites, colours are more red. The depth of the surface soil is greater where textures are coarse.

Relic horizons of highly structured red clays, typical of the red duplex soils, are sometimes found beneath these soils.

The massive gradational soils are usually found on transported material such as alluvial fans and terraces. On the steeper slopes, soils of this group may occur with the stony loams.

They are generally moderately acid and have moderate to low natural fertility.

Friable brown gradational soils

This soil group is extensive in the high-rainfall montane regions of the study area at elevations ranging between about 600 and 1,200 metres. Rainfall here ranges from 900 mm to 1,300 mm or more, and winter snow may be occasional to common but not persistent. The soils intergrade between organic loams and the friable red gradational soils, or red gradational soils.

The typical soil in the higher-rainfall zone has a thin litter layer overlying a very dark brown to black organic loam 10--20 cm thick, very porous, and with strong crumb structure. In the underlying horizons, the influence of organic matter diminishes with depth and the structure is less-well developed. Colour becomes strong brown then yellow-brown or red-brown, depending on the nature of the parent material; porosity decreases, although consistence remains friable throughout. Soil depth is usually more than 1 metre, but profiles on steep slopes may contain numerous rock fragments that become more abundant with depth.

In lower-rainfall areas and at lower elevations, the soils have less organic matter, structure is not as strongly developed, and consistence is firmer. Soil depth is more variable, with the shallow forms being more common. The profile may contain large proportions of rock fragments. These soils are acid to very acid, with moderate to low natural fertility. They have relatively high moisture-storage capacities and are very permeable.

Red gradational soils on basalt

Finely structured, dark brown loam--clay loam at the surface becomes moderately to well-structured strong red-brown clay loam to light clay with depth. Darker brown colours persist into the subsoil at the upper end of the elevation range. The soils are acid throughout and usually have higher-than-normal levels of phosphorus and calcium.

These are characteristic soils of basalt parent material at intermediate and lower elevations. Although they are usually deeply weathered, rounded pieces of unweathered basalt occur within the profile.

In areas where these red forms predominate, soils of less well-drained sites resemble yellow gradational soils.

Red gradational soils, fine structure

In colour and texture profile, these resemble the friable red gradational soils but the subsoil is more strongly developed to form a very fine sub-angular--blocky structure. The natural structural units have shiny surfaces, and the consistence is hard when the soil is dry. Yellow forms occur where drainage is restricted.

They are usually associated with areas of low relief and may be soils of an earlier weathering cycle. Stumps of red clay of the type occurring in the subsoil are sometimes found beneath less-strongly differentiated soils, such as the massive gradational soils.

Friable red gradational soils

The dominant features of these soils are a dark brown loamy surface, grading through more yellow-brown loam or clay loam to the dark red or red-brown light-clay subsoil. Structure is moderate in the surface but declines in the sub-surface and is usually moderately well developed in the subsoil. The soils are moderately porous and are friable throughout. The profile depth may be as much as 3 metres in old alluvium or colluvium, but usually weathering rock is encountered within little more than a metre.

These soils attain dominance on most siliceous rocks in areas where annual rainfall is about 1,000 mm and slopes drain freely without being steep. Occasionally yellow forms occur on less-well drained sites within areas of these soils. They are acid to very acid, and of generally moderate to low natural fertility.

Soils with Duplex Texture Profile

Red duplex

Red duplex soils predominate on valley slopes and rolling topography where rainfall is less than about 1,000 mm. They usually have a poorly structured to structureless topsoil, which sets hard when dry. The red subsoil is typically a well-structured clay that is compact and has relatively low porosity. The boundary between topsoil and subsoil is relatively sharp, and soil profiles are acid throughout. They have moderate surface permeability and moderate sub-surface drainage.

Yellow sodic duplex soils, coarse structure; yellow duplex soils

The yellow-brown subsoil clay and the contrast in texture are major distinguishing features of these soils. Sodic duplex soils have a very distinct boundary between the pale loam sub-surface horizon and the strongly coloured heavy clay subsoil. Small ironstone concretions may be present at the boundary.

The subsoil clay shrinks as it dries and expands on wetting. The surface of such soils is commonly very irregular; when the subsoil is wet it acts as an impermeable layer and the surface soil becomes saturated during wet weather.

Yellow duplex soils have a less distinct change between the paler loamy sub-surface horizon and the clay subsoil. The transition zone may be as much as 10 cm thick and the subsoil clay does not expand and shrink appreciably. These soils are more permeable than the former group, but are not as well drained as the red duplex soils.

Both forms have acid surface soils; subsoils of either may be only mildly acid or alkaline. In areas where drainage concentrates, these soils may even have free lime in the subsoil.

Soils of the sodic group occur occasionally on broad ridgetops to the south of Omeo. They are not common in the study area. Yellow duplex soils occur in lowland areas where soil drainage is rather impeded. They also occur on rolling topography around Omeo and Benambra.

Explanation of Some Terms

Structure: the arrangement of soil particles in undisturbed soil. Naturally occurring aggregates vary in their strength of development from "massive" where no natural aggregates are apparent, through "weak" and "moderate", to "strong" where discrete aggregates are obvious in the undisturbed soil. The aggregates are described in terms of size and shape.

Consistence: a qualitative evaluation of the mechanical strength of soil fragments and the way they break when squeezed between thumb and fingers.

Gley: grey and blue-green mottled colouration, which develops in soils subject to periodic saturation.

Self-mulching: occurs when clay soils break up into small aggregates as they dry out.

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9. VEGETATION

The natural vegetation of an area is determined largely by the physical factors of the site - climate, topography, and soils and their parent materials. Factors such as fire and grazing, however, can alter vegetation structure, particularly the characteristics of the lower strata, and may also alter the relative abundance of plant species.

The major environmental factors that influence vegetation vary greatly in the study area. This is reflected in the fact that more than one-third (24) of the 62 major vegetation alliances tabulated for Victoria by Frankenberg are represented here.

Approximately 1,050 native flowering plant and fern species have been reliably recorded for the Alpine study area. These include 92 grasses (family Gramineae), 64 sedges (family Cyperaceae), 24 rushes (family Juncaceae), 79 orchids (family Orchidaceae), 34 wattles (genus *Acacia*), 38 eucalypts (genus *Eucalyptus*), 22 beard-heaths (genus *Leucopogon*), and 18 buttercups (genus *Ranunculus*).

Scientific names of plants mentioned in the text, together with the appropriate common names, are listed in Appendix 2A.

Most of the flora is typical of the north-eastern Highlands, but some foothill forests on the southern fringe are typical of silvertop and stringybark forests found elsewhere in Gippsland.

The far south-eastern section of the study area supports plants typical of East Gippsland "jungle" gullies.

Cool, wet, southern elements, typical of Tasmania, are represented by southern sassafras gullies in the east of the study area and by mountain ash forests distributed at numerous localities in the southern section.

Species in the dry and warm Snowy River valley are typical of the plains and foothills on the inland side of the Great Dividing Range. They include white cypress pine, white box, and kurrajong.

The flora includes about 150 plant species that have been introduced into the study area - some from the time of early exploration and settlement. Those that are considered to be pest plants are discussed in chapter 13.

Importance of vegetation

Natural vegetation is particularly important when considering possible uses of land. It integrates and quite sensitively reflects subtle changes in environmental factors. For this reason, and because its main components can be readily seen and mapped in the field or from aerial photos, it provides a very convenient way of assessing site factors that, by themselves, would be hard to measure directly.

Moreover, the vegetation itself often provides for many of Man's needs such as timber and recreation, protects other values such as soil stability and water quality and yield, provides habitats for animals, and constitutes a major part of what we regard as scenery, naturalness, or wilderness.

Classification

Because of its diversity, only a broad description of the vegetation can be presented here. More detail - especially on the floristics of the vegetation - appears in the block descriptions. As in previous reports, the vegetation has been classified into a number of structural forms based on the height and form of the tallest stratum and on the percentage of projective foliage cover (see Table 4). Table 5 lists the native vegetation units, and their distribution on public land is shown on Map 6.

The classification is based on that developed by Specht, but has been modified to better describe the particular vegetation of the study area, to enable use of the data available, and to meet land-use planning objectives.

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. Each unit is readily recognized in the field and reflects the operation of a certain set of environmental factors.

Additional floristic information - from a sample of 193 plots distributed in different localities and environments in the study area - was collected and analysed by the Zurich--Montpellier system. This system groups similar stands, using floristic similarity as a criterion. Information obtained from other comprehensive vegetation surveys has also been incorporated in the vegetation descriptions. The floristics are treated in the block descriptions.

Vegetation Units

The main vegetation units for each mapping category are briefly described below.

Alpine and sub-alpine open areas

This type embraces a mosaic of structural forms that, in alpine environments, include dwarf herbfield and heathland and short herbfield. Tall herbfield, grassland, dry, moist, and wet heathlands, mossland (bog), and sedgeland (fen) are common to both alpine and sub-alpine environments.

Table 4

STRUCTURAL FORMS (ALPINE STUDY AREA)

Life form and height of tallest stratum	Projective foliage cover of tallest stratum*		
	Dense (70-100%)	Mid-dense (30-70%)	Sparse (10-30%)
Trees >40 m		Open forest IV	
Trees 28--40 m		Open forest III	
Trees 15--28 m		Open forest II	Woodland II
Trees 5--15 m	Closed forest I	Open forest I	Woodland I
Shrubs 2--8 m	Closed scrubland	Open scrubland	
Shrubs 0--2 m	Closed heathland	Open heathland	
Herbs (including mosses, sedges, lichens, forbs, grasses	Closed mossland Closed grassland Closed herbfield Closed sedgeland	Open mossland Open grassland Open herbfield Open sedgeland	

*Percentage of the area covered by foliage as measured by a vertical point quadrat technique. It is not the same as crown cover.

Table 5

VEGETATION UNITS

Structural Form		Major Species of Tallest Stratum	Associated Species of Tallest Stratum	Lower Strata	Common Species of Lower Strata
ALPINE AND SUB-ALPINE OPEN AREAS	Dwarf herbfield, heathland	Silver ewartia, hoary sunray, snow heath	Twin flower knawel, alpine stackhousia, carpet heath		
	Short herbfield	Alpine wallaby grass, leafy daisy, white purslane	Sedge (Carex hebes), star plantain, alpine tuft-rush, bristle-grass	Ground	Mud pratia, mauve leek-orchid, alpine marsh marigold
	Tall herbfield	Silver daisy, orange everlasting, mountain gentian, snow grass, yam-daisy, hoary sunray	Scaly buttons, Australian buttercup, variable groundsel, mountain woodruff, sedges, glacial eyebright, alpine podolepis, mountain plantain	Ground	Ivy goodenia, silver cudweed, sky lily
	Grassland	Snow grass	Yam-daisy, sedges (Carex hebes, C. breviculmis), mountain woodruff	Ground	Ivy-leaf violet
	Dry heathland	Alpine wattle, alpine westringia	Mountain needlewood, dagger wattle, small crowea, carpet heath	Ground	Bulbine lily
	Moist heathland	Rusty pods, alpine grevillea, alpine oxylobium, alpine mint bush, alpine phebalium, leafy bossiaea, myrtle tea-tree	Alpine orites, tree violet, common oxylobium, mountain plum pine, alpine star-bush, tall rice-flower, alpine pepper	Ground	Silver daisy, snow grass, common raspwort, scaly buttons, grass trigger-plant, sky lily
	Wet heathland	Alpine baeckea, alpine bottle-brush, drumstick heath, thyme heath, swamp heath, myrtle tea-tree	Snow heath, yellow kunzea, small-fruit hakea, coral heath	Ground	Creeping fan-flower, variable willow-herb, alpine water-fern
	Mossland	Sphagnum moss, candle heath, spreading rope-rush, alpine tuft-rush, fan tuft-rush	Alpine baeckea, mountain baeckea, alpine bottle brush, coral heath	Ground	Bog buttercup, dwarf buttercup, silver astelia, alpine leek-orchid, pale sundew, white purslane, Gunn's willow-herb
	Sedgeland	Tall sedge, tall spike-rush, austral rush	Other sedges, rushes	Ground	Mud pratia
SUB-ALPINE WOODLAND, SCRUBLAND AND OPEN FOREST I		Snow gum (white sallee)	Black sallee, ash mallee, spinning gum, mountain gum, candlebark	Ground	Snow grass, slender tussock-grass, ivy-leaf violet, showy violet, granite buttercup, prickly starwort, mountain woodruff, bidgee-widgee, mountain cotula, Australian carraway, silver daisy, glacial eyebright, hoary sunray, ivy goodenia, creamy stackhousia, grass trigger-plant, variable groundsel, pale vanilla-lily, common billy-buttons, purple eyebright, common raspwort, slender rice-flower
SUB-ALPINE TO MONTANE OPEN FOREST II		Mountain gum, snow gum	Candlebark, broad-leaf peppermint	Shrub	Alpine oxylobium, alpine phebalium, rusty pods, leafy bossiaea, alpine pepper, alpine mint bush, mountain beard-heath, rough coprosma, gorse bitter-pea, prickly bush-pea, mountain hickory wattle, dusty daisy-bush, silky daisy bush, royal grevillea, tall rice-flower, derwent speedwell, elderberry panax, cascade everlasting, sticky everlasting, clustered everlasting, tasman flax-lily, mother shield-fern, common oxylobium, pink beard-heath, prickly broom-heath, honey-pots, dwarf geebung, guinea flower
SUB-ALPINE WOODLAND TO OPEN FOREST I		Black sallee	Mountain swamp gum	Ground Shrub Small tree	Common wheat-grass, common bog-rush, tall sedge, variable willow-herb, creeping cudweed, kidney weed, twin-flower knawel, showy violet, scaly buttons, mountain plantain, bidgee-widgee, mountain woodruff, alpine water-fern, sedges, mountain cotula, ivy-leaf violet, stinking pennywort, common lagenophora, small-flower mat-rush, prickly starwort, grass trigger-plant, ivy-leaf goodenia, alpine trachymene Rosy baeckea, mountain beard-heath, dusty daisy-bush, alpine oxylobium, common oxylobium, slender rice-flower, alpine pepper, silver wattle, leafy bossiaea, small-fruit hakea, coral heath, mountain mirbelia Mountain tea-tree
OPEN FOREST IV		Alpine ash	Mountain gum	Ground Shrub Small tree	Snow grass, tussock grass, slender tussock grass, hedgehog grass, common wheat-grass, ivy-leaf violet, showy violet, prickly starwort, bidgee-widgee, common lagenophora, pale vanilla-lily, tasman flax-lily, scrub nettle, forest mint, hairy pennywort, Australian carraway, tall bluebell, royal bluebell, crane's-bill, orange everlasting Rough coprosma, prickly currant-bush, hop bitter-pea, mountain beard-heath, mountain pepper, dusty daisy-bush, sticky everlasting, elderberry panax, common cassinia, derwent speedwell, prickly bush-pea, forest clematis, small-leaf bramble, mother shield-fern, fish bone water-fern Silver wattle, tree lomatia, mountain hickory wattle, mountain correa, hazel pomaderris, mountain tea-tree, soft tree-fern
		Shining gum, mountain ash	Manna gum, alpine ash	Ground Shrub Small tree	Giant mountain grass, prickly starwort, forest starwort, bidgee-widgee, forest pennywort, crane's bill, scrub nettle, shade nettle Rough coprosma, white elderberry, derwent speedwell, prickly bush-pea, Australian clematis, forest clematis, mother shield-fern, bat's-wing fern, hard water-fern, fishbone water-fern, spreading fan-fern Silver wattle, tree lomatia, stinkwood, mountain correa, hazel pomaderris, sassafras, musk daisy-bush, blanket-leaf, Victorian christmas-bush, soft tree-fern, rough tree-fern
OPEN FOREST III		Mountain gum	Candlebark, alpine ash	Ground Shrub Small tree	Tussock grass, common wheat-grass, hedgehog grass, kangaroo grass, tall bluebell, austral bugle, ivy-leaf violet, showy violet, prickly starwort, forest starwort, prickly woodruff, mountain woodruff, black-anther flax-lily, pale vanilla-lily, grass trigger-plant, pink-bells, common lagenophora, common raspwort, stinking pennywort, austral bear's ear, sheep's burr, bidgee-widgee, austral crane's-bill, smooth nettle, scrub nettle, forest mint, honey-pots Hop bitter-pea, prickly bush-pea, rough coprosma, prickly currant-bush, gorse bitter-pea, mountain beard-heath, shining cassinia, common cassinia, tough rice-flower, elderberry panax, handsome flat-pea, white elderberry, small-leaf bramble, mother shield-fern, austral bracken, common ground-fern, fishbone water-fern Silver wattle, narrow-leaf wattle, varnish wattle, cherry ballart, hazel, mountain correa, river lomatia, tree lomatia, prickly tea tree, Victorian christmas-bush, snowy daisy-bush, blanket-leaf, musk daisy-bush, austral mulberry, blackwood, soft tree fern
		Messmate stringybark	Manna gum, narrow leaf peppermint, mountain grey gum		
		Narrow-leaf peppermint	Manna gum, messmate stringybark, candlebark, eurabbie, yellow stringybark		
		Manna gum	Narrow-leaf peppermint		
		Silvertop	White stringybark	Ground Shrub Small tree	Tussock grass Prickly bush-pea, box-leaf bitter-pea, sunshine wattle, handsome flat-pea, gorse bitter-pea Mountain hickory wattle, cherry ballart
OPEN FOREST II		Broad-leaf peppermint	Brittle-gum, candlebark, mountain gum, long-leaf box	Ground Shrub Small tree	Tussock grasses, silvertop wallaby-grass, kangaroo grass, slender wallaby-grass, forest woodruff, pink-bells, heath pink-bells, common raspwort, bidgee-widgee, austral bugle, creeping cudweed, variable plantain, solenogyne, dwarf geebung, grass trigger-plant, honey-pots, diggers' speedwell, matted bossiaea Twin flower, beard-heath, twining glycine, common beard-heath, red-stem wattle, gorse bitter-pea, narrow-leaf bitter-pea, prickly bush-pea, hop bitter-pea, small leaf parrot-pea, prickly broom-heath, daphne heath, common heath, woolly grevillea, mountain banksia, silver banksia, leafless sour-bush, handsome flat-pea, purple coral-pea, holly lomatia, cluster flower geebung, spiny headed mat-rush, silky daisy-bush, box-leaf wattle, pale-fruit ballart, dwarf sour bush, mountain milkwort, austral bracken, shining cassinia, blunt-leaf guinea flower Silver wattle, mountain hickory wattle
		Red stringybark, broad-leaf peppermint	Long-leaf box, brittle gum, candlebark		
		Red stringybark	Long-leaf box, red box, brittle gum		
		Silvertop	White stringybark, red stringybark, broad-leaf peppermint	Shrub Small tree	Heath pink-bells, narrow-leaf bitter-pea, box-leaf bitter-pea, gorse bitter-pea, prickly bush-pea, handsome flat-pea, austral bracken, holly lomatia, shining cassinia, sunshine wattle Mountain hickory wattle, narrow-leaf wattle, prickly tea-tree
OPEN FOREST I		Broad leaf peppermint	Brittle gum, candlebark	Ground Shrub Small tree	Tussock grass, kangaroo grass, bidgee-widgee, forest woodruff, common raspwort, grass trigger-plant, matted bossiaea, dwarf geebung, honey-pots, ploughshare wattle, heath pink-bells Derwent speedwell, cluster flower geebung, common heath, daphne heath, prickly broom-heath, common beard-heath, gorse bitter-pea, hop bitter-pea, narrow-leaf bitter-pea, purple coral-pea, handsome flat-pea, small leaf parrot-pea, prickly bush-pea, woolly grevillea, slender dodder laurel, silky guinea flower, mountain milkwort, spiny headed mat-rush, pale fruit ballart, mountain banksia, box-leaf wattle Silver wattle, cherry ballart
		Red stringybark	Long-leaf box	Ground Shrub Small tree	Kangaroo grass, common wheat-grass, wallaby-grass, bidgee-widgee, austral bear's-ear, slender tick-trefoil, kidney weed, solenogyne, honey-pots, diggers' speedwell Cat's claws, daphne heath, blunt-leaf guinea flower, common beard-heath, shining cassinia, common correa, fringe-myrtle, wedge-leaf hop bush, hedge wattle, varnish wattle, golden wattle, drooping mistletoe, silver banksia, sweet bursaria Drooping sheoak
		Red box	Yellow box, long-leaf box, but but, red stringybark		
		Silvertop	Red stringybark, brittle gum, red box, broad-leaf peppermint, long-leaf box	Ground Shrub	Kangaroo grass Narrow-leaf bitter pea, daphne heath, spiny headed mat-rush, sunshine wattle
WOODLAND AND OPEN FOREST II		Mountain swamp gum	Candlebark, black sallee	Ground Shrub	Mountain plantain, self heal, scaly buttons, carraway, Gunn's willow herb, common billy buttons, pale vanilla-lily, tussock grass Alpine bottle-brush, small-fruit hakea, mountain baeckea, snow heath, common bog-rush, [illegible]
WOODLAND AND OPEN FOREST I		White box	Black cypress pine, white cypress pine, long leaf box, yellow box	Ground Shrub Small tree	Kangaroo grass, bent grasses, tussock grasses, cane wire-grass, cranberry heath Daphne heath, urn heath, common correa, small leaved clematis, shrubby platysace, grey everlasting, burgan, snowy river wattle, boomerang wattle, golden wattle, sickle fern, variable sword sedge, pepper everlasting Rock wax flower
		Black cypress pine, white cypress pine	White box, long-leaf box		

The largest area of alpine vegetation is on the Bogong High Plains and on associated prominences such as Mounts Bogong, Feathertop, Fainter, Loch, and Hotham. Smaller areas may be found on peaks such as Mounts Buller, Stirling, Howitt, Speculation, and Wellington, and on high ridges such as the Blue Rag Range.

Alpine vegetation occupies an altitude range between 1,980 m at Mount Bogong and about 1,600 m or 1,650 m - the tree line. On some southern slopes, however, this vegetation type may be found at elevations of about 1,550 m.

Total annual precipitation in the alpine vegetation zone usually exceeds 1,600 mm and may be as high as 2,400 mm. Winter precipitation is in the form of snow, but snow may fall during any month of the year. It usually persists from June to September and may remain until early summer on some sheltered sites. These "snowpatch" areas usually support short herbfield. Very low temperatures and severe frosts characterize the winter months, but snow cover protects the vegetation from these extremes.

In summer, evaporation exceeds rainfall, and the moisture status of the site - as influenced by topographic position and soil type - is a factor determining vegetation patterns.

Exposure to strong winds also influences the pattern. Dwarf herbfields and heathlands may be expected on the most exposed sites, while mosslands are limited to wet, relatively protected sites.

The sub-alpine environment is less severe for plant growth. To some extent adjacent forests or woodlands protect most open areas from wind. Snowfalls are common in winter, and snow lies on the ground for several months except at the lower elevations. Open areas may occur at about 1,100 m elevation, such as on the Nunniong Tablelands, but may range up to 1,700 m, as on the Davies Plain Ridge. They are commonly situated on tablelands or in narrow valleys and other "frost-hollow" sites. Annual rainfall usually exceeds 1,000 mm.

Dwarf heathlands and herbfields are limited to the most exposed sites at the higher elevations, such as Mount Loch, and are associated with stony loams, The plants have or assume a cushion-like or prostrate form and are usually separated by bare ground.

Short herbfields are characteristic of soaks, damp sites, and areas where snow persists longest. They are found at the higher elevations and occur most extensively on the alpine tracts of the Bogong Tablelands and nearby mountains. Elsewhere they are limited to small areas such as Mounts Stirling and Howitt.

Tall herbfields are common in the alpine zone and are extensive around Mounts Bogong, Nelse, Fainter, Hotham, Feathertop, Howitt, Speculation, Buller, and Stirling. Forbs (including many showy flowers) and grasses are the main plants in this unit. Tall herbfields are usually associated with organic loams.

Grasslands are dominated by snow grass tussocks, and various forbs occupy the inter-tussock spaces. They are found throughout the study area in alpine and sub-alpine environments, often in cold-air drainage situations, and are associated with organic loams. They predominate on many of the sub-alpine plains on the Bennison, Dargo and Nunniong Tablelands. Alpine grasslands are best represented on the Bogong Tablelands.

Dry heathlands may be found at numerous localities at the higher elevations, but are limited to the driest rockiest sites such as at the Razor and Gable End. Soils may be stony loams or dry peats, or may be virtually non-existent.

Moist heathlands vary from less than one to a few metres in height, and foliage cover may be open to closed. They are common on rocky sites in the alpine environment on stony loam or organic loam soils. Moist heathlands may also be found adjoining snow gum (white sallee) woodland in sub-alpine tracts and the same constituent species often form an understorey to the woodlands. The species composition varies considerably.

Wet heathlands are often situated along streamsides or in other moist to wet situations in alpine, sub-alpine, and sometimes montane environments throughout the study area.

Mosslands (bogs) are restricted to wet situations at many localities in the same environments. They appear to have been more widely distributed in the past. Soils are peats formed from the dead plant remains of the associated mosslands.

Sedgelands (fens) are confined to swamps or other wet areas in these alpine, sub-alpine, or montane environments.

Sub-alpine woodland, scrubland, and open forest I

Snow gum (white sallee) is the characteristic tree of these structural types, and the vegetation unit takes its name from this species. In some localities, however, black sallee, ash-mallee, or spinning gum may be a major component, such as black sallee at Mount Delusion and ash-mallee at Mount Useful. Mountain gum and candlebark may also appear as minor components of the tree layer.

The trees may form a woodland or may form open forest or scrubland (thicket). The understoreys commonly vary from grassy to grassy with scattered shrubs, and are common at such localities as the Bennison, Bogong, and Dargo Tablelands and Davies Plain Ridge. Understoreys may also be densely shrubby.

This snow gum vegetation unit encloses open plains and watercourses at many places. It grades fairly rapidly into alpine vegetation at its upper limits and also into alpine ash forests where the two types adjoin. On the other hand the interface between this and the mountain gum--snow gum unit is often more gradual.

The unit covers considerable areas throughout the study area - notably at the Bogong, Paw Paw, Dargo, and Bennison Tablelands, the Wellington and Howitt Plains plateaux, and Davies Plain Ridge. It is also extensive around many of the higher peaks and ridge systems such as Mounts Skene, Buller and Stirling, the Bluff to the Nobs and Mount Cobbler, from Mount Murray to the north of Mount Feathertop, Mounts Bogong, Wills, Pinnibar, Gibbo, and Nunniong, and the Cobberas areas.

Elevations commonly range between 1,300 and 1,600 m, but this vegetation unit may extend up to about 1,800 m - such as at Mounts Cope and Pinnibar and the Cobberas - and is quite often found at elevations down to 1,200 m. Precipitation generally exceeds 1,200 mm annually and in winter usually takes the form of snow. In most areas snow persists throughout the winter months. Soils are usually organic loams, stony loams, or friable brown gradational soils.

Sub-alpine to montane open forest II

The major unit of this formation type commonly contains both mountain gum and snow gum. Candlebark is a frequent associate, and broad-leaf peppermint may occasionally be present. In some areas scattered mountain gums emerge above a general snow gum canopy.

This unit is most extensive in a broad belt embracing the Nunniong, Native Cat, and Wulgulmerang Tablelands (northern section only). Another belt extends north-west from Mount Phipps, includes the Paw Paw Tablelands and Cobungra River valley, and reaches to the Dinner Plain area. Large areas may also be found on the southern sections of the Dargo and Bennison Tablelands, in the Moroka basin, and on the Mount Cobbler Plateau.

The unit usually ranges between 1,200 and 1,400 m elevation, but may extend up to 1,500 m and descend to below 700 m as at Omeo and near Wulgulmerang.

Average annual rainfall varies considerably - from less than 700 mm up to about 1,800 mm. Soils are usually gradational and include friable brown gradational soils and the shallow forms of friable red, stony red, and yellow-brown gradational soils.

Sub-alpine woodland to open forest I

The black sallee vegetation unit commonly has an herbaceous understorey with occasional shrubs. It is scattered throughout the area and mainly confined to wet soils where low temperatures are common and severe frosts frequent. Typical situations where these factors apply are along watercourses and around small plains at elevations from about 900 m (where mountain swamp gum may occur in mixture) up to about 1,500 m. Soils are usually grey-brown loams, generally gleyed.

Open forest IV

The alpine ash unit usually occurs as pure stands of alpine ash, but may occasionally include mountain gums. Understoreys may be herbaceous, including various grasses and forbs, or may consist principally of shrubs, ferns, and small trees.

In many areas shrubby understoreys are linked with relatively recent disturbance such as fire and logging.

Alpine ash forests are widely distributed throughout the study area and cover extensive tracts of land. In moderately to highly dissected topography, this unit is found on moist sheltered sites. So its distribution in some areas tends to appear as a number of discrete stands separated by high ridges and dry spurs.

Whole valleys may support these forests, however, where the environment is particularly suitable - such as in the headwaters of the Wongungarra, Dargo, West and East Kiewa, and Mitta Mitta Rivers and Wheelers Creek. Other large contiguous areas may be found on the mid slopes around Mount Buller, Mount Stirling, and the Razorback, on tablelands such as the Nunniong, Pinnibar, and Dargo (southern section) Tablelands, and on plateaux and moderately dissected uplands such as at Connors Plains, Dinner Creek, Mount Baldhead, Mount Delusion, Mount Phipps, and the Sunnyside--Sugarloaf Hill area.

Many mature stands have been harvested, but considerable areas of mature alpine ash still remain. Wildfire regrowth stands are scattered throughout. The largest areas are in the headwaters of the Dargo, Wongungarra, Ovens, and East Kiewa Rivers and Black Snake, Handford, Davies Plain, Snowy, Frosty, and Horatio Creeks.

Elevation for this vegetation unit ranges between 800 and 1,500 m. Annual rainfall exceeds 1,000 m, with moderate to high falls of snow in winter that may persist for periods varying from a few weeks to some months across this altitudinal range. Soils may be deep organic loams or friable brown gradational soils.

The other main vegetation unit of open forest IV is shining gum --mountain ash. Each of these species may form pure stands or may occur in mixture with each other and also with alpine ash and manna gum. The understorey may be a low stratum of ground ferns and other plants, shrubby (with a ground layer of herbs), or a wet gully type.

Such forests are almost entirely confined to south of the Great Dividing Range. The most extensive stands, either fire regrowth or mature, occur near Mountain Ash Spur in the Barkly River valley, at Mount Hump Creek, south of Mount Ewen, in the Nicholson River--Haunted Stream headwaters, at Ah Chows Creek, and at Black Satin--Betts Creeks.

The stands occupy moist, sheltered sites at elevations ranging from about 400 m up to 1,200 m where annual rainfall varies from about 1,000 to 1,600 mm. Snowfalls are light and infrequent. Soils are friable brown or friable red gradational soils.

Open forest III

Several distinct units comprise this formation. The first contains mountain gum forests, often in pure stands but sometimes associated with alpine ash, snow gum, or broad-leaf peppermint. Understoreys may have scattered shrubs with an herbaceous ground layer or may be shrubby.

This vegetation unit is not extensive, but may be found at various localities in the study area such as on the Bennison and Nunniong Tablelands and the Pinnibar plateau. Elevations are usually about 1,200 m and annual rainfall is high. Soils are gradational.

Messmate stringybark forests, forming another unit within open forest III, are also relatively restricted here, especially north of the Great Dividing Range. An isolated stand at Granite Peak, near Mitta Mitta, appears to be its northern limit in the study area.

Quite large stands are found to the west of Gelantipy, to the south-east of Butchers Ridge, and on the eastern side of the Nunniong Tablelands and its southern escarpments. Other localities include Mount Tambo, Tongio Creek, Powers Creek, Jirnkee Gap, Mount Grant, Tea Tree Range, the Viking, Mirrimbah, the Low Saddle, Mountain Ash Spur, Mount Ronald, Shanty Hollow, and Mount Hump Creek.

This unit ranges from about 600 to 1,200 m in elevation, with rainfall of about 1,000--1,400 mm annually. Typical soils are friable brown and friable red gradational soils.

Messmate stringybark is often mixed with manna gum, narrow-leaf peppermint, and mountain grey gum. Understoreys are typically shrubby, with some wet gully type. In the south-east of the study area tall shrubby understoreys are typical.

The narrow-leaf peppermint unit predominates on moist sheltered aspects below about 1,100 m. Forests of this unit are widespread throughout the study area, particularly north of the Great Dividing Range. Annual rainfall is usually between 900 and 1,600 mm. Soils are typically friable red and brown gradational soils.

Trees associated with narrow-leaf peppermint include manna gum, messmate stringybark, candlebark, eurabbie (St. Johns blue gum), broad-leaf peppermint, and yellow stringybark (in Gippsland). Understoreys may be grassy with low shrubs (in lower-rainfall areas), shrubby with an herbaceous ground layer, or (in wet gullies) a dense cover of tall shrubs and small trees.

Silvertop forests more than 28 m high are located on relatively moist ridges and upper slopes on the southern fringes of the area. White stringybark is sometimes an associate. Understoreys are typically heathy to shrubby.

Manna gum forests are typical of many moist river flats and river environs, such as along the Buckland, Macalister, and Caledonia Rivers, but may also occupy moist gullies and slopes. Understoreys are often shrubby to wet gully type. Soils may be red gradational soils with weak structure, yellow-brown gradational soils, or grey-brown loams.

Open forest II

These forests occupy the drier, more exposed aspects over a wide altitudinal range (from below about 1,500 m elevation in some localities) throughout the study area.

In the higher-rainfall areas, broad-leaf peppermint in mixture with brittle gum, candlebark, mountain gum, or long-leaf box is the common vegetation unit. Understoreys are usually heathy.

On the driest sites, broad-leaf peppermint is absent and the main trees are red stringybark, long-leaf box, red box, and brittle gum. The understorey is typically heathy. The most extensive areas of these three units occur in the Wonnangatta, lower Cobungra, lower Dargo, Tambo, Suggan Buggan, Macalister, Buchan, and Mitta Mitta River valleys, and in Limestone Creek valley. Soils may be stony loams, massive gradational soils, or red or stony red gradational.

The silvertop unit usually consists of silvertop in pure stands but the species sometimes occurs in mixture with white stringybark, red stringybark, and broad-leaf peppermint. Understoreys may be shrubby to heathy. This unit is confined to the southern fringe of the study area.

Open forest I

This structural type is found on the steepest, driest slopes in the area. The most extensive areas are found in the Wellington and Macalister River valleys, the Wonnangatta Valley (including the lower Moroka River valley), the Mitta Mitta, Bundara, and Cobungra River valleys near Anglers Rest, and the Tambo, Buchan, and Snowy River valleys.

The flora is similar to open forest II. Four vegetation units have been distinguished. Broad-leaf peppermint, candlebark, and brittle gum are predominant in higher-rainfall areas, and red stringybark, long-leaf box, red box, and yellow box are common in the lower-rainfall areas. Understoreys are typically heathy. Silvertop forest is confined to the southern fringe, and usually has a heathy understorey that is sometimes sparse. Soils are usually stony loams, massive gradational soils, or red or stony red gradational soils.

Woodland and open forest II

Mountain swamp gum forests are limited to wet river flats. The species may be associated with black sallee at the higher elevations (about 900 m) or with candlebark. The understorey may include herbs, reeds, rushes, and shrubs. Soils are usually grey-brown loams. Localities where this unit is well represented include the King, Wonnangatta, Catherine, and Buffalo Rivers.

Woodland and open forest I

These structural types are limited to areas with an annual rainfall of less than about 800 mm. In the Suggan Buggan and Snowy River valleys the main vegetation units are white box and cypress pine. White box may be associated with white and black cypress pines, long-leaf box, yellow box, and manna gum. Understoreys are grassy, but ground cover may be quite sparse. Elevations range from about 160 m to 700 m. Annual rainfall varies from about 600 to 800 mm. Soils include coarse sands, hard red gradational soils, red duplex soils, and stony loams.

White box-yellow box woodlands around Tongio and Swifts Creek have been cleared, but a remnant on steep slopes remains near Cassilis.

Cypress pine stands have similar understoreys to white box areas and predominate on drier, more exposed aspects along the Snowy River and Suggan Buggan valleys at elevations ranging from about 200 m up to 540 m. Soils are similar to those under white box woodland.

Plants Endemic to the Alpine Study Area or Adjacent Areas

Twelve plants are endemic to the study area:

Brachycome petrophila - rock daisy (Little River; Boundary Creek; Murrindal River)

Carex paupera - sedge (Mount Hotham)

Celmisia sericophylla - silky daisy (Mount Bogong; Bogong High Plains)

Dillwynia capitata - slender parrot-pea (Mount Stradbroke; Mount Beauty)

Grevillea willisii - rock grevillea (upper Mitta Mitta River; Bundara River; Livingstone Creek; Cobungra; etc.)

Hibbertia spathulata - guinea-flower (Suggan Buggan; Snowy River)

Leucopogon pilifer - thready beard-heath (Bogong High Plains; Nunniong Plateau)

Monotoca rotundifolia - trailing monotoca (Brumby Point)

Olearia frostii - Bogong daisy-bush (The Twins, Mount Hotham; Bogong High Plains)

Prasophyllum morganii - mignonette leak-orchid (Cobungra)

Pterostylis aestiva - greenhood (Suggan Buggan--Wulgulmerang --Nunniong area)

Ranunculus eichleranus - buttercup (Bogong High Plains; The Bluff; McFarlane Saddle)

Ten undescribed species may prove to be endemic to the study area:

Deyeuxia sp., (aff. *angustifolia*) - bent-grass (Ballantyne Hills near Suggan Buggan)

Eriostemon sp. - wax flower (Mount Stewart north of Gillingal)

Grevillea sp. - grevillea (Mount Stradbroke)

Grevillea sp. - grevillea (Nunniong Plateau area)

Hibbertia sp. - guinea-flower (Licola area)

Hibbertia sp. - guinea-flower (Wellington River near Licola)

Prostanthera sp. (aff. *howelliae*) - mint-bush (Licola area)

Prostanthera sp. (aff. *rhombea*) - mint-bush (between Licola and Mount Margaret; near Valencia Creek road)

Prostanthera sp. (aff. *rotundifolia*) - mint-bush (between Mount Margaret and Lake Tali Karng)

Tetratheca sp. (aff. *procumbens*) - pink bells (Moroka Hut area)

Forty-six other species are endemic to the study area and adjacent areas. (Numbers indicate blocks in the Alpine study area in which the species has been recorded.)

Abrotanella nivigena - snow-wort (10: Kosciusko Plateau, N.S.W.)

Acacia dallachinana - catkin wattle (10, 14, 15: Mount Buffalo)

Acacia lucasii - wattle (18: N.S.W.)

Acacia subtilinervis - wattle (20: N.S.W.)

Astrotricha crassifolia - thick-leaf star-hair (17, 18, 19, 20: N.S.W.)

Astrotricha parvifolia - small-leaf star-hair (4, 7: between Seaspray and Bairnsdale)

Brachycome abovata - daisy (10, 16, 17: Baw Baws; Lake Mountain; Kosciusko, N.S.W.)

Brachycome riparia - Snowy River daisy (20: Genoa River gorge)

Coprosma nivalis - snow coprosma (2, 6, 7, 9, 10, 17, 18, 19: N.S.W.)

Corybas hispidus - helmet-orchid (17, 20: N.S.W.)

Dampiera sp. (aff. *scottiana*) - dampiera (15 km south-east of Licola, just outside study area)

Dillwynia prostrata - matted parrot-pea (20: N.S.W.)

Dodonaea rhombifolia - broad-leaf hop-bush (20: Pine Mountain, N.S.W.)

Drabastrum alpestre - mountain cress (17: N.S.W.)

Eucalyptus chapmaniana - Bogong gum (1, 3, 4, 5, 8, 10: Mount Buffalo, north-west Mount Bogong; Khancoban, N.S.W.)

Eucalyptus neglecta - Omeo gum (2, 3, 9, 11, 16: Frenchmans Creek)

Goodenia grandiflora var. *macmillanii* pinnate goodenia (4, 17, 20: Deddick River; also N.S.W.)

Helichrysum adnatum - everlasting (17, 19; N.S.W.)

Leucopogon riparius - river beard-heath (20: Snowy River gorge - border between study areas)

Lomandra micrantha var. *sororia* (or distrinct species) - small-flower mat-rush (1, 3, 7: Mount Tingaringy)

Myoporum floribundum - slender myoporum (17: N.S.W.)

Olearia adenophora - scented daisy-bush (4, 7, 20: Pine Mountain; N.S.W.)

Oreomyrrhis brevipes - carraway (1, 10, 16, 17: Koscuisko, N.S.W.)

Oreomyrrhis pulvinifica - cushion carraway (10, 20: Kosciusko, N.S.W.)

Pelargonium helmsii - stork's bill (10: Mount Kosciusko, N.S.W.)

Phebalium sp. (aff. *squameum*)- phebalium (20: Mount Elizabeth)

Pimelea biflora - matted riceflower (2, 4, 6, 7, 9, 10, 16, 17, 18, 19: N.S.W.)

Plantago glacialis - plantain (10: Kosciusko Plateau, N.S.W.)

Poa clivicola - poa (17, 18, 19, 20: Mount Buffalo; N.S.W.)

Poa induta - poa (19, 20: N.S.W.)

Poa hothamensis - poa (10: Mount Buffalo; Mount Porepunkah)

Poa petrophila - rock poa (2, 6, 18: N.S.W.)

Pomaderris pauciflora - pomaderris (17, 18, 20: Genoa River gorge: N.S.W.)

Pratia gelida-snow pratia (7: Mount Buffalo; N.S.W.)

Prostanthera decussata - dense mint-bush (4: western highlands, west Mount Tingaringy)

Prostanthera rhombea - mint-bush (4: N.S.W.)

Pterostylis coccinea - greenhood (17, 20: N.S.W.)

Pterostylis laxa - greenhood (13, 17, 18, 20: Mount Delegate; Monument Ridge; N.S.W.)

Pterostylis sp. (aff. *alpina*)- related to alpine greenhood (17: N.S.W.)

Schizeilema fragoseum - alpine pennywort (10, 16, 17: N.S.W.)

Stipa nivicola - alpine spear-grass (4, 6, 7, 10, 18, 19: Mount Buffalo; Mount Kosciusko, N.S.W.)

Trochocarpa clarkei - lilac berry (1, 2, 3, 4, 6, 7: Lake Mountain)

Turritis glabra - tower mustard (11, 12, 17: N.S.W.)

Wahlenbergia densifolia - fairy bluebell (9, 19: N.S.W. alps)

Wittsteinia vacciniacea - Baw Baw berry (3: Mount Donna Buang; Lake Mountain; Baw Baw Plateau)

Westringia cremnophila - Snowy River westringia (20: Snowy River gorge - border between study areas)

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10. FAUNA

The alpine study area contains large contiguous areas of public land, predominantly forested, but with some natural open areas in alpine and sub-alpine environments.

There are recent records of native species comprising 34 mammals, 183 birds, 30 reptiles, 17 amphibians, 13 fish and many invertebrates. Some are widespread and common. Others may be widespread but uncommon to rare, or may be very rare and restricted in distribution. Records of introduced fauna include 10 mammal, 8 bird, and 4 fish species. Appendix 3 lists the fauna of the area.

The distribution of a species is largely related to its habitat requirements, which vary for each species. Faunal communities comprise species that have similar habitat preferences.

Sometimes the suitability of an area for a species may depend on features such as the presence of scattered rock outcrops or decaying logs. Many habitat preferences, however, are related to the vegetation - either directly, through the food, shelter, or breeding sites that it provides, or indirectly, through factors such as topography, soil type, and temperature regime, which also influence the type of vegetation in an area. Wetlands on the other hand are primarily aquatic habitats. These, together with the other habitat types based on the vegetation classification presented in Chapter 9 are described below.

It should be recognized that treating fauna in terms of these broad habitats has its shortcomings, but, based on the present data, this is considered to be the best available approach.

Surveys have been conducted for the Land Conservation Council by the National Museum, Division of Fisheries and Wildlife, Monash University, and Geelong Grammer School. Data from these together with information from other reliable sources have been amalgamated by the National Museum staff. The resulting information was used in compiling this chapter and the block descriptions.

General Habitats

The various vegetation units described in chapter 9 are correlated with the habitats described below, as shown in Table 6.

Wetlands

These areas are seasonally or permanently inundated by fresh water. They comprise streams, swamps, lakes, and farm dams. Their suitability for habitation depends on such factors as whether the water body is flowing or standing and the water quality, the bank and bed characteristics, and the aquatic vegetation.

Table 6

CORRELATION BETWEEN HABITAT TYPES AND NATIVE VEGETATION

Habitat type	Native vegetation units
Riverine forests	Manna gum open forest III, narrow-leaf peppermint open forest III; and mountain swamp gum woodland and open forest II.
Alpine and sub-alpine and open areas	Dwarf herbfield and heathland; short herbfield; tall herbfield; grassland; dry heathland; moist heathland; wet heathland; moss-land; and sedgeland.
Sub-alpine woodlands	Snow gum (white sallee) woodland, scrubland and open forest I; mountain gum-snow gum open forest II, and black sallee woodland and open forest I.
Wet open forest	Alpine ash open forest IV; shining gum-mountain ash open forest IV; mountain gum open forest III; messmate stringybark open forest III; narrow-leaf peppermint open forest III; and silver-top open forest III.
Dry open forest	Broad-leaf peppermint open forest I and open forest II; red stringybark open forest I and open forest II; silvertop open forest I and open forest II; red stringybark--broad-leaf pepper-mint open forest II; and red box open forest I.
Woodlands	White box woodland and open forest I; and black cypress pine--white cypress pine woodland and open forest I.

Riverine forests

This habitat type encompasses manna gum and narrow-leaf peppermint open forests on stream flats at the lower elevations as well as mountain swamp gum open forests and woodlands, which may ascend up to about 900 m elevation.

Alpine and sub-alpine open areas

Heathlands, herbfields, grasslands, mosslands, and sedgelands occur in alpine (above tree-line) or sub-alpine environments. Sub-alpine open areas may be small openings in sub-alpine woodland or large plains many hectares in extent. Alpine open areas are found on the highest plateaux and peaks.

Sub-alpine woodland

The snow gum thickets, woodland, or open forest; mountain gum--snow gum open forest; and black sallee woodland and open forest have understorey plants that vary from heaths to grasses. They occupy large areas at the higher elevations and vary considerably in structure.

Wet open forest

This habitat type consists essentially of tall trees (more than 28 m) with understoreys ranging from grasses with scattered shrubs to a dense layer of tall shrubs. Predominant trees are alpine ash, mountain ash, messmate stringybark, narrow-leaf peppermint, silvertop, and mountain gum.

Dry open forest

This habitat type consists of forests up to 28 m high with understoreys that are mainly grassy or heathy, but may occasionally be shrubby. Main tree species are broad-leaf peppermint, red stringybark, long-leaf box, red box, brittle gum, and silvertop.

Woodlands

These are primarily woodlands of white box and black cypress pi
in the Suggan Buggan area.

Semi-cleared areas and forest margins

Areas that border farmland in the study area provide habitats for a number of species adapted to woodlands or grasslands. Many of these venture out into cleared land to feed and retire to the shelter of adjacent forest or woodland.

Farmland

Some areas have been extensively cleared in the study area, such as around Omeo and Benambra and on the Wulgulmerang Tablelands. Others - along some narrow river valleys, for example - have not been so extensively modified. Many of the original faunal spec have been eliminated from farmland, but some (especially birds) have been able to adapt to what is usually a woodland or grassland habitat. Remnants of the original vegetation along roads and watercourses provide valuable shelter, food, and breeding sites for both resident and migratory fauna.

Mammals

The mammalian fauna of the alpine study area is not particularly diverse, but includes species that are not found elsewhere in Victoria and some that are not common in the State.

Thirty-five species of native mammals have been recorded in the area in recent years. These comprise nine phalangerids, nine bats, four macropodids, four dasyurids, four native rodents, two monotremes, and the common wombat, the long-nosed bandicoot, and the dingo.

Introduced mammals comprise the rabbit, hare, house mouse, black rat, dog, fox, cat, brumby, sambar and red deer, and cow.

Species recorded are from actual specimens, field notes, and literature. Most of these records are dated from about 1965 to 1976.

Most native species are typical of forested land, and the study area is important for their conservation. Common mammals include the eastern grey kangaroo, black wallaby, brush-tailed possum, bobuck, ring-tailed possum, greater glider, feather-tailed glider, sugar glider, common wombat, brown antechinus, Swainson's antechinus, bush rat, Gould's wattled bat, and lesser long-eared bat.

Uncommon species in mountain forests include the tiger cat, greater long-eared bat, eastern pigmy possum, chocolate wattled bat, white-striped bat, smoky mouse (endemic to Victoria), Tasmanian pipistrelle, and the dingo.

Other rare species in the study area appear to be restricted to particular habitats. The brush-tailed rock wallaby is found among rocky cliffs, the mountain pigmy possom in alpine heathlands, and sub-alpine heathlands and woodlands, and the broad-toothed rat in heathlands and grasslands (alpine, sub-alpine, and montane environments).

Mammal Habitats

With the exception of wetlands, these have been defined broadly in terms of vegetation. This classification allows for general correlations of mammals with their habitat, but the occurrence of a particular species at a locality will depend on a number of other factors not considered here. Specific habitat factors would include presence or absence of rock outcrops, ground litter, decaying logs, and hollow trees.

Wetland (swamps, streams, lakes, dams)

Although common throughout the study area, this habitat varies considerably in its representation in different blocks. Two mammal species - the platypus and eastern water rat - are expected to occur throughout the study area, but so far have been recorded in only some blocks.

Both species usually live in streams, but may be found in lakes and billabongs that are connected with streams. They build their nests in streamside burrows. Invertebrates constitute most of their food: the platypus feeds mostly on aquatic insect larvae, crustacea, and other small aquatic animals, while the water rat's diet includes fish, fresh-water crayfish, mussels, and aquatic invertebrates, as well as some land crustaceans.

Riverine forest

Lowland river flats of manna gum and narrow-leaf peppermint forests, or swamp gum woodlands, are associated with most of the main streams in the study area, such as the Macalister, Wonnangatta, Tambo, Ovens, Buffalo, Rose, and King Rivers. They also occur along some minor tributaries.

Many mammals found in riverine habitats are also found in adjacent forests or in various habitats close to streams. Twenty-one native species have been recorded in riverine forest. They include herbivorous animals (such as the eastern grey kangaroo, red-necked wallaby, black wallaby, and common wombat), arboreal animals (such as the brush-tailed and ring-tailed possums, greater glider, and brown antechinus), and small terrestrial animals (such as the long-nosed bandicoot, Swainson's antechinus, and bush rat).

Alpine and sub-alpine open areas

Alpine areas are most extensive on the Bogong Tablelands, but are found elsewhere at the highest elevations such as at Mounts Bogong, Feathertop, Fainter, Hotham, Buller, and Howitt. Sub-alpine open areas, although scattered throughout the area, are most extensive on the Bennison, Dargo, Nunniong, and Bogong Tablelands.

The vegetation structure of these open areas varies from heathlands, herbfields, and grasslands to sedgelands and mosslands. These often form a mosaic of types in the one area and are termed alpine habitats where they occur above the tree-line. Sub-alpine habitats are found below the tree-line, usually on plains or along watercourses and other topographical depressions surrounded by sub-alpine woodlands.

Eleven mammal species have been recorded in this habitat. The mammal fauna of alpine environments is distinctive. The large herbivores such as the eastern grey kangaroo and common wombat are absent or rarely seen. Communities of small mammals, however, are characteristic of heathlands, mosslands, and sedgelands. These include the brown antechinus, Swainson's antechinus, bush rat, and (in some notable instances) the mountain pigmy possum and broadtoothed rat. These animals remain in this habitat throughout the winter, when snow covers the vegetation for several months. Some localities that have surface rocks may contain the mountain pigmy possum.

Small sub-alpine open areas have populations of small mammals, similar to those of alpine areas, but also provide habitat for other mammals such as the common wombat and, in summer, the eastern grey kangaroo.

Sub-alpine woodlands

Sub-alpine woodlands are distributed throughout the study area at the higher elevations. They follow many ridge systems and cover large areas of uplands in some localities, such as the Bennison, Dargo, Bogong, Paw Paw, Nunniong, and Native Cat Tablelands, the Moroka basin, the Cobbler plateau, and Davies Plain Ridge.

The vegetation structure varies considerably. In some exposed and high places the snow gums may assume a low thicket or low open woodland form, whereas on lower sheltered sites a tall open forest of mountain gum and snow gum is common. Understoreys vary from thick shrubs to grasses.

Twenty-four native mammals have been recorded, including the echidna and the large herbivores - eastern grey kangaroo, red-necked wallaby, black wallaby, and common wombat. Arboreal species are the bobuck, brush-tailed and ring-tailed possums, eastern pigmy possum, feather-tailed glider, sugar glider, greater glider, and brown antechinus. Small terrestrial mammals include Swainson's antechinus and bush rat, which are common, and the restricted and rare mountain pigmy possum and smoky mouse.

Bat species are the greater long-eared bat, little bat, and Gould's wattled bat.

Wet open forest

Wet open forests are distributed throughout most of the study area and form the most extensive habitat.

Twenty-eight native mammals have been recorded here. These include the large herbivores - eastern grey kangaroo, red-necked wallaby (mainly in the eastern half of the study area), black wallaby, and common wombat. The long-nosed bandicoot is not common in this habitat, nor is the tiger cat or eastern pigmy possum.

Both brown and Swainson's antechinus are relatively common and widespread throughout. These insectivorous marsupials depend on ground cover for nesting sites and forest litter for insects and other food. The bush rat is also common in this habitat and widespread, but another rodent (the smoky mouse) has been recorded in only two localities in the study area - one in wet open forest and the other in sub-alpine woodland.

Most arboreal species are widespread. These include the brush-tailed and ring-tailed possums, bobuck (mainly recorded in the western portion of the study area), and four glider species. The yellow-bellied glider and eastern pigmy possum have been recorded in several blocks in this habitat type. The six bat species recorded in wet open forest are the greater and lesser long-eared bats, Gould's wattled bat, chocolate bat, Tasmanian pipistrelle, and white-striped bat.

Dingoes and tiger cats occur here and prey on other native species, as do the introduced wild dog, fox and feral cat.

Dry open forest

One monotreme, four macropodids, eight phalangerids, the common wombat, long-nosed bandicoot, three small terrestrial mammals, five bats, and the dingo have been recorded in dry open forests.

This habitat type is distributed throughout the study area, usually at the lower elevations, but sometimes up to about 1,500 m elevation. It is closely associated with lower-rainfall areas, or with steep slopes on northern aspects in higher-rainfall areas.

Dry open forests form a mosaic with wet open forest where the terrain is dissected, to produce moist drainage lines and slopes alternating from dry to moist aspects.

The largest areas of this habitat lie in the rain-shadow valleys of the Macalister, lower Wonnangatta, lower Dargo, Tambo, Buchan and Snowy Rivers.

Mammals found in wet open forest also inhabit dry open forest, although some - such as the greater glider, bobuck, long-nosed bandicoot, and Swainson's antechinus - are to be found mainly in wet open forests, where trees are taller, the understorey shrubs are tall and often dense, and a deep litter layer overlies moist soil.

Other species found in dry open forest may have habitat preferences that are not restricted to these forests. One example is the ring-tailed possum, which appears to prefer a vegetation type containing small trees. It ranges from sub-alpine to lowland woodlands and forests. The other is the brown antechinus, which is commonly found in areas with abundant old fallen logs and a moderate to dense understorey. The presence of the bush rat is also related to shrubby or heathy understoreys. The eastern grey kangaroo is most common where understoreys are grassy.

Woodlands

The eastern grey kangaroo, brush-tailed possum, ring-tailed possum, yellow-bellied glider, feather-tailed glider, brown antechinus, eastern horseshoe bat, and bent-winged bat are known to inhabit woodlands in the study area.

This habitat has been cleared for the most part in the Swifts Creek area, but at Suggan Buggan there is a relatively large area of white box and black cypress pine woodland.

Semi-cleared areas and forest margins

These habitats occur at many scattered localities in the study area. The mammals found here are those of the surrounding forests or woodlands that venture out seeking food. They typically include the eastern grey kangaroo, red-necked wallaby, and several bat species.

Birds

Australia does not have a distinctive mountain avifauna, probably because of the limited extent and low altitudes of the country's mountains.

The forested mountains, however, are the stronghold of a number of birds dependent on this habitat type, as either residents or migrants, and the alpine study area is significant for the conservation of many forest-dwelling birds.

The majority of the 183 native bird species recorded in the study area are typical of mountainous areas.

These include common species such as the gang-gang cockatoo, crimson rosella, superb lyrebird, white-browed scrub-wren, rufous fantail, flame robin, eastern whipbird, Australian ground thrush, and pied currawong. Other less common forest species include the wonga pigeon, king parrot, brush cuckoo, powerful owl, cicada-bird, large-billed scrub-wren, pilot bird, leaden flycatcher, satin flycatcher, pink robin, rose robin, olive whistler, red-browed tree-creeper, lewin honey-eater, and satin bower-bird.

The wetlands of the alpine study area provide refuge for many waterbirds in time of drought and during summer.

Riverine environments that extend into the alpine study area along major streams also provide habitat for species such as the dollar bird, white-throated warbler, yellow-tufted honey-eater, and noisy friar-bird.

Of the total of 183, 121 species (66%) have been recorded in open forest and 95 species (52%) in woodland; 40 species (22%) are restricted largely to wetlands, and an additional 20 (11%) occur commonly in cleared agricultural land.

Bird Movements

The composition and abundance of bird population here constantly changes. Migrational movement is very obvious, particularly in the alpine and sub-alpine areas.

Many species depart from the higher elevations with the onset of winter and return with the arrival of spring. Other species are nomadic, the movements being determined by such factors as the flowering of food plants. Low gaps in the highlands are important for some species. The Mitta Mitta River valley, Morass basin, and Tambo River valley together form an important flyway for waterfowl moving between inland areas and the coastal lands.

Migration

Two types of migration occur: trans-equatorial and intra-continental.

Trans-equatorial migration

Three species are total migrants to the study area and arrive from the Northern Hemisphere.

The Japanese snipe is a summer migrant to Australia from Japan. It is recorded on alpine bogs, lowland swamps, and damp pastures between September and April.

Spine-tailed swifts and fork-tailed swifts breed in eastern Asia and spend the northern winter in Australia. They are highly nomadic, their movements apparently being determined by the effect of weather conditions on their aerial feeding.

Intra-continental migration

The majority of migratory species are insectivorous. Insect abundance is greatly influenced by changing climatic conditions, so migration has greater significance where temperature and precipitation fluctuate markedly than in more temperate climates.

To a varying extent 29 species undertake regular north--south migrations. Species that are total migrants from the study area may be only partial migrants elsewhere.

Total migrants from this area include the pallid cuckoo, brush cuckoo, golden bronze-cuckoo, sacred kingfisher, rainbow bee-eater, dollar-bird, tree martin, fairy martin, cicada-bird, white-winged triller, reed warbler, brown songlark, rufous songlark, white-throated warbler, rose robin, rufous fantail, leaden flycatcher, satin flycatcher, little friar-bird, noisy friar-bird, and olive-backed oriole.

Partial migrants include the Horsfield bronze-cuckoo, welcome swallow, dusky wood-swallow, black-faced cuckoo-shrike, rufous whistler, yellow-faced honeyeater, and white-naped honeyeater.

The yellow-tipped pardalote is a partial winter migrant from Tasmania. It is not common in the study area, probably favouring more-temperate wintering areas.

Altitudinal movements

Some or all of the highland population of 26 species move to lower altitudes during winter. The departure and arrival dates of these birds are largely determined by the onset of winter snows and the spring thaw. As these dates vary considerably, any movement they dictate is not true migration. In their lowland winter quarters some species are largely sedentary, while others may be small-scale nomads.

Obvious altitudinal movements are made by the gang-gang cockatoo, crimson rosella, fan-tailed cuckoo, flame robin, golden whistler, olive whistler, crescent honeyeater, red wattle-bird, pied currawong, satin bower-bird, and little raven.

Nomadic movements

About 20 species show erratic movements determined by the availability of food, which changes according to season and weather. In the non-breeding season some species that remain in the mountains undertake small-scale nomadic wanderings. Typical of these are the fan-tailed cuckoo, scarlet robin, and eastern spinebill.

Nectar- and pollen-feeding birds such as lorikeets and some honeyeaters are more extensive nomads. Their movements are tied to the flowering of eucalypts, which tend to be seasonal, resulting in a superficial regularity of movements.

The most extensive nomadic movements are undertaken by some waterfowl, particularly black duck, grey teal, and coot. Breeding mainly after floods in northern Victoria and New South Wales, these species have a wide post-breeding dispersal and congregate wherever conditions are suitable. Suitable wetlands are more extensive on the inland plains and waterways during winter, but during the summer months they become more restricted and the birds make a general move towards the well-watered ranges. Thus the largest numbers of waterbirds occur in the study area in summer.

Breeding

There are 91 species known to breed in the study area, but it is highly probable that breeding records for additional species would be gained by further field work. Breeding in highland areas is confined to the period between the spring thaw and the onset of winter.

Although little information is available on it, breeding here often occurs later than it does elsewhere. One example is the little raven population, which disperses widely in the non-breeding season but returns to a regular breeding site. Those breeding at the higher elevations do not return from their wintering areas in the lowlands until well into the spring, when breeding conditions are favourable. They breed at least a month later than those that remain at the lower elevations.

Breeding at lower altitudes is less restricted by climate. The emu begins breeding in May or June and the superb lyrebird as early as July, but few other species lay before September and most breeding activity occurs in November. After January, little breeding takes place.

Bird Habitats

Wetlands

The alpine study area has few important waterbird habitats. The few lakes and dams found here are gnerally too deep, cold and windswept to be of great value as waterbird feeding and breeding grounds. Some, however, may act as refuge areas during unfavourable conditions elsewhere. For example, Lake Omeo, when it contains sufficient water, is an important refuge area for waterbirds.

Lowland swamps and river flats are feeding grounds for numbers of herons, ibis, spoonbills, rails, crakes, and waterhens. Several of these areas, particularly those along Morass Creek near Benambra, provide suitable habitats for large numbers of waterfowl and could have significance as refuge areas.

The streams generally flow too fast to be of value to waterbirds. The black cormorant, little black cormorant, and little pied cormorant are uncommon visitors to the larger rivers. Black-fronted dotterels are occasionally observed on sand bars along streams.

Riverine forests

Riverine forests of tall manna gums, narrow-leaf peppermints, or swamp gum woodlands - with understoreys of herbs, ferns, wattles, or other shrubs - provide important habitat for many birds. Some birds are mostly restricted to this environment, while some are typical of dense streamside vegetation throughout the study area.

Streamside vegetation in riverine forests provides cover and nest sites for several species, including the eastern whipbird, red-browed finch, rufous fantail, and pilot bird. Other species such as the shrike-tit, noisy friar-bird, dollar-bird, yellow-tufted honey-eater, sacred kingfisher, and white-throated warbler, frequent tall trees.

Alpine and sub-alpine open areas

Alpine heathlands, grasslands, herbfields, and mosslands occur above the tree-line and similar sub-alpine plant communities are often surrounded by snow gum woodlands. These open areas support a limited avifauna, only 34 species having been recorded in them. Twentyfive of these are typical of lowland grasslands and visit alpine and sub-alpine grasslands in small numbers during summer, five are small insectivorous species that feed in the low heaths, and four are waterbirds frequenting streams and bogs.

The species most commonly observed in these areas are the nankeen kestrel, spur-winged plover, Australian pipit, brown thornbill, white-browed scrub-wren, flame robin, pied currawong, grey currawong, and little raven.

Movement from these areas during winter is almost total. A few individuals of some species - as, for example, crimson rosella, flame robin, starling, and little raven - venture out onto the snowfields from surrounding woodlands, but spend little time there. When the spring thaw begins, there is a sudden vast increase in available insect food and many birds return to the alpine and sub-alpine areas to exploit this food source.

Sub-alpine woodland

Some 80 species occur in the sub-alpine woodlands, most of these being insectivorous and many being summer migrants. During summer the gang-gang cockatoo, crimson rosella, fan-tailed cuckoo, brown thornbill, white-browed scrub-wren, grey fantail, flame robin, yellow-faced honeyeater, pied currawong, and grey currawong are common.

With the onset of the snow season most migrants have left and the majority of the remaining birds move to lower elevations, leaving only a few individuals above the snow line.

Wet open forest

There have been 86 species recorded in this forest type. Of these, 44 feed on arthropods, particuarly insects, 14 are honeyeaters, feeding on both nectar and insects, 11 feed on fruit and seeds, 10 are carnivorous, 4 are omnivorous, and 3 rely on nectar.

Species largely restricted to this habitat in the study area include the wonga pigeon, king parrot, powerful owl, superb lyrebird, cicada-bird, rufous fantail, satin flycatcher, eastern whip-bird, eastern spinebill, satin bower-bird, Australian ground thrush, large-billed scrub-wren, and pilot-bird.

Dry open forest

Dry open forest areas have a more diverse avifauna in the study area than any other habitat type. Of the 101 species recorded there, 52 feed on arthropods, 15 are carnivorous, 13 feed on fruit and seeds, 12 honeyeaters take both nectar and insects, 6 are ominovorous, and 3 feed entirely on nectar. Species largely restricted to this habitat include painted quail, white-throated nightjar, white-winged triller, spotted quail-thrush, white-throated warbler, yellow-rumped thornbill, brown tree-creeper, diamond firetail, and white-winged chough.

Woodland

White box--black cypress-pine woodland occurs in the Suggan Buggan rain-shadow area. This occurrence of woodland in an area otherwise covered by open forest and sub-alpine vegetation results in the presence of birds more typical of the western half of Victoria than of the eastern forests - for example, the wee-bill, hooded robin, brown tree-creeper, and black-chinned honeyeater.

Semi-cleared areas and forest margins

Semi-cleared land and forest margins are frequented by most forest-dwelling birds except particularly shy species. Aerial- and ground-feeding insectivorous birds often use trees on forest margins as perch sites and make forays over adjacent cleared areas. Species commonly behaving in this manner are the tawny frogmouth, laughing kookaburra, rainbow bee-eater, welcome swallow, tree martin, grey fantail, willie wagtail, restless flycatcher, jacky winter, scarlet robin, flame robin, dusky wood-swallow, and grey butcher-bird.

Farmland

Clearing of timber from lowland areas has probably resulted in a population increase of some avian species. These species were originally present in low numbers and restricted to small natural clearings in the forests and woodlands. They include the nankeen kestrel, brown hawk, stubble quail, spur-winged plover, sulphur-crested cockatoo, eastern rosella, singing bushlark, Australian pipit, yellow-rumped thornbill, willie wagtail, diamond firetail, magpie-lark, black-backed magpie, white-backed magpie, Australian raven and little raven.

The galah may be a recent arrival in this area, as it is extending its range southward throughout Victoria and has recently been recorded for the first time in several parts of the study area.

Many species that feed in farmland roost and nest in nearby forest or woodlands and are therefore only partially dependend upon this habitat.

Reptiles

Both reptile and amphibian distributions are classified into zoogeographic regions. Australia has been divided into four zoogeographic subregions, based on animal distributions. Each has a characteristic fauna. Two of them, the Eyrean and Bassian, are represented in Victoria, and the boundary between these falls at about the 510-mm isohyet.

The Bassian subregion has been sub-divided into warm-temperate, cool-temperate, and cold-temperate zones based on climate, the main factor being temperature.

The warm-temperate zone includes the inland margins of the Eastern Highlands, with elevations generally less than 300 m, average rainfalls less than 760 mm per annum, and a vegetation canopy of low density - for example woodland, open woodland, or grassland.

The cool-temperate zone includes the Eastern Highlands below 1,200 m, with low surface temperatures and annual rainfalls of more than 760 mm. The vegetation includes open to closed forest.

The cold-temperate zone consists of alpine and sub-alpine areas above 1,200 m, with very low temperatures, high precipitation (much of which falls as snow), and vegetation varying from open forest to herbfields.

Thirty reptile species have been recorded in the study area, representing five families: dragon lizards (three species); the tree goanna; skinks and lizards (nineteen species); venomous snakes (six species); and a blind snake (one species). With the exception of this blind snake, the reptiles are typical of the Bassian zoogeographic subregion - coldest of the four Australian subregions.

The three main factors influencing the distribution of reptiles in this temperate climatic zone are the prevailing environmental temperatures, availability of sunshine and basking sites, and suitable shelter from low surface temperatures in winter. Variations in these factors make it possible to recognize the three distinct thermal zones described above, each with its characteristic reptile fauna.

Much of the study area is cool-temperate Bassian, with cold-temperate areas at the higher elevations and warm-temperate areas along main river valleys and in low basins.

Some species characteristic of arid areas (Eyrean subregion) intrude into warm-temperate areas. Such species are found in the Mitta Mitta, Suggan Buggan, Snowy, and Buchan River valleys, which are warm and relatively dry with exposed rocky outcrops.

Reptile Habitats

General distribution

Reptiles distributed throughout most of the study area include the tree dragon, McCoy's skink, grass skink, garden skink, Spencer's skink, water skink (both species), southern blue-tongue and copperhead.

Reptiles with restricted distribution include the Gippsland water dragon, restricted to river banks at low elevations south of the Great Divide, and the copper-tailed and three-lined skinks, which are restricted to the far north-east and east of the study area. The tree goanna is found in the southern fringes. Warm-temperate species such as the small-eyed snake, rock skink, and three-toed skink are found along the warmer river valleys. McCoy's, Spencer's, and Coventry's skinks are largely restricted to wet open forests.

Two species found at high altitudes in the study area are rare in Victoria. One is the alpine water skink, found in a sphagnum bog on Davies Plain ridge; the other is the she-oak skink, recorded in sub-alpine woodland at Mount Hotham. The first has a disjunct distribution at high altitudes in New South Wales and the second is distributed elsewhere in Victoria in East Gippsland.

Wetlands

The wetlands at lower elevations provide habitat for reptiles such as the Gippsland water dragon, water skink (warm-temperate species), and tiger snake. At higher elevations they support the water skink (cool-temperate species) and highlands copperhead.

Riverine forests

Fourteen species of reptiles have been recorded in riverine forests and include the garden skink and red-bellied black snake.

Alpine and sub-alpine open areas

These are known to provide habitats for species including the grass skink, water skink (cold-temperate species), alpine wate skink (in mossland), highlands copperhead, and white-lipped snake.

Sub-alpine woodlands

Typical species here include the mountain dragon, grass skink, southern blue-tongue, white-lipped snake, and highlands copperhead.

Wet open forest

Species in this habitat include McCoy's skink, Coventry's skin Spencer's skink, tree dragon (lower elevations), grass skink, garden skink (at lower elevations), three-lined skink, delicat skink and copperhead.

Dry open forest

Reptiles in dry open forest at the lower elevations include th tree dragon, large striped skink, Cunningham's skink, delicate skink, garden skink, three-toed skink, copper-tailed skink, red-bellied black snake, lowlands copperhead, and small-eyed snake.

Woodlands

Near Suggan Buggan, woodlands provide habitat for reptiles, su as the tree dragon, copper-tailed skink, Cunningham's skink, rock skink and garden skink.

Amphibians

Fifteen species of anurans (frogs and toads), representing nea half of the species recorded in Victoria, have been found in t study area. Their general distribution is strongly influenced by the amount, effectiveness, reliability, and seasonal distrib ion of precipitation. Solar radiation is also important.

Particular species' distributions are also controlled by their special physiological adaptions, dispersal powers, and availab ity of suitable migratory paths. Adaption to high altitudes include wide temperature tolerances by tadpoles, modified bree ing seasons and extended larval life.

Eight species are typical of the Bassian zoogeographic subregi and seven are wide-ranging (brown-striped frog, spotted grass frog, eastern banjo frog, Lesuer's frog, Peron's tree frog, br toadlet, and common eastern froglet).

Common widespread anurans in the study area are Lesuer's frog, leaf green tree frog, Verreaux's tree frog, southern toadlet, common eastern froglet, eastern banjo frog, Victorian froglet, and brown tree frog.

Recent records for *Litoria maculata* are confined to Lightning Creek in Block 14 and at a few localities outside the study ar both in Victoria and the Mount Kosciusko area.

Some species such as Lesuer's frog and leaf green tree frog commonly occur along streams at lower altitudes. Others such as the brown-striped frog require permanent swamps, while some species such as Verreaux's tree frog, brown tree frog, common eastern froglet, and southern toadlet can breed in temporary swamps or water bodies.

Fishes

Fourteen native and four introduced fish species have been recorded in the study area. For convenience they are placed into four groups, based partly on their direct importance to Man and partly on their position in aquatic food chains.

Native game species

Five native species have commercial, recreational, and culinary values in addition to their value as native fauna. One is considered to be a threatened species, three are rare in the study area, having been collected only in the middle reaches of the Mitta Mitta River, and one species is widespread and locally common.

The Australian grayling, found in the Tambo River, is rare, with a restricted distribution, and its continued existence is considered to be threatened.

The trout cod is restricted to the cooler upper reaches of the Murray River and its southern tributaries and is extremely rare. Specimens have been taken from the Mitta Mitta River near its junction with the Dart River.

The Murray cod occurs throughout the Murray--Darling River system, except for the upper reaches. Small numbers occur in the Mitta Mitta River just within the study area.

The Macquarie perch is uncommon and has a restricted distribution in Victoria. An excellent sport and table fish, it has been collected from the middle reaches of the Mitta Mitta River.

The river blackfish is widespread in streams that have gravel beds and abundant snags. Its range may be declining due to siltation and the clearing of snags. It appears to be able to coexist with trout and is largely insectivorous.

Introduced game species

The English perch (or redfin) is a very successful introduced species. It is uncommon in swift-flowing streams, preferring slower, deeper rivers. The only records within the study area are from the middle reaches of the Mitta Mitta River.

The brown trout is widespread and common in all streams in the area. In summer it is largely confined to altitudes above 600 m because temperatures at lower altitudes may become too high (above 30°C) for its survival. It feeds mainly on insects and small native forage fish. The rainbow trout has similar habitat and food requirements, but is less common in the area.

Other introduced species

The carp has been recorded in the Mitta Mitta River near the junction of Watchingorra Creek. The European carp, an undesirable species, has not been recorded in the area.

Native forage species

Forage fish are usually small and are an important food source for larger game species and waterbirds.

Short-headed lampreys live in the sea and are parasitic on marine fish. In summer they migrate into rivers to spawn, sometimes moving many kilometres upstream. Spawning takes place in a nest dug in the stream-bed, and the eggs are covered with sand or gravel.

Adults apparently die upstream after spawning, and post-larval stages appear to descend to the sea in winter. Lampreys have been recorded in the Snowy River and may occur in other streams. The Victorian smelt, a small fresh-water species, occurs in streams draining the south-eastern slopes of Victoria including the Snowy River.

Four species of galaxiids (mountain trout) have been recorded in the study area. Cox's mountain trout is common in streams on the Bogong Tablelands and has also been recorded on the Bennison Tablelands, in Lake Tali Karng, and near Omeo. The inland mountain trout is found in the Murray--Darling River system and has been recorded in Pretty Valley Creek on the Bogong Tablelands. Galaxiids of the "olidus group" have been recorded in streams on the Bennison Tablelands, Dargo Tablelands, Bogong Tablelands, and Davies Plain, and in the headwaters of the Buchan River and Morass Creek. Mountain trout from some of these localities are considered to be the Kosciusko mountain trout. Introduced trout have apparently replaced galaxiids in the mid-sections of some streams, but the galaxiids have persisted in headwaters that are either inaccessible to, or unsuitable for, trout.

Two species of eel, the short-finned eel and long-finned eel, occur in south-flowing streams in south-eastern Victoria. Both species spend most of their life in fresh water, but adults descend to the sea in autumn to spawn. The young elvers migrate up streams in spring and summer and may remain in fresh water for many years before reaching maturity.

Another fish, the congolli, may inhabit some streams in the study area. This marine species can ascend rivers to a surprising degree, and has been seen in the Snowy River. Details of its life history are unknown.

Invertebrates

Invertebrates vastly outnumber vertebrates in the study area both in species and individuals. They include arthropods (arachnids, crustaceans, insects, myriapods, etc.), molluscs (snails, slugs, and shell-fish), and worms.

Invertebrates form a vital part of the ecosystem, performing such functions as providing food for higher animals, parasitizing other animals (ticks and lice), pollinating plants (bees, wasps, and flies), and consuming living or dead plant or animal material (aphids, scale insects, lerps, leaf-hoppers, wood-boring insect larvae, termites, flies, and worms).

Despite their importance, very little work has been done in classifying and studying the particular roles of many species except for those that have direct economic influence. This is due in part to the immense species diversity of this group. Most invertebrates in the study area have received little attention. The following notes, however, outline some of the invertebrates (mostly insects) known for the various habitats in the study area.

Pest species are treated in more detail in chapter 13. Appendix 3F gives the results of a brief survey, during which insects were collected from lower vegetation strata in various habitats. This was carried out in daylight over a period of several months during one summer. The invertebrate fauna in the Mitta Mitta valley has been more intensively surveyed as part of the Dartmouth environmental study.

Invertebrate Habitats

Wetlands

Wetlands vary from streams and small stagnant water bodies in alpine environments, through streams in wet open forest and dry open forest, to swamps and dams. Invertebrates that spend the whole or part of their life cycle in aquatic habitats include mayflies (Ephemeroptera), caddisflies (Trichoptera), stoneflies (Plecoptera), dragonflies (Odonata), aquatic bugs (Hemiptera), water beetles (Coleoptera), midges, crane flies, mosquitoes (Diptera), and snails (Gastropoda). Mountain wetlands contain prolific populations of caddisflies, alderflies, stoneflies, mayflies, and dragonflies.

Aquatic leeches and at least six species of mollusc - including a fresh-water limpet, a small mussel, and a fresh-water snail (*Bulinus* sp.) - are found in the Mitta Mitta River and/or associated swamps. The Murray crayfish is common in the lower reaches of the larger rivers, and yabbies are plentiful in swamps and dams. Shield shrimps are common in mountain pools and swamps.

Alpine open areas

Some insects are resident here, while others migrate to the alpine open areas in summer. The great majority of residents spend the winter in a dormant stage of their life cycle. In summer they become active and join the summer migrants to form an abundant and varied community, which includes mountain cockroaches and grasshoppers, biting flies, and nectar-seeking insects.

The long-horn mountain grasshopper *Acripeza reticulata*, found also in sub-alpine woodland and open forest, and the grasshopper *Monistria pustulifera* are two characteristic insects found here. The wingless cockroach *Polyzosteria viridissima* inhabits alpine mosslands. Numerous small moths frequent herbfields and heaths, and the alpine case-moth *Plutorectis caespitosa* and alpine grass caterpillar *Oncopera alpina* feed on snow grass.

In summer the Bogong moth *Agrostis infusa* migrates from lowlands to the alps, where the moths cluster in rock crevices. Butterflies include several species from families such as the Lycaenidae (*Paralucia, Neolucia,* and *Ogyris*), Nymphalidae (*Heteronympha* and *Oreixenica*) and Hesperidae (*Anisynta* and *Signeta*). The alpine silver xenica, a butterfly that in its larval stage feeds on snow grass, is usually found in Victoria only at elevations above 1,700 m.

The large variety of beetles present include the curculionids (weevils), chrysomelids (leaf beetles), and cantharids (soldier beetles). Archaic insects such as damselflies are characteristic fauna of streamsides in this habitat.

The stonefly *Thaumatoperla alpina* inhabits streamsides, as do various species of caddisfly and mayfly.

Sub-alpine woodlands

Sub-alpine woodlands provide suitable habitat for many insect species. The beetles (Coleoptera), bugs (Hemiptera), ants, bees, and wasps (Hymenoptera),lacewings (Neuroptera), and flies (Diptera) are all well represented. Characteristic butterflies are the orichora brown and correae brown, both of which feed on snow grass and other grasses in their larval stages.

Wet open forest

The tall trees, dense understoreys, and thick litter layers of these forests provide a number of habitats for a wide range of insects and other invertebrates. A brief survey of insects in 1974, chiefly in narrow-leaf peppermint understoreys, collected a number of species representing 12 orders and at least 76 families. These were mainly Diptera and also many Coleoptera, Hemiptera, and Hymenoptera.

Butterflies include Bank's brown, spotted brown, bright-eyed brown, and Klug's xenica.

Mayflies (Euphemeroptera), caddisflies (Trichoptera), and stoneflies (Plecoptera) are frequently found in this habitat near mountain streams, which they require to complete their life cycle. Other common insects include stick-insects (Phasmatidae), leaf beetles (Chrysomelidae), scarab beetles (Scarabaeidae), weevils (Curculionidae), cicadas (Cicadidae), and scale insects (Coccidae).

Leaf litter and logs provide the damp, dark habitats suitable for many invertebrates such as terrestrial flat worms, nematode worms, terrestrial leeches, molluscs, and scarab beetles.

Dry open forest

This habitat, with its less-dense tree canopies at lower heights above the ground surface, permits a greater penetration of sunlight and heat than wet open forest. This tends to favour insects rather than most other invertebrate groups.

Moths and butterflies (Lepidoptera); beetles (Coleoptera), including scarabs, chrysomelids, and weevils; bugs (Hemiptera) including cicadas, leaf-hoppers and lerps; flies (Diptera); cockroaches (Blattodea); grasshoppers (Orthoptera); and ants, bees, and wasps (Hymenoptera) are all well represented.

Butterflies in dry open forest are characterized by skippers (Hesperiidae) where they are common, but blues (Lycaenidae) and browns (Satyridae) may also be found.

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11. WATER RESOURCES

Surface Water

The study area is a highly important source of water for Victoria. It contains much of the State's productive water catchments, contributing about one-quarter of the flow in Victoria's river systems. About 60% of the water yield comes from streams flowing north from the Great Dividing Range to the Murray River system and about 40% comes from south-flowing streams. The value of these supplies in terms of existing and potential utilization for domestic, agricultural, and industrial use is discussed in Chapter 20.

Catchment yields are related firstly to precipitation rates and secondly to the percentage of this precipitation that is lost as evaporation, transpiration, deep seepage, and impounded water. The study area receives the highest rainfalls in the State - considerable areas have an average annual rainfall in excess of 1,300 mm (See Map No. 5). Most of the area is mountainous, with steep slopes and relatively shallow soils, which promotes run-off.

The highest elevations yield the most water per unit area, as rainfall is higher and evapotranspiration is lower in these regions. Also, a high proportion of precipitation is ultimately available as run-off - because it mainly falls during the cool months as snow, and the water stored in this way is released by snow melt while evapotranspiration remains relatively low.

In the Victorian catchment of Lake Hume it is estimated that land above 1,350 m, while comprising only 8% of the catchment, contributes about 19% of the water yield, and land above 1,050 m, which is only 23% of the catchment, contributes 43% of the water yield.

Similarly, land above 900 m in the Kiewa catchment produces 52% of the yield although it comprises only 23% of the total catchment area.

Mean annual discharge rates for the Bogong High Plains, indicated by stream gaugings on Rocky Valley and Pretty Valley Creeks - Kiewa catchment, are about 1,550 Ml per km^2, compared with the average for the whole Kiewa catchment of 514 Ml per km^2.

The flow regime of streams is an important catchment characteristic. During winter the snowfields withhold water from streams until the advent of warmer weather, thus helping to maintain stream flows during early summer. Heavy winter rains and subsequent deep percolation also help to sustain summer flow. The role of mossbeds is not clear, but they may retard run-off during the warmer months.

Summer flow reliability is highest in the eastern part of the study area - for streams on both sides of the Divide.

The highest average monthly flows for most major streams in or originating from the study area occur during the period July to October (see Figures 3 and 4), as indicated by long-term measurement of stream discharges. This distribution, of course, closely follows the pattern of maximum winter precipitation and the melting of snow in spring.

Short-term flow characteristics are also important, particularly with regard to flooding. Stream flow is closely related to rainfall intensity and duration, and to the characteristics and soil moisture condition of the catchment. Short-duration high-peak flows caused by water from heavy rains are reaching streams rapidly - much of it by overland flow. Prolonged light rains can result in a slower and more prolonged yield, due to most of the water reaching streams by seepage through the soil.

High-intensity rains at any time of the year can cause high stream flows in the study area and floods in the surrounding lowlands. The chance of flooding is compounded in late winter and spring, when soils may already be saturated and snow is melting following warm rains.

Water quality is an essential criterion when deciding the suitability of water for various uses or as an environment for aquatic life.

The suitability of water for domestic use, including drinking water, is affected by such factors as hardness, turbidity, colour, organic content, and concentration of total dissolved solids (T.D.S.).

Criteria for T.D.S. are:

* Above 3,000 mg per l - unsuitable
* Between 750 and 3,000 mg per l - satisfactory if the chemicals are not toxic or do not have other detrimental physical effects
* Below 750 mg per l - suitable

Water with a T.D.S. concentration below 2,000 mg per l is suitable for all livestock, but many animals will survive on much higher concentrations.

Victorian irrigation water is classified according to its T.D.S. content. All water within the area is class 1 irrigation water (0--175 mg per l) and is therefore suitable for most crops on most soils.

Streams contributing water to hydro-electric generating plants must be free from matter that could abrade or otherwise injure the machinery or silt up tunnels and pondages.

Water-quality monitoring in the study area was, until recently, confined to T.D.S. and temperature sampling at gauging stations. A program to assess water quality more fully, however, was introduced in 1975. Its aim is to determine the

FIGURE 3
MEAN MONTHLY DISCHARGE-STREAMS SOUTH OF GREAT DIVIDE.

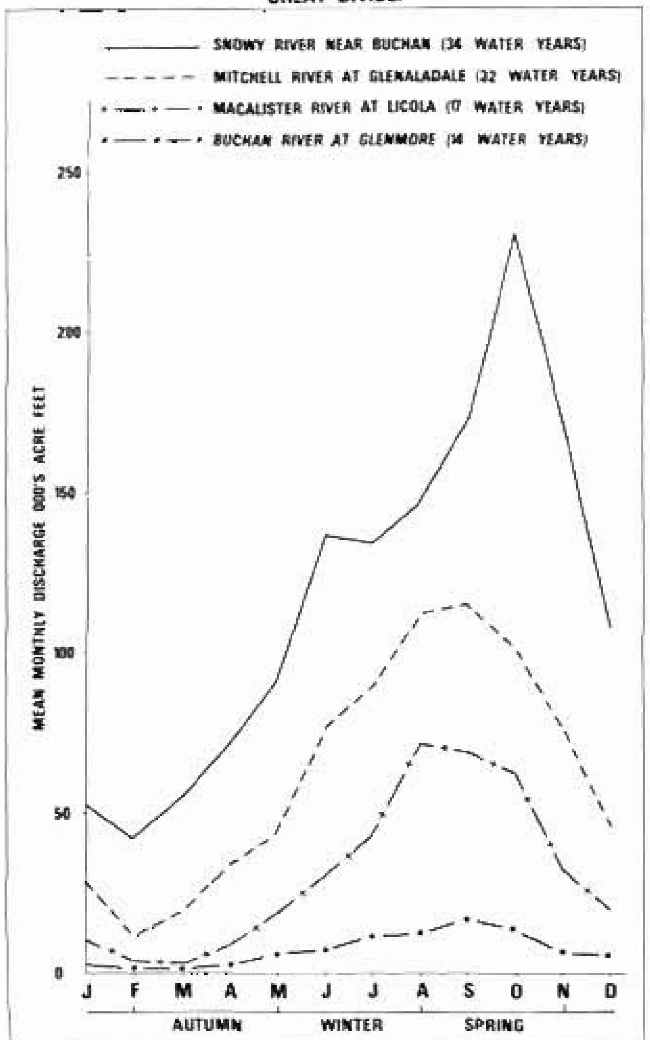
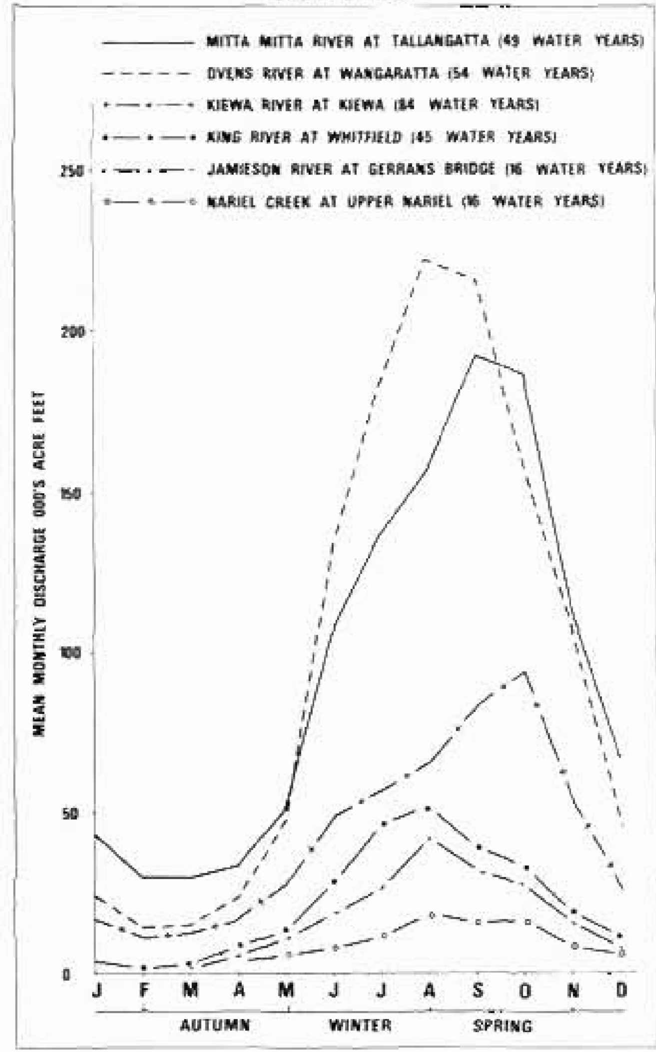


FIGURE 4
MEAN MONTHLY DISCHARGE-STREAMS NORTH OF GREAT DIVIDE.



the physical and chemical composition of water resources. Testing will be carried out on a regular basis at 300 gauging stations throughout Victoria. Many of these will monitor the water quality of streams flowing in and from the study area.

Most of the area is undeveloped public land where streams are unaffected by agricultural, urban, industrial, or domestic pollutants. Consequently, water in streams throughout the study area is generally of very high quality for all uses, with water in the northward-flowing streams being of slightly better quality than water in streams south of the Divide.

For ease of consideration, the study area has been subdivided into nine major catchment basins (see Map No. 5) that are listed and discussed below. Table 7 has been prepared to facilitate comparisons between drainage basins, and Appendix 5 presents stream-gauging data.

Catchment basins

1. Murray River; including Nariel Creek
2. Mitta Mitta River; including Snowy Creek
3. Kiewa River
4. Ovens River; including the Buckland, Buffalo, Dandongadale, Rose, and King Rivers
5. Goulburn River; including the Delatite, Howqua, and Jamieson Rivers
6. Macalister River; including the Avon River
7. Wonnangatta River; including the Dargo River
8. Tambo River; including the Timbarra River
9. Snowy River; including the Buchan River

1. Murray River catchment basin

Approximately 1,360 km^2 of this catchment lies within the study area, which represents only 18% of the total Murray River catchment area above Lake Hume. Nevertheless, this is an important water-production section of the Lake Hume proclaimed catchment, and has a mean annual discharge rate in excess of 400 Ml per km^2.

Stream flows are comparatively reliable, with 23% of mean annual discharge being contributed during the 6 months December to May, including 9% during the 3 months January to March. T.D.S. testing of the Murray River at Jingellic (outside the area) and Nariel Creek, at Upper Nariel, indicate very high-quality water.

Table 7

CATCHMENT BASIN CHARACTERISTICS

Study area drainage basin	Major streams	Area of catchment (km^2)	Estimated mean annual discharge		Reliability (% of annual discharge)	
			Approximate total (Ml)	Approximate rate (Ml per km^2)	6 months Dec--May	3 months Jan--Mar
Murray	Murray River Nariel Creek	1,360	544,000	400	23	9
Mitta Mitta	Mitta Mitta River Snowy Creek	4,150	1,106,000	255 470	21.5 -	7.5 -
Kiewa	Kiewa River	470	423,000	900	23.5	7
Ovens	Ovens River Buckland River Buffalo River Dandongadale River Rose River King River	990	396,000	400	14 - - - - -	3.5 - - - - -
Goulburn	Delatite River Howqua River Jamieson River Goulburn River	1,190	595,000	500	17.5	4.5
Macalister	Macalister River Avon River	2,000	608,000	350 150	17.5 -	4.5 -
Wonnangatta	Wonnangatta River Dargo River	3,030	909,000	300	21	5
Tambo	Tambo River Timbarra River	1,370	144,300	80	29.5	7.5
Snowy	Buchan River Snowy River	1,800	270,000	150	30	10

2. Mitta Mitta River catchment basin

Forming part of the proclaimed catchment of Lake Hume, this is the largest individual catchment basin in the Alpine area. It contains 4,150 km^2, or 82% of the Mitta Mitta River catchment above Lake Hume. This portion contributes 78% of the mean annual discharge of the basin.

Rain-shadow conditions that exist in the area around Omeo are responsible for the unusual below-average contribution. The middle section of the river between the Gibbo River junction and Hinnomunjie, which is within the rain-shadow, contributes only 182 Ml per km^2 annually, whereas the lower section contributes 254 and the upper one 322 Ml per km^2.

Mitta Mitta River stream flows are comparatively reliable, contributing 21.5% of the mean annual discharge at Dartmouth during the 6 months December to May, including 7.5% during the driest 3 months, January to March. T.D.S. testing of the Mitta Mitta at Colemans indicates very high-quality water.

3. Kiewa River catchment basin

About 27% (470 km^2) of the total Kiewa catchment is within the Alpine area. This small region contains the highly water-productive Mount Bogong, Mount Feathertop, and Mount Hotham areas and returns more than 900 Ml per km^2 annually. The Kiewa catchment is proclaimed upstream of the junction of its East and West branches.

The Kiewa River is also comparatively reliable, contributing 23.5% of the mean annual discharge at Mongan's Bridge during the 6 months December to May, including 7% during the 3 months January to March.

The mean of T.D.S. tests taken at Mongan's Bridge is 34 mg per l, indicating high water quality.

4. Ovens River catchment basin

This catchment basin includes the upstream extremities of the Ovens, Buckland, Buffalo, Dandongadale, Rose, and King Rivers, totalling approximately 990 km^2, or about 18% of the total Ovens catchment above Wangaratta.

The area is mountainous, high-rainfall country and embraces parts of Mount Hotham, the Barry Mountains, and Mounts Selwyn, Cobbler, Stirling, and Speculation. Data from gauging stations on the Ovens River at Bright and the Buffalo River at Abbeyard indicate that this catchment basin contributes in excess of 400 Ml per km^2 annually.

Its reliability is indicated by the Ovens River at Wangaratta, which yields 14% of its average annual discharge during the 6 months December to May, including 3.5% during the 3 months January to March. Water quality of all streams in the catchment is high, all streams having a mean T.D.S. reading of less than 30 mg per litre.

5. Goulburn River catchment basin

This basin includes most of the highly water-productive sections of the Delatite, Howqua, and Jamieson Rivers and less than half of the Goulburn River's watershed above Eildon. It forms part of the Lake Eildon proclaimed catchment and includes Mount Buller and parts of Mounts Stirling, Howitt, McDonald, and Skene.

This section of the total Eildon catchment has an area of 1,190 km^2, or only 30%, yet it contributes more than half of the mean annual discharge from Lake Eildon. The catchment basin contributes more than 500 Ml per km^2 annually.

Of the average annual discharge, 17.5% occurs during the 6 months December to May, including 4.5% during the 3 months January to March.

T.D.S. sampling indicates high-quality water in all streams in the basin.

6. Macalister River catchment basin

About 1,540 km^2 (or about 70%) of the Macalister River catchment and 420 km^2 of the Avon River catchment are included in this basin. The Great Dividing Range forms the western boundary of the basin catchment and the Snowy and Moroka Ranges the eastern boundary. The catchment of the Macalister River in the study area forms part of the proclaimed Glenmaggie catchment.

The Barkly, Caledonia, and Wellington Rivers are major tributaries of the Macalister River. The mean annual discharge for the Macalister River section of the catchment is around 350 Ml per km^2, while the Avon River section is subject to much lower rainfall and run-off rates.

The Macalister River contributes 17.5% of its mean annual discharge during the 6 months December to May, including 4.5% during the period January to March, and T.D.S. testing of this stream indicates high quality.

7. Wonnangatta River catchment basin

This large catchment basin of 3,030 km^2 comprises about 66% of the total Mitchell River catchment above Bairnsdale. The Great Dividing Range forms its eastern and northern boundaries and Snowy and Moroka Ranges the western boundary. There is a wide variation in rainfall over the catchment, which is almost directly related to elevation. Nevertheless the catchment is a productive one, with a mean annual discharge rate of around 300 ml per km^2.

The catchment contributes 21% of its mean annual discharge during the 6 months December to May, including 5% during the 3 months January to March. T.D.S. sampling shows the water from the catchment to be of very high quality.

8. Tambo River catchment basin

The Alpine area contains 1,370 km^2 of this catchment, which represents about 50% of the total catchment above Bruthen.

A large part of it is affected by the same rain-shadow conditions that affect the Mitta Mitta catchment, and this is reflected by the very low return of 80 Ml per km^2 for the Tambo River section of the catchment. The Timbarra River section has a higher return of around 255 Ml per km^2.

The catchment yields 29.5% of its average annual flow during the 6 months December to May, including 7.5% during the 3 months January to March.

The mean of T.D.S. observations taken on the Tambo River at Swifts Creek is 132 mg per l, which, although quite acceptable, is considerably higher than in any other stream in the Alpine area.

9. Snowy River catchment basin

The Snowy River forms the eastern boundary of the Alpine area, and only about 13% (1,800 km^2) of the total Snowy catchment is in the area.

The general contribution rate for this section of the catchment cannot be determined accurately, but it is certainly not more than 150 Ml per km^2. The Buchan River and Mellick Munjie River, however, contribute at the rate of about 200 Ml per km^2.

The Snowy River is a reliable stream, contributing 30% of its mean annual discharge in the 6 months December to May, including 10% during the 3 months January to March inclusive.

T.D.S. observations of the Snowy River at McKillops Bridge and the Buchan River indicate high water quality.

Storages

Apart from the water storages forming part of the Kiewa hydro-electric scheme, there are no large impoundments on public land.

The construction of the Dartmouth Dam on the Mitta Mitta River is scheduled to be completed in 1977. This will submerge an area of 6,800 ha when it is at its full supply level of E.L. 486, and impound water upstream along the Mitta for 52 km of its length and along the Dart River for 13 km of its length. (At full supply level the storage will hold 4 million Ml.)

Streams within the study area contribute to Lakes Hume, Buffalo, William Hovell, Eildon, and Glenmaggie. A proposed storage on the Mitchell River would receive most of its supply from the study area.

Groundwater

As in the adjacent North-eastern study area, potable groundwater is available throughout the Alpine area, but supplies obtained from bores would generally be small. Large supplies could be obtained beneath the flats of major streams, such as the Ovens, Kiewa, and Upper Wonnangatta Rivers, which have alluvial deposits of sufficient extent and thickness to form important aquifer systems.

Few bores have been drilled into these deposits, but they are known to include conglomerates and gravels capable of yielding up to 2,270 litres of water per minute (30,000 gallons per hour). This would occur at depths from near surface down to a maximum of about 60 metres and would contain 100-250 mg T.D.S. per litre. Alluvial deposits in the Morass basin contain significant volumes of high-quality (300--1,100 mg T.D.S. per litre) groundwater supplies, down to a maximum depth of 40 m in some areas.

In the interfluves and the mountain tracts of streams, groundwater occupies the spaces created by joints and other fractures in the hard Palaeozoic country rocks. The frequency and openness of these fractures, and hence the storage capacity of the rocks, vary from place to place - depending on the rock type, geological structure, and the depth and degree of weathering.

Rainfall and infiltration rates are generally high in this region and the amount of water retained in storage depends on the depth of dissection and the efficiency of the drainage system. The water table in the interfluves is generally maintained at levels well above the main streams (less than 30 metres below the surface topography) and, in periods of low precipitation, the base flow of streams is provided by springs and soaks tapping the ground-water storage.

Supplies obtained in bores would depend on the number of fractures intersected below the water table and the fracture storage volume capable of being drained in each bore.

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12. LAND SYSTEMS

The preceding sections of this report have described the features of the land in the study area - geology, land forms, climate, soils, and vegetation.

These features are not distributed at random, nor do they occur completely independently. Rather, distinct environments consisting of characteristic patterns of land forms, soils and vegetation can be recognized. These patterns often occur over large areas within a given range of climate as part of a broader pattern, thus allowing large areas of land to be described in terms of units, each with a particular range of climate, topography, parent materials, and sometimes vegetation.

In this method of characterizing the land, each feature of the environment is considered in relation to the others, instead of separately as in a soil or vegetation survey. The approach allows other attributes of the land - such as problems of development, erosion hazard, and potential productivity - to be used with the physical features of the environment in defining units.

An understanding of the nature of such areas of land, and a knowledge of their distribution, is a valuable base for land-use planning.

The most-detailed and fundamental unit for mapping and description is the LAND COMPONENT, in which the climate, parent materials, soil, and vegetation are uniform within close limits. Components usually occur in a limited number in a consistent repetitive sequence, and an area containing such a sequence is termed a LAND UNIT.

A grouping of land units that has common land forms, vegetation, or other significant attributes is termed a LAND SYSTEM.

Land systems are broad-scale mapping units, which may be delineated as the first stage in the characterization of land for land-use and management planning, and are therefore valuable where integrated information is required for large areas on a relatively broad scale.

The Alpine study area includes a great diversity of land types - 104 land systems are mapped within the area. A simplified form of presentation has been adopted for this report, whereby the land systems are delineated and identified by symbols (see Map 7), but are grouped into 18 map units, identified by different colours.

The presentation of the environmental information is similarly grouped, and Table 8 sets out sequences of soils and vegetation within these map units.

To enhance the understanding of the relations between the land systems and the map units, Figures 5A to 5E depict five landscape sections, and lines on Map No. 7 (marked with the appropriate letters) show the position of each.

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FIG 5A

Landscape cross-section A-B

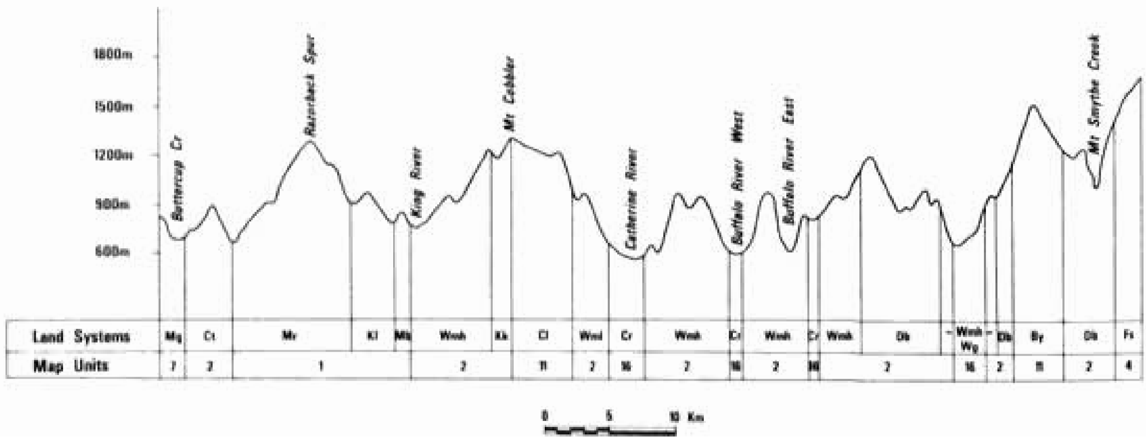


FIG 5B

Landscape cross-section C-D

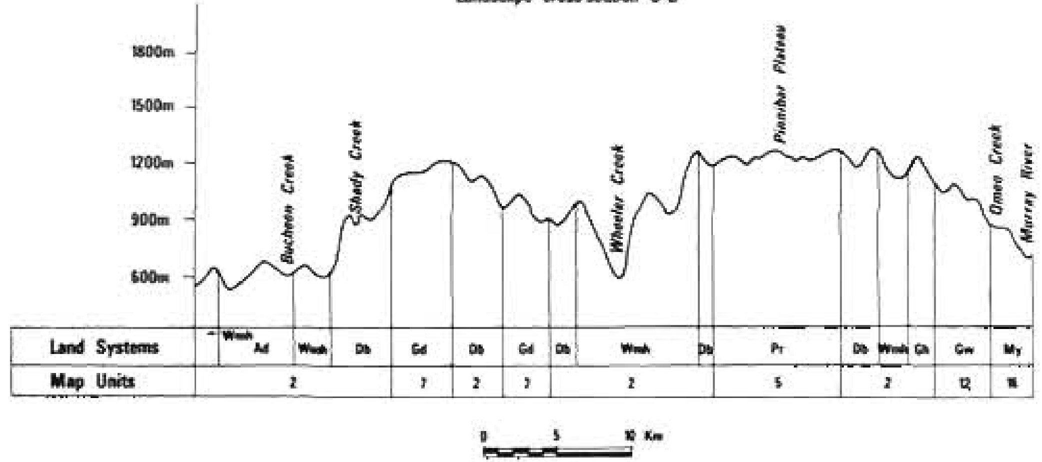


FIG 5C

Landscape cross-section E-F

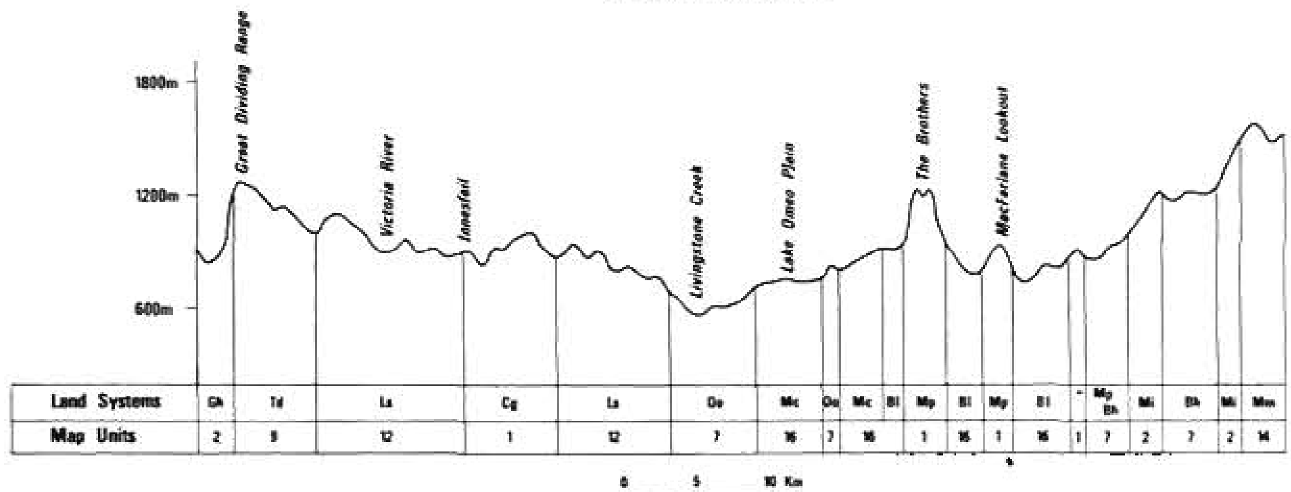


FIG 5D

Landscape cross-section G-H

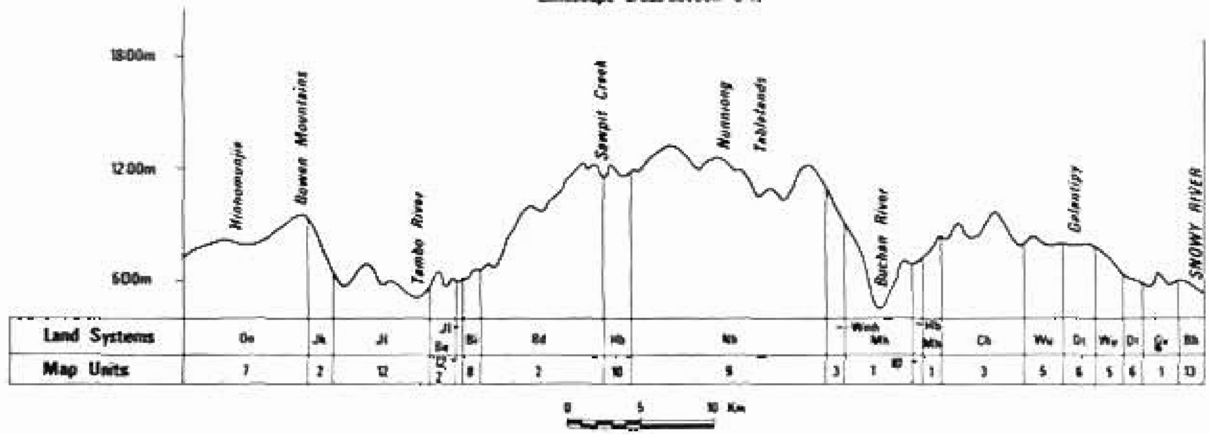
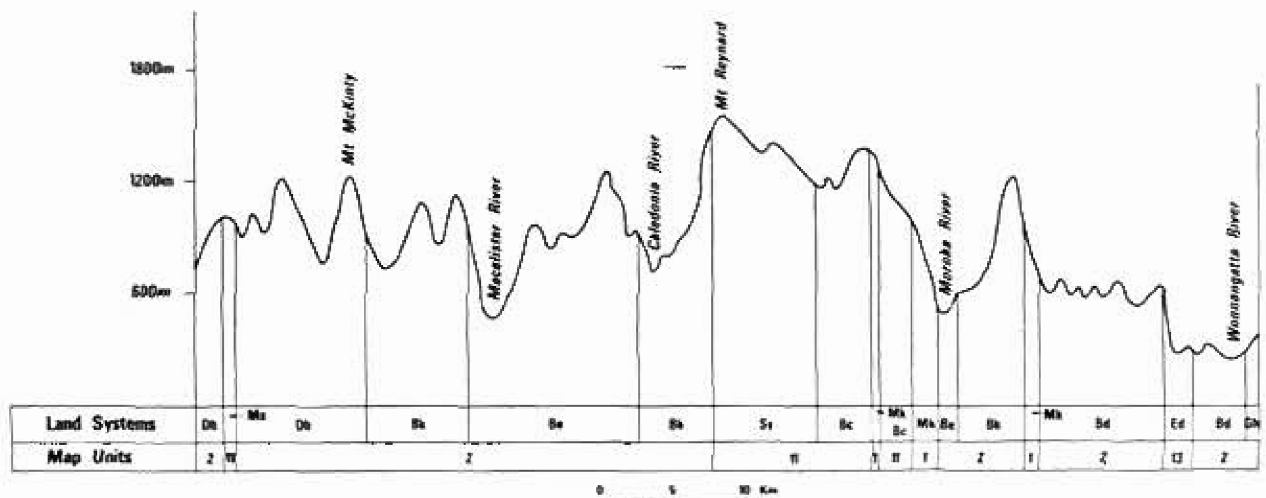


FIG 5E

Landscape cross-section I-J



LAND SYSTEMS OF THE ALPINE STUDY AREA

Sequences of predominant soils and vegetation with increasing moisture availability and/or decreasing average temperatures.

Map unit	Topography and rock type	Average elevation and range of land systems (m)	Land systems		Average annual precipitation range (mm)	Soils	Vegetation	
			Name	Map symbol			Structural forms	Predominant tree species
1	Mountainous; acid igneous & coarse-grain metamorphic rocks	0--1,200	Staleyville Marroo Low Gelantipy East Marroo High Mt Baldhead Mt Pendergast King Low Pinnacles Mirimbah Cobungra Indi Moroka Wat Wat Low Mt Buffalo	(Sv) (Ml) (Gv) (Mh) (Mt) (Mp) (Kl) (Pn) (Mr) (Cg) (In) (Mk) (Wwl) (Mb)	625 $>$ 1,500	Massive gradational soils Coarse sand soils, uniform texture Friable brown gradational soils (Stony loam soils, uniform texture)*	Open forest I Open forest II Open forest III Open forest IV Sub-alpine woodland/open forest I (Alpine and sub-alpine vegetation)*	Red stringybark Brittle gum Broad-leaf peppermint Candlebark Narrow-leaf peppermint Messmate stringybark Mountain grey gum Mountain gum Alpine ash Snow gum
2	Mountainous; siliceous sedimentary & fine-grain metamorphic rocks	0--1,200	Jirnkee Mt Jonas Buckenderra Ben Cruachan Mt Phipps Wermatong Low Wermatong High Adjie Cambatong Graham Barkly Reefton Spur Darbalang Koonika	(Jk) (Mo) (Bd) (Be) (Mi) (Wml) (Wmh) (Ad) (Ct) (Gh) (Bk) (Rs) (Db) (Kk)	625 1,500	Stony gradational soils Brown gradational soils (Red gradational soils)* (Stony loam soils, uniform texture)* Friable brown gradational soils Shallow friable brown gradational soils	Open forest I Open forest II Open forest III Open forest IV Sub-alpine woodland/open forest I	Broad-leaf peppermint Candlebark Red stringybark Silvertop Narrow-leaf peppermint Messmate stringybark Mountain ash Mountain gum Alpine ash Snow gum
3	Mountainous; acid igneous & coarse-grain metamorphic rocks	1,200--1,800	Mt Leinster Cobberas Wat Wat High Bundarrah Feathertop (Igneous)	(Mn) (Cb) (Wwh) (Ba) (Fg)	750 $>$ 1,500	Massive gradational soils Brown gradational soils Friable brown gradational soils Stony loam soils, uniform texture Shallow organic loam soils, uniform texture	Open forest III Open forest IV Sub-alpine woodland/scrubland/open forest I (Alpine and sub-alpine vegetation)*	Candlebark Broad-leaf peppermint Narrow-leaf peppermint Mountain gum Snow gum
4	Mountainous; siliceous sedimentary & fine-grain metamorphic rocks	1,200--1,800	Feathertop (Sedimentary)	(Fs)	$>$1,500	Friable brown gradational soils Shallow organic loam soils, uniform texture (Stony loam soils, uniform texture)*	Open forest III Open forest IV Sub-alpine woodland/open forest I (Alpine and sub-alpine vegetation)*	Mountain gum Alpine ash Snow gum
5	Hills; acid igneous & coarse-grain metamorphic rocks	0--1,200	Tongio-Munjie West Brookville Wulgulmerang Nunniong (Igneous) Guttamurra Pinnibar Welumla	(Tw) (Br) (Wu) (Ng) (Gm) (Pr) (Wl)	625 1,500	Yellow duplex soils Massive gradational soils Shallow friable brown gradational soils Friable brown gradational soils (Humified peat soils)*	Open forest I Open forest II Open forest III Open forest IV	Red stringybark Candlebark Broad-leaf peppermint Messmate stringybark Alpine ash
6	Hills; basic igneous rocks	0--1,200	Detarka	(Dt)	750--1,000	Red gradational soils on basalt Yellow-brown gradational soils	Open forest I	Snow gum Candlebark Broad-leaf peppermint
7	Hills; siliceous sedimentary and fine-grain metamorphic rocks	0--1,200	Omeo Beloka High Merrijig Thorkidaan Dondangadale Lucyvale (Sedimentary) Stanley Tolmie Tolmie High Glendart	(Oo) (Bh) (Mg) (Tk) (Dd) (Lv) (St) (To) (Tn) (Gd)	625 1,500	Red duplex soils/yellow duplex soils/stony gradational soils Red gradational soils Friable red gradational soils Shallow friable brown gradational soils Friable brown gradational soils	Open forest I Open forest II Open forest III	Yellow box Candlebark Broad-leaf peppermint Narrow-leaf peppermint Messmate stringybark
8	Hills; calcareous sedimentary and fine-grain metamorphic rocks	0--1,200	Bindi	(Bi)	625--750	Red calcareous clay soils, uniform texture, fine structure	Woodland	Manna gum Yellow box
9	Hills, hilly ridge tops; acid igneous & coarse-grain metamorphic rocks	1,200--1,800	Theddora Berrmarr (Igneous) Nunniong High Braithwaites Top Stirling Buller (Igneous) High Plains	(Td) (Bv) (Nh) (Bw) (Sg) (Bg) (Hp)	1,000 1,500	Friable brown gradational soils Shallow friable brown gradational soils Stony loam soils, uniform texture Organic loam soils, uniform texture Shallow organic loam soils, uniform texture (Peat soils, humified peat soils)	Open forest III Open forest IV Sub-alpine woodland/scrubland/open forest I (Alpine and sub-alpine vegetation)*	Mountain gum Alpine ash Snow gum
10	Hills and hilly ridge tops; basic igneous rocks	1,200--1,800	Higginbotham Connor's Plain Howitt Plains	(Hb) (Cp) (Ho)	1,000 $>$ 1,500	Brown gradational soil, fine structure Red gradational soils on basalt Shallow organic loam soils, uniform texture Organic loam soils, uniform texture (Peat soils)*	Open forest IV Sub-alpine woodland/scrubland/open forest I (Alpine and sub-alpine vegetation)*	Mountain gum Shining gum Alpine ash Snow gum
11	Hills and hilly ridge tops; siliceous sedimentary and fine-grain metamorphic rocks	1,200--1,800	Wongungarra Berrmarr (Sedimentary) Barry Mountains Cobbler Snowy Plains Mt Skene Buller (Sedimentary) Hotham Stanley's Name Speculation	(Wa) (Bc) (By) (Cl) (Sy) (Ms) (Bs) (Hm) (Sn) (Sp)	1,000 $>$ 1,500	Friable red gradational soils Friable brown gradational soils Shallow friable brown gradational soils Stony loam soils, uniform texture Organic loam soils, uniform texture Shallow organic loam soils, uniform texture (Peat soils/humified peat soils)*	Open forest IV Open forest II Sub-alpine woodland/open forest I Scrubland (Alpine and sub-alpine vegetation)*	Mountain gum Alpine ash Snow gum

Table 8 (contd.)

Map unit	Topography and rock type	Average elevation and range of land systems (m)	Land systems Name	Map symbol	Average annual precipitation range (mm)	Soils	Vegetation Structural forms	Predominant tree species
12	Steep hills; acid igneous & coarse-grain metamorphic rocks	0--1,200	Jingallala Tabberabbera Livingstone Yalmy Tubbut Wentworth Glen Wills Selwyn	(Jl) (Ta) (Ls) (Yy) (Tt) (We) (Gw) (Sw)	625 1,500	Coarse sand soils, uniform texture Massive gradational soils Yellow duplex soils Red duplex soils Red gradational soils Friable brown gradational soils Stony loam soils, uniform texture	Woodland Open forest I & II Open forest III Open forest IV Sub-alpine woodland, open forest I	White box Red stringybark Apple box Broad-leaf peppermint Silvertop Candlebark Narrow-leaf peppermint Alpine ash Snow gum
13	Steep hills; siliceous sedimentary & fine-grain metamorphic rocks	0--1,200	Eildon Bemboka Terlite--Munjie Cabanandra Cassilis Tabletop	(Ed) (Bb) (Tm) (Cd) (Cs) (Tp)	625 1,000	Massive gradational soils Stony loam soils, uniform texture Yellow duplex soils Red duplex soils Brown gradational soils Stony brown duplex soils	Woodland Open forest I Open forest II	Red stringybark Red box Long-leaf box Broad-leaf peppermint Candlebark
14	Steep hills; acid igneous & coarse-grain metamorphic rocks	1,200--1,800	Mt Misery Limestone Creek Davies Plain (Igneous)	(Mm) (Lc) (Dg)	1,000 1,500	Friable brown gradational soils Shallow friable brown gradational soils Brown gradational soils Organic loam soils, uniform texture	Open forest II Open forest IV Sub-alpine woodland/open forest I (Alpine and sub-alpine vegetation)*	Candlebark Broad-leaf peppermint Narrow-leaf peppermint Alpine ash Snow gum
15	Steep hills; siliceous sedimentary & fine-grain metamorphic rocks	1,200--1,800	Mt Delusion Enano Davies Plain (Sedimentary)	(Md) (En) (Ds)	750 1,500	Friable brown gradational soils Shallow friable brown gradational soils Brown gradational soils Stony loam soils, uniform texture Organic loam soils, uniform texture	Open forest II & III Open forest IV Sub-alpine woodland/open forest I (Alpine and sub-alpine vegetation)*	Candlebark Broad-leaf peppermint Mountain gum Alpine ash Snow gum
16	Undulating to flat; Quaternary alluvium, sedimentary siliceous & fine-grain metamorphic rocks	0--1,200	Swifts Creek Morass Creek Wonnangatta Traralgon Mullagong High Wandiligong Murray High Beloka Low Catherine River	(Sc) (Mc) (Wt) (Tr) (Mu) (Wg) (My) (Bl) (Cr)	625 1,500	Red-brown gradational soils Grey-brown loam soils, uniform texture Undifferentiated sand soils, uniform texture Dark calcareous clay soils, uniform texture (Yellow duplex soils)* Red gradational soils Yellow-brown gradational soils Friable red gradational soils	Woodland/open forest II Open forest II Open forest III	Mountain swamp gum Manna gum White stringybark Narrow-leaf peppermint Candlebark
17	Undulating to flat; basic igneous rocks	0--1,200	Mowamba	(Mw)	750--1,000	Brown gradational soils, fine structure Red duplex soils	Woodland/open forest II	Candlebark Snow gum Narrow-leaf peppermint
18	Undulating to flat; basic igneous rocks	1,200--1,800	Mt Jim	(MJ)	> 1,500	Shallow organic loam soils, uniform texture Organic loam soils, uniform texture	Sub-alpine woodland (Alpine and sub-alpine vegetation)*	Snow gum

* Soils and vegetation within brackets are usually present but occupy relatively small areas.

PART III

LAND USE

13. HAZARDS

Land is characterized by many governing factors, including climate, topography, geology, and living organisms. These, acting over a long period of time, have produced water regimes, soils, vegetation, and fauna that are closely associated with each other and differ according to the governing factors.

The different land types in the study area have all been altered to some degree since the first European settlement. This has been brought about by using the land for agriculture, mining, timber production, and recreation. The land has reacted in various ways according to its characteristics, and according to the particular type of use and management applied. Some land types are particularly sensitive to the changes being wrought upon them; others are less so.

The use of land may cause it to become more productive or less productive for a chosen use, and a land-use hazard may be defined as anything that threatens to reduce its ability to serve chosen purposes. The hazards associated with the management of land for various purposes are discussed below.

Physical Hazards

Soil Erosion and Stream Flow

Soil deterioration is a cost to the community, not only in terms of the direct costs involved in control and rehabilitation of soil erosion but also in the reduction of productivity of the land, deterioration of water quality, loss of capacity of water storages, and degradation of aesthetic values, quality of recreation, wildlife habitat, and other benefits that the land provides.

Soil conservation and water production are two basic aims of land management that may be adversely affected by land uses that cause soil disturbance and alteration of vegetation cover.

Vegetation and its litter enhance the development of a permeable soil surface and provide a barrier to overland flow, thus allowing more time for infiltration. Most water absorbed by the soil moves slowly through it to streams, promoting more regular stream flow and reducing the likelihood of damaging peak flows.

Vegetation and litter also protect the soil from temperature extremes that can lead to frost-heave or dessication, which create conditions favouring wind or water erosion. A well-vegetated catchment provides the best conditions for soil conservation, for a sustained yield of high-quality water, and for flood mitigation.

A statement of erosion hazard is an evaluation both of the probability that erosion will occur and of its likely severity.

The degree of tolerance to various kinds and intensities of use has a great influence on the type of use to which land may be put.

Four broad land zones that differ in their susceptibility to erosion may be recognized in the study area. These are the alpine, sub-alpine, mountain, and foothill zones.

Alpine zone

The vegetation of the treeless alpine zone is very sensitive to damage, and low temperatures during the cooler months retard vegetative growth and recovery. The erosion hazard is extremely high because the light and friable organic soils of this zone, once exposed, are subject to high-intensity precipitation and high-velocity winds. Bare soil tends to be kept in a loose condition by needle-ice, which also damages seedling regeneration.

The main summer uses in this zone are cattle-grazing, tourism, and other forms of recreation such as bush-walking. Cattle-grazing can contribute to erosion. Overgrazing of grasslands and herbfields can cause deterioration of vegetation, and trampling of mosslands can also result. It opens up the grassland and herbfield sward, exposing the friable soil in the inter-tussock spaces to erosion. Unless checked, these spaces will enlarge as erosion proceeds.

Revegetation is very difficult to achieve because of the short growing season for plants and generally harsh environment. What may appear to be slight deterioration of vegetative cover may be, in fact, serious when the slowness of recovery is considered. Infiltration and run-off are also adversely affected.

Trampling of stock in mosslands and drainage lines can result in channelling (which lowers the water table). As mosslands and the peat soils derived from them are dependent on a high water table, not only are the mosslands damaged but the peats can dry out and become susceptible to erosion. In some particularly sensitive areas in this zone, any grazing causes significant damage and such areas have been progressively withdrawn from grazing by the Soil Conservation Authority.

These include Mounts Bogong, Hotham, Loch, and Feathertop. The condition of other peaks such as Mounts Nelse, Spion Kopje, Fainter, Stirling, Skene, and Wellington is being regularly monitored.

Since 1946 the Bogong High Plains have shown marked improvement in vegetative ground cover, due largely to limiting cattle numbers and restricting the grazing period according to the growth conditions of each season.

Any earthworks in this zone can lead to serious erosion unless carefully constructed and maintained. All bare soil surfaces are subject to erosion and these must be treated in some manner. Road surfaces should be sealed or adequately paved with rock aggregate to prevent erosion. Bare soil on road batters and in toe drains and around ski-tows, lifts, and any other earthworks has a high erosion hazard and must be carefully revegetated.

Earthworks can greatly alter the drainage characteristics of soils. Normal surface and sub-surface water flow is intercepted by earthworks such as sidecut roads and becomes channelled. Flow velocity of this water also increases. Drainage water from slopes above roads and from the road surfaces - much of it channelled through culverts - must be carefully dispersed to avoid gullying or siltation, which may contribute to destruction of the mosslands.

Sub-alpine zone

Most of the sub-alpine zone vegetation consists of sub-alpine woodlands, but the open areas of this zone have similar vegetation to alpine areas. Recovery from damage can be slow at the higher elevations, where cold air drainage retards vegetation growth. Mosslands are particularly subject to damage. The predominant soils are organic loams with high porosity, excellent structure, and extremely friable or loose consistence.

Although the zone is subjected to low temperatures, high precipitation, and high-intensity rainfall, the erosion hazard is not as high as in the alpine zone because of the ameliorating effect of the trees on wind and on low surface temperatures. Nevertheless, careful control of grazing is still necessary to prevent soil erosion and protect water-supply characteristics. The provision of suitably placed watering points for stock assists in dispersing cattle and reduces trampling of mosslands and drainage lines.

Earthworks associated with roads, hydro-electricity works, and ski villages exist in this zone and in many instances also extend into the alpine zone. Soil erosion and sedimentation of streams can result unless roads and car parks are adequately surfaced and batters revegetated. The dispersal of water from earthworks requires careful planning and regular maintenance so as to safeguard stream flow and water quality.

Mountain zone

The alpine ash and mountain ash forests of the mountain zone are associated with deep organic loams at the higher elevations, but in general the soils are friable brown gradational soils. These are very permeable and are less prone to erosion than soils of the two higher zones.

Cattle usually graze in mature forests with grassy understoreys, but also graze in other forest areas where a ground cover of succulent herbs may be obtained for a few years following logging or fire. Grazing is less likely to cause erosion, but controls are necessary to discourage cattle from moving out of this zone and concentrating on higher areas where hazards are greater.

Major earthworks in this zone are associated with timber-production operations, which include roading, constructing fire access tracks, snigging logs, and loading these from dumps. Many roads and tracks are designed for infrequent or temporary use, and are consequently built to a minimum standard. Serious erosion can occur following the use of these roads under wet conditions.

Damage is not usually as severe, however, as that incurred in the alpine, sub-alpine, and foothill zones. Roads constitute a major source of concentrated surface run-off, and may contribute considerable sediment to streams during high-intensity rain.

These effects can be minimized by dispersal of drainage water from roads and snig tracks, bridging of streams, and breaching and barring of snig tracks at the completion of the logging season.

Total water yield from logged areas temporarily increases following harvesting, and surface flows usually increase together with an increased sediment load in adjacent streams. Disturbance associated with timber harvesting in mountain forests is, however, usually limited to about 2 years in a harvesting cycle of 60--80 years.

Foothill zone

Of the wide range of soil types found here, most are stable when well vegetated, but generally have a higher erosion hazard than the soils of the mountain zone. The predominant soils have relatively low permeability, and surface flows may occur more commonly than in other zones. Irregular high-intensity storms are the major eroding agent.

Vegetation varies from narrow-leaf peppermint forest through red stringybark forest to white box woodland. The average annual rainfall varies from 700 to 1,000 mm, and erosion hazard may be very high where annual rainfall is low, such as in the Omeo and Suggan Buggan valleys, and where soils are derived from coarse-grained parent material.

Grazing of cattle in this zone is usually restricted to drainage lines, creek flats, and lower slopes. Catchment efficiency is not likely to be impaired if control over stocking rates is exercised. Control is particularly important on the northern and western slopes, where the erosion hazard is highest.

The main earthworks here are roads and tracks. Run-off may become channelled along tracks and roadside drains and can cause considerable erosion that contributes to sedimentation and turbidity of streams. Careful attention to location, design construction, and maintenance of roads can minimize these effects.

Fire

Fire may also contribute to erosion, particularly where severe fires burn the vegetative cover and litter layer of the soil and expose it to subsequent water and wind erosion. The effect is most severe in the alpine and sub-alpine zones, where even the peat soils under mosslands may burn, and on dry steep slopes in foothill forests.

The term "fire hazard" refers to the quantity and flammability of vegetative materials. The fire hazard varies markedly within the study area according to elevation and aspects, but three main vegetation zones may be recognized.

Sub-alpine and alpine zones

Such country, usually above 1,350 m elevation, contains herbaceous to shrubby open areas, or stunted eucalypts with associated undergrowth. Fine fuels (plant material such as herbs, small shrubs, and small-dimension litter lying on the forest floor) of up to 50 tonnes per ha occur here. Lightning strikes are frequent at these higher elevations, and increased recreational use increaes the risk of fire from human causes.

Mountain zone

The mountain zone generally occupies land between 900 and 1,350 m. Fine-fuel accumulations vary from 50 tonnes per ha under mature eucalypt stands to almost nil under some young regrowth stands. Lightning strikes are frequent in this zone also, and the main risks from human activities are associated with recreation and logging operations.

Foothill zone

This zone is found mainly below 900 m elevation. Fuel quantities vary according to elevation and aspect. Sheltered southerly slopes carry fine-fuel accumulations up to 70 tonnes per ha, while accumulations on northern aspects may be as low as 10 tonnes per ha.

Topography plays a major role in fire behaviour, with steep slopes aiding development of convection columns and increasing the incidence of spot fires well ahead of the main fire front. Lightning strikes are common, and there is a fire risk associated with recreation and timber utilization. Burning operations by landholders on adjacent private property are a source of considerable fire risk in this zone.

Fire protection and control

Fire protection and control are important to land use in the study area. Severe forest fires apparently occurred in the study area before settlement. Regular fires in the early years thereafter were attributed to lightning and to grazing and mining activities. Prior to 1939, access was poor and fires such as those in 1851 often burnt unchecked for many weeks and covered large areas before rain extinguished them.

In January 1939, following a prolonged drought, the combination of numerous small fires and severe fire-weather conditions led to a catastrophic blaze that burnt through much of the study area. Since then extensive fires have occurred in 1951, 1952, 1961, 1964, and 1965, burning a total of some 260,000 ha in the area.

Lightning frequently causes fires, and statistics for the period 1964--74 have shown that lightning was the single major cause of forest fires in the area. Of 251 fires recorded, 54% (140) were due to lightning, 10% were due to escapes from burning operations on adjacent private property, 9% spread from campfires, and 7% were deliberately lit.

The Forests Commission, which is responsible for fire protection over almost all the area, seeks to control wildfires in the shortest possible time by early, accurate detection and rapid, effective suppression. Twenty-two fire lookouts within and adjacent to the study area, manned during the fire season, provide the basis for detection. Aerial patrols supplement the lookout system when necessary. The key to rapid suppression is access. This has been progressively extended by the construction of fire-access tracks and the retention, in strategic areas, of roads originally constructed for extraction of forest produce. Few areas are more than 5 km from this network of tracks and roads.

About 150 helipads have been constructed in remote areas, and most of the study area is within 50 km of an airstrip with facilities for storing and mixing fire-retardant chemicals. Aerial application of these often checks the spread of fire in remote areas until ground crews reach the site.

The severity and rate of spread of a fire depend partly on the amount of fuel on the ground. Fuel-reduction burning is practised in spring and autumn, both along strategic roads and tracks and on a broad scale using ground and aerial techniques. The extent of burning varies according to seasonal conditions, but averages some 25,000 ha per year. The grazing of cattle in the forests and woodlands also reduces fuel levels, which assists in subsequent control.

Floods

Although a highly productive watershed, the study area does not suffer seriously from flooding. High rainfall and shallow rocky soils are conducive to run-off, but several factors minimize the effects of flood discharges.

Most of the streams are steeply graded and have narrow valley sections, so high flows are well contained. Forests cover most of the area, retarding run-off and reducing peak discharges - spreading these over longer periods.

Significant areas of land have been cleared along parts of the Tambo and Mitta Mitta river valleys. Increased peak flows from these may contribute to bank erosion in those valleys. Further clearing of large sections of the study area would alter stream flow regimes and could lead to serious flooding effects on the flood-plains of streams outside the study area.

Biological Hazards

Fungi

The cinnamon fungus (*Phytophthora cinnamomi*) is a root-rot pathogen associated with dieback of eucalypt forests and understorey flora. It severely damaged a small area of mountain forest in the Gillingall area during 1970-71, but at these higher elevations it probably has a reduced potential to cause widespread damage because low temperatures inhibit its development. Also, most soils in the study area are well drained and evidence suggests that such soils do not favour the development of the fungus. Once soil has been infected, the fungus cannot be eliminated without incurring great expense and endangering the existing flora. Quarantine procedures appear to be the best way to control its spread to new areas.

Honey fungus (*Armillaria* sp.) causes butt and root rot in many forest trees. Infected trees are gradually weakened and often die. The fungus gradually extends from infection sites. Healthy trees are more likely to be infected following selection-felling operations where this fungus occurs because the tree stumps provide a ready source of food.

Pest Plants

A State-wide survey of noxious weeds in 1970 disclosed that 34 species of the 93 proclaimed noxious weeds were growing in the study area. Appendix 4 lists, for each descriptive block, the number of parishes in which each species has been recorded. Some proclaimed noxious weeds are widespread throughout the area; others are restricted to portions of it. Their importance is governed by the manner in which they affect the environment, the degree of infestation, and their ability to propagate and spread.

Weeds on agricultural land in the study area include great mullein, horehound, variegated, spear, and slender thistles, hemlock, thorn apple, blackberry, sweet briar, and St. John's wort. These can become a major problem if not checked. Pest plants on forested public land are usually found on sites that have been disturbed through activities associated with mining, timber-harvesting, and grazing. Clearings and roadside and streamside environs in particular often contain infestations of weeds.

In some areas, graziers have assisted the Lands Department in combating weeds on public land. The study area contains four species of particular concern: the blackberry, St. John's wort, sweet briar, and tutsan.

The blackberry

Widespread throughout the study area, the blackberry is prolific along many streamsides, tracks, and forest clearings at the lower elevations. It is a persistent plant due to its methods of reproduction and its prickly nature, which discourages animals from eating it or damaging its growth by trampling.

Its spread is attributed mainly to birds and mammals such as the fox, which eat the ripe fruit and spread the seed in their droppings. Many infestations grow in remote areas, where access is difficult and control by spraying is virtually impossible.

There is a great need to find some effective method of biological control specific to this plant. Its impenetrable tangle reduces or precludes access to streams for fishermen, bushwalkers, and other users of streamsides, reduces capability for grazing, and intrudes into natural landscapes. In some disturbed areas, however, it appears to stabilize stream banks.

St. John's wort

This perennial is gradually spreading in the study area. River valleys such as the Wonnangatta, lower Wongungarra, and lower Moroka valleys are heavily infested. The plant mainly spreads by seed, which can adhere to animals, be deposited in excreta, or be carried downstream to lodge on river banks.

Once established, St. John's wort crowds out many native herbs, and cattle that eat it can lose condition because their skin becomes over-sensitive to sunlight. It is partly for this reason that graziers in the south-western part of the study area favour black-coated Angus, as these are less susceptible than Hereford.

Biological control has been reasonably successful on farmlands and forest margins using the *chrysomelid* beetle, which feeds on the foliage. There is no effective biological control on much of the public land, however, as the beetle is apparently not effective in forest areas.

Sweet briar and tutsan

These are both berry-producing perennials. Sweet briar is widespread throughout the study area, often in inaccessible places, but it does not form thickets to the same extent as blackberry. Tutsan, however, forms dense masses adjacent to roadsides and in some areas, such as the Howqua valley, these have spread high up the hillsides making spraying unpractical, although it is at present the sole means of control.

Pest Animals

Animals inhabiting the public land in the study area that are declared as vermin under the *Vermin and Noxious Weeds Act* comprise dingoes, wild dogs, foxes, rabbits, hares, wombats, wild pigs, sparrows, and starlings. Brumbies and feral cats pose problems in some areas.

Wild dogs and dingoes

Both these predators are active in all sections of the study area, and in the past few years losses of stock, particularly sheep, on farmland adjacent to forest have increased.

Nevertheless, the larger native mammals, particularly wallabies and wombats, constitute the major part of their diet. They commonly carry the hydatid tapeworm parasite, and could possibly transmit this to Man or livestock. Control of wild dogs is by trapping - throughout the public land in summer and around the margins of private property in winter. Sometimes shooting and poisoning are also used as control methods.

Foxes

Fox habitats occur throughout the study area, ranging from alpine environments to dry woodlands. Foxes are opportunist feeders whose diet mainly comprises rabbits, sheep carrion, small native mammals, and insects. They are usually trapped, but are sometimes poisoned or shot.

Feral cats

These are also opportunist feeders. A recent survey in the Eastern Highlands indicated that feral cats rely heavily on small native mammals in forested areas. Introduced mammals, chiefly house mice and rabbits, also form an important part of the diet, while birds, reptiles, amphibians, and insects are comparatively minor sources of food.

Rabbits

Populations in the study area have been controlled by myxomatosis and poisoning. Control must be maintained, however, as rabbit populations have the ability to expand rapidly. They are most common on forest margins or in agricultural land, but are also found through forests and woodlands in small numbers.

Hares

These cause little damage to land, as their population densities are normally not very great. Their distribution in the study area extends to the Bogong High Plains.

Feral pigs

Although pigs are found in small numbers in some northern parts of the study area, control has kept populations low.

Wombats

These can be a problem where bushland adjoins farms because of their habit of digging holes under fences.

Sparrows and starlings

Both species have been recorded around settlements and agricultural land. Starlings are also found in adjacent dry open forest and woodlands, as well as in some alpine grasslands. They are aggressive birds that can take over the nesting holes of native species.

Brumbies

Brumbies are prevalent in the eastern part of the study area, particularly to the south of Cobungra station, and on the Nunniong Tablelands, Native Cat Tablelands, Davies Plain Ridge, the Cobberas area, Bogong Tablelands, and Suggan Buggan. A few are located in the Moroka basin. No general survey of numbers has been carried out, but estimates vary from a few hundred to about a thousand horses. These usually run in small groups, often consisting of a stallion with one to several mares and foals.

In some areas concentrations of brumbies damage sub-alpine mosslands and grasslands by trampling, and may compete with cattle for fodder. No reports of damage to fencing or crops by brumbies have been recorded in recent times. The Department of Crown Lands and Survey has the responsibility for issuing permits to capture the animals, but since 1966 it has ceased to grant these. Nevertheless, small numbers are still taken for pet food, or for stock or rodeo horses.

Insects

Many of the insects in the study area form part of the natural system, but some may reach plague proportions from time to time, or become a hazard to various land uses. For instance, large populations of biting flies may cause cattle on grazing runs to lose condition in their attempts to avoid the flies.

A number of insects pose problems to timber production. The spur-legged phasmatid (*Didymuria violescens*) has in the past defoliated considerable areas of forest in the Kiewa, King, and Howqua valleys and on the Mount Pinnibar plateau. Phasmatids attack alpine ash forests, with one complete defoliation sometimes killing trees, and also attack moist foothill forests of messmate, narrow-leaf peppermint, and various gums. These forests, however, generally recover. Control has been exercised by spraying the insecticide Maldison, but in some areas populations have decreased to normal levels without any control measures having been taken.

A number of other leaf-feeding or leaf-sucking insects feed on eucalypts during their larval or adult stages. Collectively these can reduce growth rates of young alpine ash seedlings, or even kill them. They include larvae of the sawfly (*Perga dorsalis*), paropsis beetles, scarab beetles, the gum-leaf skeletonizer (*Uraba lugens*), various leaf-hoppers (Eurymedidae), and other bugs (Hemiptera). The bug *Euander cicero* is abundant on litter in harvested areas and feeds on alpine ash seeds.

The ant (*Iridomymex itinerans*), an abundant and widely-distributed species, also harvests and destroys alpine ash seed.

Wood-boring and wood-destroying insects are also of concern. Wood-boring larvae of the Cerambycidae family (Longicorn beetles) and Xylorctidae in combination with defoliators (including paropsis beetles) were responsible for the die-back of 2,500 ha of snow gum at Davies Plain Ridge.

The major wood-destroying insect in alpine ash forests is the termite *Porotermes adamsoni*, which (because of its widely distributed galleries) renders trees unmerchantable. Control can be exercised by sound management techniques such as frequent thinings and prevention of physical damage to trees due to wildfire or adjacent logging.

The ambrosia beetle (*Austroplatypus incompertus*) can seriously degrade alpine ash and stringybark trees. This insect bores galleries through sapwood and heartwood. Wood adjacent to the galleries is stained by symbiotic "ambrosia" fungi. Some alpine ash stands on the Nunniong Tablelands are degraded by this beetle, but control is difficult, as little is known about its ecology.

Patches of dead snow grass that appear in alpine grasslands are often caused by two insect species. These are the alpine case moth (*Plutorectis caespitosa*) and the alpine grass caterpillar (*Oncopera alpina*), which feed upon snow grass.

Stream Pollution

Pollution of streams is not a great problem in the study area.

High turbidity levels after heavy rains are associated with agricultural land in the Omeo, Benambra, and Swifts Creek areas, where annual rainfall is relatively low.

Any use that disturbs soil or increases water run-off rates can contribute to stream turbidity. In many instances, however, careful control can minimize effects.

Some minor streams in the Bingo-Munjie locality, an agricultural area, show evidence of eutrophy due to high nutrient levels.

Pollution from domestic sullage and sewage wastes is a problem that must be met in alpine villages. Sewage treatment plants designed to cope with peak demand are necessary to prevent significant pollution. Septic tanks are seldom satisfactory because alpine and sub-alpine soils are close to saturation in winter and spring, and low temperatures inhibit the build-up of bacteria that break down solids.

Thermal pollution of streams, although not currently a hazard in the study area, can damage aquatic faunal communities - either through high temperatures due to the removal of shade by harvesting timber along streamsides, or through low temperatures due to construction of deep-water storages from which water is released at low levels in the water body.

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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 of conservation 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 food, fibre, and minerals. In some cases these activities also depend on native species.

Ecology

Irrespective of their particular interests, all conservationists are basically concerned with environments and their use. The environment has both spiritual attributes, such as inspiring landscapes and remoteness, and physical ones such as topography, timber, and minerals.

Its character results from the integration of factors including climate, topography, soils, and vegetation, which have been discussed in preceding chapters.

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 highly 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:

(i) inhabit a common environment
(ii) interact either directly or indirectly with each other (especially through food chains)
(iii) 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 fairly 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 climatic conditions.

Different systems have varying degrees of stability. The more stable often tend to be those containing the greater variety. In some of the most vulnerable, stability depends on a particular set of circumstances such as specialized vegetation; others may have inherent topographic, soil, or hydrological weaknesses.

The influence of Man

Man is an important part of most world ecosystems. He is only one of many species, but his dense and rapidly growing centres of population and his ability to manipulate other species and parts of his physical environment make him very influential. He has affected - either directly or indirectly - all parts of this study area. Pressure of grazing by rabbits or domestic stock and the invasion by exotic plants have changed the original vegetation in many areas.

Timber-harvesting has changed much of the virgin forest, while the fire regime has been greatly altered. The network of access tracks is such that few parts of the area are further than 5 km from the nearest vehicle track.

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

Man must provide himself with adequate supplies of food and fibre, many of which he can best obtain from artificial systems such as wheat farms and softwood plantations. He must manage such systems in a way that allows the combination of introduced plant and animal species to maintain general stability within the soil, topographic, hydrological, and climatic systems, just as the original natural combination did.

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

Conservation Needs

Some of the types of land required to satisfy the needs of nature conservation are 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 set aside 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 necessarily requires a monopoly of the land. Often they are compatible with each other or with commercially productive uses.

Areas for reference

Continued studies of natural features and their dynamics increase our knowledge of the ecological laws and processes on which Man's survival may ultimately depend.

Viable and relatively undisturbed examples of all land types (differing in land forms, soils, or biological communities) need to be set aside as reference areas to which those concerned with changing and managing land for either productive or aesthetic uses can refer when trying to solve the resultant problems.

Reference areas, therefore, act as standards against which the progress and effect of human alteration and utilization of the land can be measured. They will also provide a valuable gene pool of plant and animal species. Such genetic material is already being used, and will be increasingly used, to endow species with advantageous characteristics.

In common with references and standards used in other fields, these areas must not be tampered with, and natural processes should be allowed to continue undisturbed. Access should be restricted and experimental manipulation should not be permitted.

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. Few, if any, areas suitable for reference remain for some land types in the study area, such as those in the Morass basin. Conscious effort must be made to retain reference areas in suitable remnants representing other land types now mostly developed.

Park areas

Other examples of each of the major land types and their biological communities are also required for less restrictive inspirational, 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 that their naturalness may be impaired as little as possible. Limited areas such as information centres, however, may be intensively used.

Parks may contain primitive areas suitable for solitude, inspiration, and primitive unconfined forms of recreation. On the other hand, smaller parks are of particular importance to regional populations. Higher densities of visitors are permitted and so the naturalness correspondingly declines. These parks still provide opportunities for contact between Man and nature, however, and serve the important function of reducing the pressure of visitors on more restricted parks.

Education areas

Education in the components and functioning of ecosystems is an important step in the conservation of natural resources. It is becoming increasingly important, both as a 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 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.

Nature, however, is to be experienced through all of the senses, and components should be collected, where necessary. In some circumstances laboratory facilities and associated accommodation are needed so that successive groups can undertake long-term studies. As these activities may not always be compatible with full preservation, some land will need to be set aside especially for education.

Endemic and endangered species

Each 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 our environment. Many people feel that Man also has a moral responsibility to avoid endangering species.

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

Those endemic in the study area, and threatened species, must receive high priority for preservation. Endemic plants are listed in Chapter 9.

Appendix 2B lists these and other significant plants in the study area for each block.

None of the vertebrate animals recorded in the study area are endemic to it, but three mammal species (the mountain pigmy possum, smoky mouse, and broad-toothed rat) and three fish species (The Australian grayling, Macquarie perch, and trout cod) are considered to have threatened status.

Special values

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

The occurrence of a species near the limits of its distribution is of particular scientific interest. A number of both plant and animal species mentioned in Chapters 9 and 10 respectively reach these limits within the study area.

Some species, such as cave-dwelling bats, favour certain areas as breeding or sheltering sites. Others - nomadic or migratory animals - favour areas as resting places; for example, waterfowl use Lake Omeo during their movements.

Some areas provide particularly good examples of a geological feature or process, for instance the sequence of interbedded sediments and volcanics exposed at Snowy Bluff or the periglacial rock rivers at Mount Wombargo.

The scientific naming of plants and animals is an important criterion in research. It involves accurate identification of specimens, preferably to species level. Particular specimens are used as a basis for the naming of distinct groups.

The single specimen selected by an author as being representative of a particular group in the original description of a species is known as the holo-type, and the locality from which the type is collected is known as the type locality. Comparative material from such localities may be required when referring to or revising single species or groups of species.

Mount Cobberas and Mount Buller are two areas in particular where a number of type specimens have been collected.

Small areas

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

Since these small areas of public land often still bear, perhaps in a modified form, their original vegetation, they make a contribution to regional character out of all proportion to their size.

Productive areas

Some native species are valued for direct use. Game-hunting, a popular form of recreation, depends on the reliable supply of native ducks. Much of the native flora provides honey, and wood is obtained from many species, mainly eucalypts.

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 to be conserved, the degree to which the area can be managed, and the extent to which influences that tend to upset the natural balance can be controlled.

Large consolidated reserves have less perimeter relative to their area than small or irregular ones, and so tend to be better-buffered against the effect of intrusive factors. Communities that exist in more variable climatic zones - prone to drought, floods, or fire - usually require larger areas (or more examples) set aside to ensure survival.

Careful management may enable small areas to remain viable. Management may take the form of using controlled fires to change vegetation, 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 considerations of viability, many other factors influence the selection of areas for nature conservation. Land is a limited resource, and good planning requires compatible uses to be grouped together on one area if possible. Where possible, a single reserve should cover a number of land types.

The migratory and nomadic existence of some animals requires corridors of habitat - linking, for example, breeding and feeding grounds.

Such corridors may be left intentionally through areas used for agriculture or softwood production, and they may even be used for a number of other purposes such as hardwood production. In some cases, few alternatives are available, as only remnants of the natural systems remain. Where they exist, areas with natural boundaries such as watersheds should be selected, as they are usually easier to manage and maintain.

Probably, in practice, a balanced system of nature conservation will include a few big areas in which the major communities and land types are represented, supplemented by a greater number of smaller areas that are more intensively managed for a particular purpose.

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15. RECREATION

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

The public land in the alpine study area constitutes a significant resource for many types of recreation, particularly snow sports, adventure driving, fishing, and bushwalking.

Some places, particularly those closer to Melbourne, are showing evidence of over-use. Others have considerable potential to meet increased demands.

Recreation Environments

Several broad recreation environments may be distinguished on the public land. Each offers a different range of recreation experiences and the characteristics that determine the range are briefly outlined below. Map No. 8 indicates the pattern of these environmental zones.

Including all land above the tree line (about 1,600 m), the alpine zone is a high-altitude environment characterized by frequent snowfalls in winter and mild to cool summers. Weather conditions can deteriorate very rapidly at any time of the year, particularly during the cooler months, bringing discomfort and even danger to the unprepared. Blizzards are common in winter, and fog rolling in over snowfields quickly produces "whiteout" conditions that can threaten one's safety. Even in summer, frosts and fogs are not uncommon while thunderstorms can be frequent. Because of the high altitude, losses of body moisture can be considerable. The risks associated with this type of climate enhance the attractiveness of this zone for some.

Of prime importance, however are the attractions of the snowfields for snow sports and the natural, often dramatic, landscapes of this zone. Low vegetation, providing massed displays of showy flowers in summer, clothes high ridges, peaks, and rolling plateaux. Fauna includes birds typical of lowland grasslands, numerous and varied insect populations, and small ground-dwelling mammals.

Unfortunately the attractiveness of this zone can be easily marred because soils and vegetation are sensitive to any disturbance such as that caused by trampling, and crushing or compaction by vehicles.

The sub-alpine zone, ranging from about 1,000 m up to about 1,700 m, has a milder climate than the alpine zone, with snow persisting for a few months each year. Heavy snowfalls produce a winter wilderness by covering roads, tracks, and other earthworks.

Some shelter from strong winds is afforded by woodlands. These are predominantly composed of snow gums and mountain gums, which, when stunted and gnarled, are particularly appealing. Variety is added by the interspersion of sub-alpine meadows, where showy flowers provide colourful displays in spring and early summer. Birds such as the flame robin and mammals such as the grey kangaroo and wombat provide additional interest for the visitor.

Soils and vegetation are still relatively sensitive to disturbance, particularly in open areas and on steep slopes. The effects of severe fires in snow gum areas remain evident for many years.

The montane forest zone receives moderate to light snowfalls in winter and typically carries tall forests of alpine and mountain ash, which range from about 800 m up to about 1,400 m in elevation. Understoreys vary from grassy to gully-type vegetation. Unobscured views are rare, and walking in some areas may be impeded by dense undergrowth. Birds are often difficult to observe, but large mammals such as the wombat and black wallaby are readily seen. Soils and vegetation here can withstand recreation pressures better than in other zones.

The moist foothill forest zone, situated below about 1,100 m elevation, is characterized by relatively open forests of narrow-leaf peppermint except on the more sheltered and wetter sites, where forests are taller, denser and more shrubby.

Particular features include the wattles flowering in spring, a wide range of readily observed forest-dwelling birds, and common occurrences of grey kangaroos, black wallabies, and wombats. Soils resist compaction reasonably well in most areas.

Steep, dry slopes bearing short trees are typical of the dry foothill forest zone. Understorey shrubs are attractive when in flower, and birds can be readily observed. Soils are shallow, often stony, and prone to erosion.

The dry woodland zone is limited to the rainshadow valley of the Snowy and Suggan Buggan Rivers, where woodlands of white box and cypress pine predominate. Birds and mammals here are typical of dry woodlands and contrast with fauna of nearby mountainous areas. Soils are particularly sensitive to disturbance.

The riverine zone is especially sought-after by visitors for many different types of recreation as it includes major permanent streams and their environs.

The streams provide opportunities for canoeing, fishing, swimming, and their environs for activities such as nature observation and camping.

Vegetation often consists of tall manna gum forests on river flats, but may be low and scrubby in dry rocky areas (such as along the Snowy River).

Birds and mammal populations are usually plentiful and varied in this environment. Soils vary from relatively resistant to recreation pressure to sensitive, as for example in swamp gum woodlands.

Natural lakes are few. They include Lake Tali Karng and smaller water bodies, as well as Lake Omeo, which, when full, has a surface area of about 700 ha.

Man-made lakes include Pretty Valley Pondage, Rocky Valley Pondage, and others in the Kiewa Scheme. Dartmouth dam, at present under construction, will be one of the major inland water bodies in Victoria. The various water bodies offer recreation opportunities that can differ considerably.

The main areas of agricultural land are in the Omeo--Benambra--Swifts Creek region, and on the Wulgulmerang Tablelands.

These cleared areas contrast with the predominantly wooded landscapes of the study area. Topography varies from flat (around Benambra), through gently undulating (at Wulgulmerang), to steep (for example, near Licola). The major roads pass through this zone.

Activities

Recreation driving

Recreation driving may involve four-wheel-drive or two-wheel-drive vehicles, trail bikes, or road bikes. The type of vehicle used depends on the accessibility of an area and the recreational experience desired. Driving may have any one of several prime aims - such as touring, visiting sites of special interest, or testing driving skills - but is often associated with other pursuits - such as camping, fishing, walking, and photography. Sometimes vehicles merely provide the means of access to an area where a particular recreational activity can be enjoyed.

Access in the study area varies from sealed highways to jeep tracks. Most users, apart from bike-riders, appear to travel as families. The area receives most use from spring through to autumn, the most popular times being at weekends and on public holidays, including long weekends, Easter, and Christmas. Some users are organized clubs and their trips may include travel by convoy from an assembly point, although at other times club members arrange their own independent excursions. Many participants, however, do not belong to clubs.

The area to the west of the Dargo High Plains - the region closest to Melbourne and the Latrobe Valley - is most often used by many enthusiasts, but others such as north and east of Omeo, also receive moderate usage. Commercial four-wheel-drive safaris operate from Mount Beauty, Omeo, Heyfield, and Melbourne.

The capability of an area to attract people with four-wheel-drive vehicles or trail bikes is based on many factors such as remoteness, steepness of terrain, challenging tracks, scenic views, wildflower displays, and opportunities for canoeing, fishing, exploring historic sites, and fossicking.

In some cases, users of remote areas consider that frequent encounters with other vehicles, bikes, log trucks, or other visitors (such as bushwalkers, fishermen, and campers), degrade the quality of the experience.

The most obvious hazard associated with recreation driving is the erosion of track sections, particularly when these are wet or excessively dry. The hazard potential could be reduced by closing tracks in highly sensitive areas, controlling use when tracks are most susceptible to damage, and re-routing or otherwise improving tracks. Most of the measures are currently being implemented.

Off-road use without the written permission of the land management authority contravenes the provisions of the *Land Conservation (Vehicle Control) Act* 1972, and almost invariably damages the vegetation and soils.

Demand for areas for four-wheel-driving is expected to increase with increase in disposable income and the tendency for families to own more than one vehicle. The rate of increase in trail-bike riding is expected to decline, but may be sustained for some time yet as these machines are relatively cheap to buy and use.

The network of fire-access tracks is close to completion, and any further access would be mainly provided in the form of logging roads.

Motor-touring in summer is facilitated by through-roads that in many cases have been upgraded for tourist purposes. The principal routes used are the Licola--Jamieson road, the Harrietville road to Omeo via Mount Hotham, the Dargo road, the road from Falls Creek over the Bogong Tablelands, the Benambra--Black Mountain road, and the Omeo Highway. The Mount Buller road and Tamboritha road on the Bennison Tablelands are well used also. The Jindabyne--Buchan road will shortly be re-opened following its closure because of storm damage.

Cross-country skiing

This activity embraces day trips from nearby holiday accommodation or from homes, overnight trips to huts or snow camping, langlauf racing, and ski-orienteering. Few skiers using vehicles to get to snowfields are prepared to walk for more than 2--3 hours to reach areas suitable for skiing. At present most cross-country skiing is done on the Bogong Tablelands (around Falls Creek particularly), the Mount Hotham--Mount Loch area, and the Baw Baw plateau (Melbourne study area). Other areas such as Mount Skene, Mount Stirling, The Bluff, Mount Howitt, Bennison Tablelands, Mount Feathertop, and the Dargo Tablelands are also used. Large areas have potential for this sport. As well as those already mentioned, they include the Nunniong, Paw Paw, and Native Cat Tablelands, Davies Plain Ridge, Mount Phipps area, Moroka area, and Howitt Plains plateau.

Cross-country skiing has a longer season than downhill skiing, and different land requirements. Areas above 1,500 m are generally suitable, and those between 1,200 and 1,500 m are suitable after heavy snowfalls. Above the tree line there is usually good skiing in winter and spring.

Areas of dense heathland require deeper snow cover than herbfield or grassland. Snow gum woodlands and sub-alpine plains generally provide good skiing and afford more shelter in bad weather. Snow gum forests and thickets are more difficult to negotiate, and alpine ash forests are suitable for skiing only after heavy snow-falls. The best topography for touring is flat to undulating or rolling country. In heavily dissected terrain skiing is usually confined to ridge-tops and spurs. Steep country is generally avoided.

This activity is growing rapidly, although the number of skiers is still small relative to downhill skiers. Its growth rate is likely to be sustained for some time because it costs relatively little, a number of suitable areas are reasonably accessible, and it is more enjoyable for novices than downhill skiing. Conflicts with other uses are few, but construction of refuge huts or other over night accommodation and marked trails may conflict with some forms of summer recreation.

Some ski-tourers advocate the erection of a system of refuge huts, while others fear that this will in fact actually increase the risk of serious accident, as well as encourage over-use of bushwalking areas in summer.

Downhill skiing

The only opportunities for downhill skiing on the Australian mainland are in the Victorian eastern highlands and in the Kosciusko National Park, New South Wales. In 1974, Victorian ski resorts received an estimated 330,500 separate visits. The three in the study area - Mount Buller, Falls Creek, and Mount Hotham - accounted for 70% of these. Mount Buffalo and Mount Baw Baw, outside the study area, accounted for the remaining 30%.

Resorts in New South Wales also cater for a substantial number of visitors to snowfields. In 1974, it was estimated that about 97,000 separate visits were made to ski resorts serviced by the Kosciusko road during the ski season. No figures are available for Thredbo Village (which receives a high proportion of Victorian visitors), but it can accommodate 1,630 overnight visitors, compared with a total of 2,560 visitors at ski resorts served by the Kosciusko road.

In Victoria, the largest ski resort (Mount Buller) caters mainly for Melbourne visitors, a high proportion of whom visit the area on weekends. In peak periods, Falls Creek caters for about 2,000 overnight visitors and 4,000 day visitors from nearby low-level accommodation. Visitors come from all over Victoria and from South Australia and southern New South Wales. Mount Hotham caters mainly for experienced skiers originating from Melbourne, local communities, or interstate.

Visitor-bed capacity in the various resorts in New South Wales in 1976 totalled 4,335. Table 9 shows the locations of the Victoria total of 8,050 visitor beds.

Growth of downhill skiing

The number of separate visits to Victorian ski resorts during the snow season grew at an estimated 14% annually, from 1971 to 1974 inclusive.

Existing ski resorts vary in their capabilities to cater for the increasing demand. The location of the user population and the future mix of skier categories are two main market components that should influence the development of facilities.

Table 9

SNOWFIELD ACCOMMODATION (1976)

Resort	No. of visitor-beds
Mount Buller	4,325
Falls Creek	2,035
Mount Hotham	1,120
Mount Baw Baw	325
Mount Buffalo	245
Total	8,050

The main user market in Victoria is likely to come from Melbourne, Albury--Wodonga, and the Latrobe Valley.

In Victoria, the lift-serviced slopes at existing resorts, taken as a whole, can cater for a skier population in the proportions of beginner 29%, novice 28%, intermediate 35%, and advanced 8%.

Planning to meet the expected growth in demand for snow-based recreation must consider the snow resource as a whole, and take into account the intrinsic development potential of each area, together with the market requirements.

Plans for the existing resorts are as follows. In New South Wales the design limits for the resorts are based on ski-slope capacity. Existing access, however, may act as a more severe restraint than this criterion. The limits at present are set at 7,635 overnight visitors (currently the resorts contain 4,335 visitor-beds) and 21,050 day visitors for the five main resorts. In Victoria, plans for development at Mount Baw Baw and Mount Buffalo (both outside the study area) recognize the limited potential in these areas.

Mount Buller at present has a full range of slopes from beginner to advanced. Its total existing capacity of lift-serviced slopes is calculated to be 4,160 skiers at any one time. This is fully utilized during the peak periods. Opportunities exist for the creation of 122 ha of new ski slopes at Corn Hill, making a total of 244 ha. An expansion to 4,700 visitor-beds from the existing level of 4,325 would be required to meet the resultant increased capacity.

Falls Creek had 2,035 visitor-beds in 1976, and a limit of 3,000 beds has been set. The resort has extensive novice and intermediate slopes, but virtually no beginner or advanced slopes. Its estimated capacity of lift-serviced slopes is 1,540 skiers (on slopes and lifts and in queues).

Mount Hotham has limited beginner and novice slopes, but has a large potential for intermediate and advanced slopes. Its estimated existing capacity of lift-serviced slopes is 770 and it contained 1,120 visitor-beds in 1976. Expansion of accommodation and facilities is currently under review.

A report by a consultant firm recommends a maximum overnight design population of 3,500 people (about 3,250 visitor-beds) and facilities to cater for 3,500 downhill skiers, 1,000 cross-country skiers, and 1,000 other visitors.

New areas

A number of new areas have potential for development, some of which could be developed in conjunction with existing resorts. The ski slopes should encompass the full range of downhill skier classes and be at sufficient altitude to ensure a reliable, long-lasting snow cover.

Sheltered slopes should be available, as well as a variety of aspects to provide good snow conditions under various climatic conditions. Other major considerations include location relative to the main population centres, access, parking facilities, environmental effects, and potential conflicts with other uses and values.

The location of associated accommodation is also important. With the exception of Thredbo, Tatra, and Baw Baw (which are at the 'snow line'), all alpine villages are above the regular winter snowline. Their elevations vary from 1,370 m at Falls Creek to 1,750 m at Hotham Heights. A number of low-level centres (such as Bright and Harrietville) currently provide accommodation for day visitors to the snowfields.

Low-level villages, well below the snowline, are an alternative to high-level villages. It is argued that they pose less environmental hazards, are less costly to develop and maintain, are more accessible from population centres, and provide a year-round tourist attraction, because facilities for tennis, bowling, golf, and other forms of recreation can be more readily provided.

Disadvantages that are cited include the physical problems and expense of transporting large numbers of skiers to and from the slopes, particularly in the event of adverse weather, and the continuing need to provide staff accommodation and many services such as shelters, medical facilities, toilets, and eating facilities at the snowfields.

Advantages given for high-level villages include the preference of many visitors to live in the snow for a number of reasons, such as the complete change of living environment and the convenience of nearby accommodation.

Disadvantages include the high cost of facilities and services (for example, water supply, sewerage, garbage disposal, electricity supply), the environmental hazards and conflicts with other uses, the difficulty of access, and the limited season of use. Adequate planning may overcome many of the objections to high-level villages.

Some of the areas that have been suggested by various sources as having potential for development as ski resorts are discussed below. This section of the report does not discuss other potential uses of these areas, however. Possible broad environmental effects of any development are treated in chapter 13.

The potential areas for development can be expressed in terms of ski-slope capacity, and the numbers cited below include only those people skiing down the slopes at any one time (about 25% to 33% of total ski capacity).

Mount Stirling has a wide variety of slopes in the three main skier categories (beginner, intermediate, and advanced) with some suitable for skiing in most weather conditions. Access is from Mirimbah, and ski slopes would be an average of about 3½ hours travel time from Melbourne. It has an estimated ski-slope capacity of 4,200. The area could be developed to complement the facilities at Mount Buller. Overnight accommodation could be provided at the snowfields or further west in the Delatite River valley.

Mount McKay has an estimated ski-slope capacity of 2,000. It can be reached (via the Falls Creek road) within about 5 hours from Melbourne and 2 hours from Albury. The area could be developed in conjunction with Falls Creek.

Bakers Spur development would involve new road construction for access. The estimated average travel times are about 5 hours from Melbourne and 2 from Albury. The area contains extensive slopes (ski-slope capacity 4,600) with a wide variety for all skier classes. Slope aspects also vary. Overnight accommodation could be provided at the snowfields.

Cobungra Gap--Mount Loch would need costly provision for access, involving the upgrading of the West Kiewa road and extension of this to link with the Hotham--Omeo road.

Average travel time from Melbourne would be 5 3/4 hours, from Albury 2 hours, and from the population centres in Gippsland 4½ hours. A range of slopes, particularly for intermediate and advanced skiers, add up to a total ski-slope capacity of 2,700. This area could be developed in conjunction with Mount Hotham. Overnight accommodation could be provided near the snowfields.

Mount Fainter would necessitate costly construction of access roads. Average travel time would be about 5 hours from Melbourne, and 2 hours from Albury. Ski-slope capacity is estimated at 3,100 - catering mostly for intermediate and beginner skiers.

Bungalow Spur has some potential. Proposed access is from Harrietville via a 'low-profile' cabin lift installed along a steep gully. Travel from Melbourne to Harrietville takes about 4½ hours, and from Albury about 1½ hours. A 'core area' of mainly intermediate-class slopes on the south side of the Spur could cater for an estimated 2,760 skiers (on slopes, lift, and queue).

This area could be extended into skiing bowls to the north and east to cater for a total of 7,000 skiers.

Mount Bogong has extensive snowfields with long downhill runs. Slopes could cater mostly for advanced skiers; those suitable for intermediate skiers and beginners appear to be limited.

Access would be costly to construct. Average travel time from Melbourne would be about 5 hours and from Albury about 2 hours.

Ice climbing

Some mountains in the study area present considerable challenges to bushwalkers who visit the study area in winter. Alpine mountaineers may also use the more difficult terrain for practice before climbing higher and more rugged peaks in New Zealand or elsewhere. A growing number of adventurers find appeal in conquering the snow- and ice-covered slopes of such features as Mounts Feathertop, Bogong, and Buller and The Bluff and Crosscut Saw. Equipment such as ropes, ice axes, and crampons is often necessary. The technical difficulty of climbing on ice or snow, the hazard of adverse weather, the sense of isolation, and the beauty of the winter landscape combine to give a sense of adventure.

Wilderness recreation

A growing number of people seek wilderness recreation. This involves the perception of being part of nature, of an environment unaltered by human intervention, of isolation, and of being exposed to the challenge of the elements. In a wilderness, Man is seen to function as a part of the natural system, and on equal terms with nature. Wilderness activities include canoeing, hiking, and cross-country skiing.

The main elements of the appeal of wilderness are:

* spiritual refreshment and an awareness of solitude arising from close contact with the uninhabited, undisturbed natural environment

* the knowledge that large wild natural areas, unaltered by Man, exist and can be experienced

* refuge from the pressures, sights, and sounds of modern urban life

* the adventure and challenge of putting one's powers of endurance and self-reliance to the test in an undisturbed natural environment

Wilderness, therefore, requires land that still retains its primeval character, and is without improvements or human habitation. Spaciousness is an added characteristic essential to distinguishing Wilderness Areas from the many other smaller undisturbed or primitive areas that may be found as "islands" even in zones that have been developed for more intensive uses. These smaller areas can provide some degree of solitude, but many wilderness users regard them as an inadequate substitute for their requirements.

Large areas at the higher elevations in the study area provide a wilderness experience in winter, due partly to the thick mantle of snow that covers tracks and other signs of Man's activities and partly to the challenge of travelling and surviving in difficult terrain under adverse weather conditions. In summer, however, the opportunities are limited. Few areas are very far from roads or tracks and vehicular use of these is increasing. Even where no vehicular tracks reach, opportunities for wilderness recreation may be low. For example, some high ridges and peaks may be popular walking routes traversed by many people, and sometimes they afford extensive views of nearby agricultural land.

Areas that appear to be well suited for wilderness recreation have few or no tracks, are little-used at present for recreation or other purposes, are difficult to traverse, and have few or no views to obviously altered landscapes.

The headwaters of the Avon, Tambo, and Buchan Rivers and the Davies Plain area, for example, have most or all of these characteristics.

Bushwalking

Several types of bushwalking can be identified: short walks for pleasure, nature observation, or to visit sites of interest; half-day or one-day hikes; and overnight and extended hikes. Walking is sometimes associated with activities such as fishing, rock-climbing, and other adventure activities.

The growth in club membership and the creation of new clubs indicate that bushwalking has regained its pre-war popularity. In Victoria, it has been closely linked with the mountains, particularly for overnight and extended hiking. The alpine study area and part of the adjacent Melbourne study area form a large - and probably the most popular - proportion of the country used for bushwalking in the State. The alpine walking track from near Walhalla in the Melbourne study area to the Australian Capital Territory passes through the study area.

Requirements for bushwalking are varied. They include campsites close to streams or springs, features of interest, and panoramic views of essentially natural landscapes. Untracked areas with these characteristics are valued highly.

Areas that receive most use at present are the Bogong Tablelands and associated peaks and areas in the western section of the study area such as the Howqua, Jamieson, and King River valleys, the Great Dividing Range and environs from Mount Skene to Mount Hotham, the Macalister, Wellington, and Wonnangatta River valleys, and the Bennison Tablelands. The Cobberas Range and Suggan Buggan area in the far east are also very popular.

Horse-riding

A few commercial enterprises conduct horse-riding tours, mostly during the warmer months and for several days at a time. One such enterprise is based near Merrijig and another at Valencia Creek. The areas visited include the Howqua River, Mount Howitt, Howitt Plains, Bennison Tablelands, and the Wonnangatta valley. Stables catering for this type of activity also exist at Mount Beauty, Omeo, and Mitta Mitta. Privately organized riding tours are gaining popularity and a National Horse Trail, which passes through the study area, has been proposed.

Hunting

Rabit- and fox-hunting are common around small settlements and private property. The most significant form of hunting on public land in the area is for deer.

The main species hunted, the sambar deer, tends to be a solitary rather than a herd animal. It is hunted throughout its known range in the alpine area, embracing all but the far north-eastern section. The territory most frequently hunted covers all that area west of Mount Baldhead, Cobungra, and Harrietville.

Red deer are mainly confined to the east of the Tambo valley. They are few in number and hunting activity is low.

Animal movements are dictated by availability of food plants, water, and shelter. During the warmer months, sambar deer may be found at the higher elevations in alpine ash forests as well as in the valleys. In winter they usually occupy valleys and gullies below the snow line. Both deer-stalkers and shooters using hounds operate mainly from May to September. Hunters use the system of roads and jeep tracks for access, but some walk considerable distances to hunting areas. It is estimated that at present about 2,000 deer-hunters use the area. Most go out on weekends and long weekends during the season.

Hunting for ducks takes place at a few localities in the study area such as around Gelantipy, Morass Creek, and the Tambo River.

Fishing

Most trout streams in eastern Victoria have their source in the study area, which contains a high proportion of all trout-angling streams in the State. All rivers and even quite small streams in the area are suitable for fishing. Many anglers consider that access is adequate to meet their requirements. Distance from home, however, and the presence of impenetrable blackberry thickets limit use of some streams.

Fishermen may visit the area as individuals, in small groups, or with angling clubs. One-day visits for this purpose are popular, but fishing may often be associated with camping or other activities over long periods.

Victoria contains an estimated 150,000 to 200,000 fresh-water anglers. Perhaps 30--40% of these would use the study area at some time or other during the year. Streams closer to Melbourne - such as those in the Goulburn and Macalister River watersheds - are frequently fished. Most north-eastern streams - such as the King, Buffalo, Buckland, Rose, Ovens, Kiewa, and Mitta Mitta Rivers and the Thowgla and Nariel Creeks - are also regularly used. In the Omeo district many tributaries of the Mitta Mitta are popular for the sport.

The best fishing conditions usually occur from December to mid February and then again in April, and most fishing is done between September and April.

Most streams are dominated by populations of introduced brown and rainbow trout, which provide the great bulk of the quarry. Small populations of native sporting fish remain in a few streams - Murray cod in the lower Kiewa River and Murray cod, trout cod, and Macquarie perch in the lower Mitta Mitta River. Blackfish live in many streams in small numbers. Grayling are present in the Tambo River headwaters but their distribution is not well known.

Canoeing

White-water canoeing involves both one-day and overnight trips. Activities include racing, slalom, and touring.

For canoeists, the major importance of streams in the study area is that they provide water for the popular canoeing rivers outside it. Therefore maintenance of water quality and flow in mountain streams is of prime concern. Many streams in the alpine area are blocked with trees or blackberry bushes. Others - such as the Wongungarra, Dargo, and Wonnangatta Rivers - can be used during high flow periods, which occur mainly in winter and spring.

Some streams are regularly used. These include the Barkly and Macalister Rivers (in winter and early spring); Delatite, Howqua, and Jamieson Rivers (spring and periods during the winter); the Mitta Mitta River (about 50 km of this stream will shortly be flooded by the Dartmouth dam); and the Snowy River.

The potential of streams in the area is almost fully realized, as access to streams is adequate, other than after exceptionally wet periods.

This sport is a growing one, and the more popular and accessible streams in Victoria are expected to cater for most of the demand. Opportunities for flat-water canoeing exist at Rocky Valley pondage and other lakes. The Dartmouth project will provide for flat-water canoeing and other boating activities.

Rock-climbing

At present, few sites in the study area hold great attractions for skilled rock-climbers. Inaccessibility and distance from main population centres severely limit weekend use. The main areas climbed include the Little River Gorge, Buchan Rock, the Niggerheads, the Sentinels, and Gable End. Other areas (such as the Snowy River Gorge, Hanging Rock near Suggan Buggan, and the Razor) have potential for this sport.

Caving

This specialized sport has a small but enthusiastic following. A few suitable caves associated with limestone formations occur in the far east of the study area.

Fossicking

Prospecting for alluvial gold is an activity that is pursued on many of the numerous gold-fields in the study area.

In some instances digging for old bottles and other artifacts accompanies prospecting. Little gemstone-collecting takes place in the study area, as suitable localities are few and often remote from the major population centres. The best-known area for gemstones is in the Gelantipy district.

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16. AGRICULTURE

The study area is part of a larger region comprising 11 shires in Gippsland and north-eastern Victoria, which have been grouped as shown in Table 10. A brief consideration of agricultural land use in this region is useful, especially for cattle production, as many cattle - mostly in the north-eastern shires - are taken onto public-land grazing blocks in the study area from home properties outside it.

Sheep numbers in the larger region have averaged about 5% of Victorian flocks between 1972 and 1976, and during this time reductions in flock numbers have ranged from 41,400 (27%) in Tallangatta and Upper Murray Shires to 106,020 (26%) in Alexandra and Mansfield Shires.

Dairy cattle numbers have also decreased between 1972 and 1976 - by as little as 840 (15%) in Alexandra and Mansfield Shires and as much as 2,720 (30%) in Omeo and Tambo Shires.

On the other hand, consistently high increases have occurred in beef cattle numbers, partly reflecting a shift from sheep to beef cattle. Increases vary between 9,860 (10%) in Oxley, Myrtleford, and Bright Shires, and 31,510 (26%) in Maffra, Avon, and Bairnsdale Shires. The totals on the average make up about 14% of beef cattle in Victoria.

Agricultural areas on private land in the study area are indicated on Map 9 of this report, which also shows the areas of public land regularly grazed by cattle. Some relatively small discrete agricultural areas on its borders, such as at Merrijig and Tawonga, adjoin much larger tracts in other study areas. A number of other small parcels - both well within and bordering the study area - are remote and isolated.

The two major agricultural areas are in the Omeo Shire and on the Wulgulmerang Tablelands in Tambo Shire. About 81% of Omeo Shire lies within the study area and Table 11 gives trends in stock numbers, crop areas, and numbers of rural holdings there.

Livestock production - mainly beef cattle, although sheep for wool are important in Omeo Shire - is the most important rural land use.

Tobacco in the Ovens and Kiewa valleys, and beans in the Dargo area are the only crops of significance. Produce from small-scale cereal cropping in the Benambra region is used locally.

Growing season

The growing season for pastures is an important factor governing agricultural land use. Two major climatic factors

Table 10

AGRICULTURAL PRODUCTION

Shire groups around and in Alpine study area	Alexandra, Mansfield	Oxley, Myrtleford, Bright	Tallangatta, Upper Murray	Maffra, Avon, Bairnsdale	Omeo, Tambo
Total area (ha)	584,000	660,000	660,000	898,000	915,000
Area within study area (ha)	147,000	259,000	236,000	350,000	635,000
Area freehold land within study area (ha)	7,500	8,500	8,000	17,000	140,000
Total agricultural area occupied[1] (ha)	198,850	272,690	249,020	621,490	514,200
Total area under crop[1] (ha)	1,049	6,756	1,552	4,988	1,208
Total number rural holdings[2] (1975--76)	693	1,165	723	1,465	675
Number properties using public land grazing blocks in study area	12	14	8	27	30
Total sheep numbers[3]	357,090	83,680	123,830	398,870	294,400
% change in sheep numbers (1972--76)	-26	-39	-27	-17	-16
Cattle for milk production[3]	5,130	24,700	25,910	78,670	7,560
% change (1972--76)	-15	-9	-4	-2	-30
Cattle for meat production[3]	86,060	104,840	140,870	131,050	86,320
% change (1972--76)	+19	+10	+13	+26	+14
Approximate cattle numbers from home properties in Shire group using public land grazing blocks in study area[4]	2,130	3,640	1,680	6,970	7,700

1. Data are for the year ended March 31, averaged for 1972 to 1976 inclusive. Total area occupied is for all land used for agricultural production, including grazing blocks on public land.
2. A public land grazing block away from the home property is counted as a separate rural holding by the Bureau of Census and Statistics.
3. Numbers recorded at March 31, averaged for 1972 to 1976 inclusive.
4. Estimates based on information from graziers.

Sources of Shire Date: Commonwealth Bureau of Census and Statistics. Victorian Office. *Rural Industries*, 1971--72 and 1972--73.

Australian Bureau of Statistics. Victorian Office. *Land Utilization and Crops*, 1973--74, 1974--75, 1975--75, 67.

Australian Bureau of Statistics. Victorian Office. *Livestock*, 1973--74, 1974--75, and [illegible]

Table 11

AGRICULTURAL PRODUCTION WITHIN OMEO SHIRE

	1970	1971	1972	1973	1974	1975	1976	Percentage change 1970 - 1976
Area under crop (ha)	1,631	989	478	479	613	335	404	-75
Sheep numbers	309,152	323,889	285,046	222,509	235,384	245,125	250,504	-19
Cattle numbers	35,560	38,781	43,940	43,301	43,507	48,903	49,848	+40
Number of rural holdings	310	309	306	303	292	289	281	- 9

Notes:
1. The study area contains 107,400 ha of freehold land within Omeo Shire, or 81% of total Shire freehold land.
2. Annual figures recorded are at March 31 each year.
3. A 'rural holding' is defined in the sources referred to below. Public land grazing blocks are counted as separate holdings when at some distance from the home property.

Sources: Australian Bureau of Statistics, Victorian Office. Rural Industries 1969--70 to 1972--73, and Statistics of Victoria, 1973--74, 1974--75, and 1975--76.

limit pasture growth in the study area: low temperatures in winter and inadequate soil moisture during summer. The length of the frost-free period, exposure to wind, and duration of sunshine also have some effect, especially in elevated regions.

The commonly accepted mean monthly temperature limit for active plant growth is 10°C, and no significant growth at all occurs below 5.5°C.

The soil acts as a storage for water, a certain proportion of which is available for plant growth. Its storage capacity depends on its depth and other physical and chemical characteristics. The amount of moisture stored may rise through precipitation and lateral movement of water through the soil, or may fall due to evaporation, transpiration by plants, and seepage into underlying parent materials.

Estimates of the growing seasons for permanent pastures at various localities have been based on rainfall, temperature, evapotranspiration, and soil moisture. Figure 6 shows inferred patterns of growth for Mitta Mitta, Tawonga, Omeo, and Hotham Heights.

At elevations higher than at Omeo (650 m), low temperatures restrict the growing season for several months during the colder part of the year. At Hotham Heights or on the Bogong Tablelands, plant growth ceases in winter. In summer, however, moisture would not be limiting except in shallow or rocky soils.

Beef production

Beef cattle production is by far the most important agricultural enterprise in the study area.

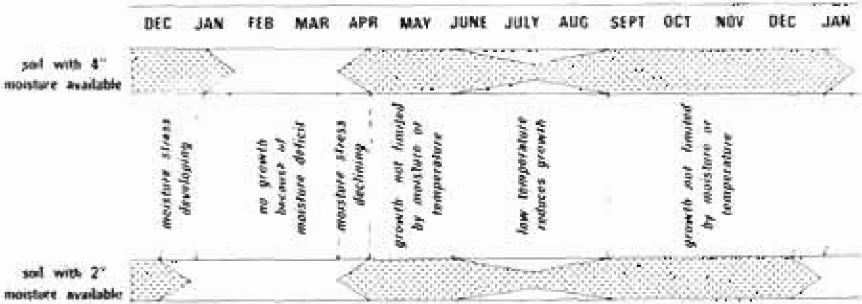
The major concentrations of cattle on private land in the study area are in the Omeo Shire and on the Wulgulmerang Tablelands in Tambo Shire. Graziers in these areas run either beef cattle only or a combination of beef and sheep. The herds are basically breeding cows, and steer weaners and surplus heifers are sold each autumn at special calf sales.

The study area contains about 81% of the freehold land in Omeo Shire, where almost all the cattle are grown for beef.

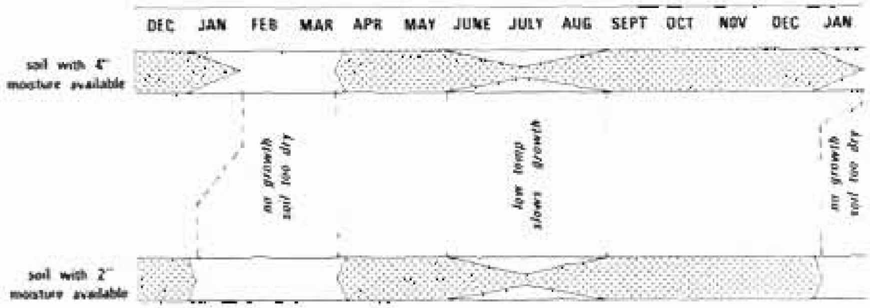
One dairy farm operates near Swifts Creek. Cattle numbers in the Shire increased by 40%, from 35,560 to 49,850, between 1970 and 1976. On average, some 20 graziers regularly run a total of about 6,300 cattle on grazing blocks in the study area. This constitutes 15% of the average cattle numbers for the whole Shire indicated in Table 11.

Hereford is the dominant breed. Most properties in these areas are generally well developed and, until recent years, superphosphate was usually applied. Because of high transport costs, development has been less intensive than in areas closer to railheads, but has achieved a level in

FIGURE 6

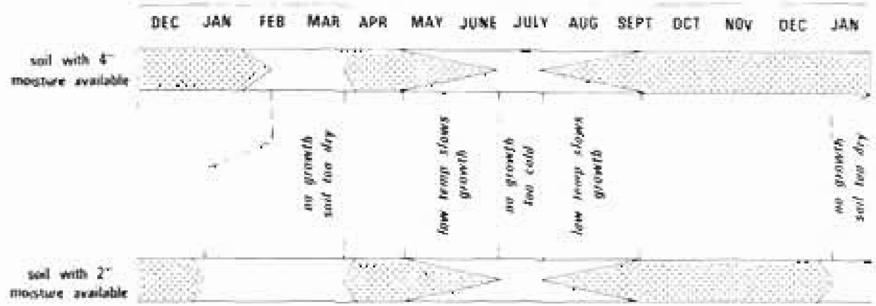


(a) Patterns of growth at Tawonga (as influenced by rainfall, potential evapo-transpiration, temperature and soil moisture storage)

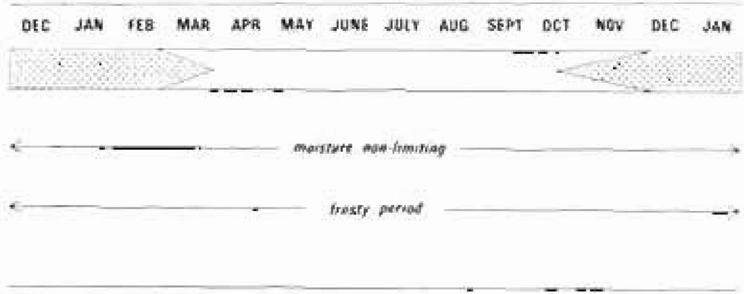


(b) Patterns of growth at Mitta Mitta as influenced by rainfall, evapo-transpiration, temperature and soil moisture storage

FIGURE 6



(c) Patterns of growth at Omeo as influenced by rainfall, evapo-transpiration, temperature and soil moisture storage



(d) Pattern of growth of frost-resistant species at Hotham Heights, where moisture is non limiting and low temperatures limit plant growth accord with the higher cost structure - in many cases, the optimum level.

Beef also dominates in the Dargo and Licola areas, and is of equal importance to sheep in the Merrijig area. The dominant breeds are Hereford at Dargo and Merrijig and Angus at Licola.

In other beef-producing areas, particularly those that have recently abandoned dairying, dairy-beef crossbred herds are frequently used.

Graziers use much of the public land in the area on an annual licence or agistment basis.

Grazing blocks currently cover approximately 1.25 million ha, but only part of this is actually grazed in any one year, and some areas not at all. Those grazed most regularly are shown on Map No. 9.

Three different systems of granting grazing rights apply:

* Grazing licences granted by the Department of Crown Lands and Survey for a period of 1 year, with or without restrictions on cattle numbers and usually renewed annually. (This is the most common system.)

* Annual grazing licences granted by the Forests Commission for blocks on reserved forest, with or without restriction on numbers

* Agistment granted by the Forests Commission on reserved forest areas, generally for a shorter term, with payment on a per-head basis

In each of these systems, the licencee, on application, is usually granted the same grazing block year after year. The number of cattle run on the grazing block varies from year to year depending on market conditions, the feed situation on the home farm, and the condition of the blocks. In recent years the number run during late spring to early autumn has averaged about 9,300 breeding cows, 6,100 calves, and 6,200 dry cattle. In winter about 2,300 cows, 500 calves, and 2,400 dry cattle have been put on the lower runs. Numbers have been greater in the past.

The cattle numbers and duration of grazing are set by the Soil Conservation Authority in two sections of the study area. These are the Bogong High Plains and adjacent high country, and the Bennison Tablelands and Moroka basin region. The advice of the Bogong High Plains District Advisory Committee is sought for the former area, and a local committee appointed by the Avon District Advisory Committee advises on the latter. In the area east of Mansfield, cattle numbers are set by the Forests Commission, after advice from a local committee appointed by the Upper Goulburn District Advisory Committee.

About 100 graziers currently run cattle on grazing blocks in the study area. In most cases, their home properties lie either within the study area itself or within about 20 km of it. Over the years, they have devised systems of management that integrate feed supplies on the home property and grazing run.

The level of dependence on the public land varies from grazier to grazier. In some cases, little use is made of the run, but in others it plays a major part in the operator's broad management system. The usual system is for cattle to be taken to the high country in late spring--early summer and remain there until the autumn.

By sending the cattle to the grazing runs, the grazier conserves some spring pasture and the summer growth on the home property, which the cattle can then graze when they return in the autumn. The effect of this system is to allow the graziers to carry higher stock numbers on the home properties through the winter, and consequently over the whole year. In some areas cattle also use grazing blocks at lower elevations during winter.

Problems include the time and labour involved in managing the stock on distant grazing blocks and the risk of stock losses due to severe weather, wandering cattle, and other causes.

Most stock are taken to and from runs by driving them along established stock routes or, to an increasing degree, by motor transport. The control of stock on the runs is achieved by a variety of methods, including the placement of wing fences on narrow ridges or in gullies, siting of small dams and salt licks, periodic mustering, or use of paddocks. Control is also assisted by the habit of most cattle to remain around localities known to them and by natural topographic features such as steep scrubby river valleys.

Generally, stock prefer the alpine and sub-alpine grasslands and herbfields, together with small clearings in snow gum woodlands. They do best where introduced clovers make up part of the pasture. Cattle seek out this feed, in addition to native forbs that grow between snow grass tussocks. Herbaceous swards under alpine ash forests provide good forage.

Native grasses such as kangaroo grass under narrow-leaf peppermint and candlebark open forests are grazed, too. Forage is also available in mountain and foothill forests for a number of years after wildfires, fuel reduction burns, or logging operations.

Production of beef cattle by mountain cattlemen makes a relatively small but important contribution to the industry in the region. Cattle returning from runs are in first-class condition if well managed, and can bring top prices.

Special calf sales in autumn at nearby centres such as Mansfield, Myrtleford, Omeo, Benambra, Heyfield, and Bairnsdale have as a drawcard the calves run in the mountains in the summer. About 23,000 calves are sold at these sales while others are held back for later marketing. At Heyfield a relatively high number (about 3,400 head annually) of older cattle from mountain grazing blocks are sold.

Details of cattle-grazing on public land contained in this report were obtained in most instances from the Mountain District Cattlemen's Association of Victoria. Details of location of home properties, access routes used, and estimates of numbers of stock are given in the block descriptions. Stock numbers may vary greatly according to the season, and those quoted have been averaged for the 5 years 1971--75. In the descriptions, adult breeding females are referred to as cows, calves are young animals up to 12 months of age, and dry cattle are mainly steers but include bullocks and bulls.

Sheep

The major concentration of sheep in the study area is in Omeo Shire - in 1970 about 309,000 were run on private property there. It is estimated that about 266,000 of these were on properties within the study area.

Because of the effects of low wool prices and drought, sheep numbers in the Shire had fallen to about 222,500 by 1973, but have increased since then to about 250,500 in 1976.

Most of the sheep are Merinos bred for wool production. Sales of wether weaners and first-cross ewe weaners are important sources of supplementary income for producers.

Some sheep are also run in the Gelantipy, Dargo, Licola, and Merrijig districts for both wool and prime lambs. In general, sheep are better suited to drier districts within the study area, and it is rare to see sheep on the lush pastures of the higher-rainfall areas and on the river flats.

Dairying

Dairying in north-eastern Victoria has declined in importance, particularly on the flats and foothills of the river valleys. Many producers moved out of dairying and into beef production during the last 10 years, because of the higher prices paid for beef compared with dairy products, increasing labour costs, and the need for capital outlay for bulk collection and refrigeration facilities.

There are now only 13 dairy-farmers in the study area - 11 in the north-east, one at Swifts Creek, and one at Timbarra. Dairy--beef cross animals, however, comprise up to 50% of the beef herds in the river valleys of the north-east adjacent to other study districts. These herds have developed from animals previously kept for dairy production, and are now usually used to produce vealers.

Cropping

The main enterprises in the area are tobacco-growing, bean production, cereal-cropping, and horticulture.

Tobacco production is confined to the river flats and adjacent slopes that can be irrigated in the upper reaches of the Ovens and Kiewa Rivers and along tributaries of the latter. These adjoin the major tobacco-growing areas of Victoria, which are just outside the study area. Tobacco would grow on almost all land that can be cultivated along streams in the north-eastern river valleys, but production is restricted by quotas on leaf and by the availability of water.

Beans are grown in the Dargo--Crooked River area, which is important for seed production as its isolation from other bean-growing areas prevents the spread of bacterial blights. This area also produces dry edible beans for the culinary trade, but not beans for processing, because of the high transport costs. Returns from beans provide an important supplementary source of income for some graziers in this part of the study area.

Cereal crops for grain are grown around Benambra, but the area is very limited and the produce is used for consumption on the farm.

Horticulture does not play an important part in the agriculture of the study area. Walnuts grown in the Dargo area have contributed about 4--7% of the State's production in recent years. The Upper Ovens Valley contains a walnut grove, a chestnut grove, and an apple orchard.

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17. APICULTURE

Little of the study area has been used by bee-keepers, mainly because of poor access. Many apiarists therefore do not know the district or the characteristics of the honey flora here. Some areas, however, such as at Merrijig, Licola, Wellington River valley, Dargo, Wonnangatta River valley, Tawonga, Mitta Mitta, Swifts Creek, Bindi, and Gelantipy, have been used by local and commercial apiarists for many years, and large crops of first-grade honey have been produced from some of these localities.

The honey flora are mainly red stringybark, but-but, long-leaf box, yellow box, and associated ground flora, which are distributed in foothills, river valleys and basins, usually close to private property. Nevertheless, considerable potential for apiculture exists in the more remote areas, where honey flora include snow gum, alpine ash, shining gum, messmate, manna gum, and ground flora such as white clover and hop bitter-pea.

Because of consistently high rainfall, flowering of the mountain flora tends to be more reliable and occur more often than in drier areas.

Besides its use for honey production during the summer, the mountain flora is important for building up pollen and honey food supplies for bee colonies.

Colonies that spend summer in lowland areas may be adversely affected by prolonged periods of high temperatures, which impair their honey-producing capacity.

The invigorated colonies from mountain areas, by contrast, can produce greater honey crops from lowland areas in autumn, when nectar flows are usually abundant. It is particularly important to have healthy, vigorous colonies where nectar-producing species are deficient in pollen (such as red box) or where pollen is not collected, as in the case of yellow box.

Because of the wide variety of pollen and nectar sources in the study area, queen bees can be, and have been, successfully reared. Rearing is possible from November to March at the higher altitudes, where the ground flora are then flowering profusely while most lowland ground flora have finished flowering. The following list gives the main eucalypt honey flora.

Snow gum (a summer-flowering tree) often yields nectar, but commercial production is limited to intermittent short flows. It is a good pollen-producer.

Ash-mallee gives irregular light nectar flows that produce first-grade honey.

Black sallee yields good flows of nectar that produce choice honey. Production is low, however, because it flowers during the cooler months when weather is poor and access difficult. Pollen yields are moderate.

Alpine ash, which flowers in summer, yields heavy nectar flows at intervals of 2--3 years. Honey is of second-grade quality, but pollen yields are good.

Messmate is most useful for building up bee colonies in autumn and providing winter stores from the copious yields of pollen in late summer and autumn. Nectar flows are unreliable, but can give good honey crops at intervals of 7--8 years.

Candlebark produces a clear amber honey of medium density. Nectar yields vary from light to heavy.

Mountain grey gum produces abundant pollen and occasionally gives a honey crop of medium grade.

Manna gum gives variable nectar yields, and pollen is produced in medium to abundant quantities. It is useful to build up bee colonies before the over-wintering period begins.

Shining gum produces medium-grade honey. Nectar flows are reliable but usually light, and pollen is abundant and reliable.

Brittle gum is an unreliable nectar-producer, but gives excellent yields of pollen.

Yertchuk yields good pollen and occasionally good crops of medium-grade honey.

Red ironbark yields no pollen, but intermittently produces good crops of choice honey.

Silvertop produces a thin, dark honey and yields abundant supplies of pollen.

Narrow-leaf peppermint is an unreliable producer, but can provide good crops of honey and pollen.

Broad-leaf peppermint yields only poor supplies of nectar and pollen.

Mountain ash produces abundant pollen, but nectar flows vary from light to heavy.

Eurabbie can be unreliable in yielding nectar, but occasionally produces good honey crops. Pollen is abundant and reliable.

But-but gives reliable (but light and short) nectar flows about every 2 years, to produce good-quality honey. Heavy honey crops are infrequent. Abundant pollen yields in autumn enable bees to build up their winter stores of pollen.

Long-leaf box flowers during autumn and winter, usually every 2 years. Heavy honey crops are often produced every 4--5 years. Pollen yields are prolific and it is a valuable species for over-wintering bees.

Red box produces a medium-quality honey, but nectar flows are unreliable. Yields can be heavy in some localities. Virtually no pollen is yielded.

White box produces first-class honey from nectar flows that can be profuse. Flowering usually occurs from mid summer to mid winter, but may extend into the spring. Pollen yields may be unreliable. At times there have been heavy losses of bees working this species.

Yellow box, a useful species, regularly yields nectar to produce choicest-quality honey. Bees do not collect yellow box pollen, but alternate sources from associated ground flora such as guinea-flower and grevilleas enable honey production to be maintained.

Red stringybark produces both nectar and pollen very reliably in some parts of the study area, but less so in others. Medium-grade honey may be obtained each year for some years.

White stringybark produces good-quality honey and prolific amounts of pollen.

Yellow stringybark can yield heavy flows of nectar that produces a dark and frothy honey. Pollen yields are moderate.

Understorey species that are valuable for pollen supplies and occasionally for nectar production include hop bitter-pea, beard-heaths, parrot-peas, oxylobiums, and clover.

Hop bitter-pea produces good-quality honey.

Common beard-heath has heavy nectar yields and pollen is abundant.

White clover produces first-grade honey.

Silver wattle yields pollen in medium to abundant quantities and sunshine wattle yields nectar and abundant pollen.

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18. WOOD PRODUCTION

History of Production

Although large-scale harvesting of sawlogs has taken place only within the past 30 years, some significant use of timber commenced with the mining era of the 1850s. Splitters Range near Omeo was extensively cut over to supply mining timber, as well as construction timber for the township itself. Miners further south similarly utilized the forests around Brookville and Cassilis.

Following the decline of the mining boom, timber extraction was limited to minor quantities used for fencing and farm building. Significant sawlog harvesting in the study area did not begin until the 1930s, when timber stands near Mount Baldhead, Mirimbah, and Mount Wills were opened up.

In the mid to late 1940s many sawmills were transferred from central Victoria to the alpine ash forests of north-eastern Victoria and Gippsland. Mills were built at Swifts Creek, Omeo, and Heyfield. In the early 1950s more mills were established at Bullumwaal, Buchan, and Ensay. Further expansion came in the early 1960s with the extraction of logs from the Nunnett Ridge for mills at Buchan, and the building of a new mill at Benambra. In 1959 the first allocation of logs was made from the area north of Dargo, and in the same year the Forests Commission commenced construction of the Tamboritha road north from Licola. By 1962 this had extended logging to Mount Tamboritha, and later eastwards towards Mount Kent and northwards towards Mount Howitt. Logging has continued to extend into the more remote parts of the study area over the past decade.

Forest Types and Products

Table 12 lists the principal commercial eucalypts in the study area.

Table 12

PRINCIPAL COMMERCIAL EUCALYPTS
IN THE ALPINE STUDY AREA

Alpine ash	Narrow-leaf peppermint
Messmate	Shining gum
Manna gum	Silvertop
Mountain ash	

Table 13 shows the productivities of those eucalypts.

Table 13

HARDWOOD PRODUCTIVITY

Category	Structural form	Main timber species	*Potential productivity (M.A.I. in m^3 per ha)
High to very high	Open forest IV	Alpine ash, mountain ash, shining gum	M.A.I. range 7--18; suitable for sawlogs and pulpwood
High	Open forest IV	Messmate, manna gum	M.A.I. range 5--10; suitable for sawlogs and pulpwood
Moderate	Open forest III	Messmate, manna gum, narrow-leaf peppermint	M.A.I. range 3--7; suitable for sawlogs and pulpwood
Low	Open forest II	Candlebark, narrow-leaf peppermint, red stringybark	M.A.I. less than 3; suitable for pulpwood and inferior sawlogs
Very low	Open forest I	Broad-leaf peppermint, red box, brittle gum, swamp gum	M.A.I. very low, suitable for minor products only

*Notes on productivity:

1. M.A.I. (mean annual increment) = total volume production to a 10-cm small-end diameter under bark divided by rotation length in years
2. The M.A.Is. used are broad-hectare figures for large areas.
3. The proportion of pulpwood volume to sawlog volume varies from about 7:1 to 1:1, depending on the site, quality of the stand, and the past history of utilization and fire.

Mountain forests

Mountain forests mostly occur on friable brown and red gradational soils above an elevation of 450 m where precipitation generally exceeds 1,200 mm. Logging of these forests is limited to the warmer months. The two principal species are alpine ash (which is the predominant commercial species) and mountain ash. Shining gum occurs in several scattered areas, for example Spring Hill and Mount Useful Creek, mixed with alpine ash.

Alpine ash has optimal altitudinal range of 950 to 1,400 m, although it is found as low as 600 m and as high as 1,580 m. Mature stand height averages 50 m, but may be less than 30 m on more exposed sites. Stand heights exceeding 65 m are confined to the best sheltered sites.

The mountain forests within the study area cover about 225,000 ha, and show a marked tendency to grow in stands of a single species. About one-third of these forests are mature, the remainder being younger regrowth resulting from past logging or wildfires.

Although the study area escaped the worst of the 1939 fires, significant areas of alpine ash forests were burnt in the heads of the Ovens, Kiewa, and Mitta Mitta Rivers, and south of the Great Divide in the heads of the Wongungarra and Dargo Rivers. Most of these now carry forests of advanced alpine ash regrowth, constituting an important future timber resource.

In some areas the forests occur as large contiguous stands occupying valleys, the mid slopes of mountains, or tablelands. In many others they are scattered discrete stands in sheltered situations separated by other less-productive forest types, and here a great deal of road construction is needed to gain access to relatively small quantities of timber. The cost of road construction and maintenance and road transport can be considerable where long haulage distances to conversion centres are involved. Logs taken to the Heyfield mills, for example, are transported for distances of up to 150 km, and mills at Mansfield and Benalla receive logs from more than 90 and 154 km away, respectively.

The ash species are the most productive indigenous species in the State, and the attractive appearance of their timber, low incidence of defect, and relatively low density make them some of the most important commercial species in Australia. The better-quality timber is seasoned for use in flooring, internal joinery, and cabinet-making. Ash is also important as a raw material for paper-making, having the necessary light colour, low density, relatively long fibres, and a favourable fibre diameter: fibre length ratio for the manufacture of high-quality paper.

Conditions required for the regeneration of these forests are a seed-bed of soil exposed by mechanical means or by fire (in the latter case an "ash-bed" is formed), no overhead shade, and a supply of viable seed. Such conditions occur naturally following intense wildfire, but can be created artificially by clear felling, controlled burning to produce an "ash-bed", and seeding. Seed is sown prior to winter to ensure adequate germination the following spring.

In the early days, those harvesting mountain forests, particularly of alpine ash, did not always follow it up with successful regeneration measures, as they did not fully understand the need for exposed soil or "ash-bed" and full sunlight. The use of crawler tractors for logging after about 1939 caused greater soil exposure and disturbance. This led to fewer regeneration failures, but some logged areas still failed to regenerate successfully. Intensive research in the 1950s, however, defined the silvicultural requirements of the species, and since then adequate regeneration of logged stands has usually been achieved.

Moist foothill forests

These generally adjoin the lower elevations range of the mountain forests. Soils are similar although generally not so deep, slightly more differentiated, and frequently lighter in colour. Rainfall is generally in the range of 900 to 1,200 mm annually. Stand heights range between 30 and 40 m on the better sites, but are less on drier and more exposed sites. A total of about 580,000 ha of high-quality forest occurs within the study area.

Sometimes termed mixed-species forests, these tend to occur as mixtures of several species, chiefly messmate, manna gum, and narrow-leaf peppermint. Other commercial species of more localized occurrence are white stringybark, yellow stringybark, silvertop, and eurabbie.

Although they grow more slowly than the ash species, their accessibility and extent make the higher-quality moist foothill forests of the study area an important component of the State's hardwood sawlog resource. Sawn timber from these forests is widely used in house-framing and general construction; and wood from them could comprise an important source of raw material for paper and paper-board manufacture.

Regeneration following harvesting, particularly of the moister and the more-sheltered stands of this type of forest, requires conditions similar to those needed to successfully regenerate ash species. Clear-felling followed by burning and artificial seeding with indigenous species ensures the establishment of a new forest. On the drier and more exposed sites, seedlings can often withstand shading by the remaining overstorey vegetation provided they are established on a suitable seed-bed, and thus regeneration can be achieved in smaller gaps in the mature overstorey. This allows some flexibility in regeneration procedures.

Removal of only some of the mature trees, together with the associated soil disturbance, allows seedlings to become established in the gaps thus created; the seed source in such cases is usually the remaining overstorey, although artificial seeding may be required in some instances.

Dry foothill forests

These forests grow on poorer soils, usually below 500 m elevation, in areas of annual rainfall generally less than 800--900 mm. Mature stands rarely have a top height exceeding 30 m. They are a source of minor timber products such as durable posts and poles, and also firewood. Typical species are broad-leaf peppermint, red stringybark, brittle gum, and red box. In the far east of the study area, some 17,000 ha of white box occurs as an almost pure forest along the Snowy and Suggan Buggan Rivers.

Table 14

SAWMILL CENTRES & ASSOCIATED WORK FORCE BASED ON STUDY AREA

Centre	No. of sawmills	Direct Employees (Mill & Forest)	Total volume converted annually (m^3)
Mansfield	6	110	67,800
Jamieson	1	10	4,500
Benalla	1	25	9,900
Wangaratta	1	10	1,800
Ovens & Kiewa Valleys	3	105	33,750
Mitta Mitta Valley	3	65	34,500
Cudgewa--Corryong	3	25	12,600
Heyfield	6	280	86,544
Dargo--Briagolong	2	30	15,600
Stratford	1	15	3,000
Bullumwaal	2	25	9,750
Swifts Creek--Ensay	3	115	48,000
Benambra	1	20	12,000
Nowa Nowa	3	85	37,168
Buchan--Buchan South	2	60	17,250
TOTALS:	38	980	394,162

Softwood plantations

There are no softwood plantations on public land in the study area, and the Forests Commission has no plans to establish any.

The Wood-based Industry

Approximately 1,000 persons are directly employed in sawlog harvesting operations on public land in the study area, and in the 38 sawmills drawing supplies from the area (see Table 14).

These plants use a total of about 394,000 m^3 per annum from forests within the study area, which represents nearly one-third of the State's current annual hardwood sawlog output from State forests. Their annual production of sawn timber for 1974--75 was 118,600 m^3 of ash-type eucalypts (67%) and 57,500 m^3 of other species (33%). The seasoning-quality timber sawn represented 85% of Victoria's production.

Ash-type eucalypts are fast-growing species, and well suited for the manufacture of pulp as well as high-quality timber. The integrated harvesting of stands for both pulpwood and sawlogs assists in the complete utilization of sawlog trees and facilitates the reforestation of the area.

Integrated operations differ from intensive sawlog operations by the removal of wood that would otherwise remain (either as cull trees or as sawlog residue that would be burnt during the regeneration process or left to decay). Live cull trees that remain on a harvested area can inhibit the germination and growth of regeneration. If killed, they then constitute a fire hazard.

The sole current user of pulpwood from the study area is Australian Paper Manufacturers Ltd (A.P.M.), whose pulp mill is located at Maryvale. The *Forests (Wood Pulp Agreements) Act* 1974 provides for an increase in the annual supply of hardwood pulpwood derived from State Forests - rising from a level of 255,000 m^3 in 1974--75 to 765,000 m^3 by 1983. In 1974--75, 50,600 m^3 of pulpwood was supplied from the study area (from blocks 1, 4, 6, 7, and 12). This volume represented 20% of the minimum annual supply of eucalypt pulpwood required to be made available under the *Act*.

In addition, during 1974--75 36,500 m^3 of chipped sawmill residues were supplied to A.P.M. from sawmills drawing sawlog supplies from the study area.

The Forests Commission estimates that the study area contains 80,000 ha of mature mountain forests (ash-type eucalypts) and 580,000 ha of high-quality moist foothill forests. Advanced ash regrowth stands 35 years of age and older total about 75,000 ha while younger fire regrowth and logging regrowth total about 70,000 ha.

Future Victorian wood supply and demand

The long lead time necessary for wood production means that forecasts of wood supply and demand must be made many years into the future.

Such forecasts are extremely difficult to make with confidence. The supply could again be affected by events such as the catastrophic fires of 1939 (which destroyed large areas of productive forests) and imports of wood products (which depend on the international political situation and on competition between countries for available resources).

Changes in technology could affect the demand, as could changes in population growth rate.

Despite these uncertainties, forward planning is necessary to ensure that adequate supplies of wood are available to meet community requirements in the future. Forests Commission estimates and plans for sawlogs are shown in Figure 7 and described below.

Sawlog demand

Victoria annually consumes 2.4 million m^3 (G.R.W.E.) of sawn timber. (Gross Round-wood Equivalent - G.R.W.E. - is the total of the various wood products, expressed as the volume of round-wood required to produce them.) Of this volume, Victorian State forests supply about 1.2 million m^3 of hardwood and the State's public and private softwood forests supply 0.3 million m^3. The balance is obtained from imports - mostly from South Australia and Tasmania (0.5 million m^3) and also 0.3 million m^3 from overseas (principally New Zealand and North America). Future demand is calculated as a function of predicted population numbers and estimated *per capita* consumption of various wood products.

The sawlog equivalent of Victorian sawn timber needed in 2001 is expected to be between 2.7 and 3.2 million m^3. This is based on State estimates for that year of between 4.05 and 4.78 million population and a *per capita* consumption of 0.67 m^3 per annum.

Sawlog supplies

There are three major sources for future supply of sawlogs from Victoria: the mature hardwood forests, the hardwood regrowth forests (both older ones resulting from the 1939 wildfires and younger forests resulting from later fires and regeneration operations), and softwood plantations. Imports of sawn timber augment the supply at present, and this is likely to continue.

The Victorian hardwood sawlog supplies depend almost wholly on State forests, as there is no significant continuing private source of hardwood logs.

The existing mature ash forests on public land provide about 450,000 m^3 of sawlogs annually. This rate cannot be continued indefinitely, as the timber resource is limited. The Forests Commission plans to progressively reduce this cut, to integrate with the phasing in over the next 15--20 years of supplies from the 178,000 ha of advanced ash regrowth currently available for timber production. More than half of this is in the Melbourne study area. Some 22,000 ha of mature and 27,000 ha of regrowth ash forests here are within water supply catchments controlled by the Melbourne and Metropolitan Board of Works, and are not currently available for timber production.

Foothill mixed-species forests on public land provide 780,000 m^3 of sawlogs annually, used mainly for framing and construction timbers. The Forests Commission plans to complete the harvesting of most of the original forest over the next 70 years, tapering off the supply as mixed-species regrowth forests become merchantable.

Softwood sawlog supplies come from both public and private land. In 1974/75, State and private softwood plantations produced 194,000 m^3 and 78,000 m^3 respectively. The volume will increase markedly after 1990 as plantations begun in the 1960s are harvested. The average annual rate of plantation extension between 1967 and 1976 inclusive has been about 3,100 ha for private and 4,200 ha for State-owned plantations.

Pulpwood demand

Wood from both softwood and hardwood forests is required as a raw material for pulp, which can be manufactured into paper and paper products, and for reconstituted-wood products such as hardboard and chipboard. Other raw materials include re-cycled waste paper and chips from sawmill residues.

The demand for pulpwood in relation to supply is best considered on an Australia-wide basis rather than for Victoria, as the major users of pulpwood here send much of their product to other States to help meet their demand, while Victoria imports considerable quantities of paper and paper products.

The packaging and industrial paper industry has most relevance to the study area as A.P.M., which manufactures these products, draws part of its supply from there.

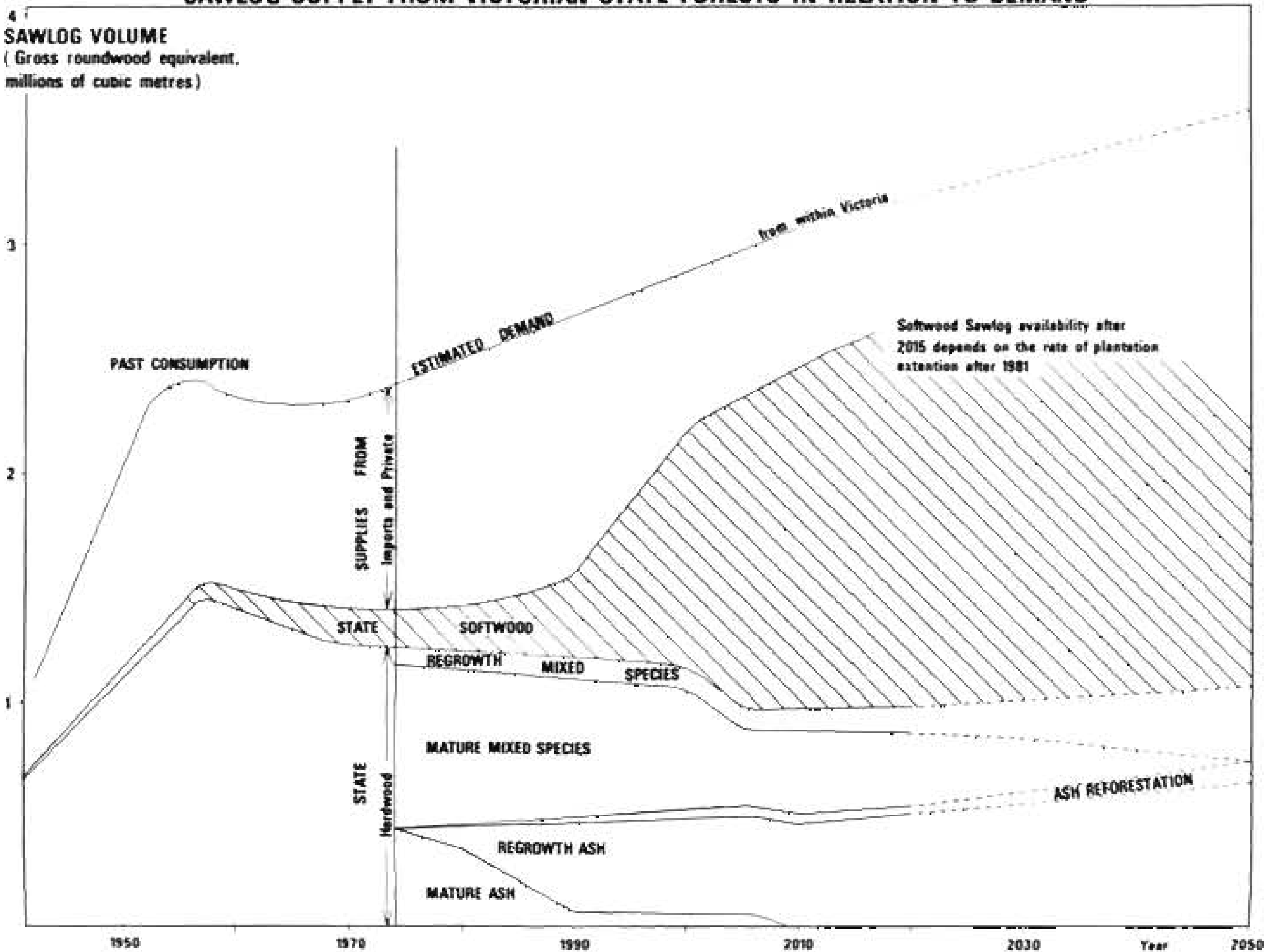
Australia consumed about 720,000 tonnes (2.59 million m^3 G.R.W.E.) of packaging and industrial paper in 1970. From national predictions for 2010 - a population of between 16.5 million and 19 million and a *per capita* consumption of 0.116 tonnes per annum - the demand for packaging and industrial paper is expected to be between 1.9 and 2.2 million tonnes (5.5 million and 7.9 million m^3 G.R.W.E.) per annum by that year.

Pulpwood supply

A.P.M. plans to meet its share of the projected demand partly by increasing its paper-production capacity at Maryvale. In order to do this, legislation guarantees minimum annual supplies of both softwood and hardwood pulpwood from public land. In the past, A.P.M. has not always used its minimum annual supply because of market and other factors. The *Forests (Wood Pulp Agreement) Act* 1974 has provided for increased eucalypt pulpwood supplies (rising from a minimum annual supply of 255,000 m^3 in 1974--75 to 765,000 m^3 from 1982-83 onwards, at least 80% of which is to be available from within the designated supply area over which A.P.M. has exclusive rights).

Figure 7

SAWLOG SUPPLY FROM VICTORIAN STATE FORESTS IN RELATION TO DEMAND



part of this increase would be sought from the study area. Supplies of pulpwood from there could also be required for a possible pulp-manufacturing industry based in East Gippsland.

The Forests Commission estimates that hardwood forests in the study area that are within economic distance of Maryvale and are available and suitable for integrated sawlog--pulpwood harvesting could provide a sustained annual yield of about 200,000 m^3 of pulpwood. Hardwood forests outside the study area but within A.P.M.'s designated supply area can provide an estimated supply of about 600,000 m^3 of pulpwood annually.

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19. MINERALS AND EXTRACTIVE MATERIALS

The study area contains a range of metallic and non-metallic minerals, as well as traces of fuel minerals (uranium and lignite) and several deposits of extractive industries materials (slate, limestone, marble, sand, and gravel). Geological conditions that are favourable for a number of minerals exist within the study area.

At present little production of minerals or construction materials occurs, but there are several active exploration programmes currently progressing and plans for mining some minerals and materials. Present mining activities cover only very small percentages of public land in comparison with past activities.

Historically, the most valuable mineral product was gold. Although current gold production is low, recent large increases in the price of gold mean that mines with average-grade ore may once again become economic. Known occurrences of minerals and materials, together with regions with potential for production, are shown on Map 10 and discussed below.

Metallic Minerals

Gold

Many thousands of kilograms of gold have been extracted from the study area since its discovery here in 1851. The shallow alluvial gold that was initially worked came from surface reefs in the surrounding country rock. It has been almost completely utilized, but enough remains to interest prospecting enthusiasts. In the 1860s and 1870s, shallow reef-mining commenced as the alluvial gold was traced back to its origin in the reefs.

Deep-lead mining for alluvial gold in old river beds buried by alluvium or volcanic rock commenced about the 1870s. Deep-lead mining on the Dargo Tablelands initially involved drives where the old river gravels were exposed at the surface; later, shafts were dug, but these failed to locate gold. Large-scale reef-mining, dredging, and sluicing operations were in progress in the late 1880s.

Gold production reached a maximum between 1902 and 1910, but has gradually declined since due to the increasing difficulty and cost of winning the metal. The operation of the Tronoh dredge at Harrietville and the reef mining at Glen Wills revived production from the mid 1940s to the mid 1950s. About half of the 23,000 kg of gold extracted since 1883 has been produced from seven mines and dredges, with the Maude and Yellow Girl Mine at Glen Wills producing the greatest amount - 3,220 kg of gold extracted from 205,000 tonnes of ore. Table 15 gives details of major mining and dredging operations.

Table 15

MAJOR MINING AND DREDGING CONCERNS

Mine or Dredge	Operation	Locality	Gold Produced (kg)
Cassilis Mine	Lease Current	Cassilis	2,890
Good Hope Mine	Terminated 1921	Grant	1,000
Hinnomunjie Dredge	Terminated 1922	Omeo	1,300
Maude & Yellow Girl Mine	Lease Current	Glen Wills	3,220
Rose, Thistle & Shamrock Mine	Terminated 1932	Harrietville	2,180
Sambas Mine	Current	Harrietville	1,350
Tronoh Dredge	Terminated 1954	Harrietville	1,710

Two gold-mines are still operating in the study area. These are the Sambas mine at Harrietville, and the Red Robin mine near Mount Hotham. In all, about 18 mining and gold leases are current.

Major exploration companies are actively exploring in the Cassilis and Limestone Creek areas.

Potential gold production in the area is based largely on reefs. Reef gold mostly occurs in quartz veins and these occur in belts that are usually associated with a low degree of regional metamorphism. Veins in the Omeo metamorphics or in granite plutons tend to carry base-metal sulphides at depth, such as at Glen Dart and Cassilis. Veins are found along fault planes as at Cassilis, or in fissures, along bedding planes, or associated with igneous dykes as at Harrietville. Auriferous veins following bedding planes are found to be the most persistent.

Most reefs do not outcrop through the soil mantle, and are usually discovered only after panning soil samples. It is not certain therefore that all gold-bearing reefs under the soil sub-surface have been discovered, let alone those terminating before they reach the soil mantle.

Main gold-fields

Aberfeldy. The section in the study area includes the Blackwall reef and various quartz reefs near Mount Useful.

Howqua. Gold was worked in Camerons Creek, and Lickhole, Barneys, Malcolms, and Stockyard Creeks from alluvium and reefs. In the Great Rand mine, associated minerals were phosphate, pyrite (iron sulphide), pyrrhotite (iron nickel sulphide), with minor galena (lead sulphide), sphalerite (zinc sulphide), chalcopyrite (copper iron sulphide), and arsenopyrites (iron arsenic sulphide).

Crooked River--Grant. Alluvial mining was replaced by the working of quartz reefs, but this activity ceased in the 1920s. Propositions to dredge the Wongungarra and Wonnangatta Rivers have been considered by mining companies over the past 20 years.

Dargo. A cluster of auriferous areas in the headwaters of the Dargo River, the Frosty and Horatio Creeks, and by the Dargo Tablelands comprise the Dargo gold-fields. Alluvial diggings were followed by reefing and working the Tertiary gravels at the edge of and under the Dargo Tablelands. Isolated attempts to find gold in the deep leads under the basalt as recently as 1926 met with failure because of low yields, or absence of auriferous gravels.

Harrietville. Gold was produced by shallow alluvial workings, reef mining, deep-lead mining - firstly by shafts and then by dredges, and sluicing of terrace gravels. The highly productive Rose, Thistle and Shamrock mine was closed in 1932 due to failure of timber in the inclined underground shaft, which extended far beneath the surface.

The Sambas and Red Robin mines continue to operate. Further reefs are likely to exist, particularly between the Sambas and Rose, Thistle and Shamrock mines.

Omeo. Gold was obtained from this field by working alluvium in streams, dredging river flats, sluicing high-terrace gravels, and reefing. Reef mining was discontinued in 1914.

Cassilis. Considerable gold has been produced from auriferous reefs in this field. Galena and pyrites are associated with it. Interest in the field has continued, and many leases remain current, including leases over the Cassilis and King Cassilis mines, which have operated spasmodically recently. A major mining group has an exploration licence over the remainder of the Cassilis field, extending north towards Cobungra.

Haunted Stream. Most of the gold from this field came from reef mining.

Glen Wills--Sunnyside. Gold production followed the early mining of tin. Miners mostly worked quartz veins in the surrounding schists and granite.

Gibbo River. Alluvial and reef mining have ceased on this field.

Limestone Creek. Alluvial gold was won in this area from the 1860s to about the turn of the century.

Dart River--Zulu Creek. Alluvial mining was followed by reef mining, but reefing ceased by 1905 because of the difficulties of access and recovery of gold from sulphide ores. In 1939 a metallurgical test on ore from Zulu Creek indicated economic yields, but mining did not proceed. An exploration licence held over the area expires in March 1978.

Silver--lead--zinc

The main silver--lead--zinc deposits are in the eastern half of the study area. Particular known deposits include:

The Gelantipy lode - Glen Sheil Mine, south-east of Gelantipy, is 1--2 metres thick and 250 m long, and yields 30--720 grams of silver and 0--10 g of gold per tonne.

The Campbells Knob deposit consists of quartz veins with galena, sphalerite, and minor chalcopyrite in a small granodiorite body.

The Danes Creek deposit, south-east of Dartmouth, consists of chalcopyrite, sphalerite, galena, and pyrites disseminated through the Mitta Mitta volcanics.

Forsythe's silver lodes - the Silver King and Comstock. Base-metal sulphides and silver minerals are found in quartz veins running through metamorphic rocks.

The Dart and Cassilis gold-fields contain relatively high percentages of galena associated with the gold.

Limestone Creek. A major lead geochemical anomaly has been recently discovered to the west of some limestone caves near Limestone Creek.

Copper

Copper in the form of chalcopyrite is associated with many of the silver--lead--zinc deposits in the Dart, Cassilis, Zulu Creek, and Limestone Creek goldfields. It is associated with gold at Howqua. The Mammoth lode at Gibbo River consists of a band of mineralization associated with a 30-metre-wide quartz porphyry dyke intruded into Ordovician shales. The mineralized band extends for 1.6 km, but has only been tested at its northern end, where it consists of pyrite and gold together with copper, lead, and zinc minerals.

Regional geochemical exploration is limited in the eastern part of the study area, although geological formations are favourable for this metal. Recent work has located a copper deposit in this region but subsequent drilling indicated that it was not economic to mine at present.

Tin

The Mount Wills tin-field is one of the most extensive in Victoria. The tin is in the form of cassiterite, which occurs within dykes and lenticular bodies of pegmatite, graphic granite, greisen, and occasionally large masses of diorite. These intersect Ordovician schists in a belt adjacent to the south-eastern margin of the granite massif of Mount Wills. Tin has been mined intermittently between 1890 and 1914.

Since then mining has ceased, but rising tin prices in the 1960s renewed interest and a number of leases and licences were taken up. Many lodes have been sampled, but no results are available. It is likely that the ore is generally low-grade, although the total reserves must be large because of the number of known ore bodies.

Alluvial tin is associated with terraces along the Mitta Mitta River tributaries in this region. Tin has also been mined at Surveyors Creek in the far north-east of the study area but production has now ceased. Prospecting in the area, however, is current.

Chromium

A chromite deposit in serpentinite near the Dolodrook River is disseminated through bands associated with shear zones in the serpentinite. Some 200 tonnes of ore have been mined; further production has ceased, however. Geophysical sampling to establish the amount of reserves was undertaken in the 1960s, but was not completed. A deposit of chromite has also been located on Limestone Creek.

Nickel

Nickel minerals are found associated with serpentine at Dolodrook, in the Howqua gold-field, and generally along the Licola--Jamieson axis.

Manganese

Manganese oxide occurs near New Guinea Spur by the Snowy River.

Mercury

Some free mercury and cinnabar (mercury sulphide) occurs in small quartz veins in slate and sandstone at Quicksilver Creek, a tributary of the Jamieson River.

Molybdenum

Molybdenite occurs in quartz veins in granite near a contact with Ordovician sediments at Simmonds Gap, 20 km south-east of Bright. The veins vary from 0.5 to 2 metres in thickness.

Bismuth

Bismuthinite occurs in association with molybdenite at Simmonds Gap, and is also found at Sunnyside.

Tungsten

An extensive series of lodes of wolframite (iron manganese tungstate) is located 15 km north-east of Benambra, in metamorphosed sandstone forming the crest of Mount Murphy. The lodes have been mined in the past when the price of wolframite was favourable.

Arsenic

Arsenopyrite, which occurs at Cassilis among complex sulphide ores, has been profitably mined.

Fuel Minerals

Uranium

Tobernite (copper uranium phosphate) has been found on the dumps of the Old Meerschaum Mine at Sunnyside, 21 km north of Omeo. This mine was located on a shear zone within the Mount Wills granite. A small deposit of uranium has also been detected at Mount Pleasant east of Benambra, in one of the Triassic syenite intrusions.

Lignite

A shaft sunk on the Dargo Tablelands in 1926 (near the site of the old hotel on the Dargo--Mount Hotham road) penetrated lignite from 6 m to 12 m. The extent of the deposit is not known.

Non-metallic Minerals

Barytes

Barytes was mined in a lode, 150 m long by 1 m wide, located to the west of the Buchan--Gelantipy road near Butchers Ridge. Other occurrences are known near the Glen Shiel Mine (east of Butchers Ridge) and at the Snowy River near Campbells Knob.

Corundum

A corundum deposit is known near the Dolodrook River and is associated with Cambrian serpentine.

Pyrite

This ore of sulphur has a minor occurrence near Tawonga.

Phosphate

Small occurrences of phosphate are associated with Cambrian rocks at Timbertop Creek and Howqua River, and near Violet Hill.

Extractive Industries Materials

Limestone and marble

Massive limestone lenses are interbedded with Upper Cambrian tuffs at the Dolodrook River. Of the nine lenticular limestone bodies, the largest is 270 m long and has a 65% limestone content.

To the west of the Barkly River are similar smaller lenses, interbedded with Cambrian volcanics. One such deposit is between Riggall Gap and Tiger Creek.

Limestones of Silurian and Devonian age are found east of the Omeo Highway. Deposits in the Mitta Mitta valley occur as lenses interbedded with great thicknesses of sandstone, siltstone, and conglomerate of the Wombat Creek Group. Lenticular beds of compact limestone and marble suitable for building stones are located near the junction of the Mitta Mitta River with the Gibbo River and Wombat Creek.

There has been only minor utilization of the deposits in this remote area.

Limestone deposits of Devonian and Silurian age occur in the Bindi basin of the Tambo River. The main one near Old Paddock and Bindi Creeks extends for about 13 km in a belt 0.5 km wide along a ridge trending north-nor'-west to south-sou'-east. Reserves of this Devonian age deposit amount to 280 million tonnes with 95% calcium carbonate. A limestone bed of Silurian age striking east--west at Marble Gully, 5 km east of Bindi has reserves of 500 million tonnes with a grade of 96% calcium carbonate. Both limestones are high-grade and free of clay, quartz sand, and magnesium carbonate.

About 5 km north-east of Benambra is Pyles deposit. This consists of a fossiliferous band of limestone 5 m thick. It was formerly burnt in a kiln to form lime suitable for cement.

Several lenticular beds of marble and limestone have been found along tributaries of Limestone Creek. Marble deposits near the junction of Painters and Limestone Creeks and at Stoney Creek are possible dimension stone quarry sites. Each deposit covers more than 12 hectares and contains massive marble of excellent texture, colour, and pattern. Other limestone deposits are situated in the Gillingall and W Tree areas.

Slate

A large slate deposit on a high ridge 20 km east of Jamieson covers an area of 3 km by 1 km. The quality of the slate is generally high. Production has begun following the construction of an extraction road from Howqua. Indicated workable reserves are of the order of 130 million tonnes.

Gravel and sand

The only production of gravel and sand within the study area, other than material involved in the construction of the Dartmouth dam, is for road-making. Materials required for this dam are being obtained from the project area and are not further considered here.

The three sources of road-making material used in the study area are river gravels, hill gravels and older basalts.

* River gravels include gravels from dredge tailings along the Ovens River. These have a high percentage of soft shale and tend to break down in frosty conditions. Gravels from the Kiewa River at Tawonga have a high percentage of gneiss, which has a high mica content. This adversely affects its value as a concrete aggregate material. The gneissic gravels, however, do not break down in frosty conditions.

* Hill gravels, the commonest material used on the roads, comprise eluvial and colluvial material from the lower slopes of hills. Those derived from the extensive Wonnangatta beds (Ordovician) consist of irregular fragments of the parent material in a red sandy clay matrix. This type binds well and is useful in unsealed roads. These gravels have also been used in the construction of sealed roads, although their tendency to possess high plasticity makes them less satisfactory. In general, the quality of hill gravel varies greatly.

* Older basalts include materials such as that quarried at Mount Little Higginbotham. This particular one has been found difficult to crush and the product is deficient in fine fractions.

A number of agencies carry out road construction and maintenance work in the study area.

The six Shires - Avon, Upper Murray, Omeo, Bright, Maffra, and Tambo - are involved with road-works. They have an annual requirement for road materials of 26,525 cu m at present. Most of this material is won from small local pits situated on public land, and the Minerals Map (No. 10) shows the approximate location of many of these pits.

Necessary road improvements will increase the demand for road-making materials, and the total requirement of the Shires over the next 10 years is estimated to be 465,000 cu m of gravel and sand. Allowance should be made for a spread of small quarries to supply these demands at a reasonable distance (less than 16 km) from the point of use.

The Forests Commission of Victoria estimates its requirements to be 2,850 cu m annually for maintenance and construction of their roads and tracks within State Forest - that is, 28,500 cu m over the next 10 years. This material would be obtained from a number of widely scattered small pits and quarries.

Both the Benalla and Bairnsdale divisions of the Country Roads Board construct roads within the study area. Their requirements are estimated at 51,000 cu m annually over the next 10 years, a total of 510,000 cu m.

This includes material to seal the Alpine Road progressively over the next few years, which will require higher-quality gravels and sands than those used by the Shires or Forests Commission; and the establishment of a number of quarries containing higher-quality material will be sought.

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Most of these deposits are likely to be on public land, but precise localities will only become known as investigations and construction proceed.

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20. WATER UTILIZATION

Existing storages

The alpine area is extremely important for water production in the State, being the catchment for a number of major streams, some of which contribute a high percentage of the total inflows to major storages located outside the study area.

These storages and their capacities are:

Lake Eildon	3,390,100	megalitres
Lake Hume	3,059,000	"
Lake Glenmaggie	190,300	"
Lake Buffalo	24,100	"
Lake William Hovell	12,330	"

There are no major irrigation storages within the study area at present, although one is being constructed on the Mitta Mitta River at Dartmouth. This storage will have a capacity of about 3,700,000 megalitres and impounding of water is likely to begin in 1977.

The State Electricity Commission has constructed Rocky Valley Dam, Junction Dam, and minor storages for power generation on the Kiewa River near Falls Creek.

Proposed storages

The completion of the Dartmouth storage will mean that a large part of the flows of streams flowing north from the region will be regulated. The Kiewa and Ovens catchments will be the only systems with minor regulation of flows. Water from the Kiewa River is subject to the *River Murray Waters Agreement*, and is shared by the States of Victoria, New South Wales, and South Australia in accordance with that *Agreement*. Any further utilization of the Kiewa River would be subject to this, and no storages are projected or appear feasible at present. Any further water-conservation projects in northern Victoria will probably be concentrated in the Ovens system, and these projects may be of two types:

* relatively small storages, to safeguard development of localized areas and regulating only a small portion of total flow

* relatively large storages, designed to safeguard local development and to supply the requirements of areas further downstream: this would regulate a large proportion of total flow

A storage of the first type, on the Buckland River, has been investigated and its construction included in planning programmes. The site for this is just outside the study area, but a large part of its contributing catchment lies within the area. The storage is designed to impound 10,500 Ml, at a cost estimated at $3.9 million in 1971, and would safeguard existing irrigation development of about 935 hectares in the upper Ovens valley and allow additional development up to 2,200 hectares.

Of the larger type, a second stage of the Buffalo Dam, which would impound nearly 1,000,000 Ml, was estimated to cost $65 million in 1963, but inflation has significantly increased this figure. The construction of the Dartmouth Dam will defer the requirement for this larger storage for some time.

Only one of the streams flowing south from the study area, the Macalister River, is subject to major regulation. Lake Glenmaggie, on this stream, is outside the area. The storage impounds 190,300 Ml, and has an average annual inflow of 581,000 Ml. Sites for additional storage are available on the river at the 1969 costs of $9 million for 125,000 Ml and $16 million for 370,000 Ml, but in that year the State Rivers and Water Supply Commission recommended that the provision of an extra storage on the Macalister River be deferred because costs of construction would outweigh benefits.

The only other south-flowing stream on which regulation is proposed is the Mitchell River. This receives water from the Wonnangatta River Basin (in the alpine area).

A 25,000 Ml storage is proposed at a site near Tabberabbera, just outside the study area, at a cost (in early 1974) of about $7 million. This storage will safeguard the existing irrigation development of about 2,800 hectares along the Mitchell River flats, allow for some additional irrigation on the flats, and safeguard urban and industrial growth at Bairnsdale and adjacent centres.

The feasibility of a much larger storage at the same site has also been investigated. This would provide for irrigation and other purposes on a regional scale, but is not considered justified under present economic conditions.

The approach to the assessment of water-supply projects has changed considerably in recent years. More emphasis is being placed on the consideration of the social and environmental effects of any project, along with the possible values for irrigation, urban and industrial use, power generation, recreation, and the conservation of aquatic and wetland habitats.

In Victoria, studies of environmental effects now have a significant influence on the nature, location, and operation of water-conservation projects.

Within the study area, the Dartmouth project is the subject of such studies. Their main purpose is to establish the physical and biological conditions of the ecosystems the Dam will affect, so that its influence can be properly monitored and operational procedures modified where necessary.

Utilization of Surface Water Resources

Most of the study area is forested public land receiving high rainfall. Irrigation development on farmland is virtually non-existent. Streams that rise in (and derive most of their flows from) the area, however, support large tracts of private irrigation development in other regions. The catchments also contribute to storages that support considerable areas of public development in the irrigation districts of northern Victoria and Gippsland. Tables 16 and 17 set out details of both private and public irrigation development. Table 16 also gives details of the numbers of authorized diverters of water for domestic and stock use and of industrial permits.

Water from Lake Hume, supplemented by excess flows from tributaries of the Murray River below Albury and by diversions from the Snowy Mountains Scheme, irrigated more than 230,000 hectares during the 1973/74 irrigation season (see Table 17). The Lake Hume storage is not sufficient to support existing irrigation development during droughts, and the main purpose of the Dartmouth Dam is to increase the security of irrigation supply and to provide for an increase in South Australia's entitlement to River Murray water.

Lake Eildon is the major storage serving the Goulburn Irrigation System. Table 17 summarizes the extent to which specific areas depend on it.

Lake Glenmaggie is the major source of supply for the Maffra--Sale Irrigation Area, in which 19,155 hectares were irrigated in 1973/74. A small amount of water, of the order of 10% in an average year, is supplied when available from the unregulated flow of the Thomson River, and the remainder is supplied from Lake Glenmaggie.

Lake Buffalo safeguards development under private diversion permits and licences along the Buffalo and Ovens Rivers. Similarly, Lake William Hovell safeguards development along the King River. The total irrigated area served by these two storages is about 6,000 hectares (see Table 16).

Stock, domestic, and urban water supply

Several places within the area have reticulated water supply systems. Table 18 gives details of the systems supplying the three towns - Mount Beauty, Swifts Creek, and Omeo. The systems in the three alpine resorts - Falls Creek, Mount Buller, and Hotham Heights - draw their water from nearby mountain streams. Bogong village and Dartmouth village also have reticulated water.

Much of northern Victoria and Gippsland depend on water that comes from the study area for stock, domestic, and town supplies. Water from Lake Eildon is transported as far as the Wimmera--Mallee domestic and stock system.

Table 16

WATER REGULATION AND USE 1973/74

Drainage basin	State of regulation	Irrigation		Domestic & stock permits	Industrial permits
		Licences & permits	Total area (ha)		
River Murray, above Lake Hume	Natural flow	14	123	23	1
River Murray, below Lake Hume	Regulated	-	17,300	-	-
Mitta Mitta River	Natural flow	61	725	82	4
Kiewa River, upstream of Murray River*	Natural flow	140	2,005	105	3
Ovens River, upstream of Wangaratta (*but not King River)	Partial regulation (L. Buffalo & L. William Hovell)	608	5,087	276	13
Goulburn River and tributaries, above Lake Eildon	Natural flow	16	132	41	1
Macalister River (including Avon River)*	Partial regulation (L. Glenmaggie and Thomson R. diversion)	165	1,916	60	5
Wonnangatta (Mitchell) River*	Natural flow	138	1,864	52	2
Tambo River (*upper section only)	Natural flow	85	699	98	12
Snowy River	Natural flow	49	664	25	1

* Systems considered fully committed (closed to further irrigation development based on existing regulation).

Table 17

IRRIGATION AREAS DEPENDENT ON LAKE EILDON AND LAKE HUME

Area or district	Area irrigated 1973/74 (ha)*	Source or sources of supply	Extent of dependence on storage
Lake Eildon			
Goulburn private diversions	6,200	Eildon, unregulated Goulburn flow below Eildon	Total, except during periods of surplus on the Goulburn
Shepparton	37,048		
Rodney	56,159	Eildon, Waranga	Almost total, especially in the autumn of normal years and throughout dry years: Waranga basin provides some regulation of inflows below Eildon
Tongala--Stanhope	23,580		
Deakin	13,222		
Rochester	36,215		
Dingee	2,264	Eildon, Waranga, Campaspe system	As for Rodney etc., except that small volumes are injected from the Campaspe system at times of peak demand
Calivil	9,760		
Tragowel Plains	37,146		
Boort	14,723	Eildon, Waranga, Loddon system	Varies according to season: typically about 60% Loddon water and 40% Goulburn water
West Loddon	1,029		
Lake Hume			
Murray Valley	48,584	Hume and uncontrolled inflows below Albury	Total
Torrumbarry	104,682	Ditto	Ditto
Pumped districts	30,221	Ditto	Ditto

Note: *Actual irrigated areas, which are naturally less than total irrigable areas.

Table 18

URBAN USE WITHIN AREA

Source of supply	Quality of supply & treatment	Annual consumption (megalitres)	Daily consumption (thousand litres)		Domiciles supplied
			Min.	Max.	
Mount Beauty: Simmonds Creek, West Kiewa River	Reticulation generally satisfactory, although on some occasions the *E. coli* count does exceed acceptable limits; no treatment facilities	272 (Est.)	1,500	5,000	630, inc. 5 industrial
Omeo: Livingstone Creek	Limited number of tests carried out, but reticulation appears satisfactory; no treatment facilities	100 (Est.)	50	500	100
Swifts Creek: Tambo River	Reticulation appears generally satisfactory; supply chlorinated	90 (Est.)	140	680	67

Hydro-electric power

The Kiewa hydro-electric scheme relies on water for hydro-generation from the watersheds of the East and West Kiewa Rivers as well as areas on the Bogong High Plains in the Mitta Mitta River catchment (diverted via water races) - a total of about 30,300 ha. The scheme could be extended yet further, involving the tapping of additional water catchments and building of new storages.

It is proposed to operate a hydro-electric power station in conjunction with the Dartmouth Dam on the Mitta Mitta River. This would require a special entitlement of 37,000 Ml of water annually.

Future requirements

Significant use within the study area of the water arising in it is unlikely in the foreseeable future. Increased irrigation, urban, and industrial development outside the area will, however, demand a progressive harnessing of these water resources by the construction of storages inside and outside it. Irrigation development has already dictated the regulation of much of the water flowing to the north and, to a much lesser degree, the south-flowing streams.

Utilization of groundwater resources

The only part of the study area where groundwater has been substantially utilized is around Benambra, where about 28 bores produce high-quality water with total dissolved solids contents ranging from 300 to 1,100 mg per l; yields range from 780 to 1,800 litres per minute. The water needs to be softened, however, before use in hot-water services.

Water quality and treatment

The quality of water in each individual catchment is discussed in the Surface Water Resources section of chapter 11. Most of the streams within the study area flow through forested public land and are not subject to most sources of stream pollution. At present, no intensive testing of water within the study area is conducted, but the limited information available, together with results of regular salinity tests taken at gauging stations both inside and outside the area, indicate high quality.

Considerable areas of agricultural development occur along the middle section of the Mitta Mitta River around Omeo and (to a lesser degree) along the Tambo, and both these streams are subject to intermittent high turbidity readings.

Water within the area is suitable for all purposes (including urban, industrial, stock and domestic supplies, and irrigation) with very little need for treatment.

Water resources management

Water resources management is inextricably bound up with land use with respect to catchment areas, stream frontages, location of water users, and problems of waste-water disposal. In the study area the vital need to maintain the quality and quantity of stream flow from the catchments forms the main link between the two.

Extensive logging may alter stream flow regime and total run-off, and may have some effect on water quality. The further development of land for agriculture would have similar effects, and mineral extraction may cause problems of pollution and siltation. The effects of any significant build-up of these competitive land uses would have to be carefully considered.

The high value placed on the water supply characteristics of much of the study area is demonstrated by the measures taken to regulate land use. The Governor-in-Council may proclaim a water supply catchment on the recommendation of the Land Conservation Council. Proclamation establishes the importance of water in the management of all lands in the catchment, and provides the mechanism for controlling land-use activities that may cause deterioration of the water supply characteristics.

Catchments that have been proclaimed and that have at least their upper reaches within the study area are Hume, Eildon, Glenmaggie, Nicholson, and Upper Kiewa.

The Soil Conservation Authority is responsible for the supervisory control of all grazing and earthworks in areas above 1,220 metres elevation.

21. UTILITIES

In addition to the supply of water, other types of public services within the study area have important implications for the use of public land. These include the supply of electricity and provision for transport, communications, and survey sites.

Electricity

The State Electricity Commission governs the generation and bulk transmission of electricity throughout Victoria. About 85% of the State's requirement is supplied by base-load thermal stations in the Latrobe Valley. Peak-load stations in Melbourne supply a further 1%, and the hydro-electric schemes (Kiewa, Cairn Curran, and Eildon--Rubicon) 6%. The remaining 8% is derived from the Snowy Mountains hydro-electric scheme and a generating station on the Hume reservoir.

The Kiewa hydro-electric generating scheme lies fully within the study area, and in 1974/75 supplied 2.7% of the total State output. This system is used mainly for peak-load supply, due to the relative convenience with which it can be brought onto load or shut down. At present the three power stations, McKay Creek, Clover, and West Kiewa have a combined generating capacity of 184 megawatts, which is 4% of the State's installed generating capacity.

The power generated is channelled into the State system via two single-circuit 220-kV transmission lines from Mount Beauty to Dederang, and one double-circuit 220-kV line from Mount Beauty via Eildon to Thomastown. Also, from the Mount Beauty terminal station and Clover Flat substation, 22-kV distribution lines feed out to surrounding areas, and a 66-kV line runs from Mount Beauty to Wangaratta via Bright.

The 220-kV transmission lines follow routes that, in forested land, are usually cleared to a width of at least 30 m. The 22-kV and 66-kV distribution lines follow road reserves or easements and are carried on wooden poles, except for a section of the 66-kV line between Mount Beauty and Bright, which runs between steel towers.

Present trends indicate that the demand for electrical energy will almost double in 10 years and, to cope with this, a large expansion of the generating system will be required. Already a 150-MW capacity hydro-electric generating station is proposed near Dartmouth once the dam on the Mitta Mitta River is completed.

On the Kiewa scheme, plans exist for the utilization of the unused 400 m head between McKay Creek power station and Lake Guy. Under current proposals, a new station would be situated either on the Rocky Valley branch of the East Kiewa

River or near the confluence of the Rocky Valley and Pretty Valley branches. The station would have a generating capacity of 200 or 250 MW and is being considered among the possibilities for peak-load supply stations that will be required within the next 30 years.

The construction of a number of storage and diversion dams, aqueducts, and underground conduits - involving not only the Kiewa catchment but also the headwaters of the Mitta Mitta (Big) and Cobungra Rivers - would also be sought. The additional water would provide a substantial generating capacity.

Possibilities for a pumped-storage generating station located near the confluence of the Diamantina and West Kiewa Rivers have been investigated. This would involve a dam on the West Kiewa River and upper storage dam at the extreme headwaters of Tawonga Hut Creek. An aqueduct and tunnel would connect the upper storage with Pretty Valley storage. Transmission lines would be located along the West Kiewa valley. At present the need to construct such a scheme in the study area is not expected until at least the year 2000.

Easements

Cleared easements are necessary along transmission lines in forested land in order to maintain safety standards, and to allow access for maintenance. Easement width depends on transmission voltage, the number of lines involved, and the type of terrain. Straight-line, above-ground transmission minimizes the costs and electrical losses.

Within the study area, plans for the routing of a single-circuit 220-kV transmission line from the proposed Dartmouth power station to Mount Beauty have been finalized.

Transport

No rail heads lie within the study area, the closest being at Mansfield, Bright, and Heyfield. Private airstrips provide some access, but most transport is by road.

The road authorities in the study area are the Forests Commission, Country Roads Board, State Electricity Commission, and, in some cases, local shires.

In recent years road-building and road-improvement schemes have led to greatly increased access here. Less than 20% of the study area is more than 5 km (plan distance) from a two-wheel-drive road, although many of these are two-wheel-drive roads only in dry weather. The degree of access, however, also depends on the nature of the terrain between tracks. Less than 1% of the study area is more than 5 km (plan distance) from a four-wheel-drive track. Public use of this access by both trail bikes and four-wheel-drive vehicles is increasing rapidly.

The major roads are frequently used by tourists during the drier months. Those that link north-eastern Victoria with

Gippsland are the Licola--Jamieson tourist road, the Dargo road, the Harrietville--Omeo road and Buckety Plains road from Falls Creek, both of which join the Omeo Highway, the Omeo Highway linking Wodonga with Bairnsdale, and the road linking Corryong with Omeo.

Some through-roads are closed for the entire winter because of snow, but those servicing ski resorts are cleared and maintained. Others may become impassable for short periods following adverse weather.

The construction of roads in mountain areas for timber production, fire control, or other reasons has facilitated public access into these environments. Although some forestry roads and tracks have been permanently upgraded to form important thoroughfares, many constructed for timber extraction have become overgrown after logging operations have ceased.

Several low-level all-weather roads between Gippsland and north-eastern Victoria have been proposed. The proponents maintain that an all-weather through road linking the two regions would bring many benefits through increased commercial trade between them and an increased tourist influx into eastern Victoria. At present, sections of the Omeo Highway may be closed for short periods following snow on four or five occasions each year, but snow-clearing is not a serious problem, and this service is already provided.

The Country Roads Board investigated the construction of a road between Crooked River and Abbeyard and considered it to be uneconomic. Linking Sale to Wodonga, this route would involve construction of 64 km of new road and a number of bridges, and the upgrading of 187 km of existing road. It would have a maximum elevation of 975 m as it crossed a gap in the Barry mountains. The road would reduce travelling time getween Sale and Wodonga by about one hour when compared with the Hume Highway--Princes Highway route via Yea. Its construction was estimated to cost about $25 million (1976).

Consideration has also been given to constructing a road from Mount Beauty up the West Kiewa River valley, over Cobungra Gap (1,350 m), and down the Cobungra River valley to join the existing alpine tourist road above Omeo. Such a road would probably have a slow twisting alignment, and snow-clearing would be required on approximately 20--30 days of the year even if the road level was kept as low as possible. Travel time from Wodonga to Sale would be about 5 hours.

Alternatives have also been proposed for routes along the Mitta Mitta valley between Omeo and Mitta Mitta township. Four possibilities have been recognized, as shown in Table 19. The alternatives are currently under investigation by the Country Roads Board and other interested bodies. The comparison will include, in addition to construction and maintenance costs, soil erosion hazard, landscape quality, and other land use considerations associated with each proposal.

Table 19

ALTERNATIVE ROUTES

		Route 1 Existing Omeo H'way	Route 2 Mount Martin	Route 3 Limestone Gap	Route 4 Knocker
Length (Omeo--Mitta Mitta)	km	114	108	114	103
Maximum elevation	m	1,350	1,180	930	1,371
Length above 900 m elevation	km	26	18	0.5	37
Travel time by car	hrs	2	1.8	1.9	1.7
Estimated cost of construction (1976 $)		$20.3 million	$17.2 million	$17.4 million	$17.0 million
Estimated maintenance cost over 30 yrs (1976 $)		$ 4.2 million	$ 5.6* million	$ 6.1* million	$ 6.3* million

* The existing Omeo Highway (option 1) must still be maintained even if one of these alternatives is adopted.

Navigation aids

The Department of Transport maintains a set of navigation aids at Mount Livingstone, near Omeo. This installation comprises a set of distance-measuring equipment and omnidirectional radio beacons, and is serviced by a road constructed for that purpose.

Communications

In addition to telephone facilities, telecommunication sites occupy a number of areas. The Post-Master General's Department, Forests Commission, and State Electricity Commission use this means of communication in the discharge of their responsibilities. The P.M.G. Department has a total of 10 radio installations in the study area, consisting variously of buildings, towers, and poles. Four new installations are proposed - at Glen Valley, Sam Hill (Omeo), and two sites at Mount Buller.

Other services

Apart from the above utilities, many other institutional uses require small areas of public land. These include schools, cemeteries, and trigonometric stations.

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22. 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.

Groups with a wide range of interests are making growing demands for resources on public land. In this situation the interaction of various uses becomes an important issue that must be considered before decisions can be made on the allocation of public land. This chapter examines the nature of the interactions.

Land use compatibility

Each type of land use requires a certain set of resources for its operation, and these have been discussed in the relevant chapters. In many cases the resources required overlap in both time and space, thus providing a source of potential conflict. Moreover, the operation of each will have a series of direct and indirect effects on most other uses. These effects may be considered as:

* 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 in order to obtain the best combination of uses on a land management unit. In practice, there are several ameliorating factors, which include the following:

* Activities occur at different levels of intensity. (Incompatibility between two activities at a high intensity may be reduced if the operations of one become less intensive.)

* Some activities occur for a short period, thus restricting their effects and allowing other activities to continue in 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.)

* Compatibility between uses in an area changes over time as the once-harmful effects of one activity are lessened.

* Prevailing social attitudes towards the tolerance of harmful inter-effects may change. (In some cases improved technology - for example better methods of water treatment - helps change these attitudes.)

* Skilful management techniques can reduce possible competitive effects of an activity on others.

Land use flexibility refers to the degree to which any one activity precludes (by its operation) other activities' utilization of a given resource. Flexible uses include those having either negligible or beneficial effects on others.

The following sections give a general outline of relations between broad land use categories in the study area. This report does not deal with relations between various activities or aspects within each major category of use, although the same principles would apply. Those between various forms of recreation, however, are briefly considered.

Agricultural production

The clearing of land in the study area for agricultural activities has in some cases introduced a diversity of visual interest that has provided enjoyment for many people, including those engaged in sightseeing, picnicking, and other forms of passive recreation. The pastoral river flats along the Macalister River, for example, provide a contrast with the enclosing forested mountains.

Clearing and development of land for agriculture is normally incompatible with conservation of native fauna and flora since, although some species benefit, most are severely reduced in number or eliminated by the removal of native forest and the introduction of alien plants and animals.

Agriculture can affect water production, as the conversion from forest to grassland may lead to increases in total water yield, turbidity, and salinity, as well as a reduction in summer stream flow. Pollution may also result from excessive or injudicious use of fertilizers and pesticides or from the concentration of stock near water-courses.

Forest grazing can conflict with nature conservation because of the disturbance to the environment caused by stock grazing and watering, and the introduction of alien plants. It is also competitive with some forms of recreation that require natural environments. With careful management, however, it may be compatible with catchment protection and water production in most environments.

Apiculture

Apiculture is a flexible land use, which is based largely on the maintenance of native flora. It is competitive to some degree with uses such as agriculture.

Hardwood timber production

This is a relatively flexible land use, particularly when carried out at only a low intensity. It is compatible with forest grazing, honey production, and all but the strictest forms of nature conservation. It can benefit some forms of outdoor recreation by providing access tracks for walking and pleasure driving.

Harvesting operations have an immediate effect on values such as vegetation, fauna, and landscape. Most effects may be shortlived, but some are likely to be long-term. The effects become more noticeable as the size of the area being harvested increases. In mountainous terrain the visual impact of harvesting may advsersely affect some recreation values at points some distance from the actual operation.

Increasing the levels of hardwood production decreases its compatibility with other uses, such as nature conservation and many forms of recreation. Intensive production practices may favour certain timber species, remove trees containing animal nest sites, greatly reduce the size to which trees are allowed to grow, and intensify harvesting activities.

Hardwood timber production competes with agricultural production and with recreation activities requiring solitude.

Water production and conservation

The production of water is an important use on public land. To some extent it is competitive with agriculture, hardwood timber production, mining, and recreation, depending on the intensity of production and the management techniques employed in these activities.

The competition applies especially to the quality of water and the seasonal distribution of yield.

Logging, road-making, clearing, grazing, and pedestrian or vehicular traffic can contribute to soil disturbance and reduced water absorption, causing increased surface flow, which results in stream turbidity and increased peak stream flows.

Water storages increase the opportunities for some forms of recreation, such as lakeside picnicking and water-based activities.

Inundation by water in storages has various effects on nature conservation. It destroys the original habitats, and this may be important if the area contains endemic or notable species. The water body, however, creates a new aquatic habitat that has value for some fish and waterfowl. Variations in level as it is utilized can reduce its value for nature conservation. Storages alter flow regimes and may also affect water temperature and oxygen content downstream. Thus they can affect wildlife habitat away from the actual storage site.

Compatibility between water utilization and nature conservation can be enhanced by design of structures and operation procedures. Dartmouth Dam, for example, has a high-level outlet incorporated in its structure. This can be used to ameliorate any effects on downstream wildlife habitat caused by the temperature of water released from the storage. Provision has been made in the dam structure for possible future construction of a multi-level intake tower if this is ever considered desirable.

Public utilities and transport

In general, provision of these services requires the setting aside of small areas of land only, but in most cases this represents an inflexible use. Land is required to provide sites for facilities such as roads and structures for the generation, transmission, and distribution of electricity, for telecommunication installations, and for trigonometrical stations.

Transport routes have been essential for the development of all economic land uses and have increased the opportunities of many people seeking recreation. Road construction in remote areas, however, may reduce their solitude appeal.

Cleared easements for electricity transmission are competitive with vegetation and some wildlife habitats, and may be visually unattractive from some viewing points. Recently adopted policies regarding the design and installation of transmission lines (which aim at retaining as much vegetation as practicable along easements) will reduce the conflict with some other uses.

Telecommunication installations on summits or peaks may conflict with scenic and other values, especially where sited on attractive or remote landscapes.

Urban and industrial uses

Urban areas contain a multitude of different activities that collectively are competitive in space with most non-urban uses, including agriculture, timber production, apiculture, water conservation, mining, and many forms of outdoor recreation. Moreover, the presence of 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.

Nature conservation

Areas set aside specifically for strict nature conservation and for scientific purposes are competitive with all other uses except water production, and are therefore inflexible.

The use of large areas of public land for recreation, water production, and hardwood production can, however, be compatible with the retention of many nature conservation values. But these values are incompatible with activities that radically change the native vegetation, such as urban development and many agricultural enterprises.

Mining

Mining and extractive industries are scattered throughout the study area. These can be competitive with most forms of land use through site disturbance, roading, and pollution. Competition is usually localized, however, and its degree depends on the type and scale of operation. Underground mining does not usually involve as much site disturbance as open-cut mining or surface stripping, but dumping of waste material such as mine tailings may still conflict with other uses. Cyanide poisoning of people or stock by drinking water flowing from mining dumps treated with this chemical is a hazard in some areas.

Associated accommodation and on-site processing of materials can contribute to pollution of streams and of the atmosphere. Most effects of this nature, however, can be minimized by proper location, design, and maintenance. Conflict with landscape values is localized - but may be serious where these values are high and the mining operations are obvious. Exhausted quarries and open-cut mines may be useful as rubbish dumps or sites for some forms of recreation.

Outdoor recreation

Outdoor recreation encompasses a wide range of activities. Their relations with other land uses vary according to their type and intensity. Some pursuits such as adventure driving, fishing, and bushwalking can become self-competitive, especially at high usage rates. Wilderness recreation is incompatible with most other uses as it requires both land where Man's activities are minimal and also a low density of visitors, but is compatible with water production.

Bushwalking and cattle-grazing conflict where they use common water sources and camp sites. The presence of cattle, especially in natural open areas, introduces an element that many walkers regard as alien to the natural environment they seek to experience. On the other hand, walkers often follow cattle tracks and use cattlemen's huts for shelter.

Vehicular tracks, logging roads, and recently harvested timber stands are competitive with the natural surroundings that many bushwalkers seek. Roads and tracks, which in some areas increase the accessibility of prime bushwalking areas for weekend or long weekend trips, usually increase the conflicts between bushwalkers, four-wheel-drive-vehicle users, and trail-bike riders. The noise of trail bikes and the competition for camp sites appear to be the main sources of conflict.

Competition between different recreation activities often centres on huts, which tend to attract people to a particular site - intensifying track erosion, rubbish-dumping, and trampling and cutting of vegetation. Huts, however, provide a facility for many people and may add to the charm of the mountain areas. With careful siting, plus careful choice of construction materials and adequate maintenance, they can add to an area's capability for many forms of recreation.

There appear to be few conflicts in winter in the study area. Deer-hunters use the lower country during this period and make few contacts with other visitors. Hunting with hounds and stalking, however, are not usually compatible in the one area at the same time.

At the higher elevations in winter, logging and mining operations cease, the cattle are taken to home pastures or lower elevations, and adventure driving is restricted. Cross-country skiing and downhill skiing use different types of terrain. the use of snow-mobiles is strictly controlled and, except in search and rescue operations, is limited to authorized personnel using defined village-access ways.

PART IV

BLOCK DESCRIPTIONS

BLOCK DESCRIPTIONS

This part describes for each block its location and land tenure, the nature of the land, present uses, capabilities for various uses, present condition of the land, and likely land use hazards.

A consistent format of headings and sub-headings has been used to help compare specific information for various blocks. Some sections deal only with the public land. These include vegetation, recreation, apiculture, and wood production.

A key diagram on the following page gives the approximate location of each block in the study area. Greater detail for all blocks is shown on Map 1.

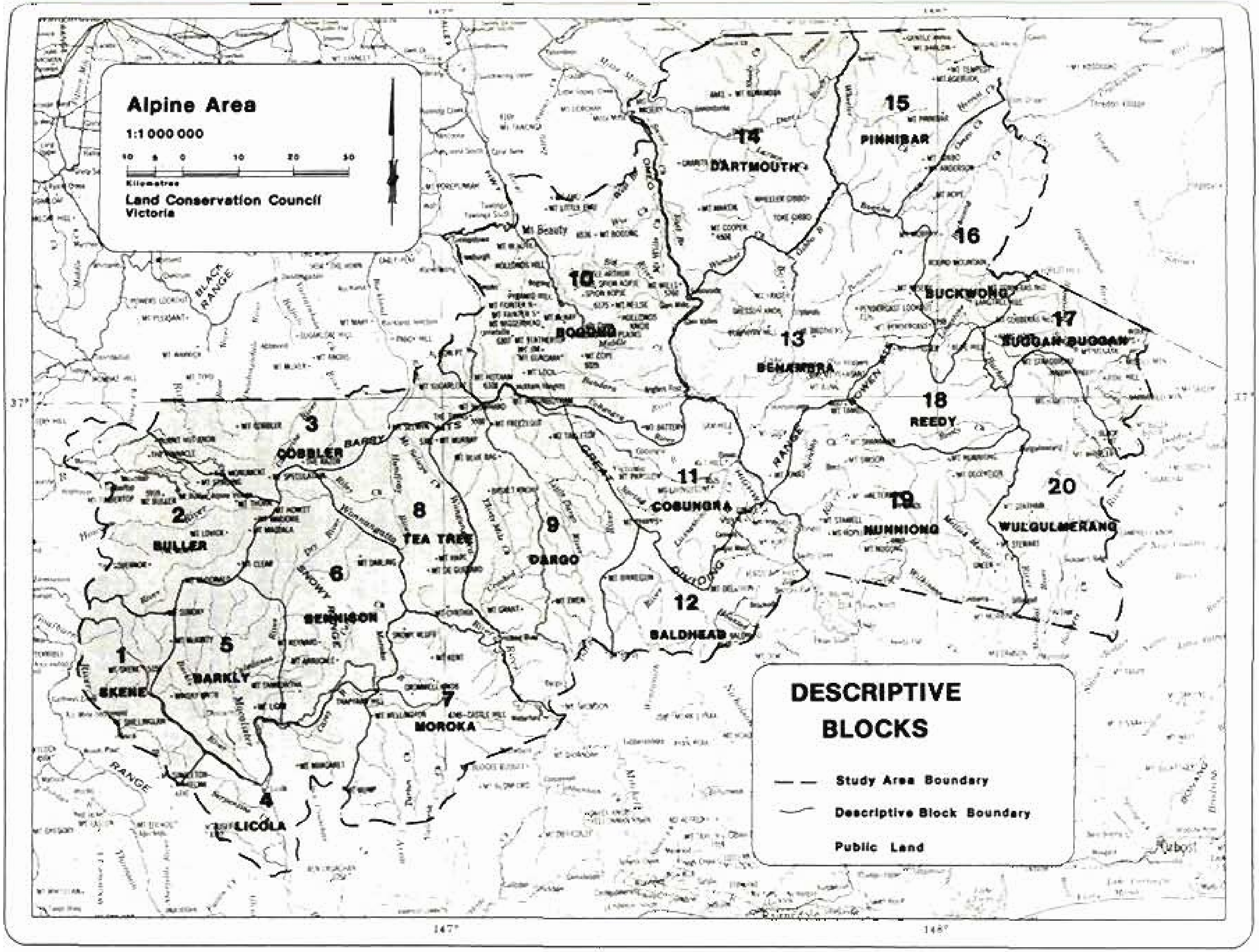
Appendix 2A lists the scientific and common names of all plants mentioned in the text, and 2B lists the significant plants recorded for each block. The vertebrate fauna recorded for each block are listed in Appendix 3, and Appendix 4 lists the noxious weeds by blocks, with an indication of their distribution.

Capability

This term refers to the value of the land for the particular use to which it may be put. Present levels of use are described, where possible, to give some indication of capability. The potential productivity of land is important, particularly in the long term. For some uses such as nature conservation it is based primarily on the inherent characteristics of the land. For others it also depends on inputs (such as fertilizer applications) that raise productivity.

Capabilities are given in general terms only, because the amount of information available has varied from block to block, and because some of the values have been difficult to quantify.

In assessing capability, comparisons have been made with other blocks and, where practical, with other parts of the State. The ratings for various uses cannot be directly compared with each other.


Alpine Area
1:1 000 000
Kilometres
Land Conservation Council Victoria
DESCRIPTIVE BLOCKS
Study Area Boundary
Descriptive Block Boundary
Public Land
1 SKENE
2 BULLER
3 COBBLER
4 LICOLA
5 BARKLY
6 DENNISON
7 MOROKA
8 TEA TREE
9 DARGO
10 BOGONG
11 COBUNGRA
12 BALDHEAD
13 BENAMBRA
14 DARTMOUTH
15 PINNIBAR
16 BUCKWONG
17 SUGGAN BUGGAN
18 REEDY
19 NUNNIONG
20 WULGULMERANG

1. SKENE

A. Location and Tenure

Skene block covers a total area of 41,500 ha, all of which is public land in the form of unreserved Crown land, except for a small area of freehold land along the eastern bank of the Goulburn River, near Snake Creek.

County of Wonnangatta: Parishes of Knockwood and Kevington.

B. Nature of the Land

1. Climate

The climate is influenced most by the elevated mountainous terrain of the block and the prevailing westerly air stream. The air streams deposit most of their moisture on the slopes and ranges west of the Great Divide - which forms a high ridge on the eastern border of this block.

Average annual rainfall varies from 1,200 mm on the western and southern borders to more than 1,600 mm at Mount Skene. Much of this falls as snow during the winter months when daily mean temperatures are low.

Regular snowfalls can be expected above 1,000 m from June to October, but can occur at any time of the year during the irregular "southerly outbreak". On the higher elevations around Mount Skene, snow may persist for a few months.

2. Geology and physiography

The predominant land form is moderately dissected mountainous terrain, developed on alternating beds of steeply dipping Lower Ordovician felspathic sandstones and siltstones (Donnelly and Serpentine Creek beds) and Upper Ordovician black shales (Easton Shale). The Lower Ordovician sediments were previously believed to be Silurian in age and are shown as such on the geological map.

Lower Devonian sandstones and siltstones (previously believed to be Silurian in age) outcrop around the Goulburn River. Cambrian volcanics with minor sediments are exposed in the Jamieson River Valley (south branch) and further south at Connors Plain.

Remnants of early Tertiary basalt exist on the Spring Hill and Connors Plain plateaux (1,250 m and 1,200 m respectively). Other plateaux occur along the Great Divide at Mount Shillinglaw (1,250 m) and at Mount Skene (1,570 m), the highest point in the block.

Major ridges extend from the Mount Skene area towards the Goulburn River, with up to 500 m between ridges and adjacent valley floors. The lowest elevation is 350 m along the Goulburn River on the study area border.

3. Soils

The area consists of highly dissected mountains on predominantly sedimentary rocks with elevations ranging up to 1,571 m at Mount Skene.

The broad, highest ridge crests have shallow organic loams and stony loams, which tend to shallow friable brown gradational soils on lower ridges. The higher slopes carry friable brown gradational soils, and the shallow forms and stony loams are more common on steep dry slopes and at lower elevations.

On moist lower valley slopes friable red gradational soils predominate, but stony red gradational soils are typical on the drier slopes in the valleys. Gravelly loams are common in steep valley bottoms. The basalt residuals of Connors Plain and Spring Hill have red gradational soils.

4. Vegetation

Sub-alpine grasslands and heathlands are confined to a few locations north of Mount Skene at about 1,500 m elevation. Snow gum open forest and thicket is more extensive, but generally restricted to elevations above 1,300 m at Mount Sunday, the high ridge trending north--south from Mount Skene, between Mounts Singleton and Selma, and along part of the Champion spur. Ash-mallee is associated with snow gum south of Mount Skene and near Mount Selma. Understoreys may be shrubby (Muellers bush-pea, alpine oxylobium, alpine pepper, and dusty daisy-bush), heathy, or occasionally grassy.

Mountain gum--snow gum open forest occurs between Mount Sunday and Rumpff saddle, at Mount Shillinglaw, and on the Champion spur at elevations of 1,200 to 1,250 m.

Extensive stands of alpine ash open forest IV occur below sub-alpine forests in stream headwaters at elevations generally ranging from 900 to 1,300 m. These forests also flank the Jamieson--Licola road along the Great Dividing Range from south of Mount Skene to Spring Hill. Most stands either have been harvested or are wildfire regrowth stands. Understoreys may be shrubby (hop bitter-pea and silver wattle) in regrowth forests. Understoreys with scattered shrubs such as silver wattle and gorse bitter-pea or shrubby understoreys (blanket-leaf and hop bitter-pea) are typical of mature forests.

Open forest III generally occupies sheltered aspects below the alpine ash, and descends to the lowest elevations in the block. Narrow-leaf peppermint, associated with mountain gum and manna gum, predominates.

Understoreys are usually shrubby (silver wattle and austral bracken), but may be grassy. There are minor occurrences of messmate stringybark in moist gullies, with blanket-leaf, musk daisy-bush, and Victorian christmas-bush understoreys.

Dry exposed aspects below 1,200 m carry open forest II or open forest I. Broad-leaf peppermint, brittle gum, and candlebark forests occur mainly in the Black and Snake River catchments. Understoreys are usually heathy, including species such as narrow-leaf bitter-pea, prickly bush-pea, daphne heath, and honey-pots. At the lower elevations red stringybark and long-leaf box are associated tree species.

5. Fauna

The fauna of this block is not well documented. Four native mammal, fifty-nine native bird, and six amphibian species have been recorded. The Goulburn River, Jamieson River, and other streams provide wetland habitats. Riverine forests are restricted to lower sections of the major streams. Sub-alpine open areas are restricted to the Mount Skene area, but sub-alpine woodland is distributed along the higher ridges. Wet open forests and dry open forests are extensive.

Birds recorded in wetlands include the white-necked heron, which frequents streams and other wetland habitats. Those in sub-alpine grasslands include the emu, welcome swallow, Australian pipit, and white-backed magpie. Wet heathlands are inhabited by the brown thornbill, white-browed scrub-wren, yellow-faced honeyeater, and white-eared honeyeater.

Species recorded in sub-alpine woodland include the Australian ground thrush, southern yellow robin, and eastern spinebill. Interesting species in wet open forest include the powerful owl at Connors Plain, and the Lewin honeyeater near Mount Skene.

Recorded mammals include brush-tailed possum, common wombat, brown antechinus, and the bush rat, all typical of open forest. Introduced species include the rabbit, fox, and sambar deer.

The common eastern froglet, Victorian froglet, brown tree frog, Lesueur's frog, leaf green tree frog, and Verreaux's tree frog have been recorded in the block.

6. Land systems

The Wermatong High, Wermatong Low, Darbalang, Mount Skene, Connors Plain, and Barry Mountains land systems are represented in the block.

C. Present Use and Capabilities

1. Nature conservation

This block has moderate to high capabilities for nature conservation. Environments range from sub-alpine woodlands to riverine forests. Most areas have been roaded and many timber stands harvested.

Although not well investigated, the flora of this block is known to include five significant species, four of which occur on the summit of Mount Skene.

These are ash-mallee (*Eucalyptus kybeanensis*) at its most westerly locality; the carraway (*Oreomyrrhis brevipes*); the small-flower mat-rush (*Lomandra micrantha* var. *sororia*) only known at several sites; and the lilac berry (*Trochocarpa clarkei*), which is endemic in the western parts of the Victorian Alps.

2. Recreation

Features of this block (one of the closest to Melbourne) include the Goulburn and Jamieson Rivers and Mount Skene. It has high to moderate capabilities for recreation driving, fishing, and deer-hunting, and moderate capabilities for cross-country skiing, canoeing, bush-walking, and fossicking.

Although this alpine area is the closest to Melbourne, bushwalkers only use it infrequently. The existence of a major tourist road crossing Mount Skene, the large number of roads and tracks in the area, and extensive logging have reduced its attractions for them. A walking track that crosses the headwaters of the Black River ascending to Mount Shillinglaw and along the Great Divide to Mount Sunday receives moderate use.

This block supports a moderate amount of recreation driving, particularly the main ridge tracks between the Jamieson--Mount Skene--Connors Plain road and the Goulburn River. Some traffic is associated with the attractions of the Gaffneys Creek, Woods Point, and Aberfeldy areas. The Licola--Jamieson tourist road traverses the block and receives regular use in summer.

Sambar deer are hunted throughout the block, including around Mount Skene and in the Black River valley. The Jamieson and Goulburn Rivers provide opportunities for fishing.

The high ridge extending north and south from Mount Skene provides opportunities for cross-country skiing and is accessible by two-wheel-drive road from Jamieson and Licola.

The Goulburn River upstream of Knockwood offers occasional seasonal opportunities for canoeing. This section is rarely used; however, the section between Knockwood and Jamieson provides a popular weekend trip.

Fossickers engage in gold-panning on the Jamieson gold-field. The Cinnabar mine near Jamieson provides interest.

3. Agriculture

Five of the six graziers using the public land are based in Gippsland, with properties at Licola North, Glenmaggie, Heyfield, and Briagolong. The other is based at Mansfield. About 400 adult animals are grazed here during summer, mainly in the grassy alpine ash forests and snow gum woodlands along the higher ridges. About 150 of these are cows and their calves and 250 are dry cattle. Angus is the predominant breed. Main access routes are Middle Ridge to Mount Skene and the Licola--Jamieson road. There is negligible private land in the block.

Forest-grazing capability is moderate, and is based mainly on the management of alpine ash forests. Capability for agricultural development is low.

4. Apiculture

This block is accessible to and often used by apiarists, but access could be improved. Main honey flora are snow gum, alpine ash, ash-mallee, brittle gum, and black sallee. Understorey plants valuable for pollen and sometimes nectar include beard-heaths, parrot-peas, oxylobiums, and hop bitter-pea.

5. Wood production

Much of the block has a high capability for timber production. Stands of regrowth and mature alpine and mountain ash totalling 12,800 ha occur along the Great Dividing Range, north-west from Mount Skene, and in the South Jamieson River and its tributaries. Most of the stands reached by forest roads have been harvested and regenerated. Extensive stands of moist foothill forest - composed mainly of messmate and manna gum - occur in Handford Creek and the Jamieson River, and adjacent to ash stands on the fall into the Goulburn River. These have moderate to high capabilities for timber production.

Each year, the 11 mills (three at Mansfield, six at Heyfield, and one each at Benalla and Jamieson) together cut about 30,800 m^3 of sawlogs from about 420 ha of forest. A.P.M. obtains pulpwood supplies from integrated harvesting operations.

6. Minerals

The former Aberfeldy gold-field extended along Champion Spur in the southern part of the block, but the block has only poor possibilities for further gold production. Good possibilities for nickel discovery are, however, associated with Cambrian rocks in the north-eastern part. Mercury deposits are known in the north.

7. Water production

The main streams are the Goulburn and Jamieson Rivers, sections of which form the western and northern boundaries. The entire block receives more than 1,200 mm rainfall annually. It includes less than half the Goulburn River catchment, and the total mean annual discharge of this stream is 403,600 Ml. Water quality is high in all streams. Lake Eildon, used mainly for irrigation supplies, receives some of its inflow from catchments in this block.

The capability for water production is high.

D. Hazards

The soil erosion hazard is highest around the sub-alpine environs of Mount Skene and lowest in the wet mountain forests on the more gentle slopes. The fire hazard is high. A fire lookout at Mount Skene is manned when necessary. Seven noxious weed species have been recorded in the block.

2. BULLER

A. Location and Tenure

The block covers a total of 72,900 ha, of which 65,500 ha (90%) is public land. This is mostly reserved forest (43,500 ha), and includes an alpine reserve at Mount Buller. Unreserved Crown land totals 22,000 ha. The freehold land is mainly confined to the north-west slopes of the Eastern Highlands.

County of Wonnangatta: Parishes of Changue, Narbourac, and Warrambat.

County of Delatite: Parishes of Mirimbah, Merrijig, and Gonzaga.

B. Nature of the Land

1. Climate

Being on the edge of the Eastern Highlands, the block experiences the full effect of cold fronts from the prevailing westerly air stream. South-westerly to north-westerly air streams deposit their moisture after cooling on uplift from the undulating lowlands to Mount Buller and the Great Divide, which forms a high ridge on the eastern border.

Average annual rainfall increases from 780 mm at Merrijig to over 1,600 mm at Mount Buller, 15 km east, and also along the Great Divide and The Bluff. Snow may persist on the higher peaks and ridges from June to October. Snow falls regularly above 1,000 m during this period and has fallen at Merrijig on occasions.

2. Geology and physiography

This block, on the north-western edge of the Eastern Highlands, has strongly dissected mountainous terrain bordering on lower undulating land. It is the source of three major tributaries of the Goulburn River: the Delatite, Howqua, and Jamieson Rivers, all of which flow into the Eildon reservoir. A dendritic stream pattern has developed west of the Divide, with valleys broadening towards the west. Mount Buller (1,804 m) is the highest peak west of Mount Hotham. The ski village is located on a small plateau capped with Oligocene basalt. A low pass (890 m) in the Divide occurs between Mount Sunday (1,380 m) and Mount McDonald (1,626 m) in the south.

Upper Devonian--Lower Carboniferous sediments border the block on the east and north-west. Gently dipping beds of these sediments have formed a basin and small plateaux north of the Delatite River. Small plateaux on The Bluff (1,700 m), Mount Lovick (1,540 m), and Mount Howitt (1,746 m) are bordered by steep escarpments descending towards the Howqua River. The sediments have been cut through to expose, in the west, belts of Cambrian volcanics with minor sediments (Howqua greenstone) and alternating beds of Lower Ordovician felspathic sandstones and siltstones (Donnelly and Serpentine Creek beds) and Upper Ordovician black shales (Easton Shale). The felspathic sandstones and siltstones were previously believed to be Silurian in age and are shown as such on the geological map, but are now regarded as Lower Ordovician.

The mountainous area around Mount Buller and Mount Stirling is composed of Middle to Upper Devonian granites. A remnant of Upper Devonian volcanics forms a small plateau in the Mount Timbertop region.

3. Soils

Wide ranges in climate, topography, and rock type occur in this block, so it has a large number of different soils.

The highest areas, such as Mount Buller and The Bluff, have shallow organic loams and stony loams with limited areas of peats and humified peats.

At lower elevations, friable brown gradational soils predominate on moist slopes on most parent materials. On the drier slopes on granitic rocks, however, massive gradational soils predominate, and on sedimentary rocks the soils are shallow friable brown gradational, with stony red gradational soils at the lower elevations.

The broad valley bottoms in the north-west have red gradational soils on the steeper slopes and yellow duplex soils on less-steep slopes. Gravelly loams are common in steep valley bottoms. Dark cracking clays occur along some streams in these areas.

4. Vegetation

Herbfields, heathlands, and mosslands generally occupy areas above the tree line in this block. These grow at elevations ranging from 1,680 to 1,800 m at Mount Buller, and 1,680 to 1,750 m at Mount Stirling. They are also found at elevations between 1,600 and 1,700--1,740 m at Mount Marjorie and Mount Howitt respectively, and from about 1,580 to 1,770 m on The Bluff.

Snow gum open forests and woodlands occupy high ridges (Razorback Spur, Thorn Range, and The Bluff) and the upper slopes of Mounts Buller, Stirling, Howitt, Clear, and Magdala, at elevations from 1,460 to 1,680 m. Snow gum woodlands descend to about 1,340 m on the north face of The Bluff.

Mountain gum--snow gum forests occur at scattered locations (Mount Timbertop, the Jamieson--Howqua divide west of The Bluff, and the Great Divide near Mount Clear). Understoreys vary from grassy to shrubby and on dry sites typically include clustered everlasting, kangaroo grass, and gorse bitter-pea.

Extensive alpine ash forests in the block are situated below snow gum forests around Mounts Buller and Stirling and the Razorback Spur. Large stands also occur in the headwaters of the Jamieson River and north of Howitt Spur. These have all been harvested to a large extent, but some mature stands are to be found around Mount Buller, and in the Jamieson River and Lickhole Creek headwaters. Fire regrowth stands are scattered. The forests range in elevation from about 850 m on sheltered sites up to about 1,460 m. Understoreys are mainly heathy to shrubby.

Narrow-leaf peppermint with associated manna gum and mountain gum commonly comprise open forest III. These forests occupy most of the valleys below the alpine ash. Understoreys vary from wet gully type (blanket-leaf and Victorian christmas-bush) to shrubby (silver wattle, austral bracken, and prickly currant-bush), or are grassy (kangaroo grass).

River flats and some lower slopes support stands of manna gum open forest III. Dry steep aspects on the lower valley slopes support broad-leaf peppermint--candlebark open forest II with mainly heathy understoreys of narrow-leaf bitter-pea, gorse bitter-pea, tussock-grass, and guinea-flower.

5. Fauna

This block is among the best-documented in the study area. Twenty-three native mammals, 106 native birds, nine reptiles, and eight amphibians have been recorded, as well as the sambar deer and several other introduced species.

Wetlands along the streams are in some cases associated with riverine habitats of manna gum and narrow-leaf peppermint open forest with shrubby to grassy understoreys such as along the Howqua River and Jamieson River (north branch).

Alpine and sub-alpine grasslands, heathlands, and herbfields are located on the highest peaks. These are flanked by sub-alpine woodlands and, lower down, wet open forests of alpine ash and narrow-leaf peppermint. Dry open forest is limited to dry aspects. Semi-cleared and cleared areas are located around Merrijig.

Wetlands provide habitat for the platypus and eastern water rat, and various waterbirds such as the white-necked heron and wood duck.

Native mammals recorded in the riverine forests of manna gum and narrow-leaf peppermint along the Howqua River comprise the eastern pigmy possum, eastern grey kangaroo, greater glider, brush-tailed possum, ring-tailed possum, common wombat, brown antechinus, bush rat, long-nosed bandicoot, and dingo. This habitat is rich in bird species and includes, for example, the Australian goshawk, superb blue-wren, striated thornbill, white-browed scrub-wren, southern yellow robin, golden whistler, eastern whipbird, red-browed tree-creeper, white-naped honeyeater, noisy friar-bird, and olive-backed oriole.

Alpine and sub-alpine open areas support bush rats, brown antechinus, and Swainson's antechinus in wet heathlands and mosslands. The broad-toothed rat has also been recorded in this habitat. The little falcon and nankeen kestrel hunt over these areas in summer. Other birds recorded here include the fairy martin, Australian pipit, pilot bird, flame robin, and white-eared honeyeater.

Mammals in sub-alpine woodland include the bobuck, bush rat, Swainson's antechinus, brown antechinus, and common wombat. Characteristic birds found include the gang-gang cockatoo, crimson rosella, brown thornbill, white-browed scrub-wren, pilot bird, flame robin, olive whistler, eastern striated pardalote, yellow-faced honeyeater, white-eared honeyeater, crescent honeyeater, and little raven.

In wet open forest, mammals include the eastern grey kangaroo, black wallaby, brown antechinus, greater glider, long-nosed bandicoot, feather-tailed glider, bush rat, and others typical of this habitat. Characteristic birds include the crimson rosella, laughing kookaburra, white-throated tree-creeper, and pied currawong.

Dry open forest contains recorded mammal species similar to those found in wet open forest, including the echidna, ring-tailed possum, sugar glider, greater and lesser long-eared bats, and the little bat - all of which might be expected in wet open forest also.

Nine reptile species have been recorded - the tree dragon, McCoy's skink, grass skink, garden skink, water skink, Cunningham's skink, southern blue-tongue, copperhead, and blind snake (*Typhlops nigrescens*). The eight amphibians recorded are the common eastern froglet, Lesueur's frog, Verreaux's tree frog, Victorian froglet, eastern banjo frog, brown tree frog, and brown toadlet.

6. Land systems

The Wermatong High, Darbalang, Barkly, Koonika, Buffalo, Mirimbah, Cambatong, Tabletop, Merrijig, Tolmie, Buller (Sedimentary), Buller (Igneous), Howitt Plains, Stanley's Name, Stirling, Skene, and Speculation land systems are represented in the block.

C. Present Use and Capabilities

1. Nature conservation

Nature conservation values are high over much of this block. Environments range from alpine herbfields to riverine forests. Geology is varied. Roading provides access to most parts except in the Governor's area. Bird and mammal species have been well documented and are rich in numbers and diversity. The broad-toothed rat has been recorded near Mount Timbertop. A rich and diverse Upper Devonian fish fauna, including complete and articulated skeletal material, has been recorded at a single site in the headwaters of the Howqua River.

Twelve significant plant species occur in the block, seven of which are regarded as highly significant. The bent-grass *Deyeuxia parviseta* is known elsewhere in Victoria only in the Nunniong area and at Mount Wellington. The rare alpine finger-fern (*Gramitis armstrongii*) is found only occasionally on the higher peaks of the alps. The block also includes the most westerly records of a rare alpine buttercup (*Ranunculus eichleranus*), which is endemic to the study area, the lilac berry (*Trochocarpa clarkei*), and the bedstraw *Galium binifolium*, which is an East Gippsland coastal plant. Mount Buller is the type locality for at least nine plant species.

2. Recreation

Apart from a number of attractive streams, rugged ranges, and high mountains, features of the block include the ski resort at Mount Buller and remains of an old township on the Howqua River. Capabilities are very high for downhill skiing and bushwalking, high for horse-riding, recreation driving, hunting, fishing, and canoeing, moderate for ice-climbing, wilderness recreation, and cross-country skiing, and low for fossicking.

For bushwalkers, this block is one of the most important in the area. The combination of high rugged mountains with attractive river valleys in an area within 3½ hours drive of Melbourne has made it very popular. The Howqua River is a key feature, providing pleasant walking access to many points of interest and providing excellent camping sites. Many routes to the surrounding peaks begin from Howqua track. Mount Howitt is a natural junction at the head of the King, Howqua, Wonnangatta, and Macalister Rivers. Other popular walking routes lead to the summit of Stirling from the Circuit road, along the Thorn Range, along the lower Jamieson River to Mitchells, from Frys to the Jamieson River and Mount McDonald via Lickhole Creek (traversing a substantial unroaded area), and also from Mount Sunday along the Great Divide to Mount Howitt. Walkers include school groups (some with permanent nearby accommodation), youth groups, and family groups.

Commercial horse-riding tours operate out of Merrijig for several days at a time. Areas visited include the Howqua valley, Mount Lovick, Mount Clear, Mount Howitt, and Howitt Plains. Cattlemen's huts are often used for overnight stops, and activities are sometimes centred around the management of cattle in the high country.

Recreation driving is also popular here. The easy access from Melbourne and outstanding features of the area attract many four-wheel-drive owners, especially on weekends. Tracks and roads most often used appear to be around Mitchells, from Mount Timbertop to the Howqua and Jamieson Rivers, from Mount Clear to Bindaree Hut via Mount Lovick, and around Mount Stirling. Trail-bike riders also use these tracks, particularly those along the Howqua valley.

Deer are regularly hunted in several localities, such as in the Howqua and Jamieson River valleys.

A campsite with toilets provided, located at Sheepyard Flat on the Howqua River, is very popular for camping. The Delatite, Howqua, and Jamieson Rivers are all popular trout-fishing streams.

Cross-country skiing is enjoyed on the slopes of Mount Stirling and the circuit road around this mountain, often as a day trip from Mount Buller. The high ridge from The Bluff east to Mount Howitt and the area from Mount Magdala to Mount Clear and the Nobs provide extended overnight trips. Cattlemen's huts provide accommodation for winter camping although many ski-tourers prefer snow-camping in tents or snow caves.

For downhill skiing, Mount Buller is the most visited of Victorian ski resorts. In 1974 it received an estimated 120,000 separate visits. Its present capacity for skiers using the slopes and tows or in a queue at any one time is estimated to be 4,160. The resort is about 3--3½ hours' drive from Melbourne, and has a full range of slopes, from beginner to advanced. Further extension to the skiing area is planned at Corn Hill. Mount Stirling has a high potential for downhill skiing with some 1,400 ha above 1,400 m elevation, a peak at 1,738 m, and a full range of slopes in terms of both skier classification and aspect.

Good opportunities for ice-climbing occur here on the west ridge of Mount Buller, and on the Northern slopes of The Bluff, Square-Head Jinny, and Mount McDonald.

The Howqua, Delatite, and Jamieson Rivers are used by canoeists. The Howqua River offers some exciting and enjoyable canoeing after months of high rainfall. Capable canoeists can readily negotiate the 13-km section from Eight Mile Hut to Frys within a day. The Delatite is popular in spring and has varying standards of difficulty, depending on the amount and speed of water flow. A common week-end trip is from the Sawmill Settlement to Merrijig. Another is from Merrijig to the bridge on the Jamieson--Mansfield road or to Eildon Weir.

There is some fossicking activity along the Howqua River.

3. Agriculture

The 12 graziers that regularly use the public land have properties scattered around Mansfield and Merrijig. The main runs are in snow gum woodland and alpine open areas on the summits of ridges, and in alpine ash forests in the headwaters of streams. Grazing also takes place in some areas of the Howqua, Jamieson, and Delatite River valleys, in narrow-leaf peppermint and gum forests with grassy understories. Main access routes are along the Howqua River, the Mirimbah--Mount Stirling circuit road, and Buttercup Creek, Burnt Hut Knob, and the King River. About 480 cows with 400 calves and 230 dry cattle graze here during the warmer months - mid December to mid April. About 35 beasts graze around the

Howqua River--Lickhole Creek area all the year. Hereford is the main breed.

Most private land in this block is situated around Merrijig, where sheep and beef cattle are of equal importance. Fine-wool sheep are produced on properties along Buttercup Creek, while prime lambs are produced closer to Merrijig. Beef cattle, mainly Herefords, are run in this general area and on private property at Stockyard Creek, to produce store weaners or 2-year-old store steers. Most land is well developed, with pastures of subterranean clover and volunteer annual grasses; it has usually received applications of at least 1.25 tonnes of superphosphate per hectare.

Average capability for bush grazing is moderate, rising to high in the snow gum areas and the grassy alpine ash stands. The presence of clover among ground flora through almost all of the cattle runs has increased carrying capacity. Lack of water for stock in many places has been overcome by construction of small tanks or dams fed from springs. Capability for agricultural development is moderate in lower areas in the valleys but low elsewhere.

4. Apiculture

The northern section of the block is accessible but not the southern. Main honey flora are snow gum and alpine ash.

5. Wood production

Capability for hardwood timber production is high in the 12,000 ha of regrowth and mature stands of alpine ash in this block. Some of these mature stands in the vicinity of Mounts Buller and Stirling have been logged and regenerated. Others around Mount Stirling and in the Howqua, Delatite, and Jamieson (north branch) catchments have not been utilized. Stands of moist foothill forests adjacent to those of mountain forest have moderate to high capabilities. Principal species are messmate, mountain gum, and manna gum. The balance of public land generally carries dry foothill forest of gum and stringybark with low capability.

Each year the five mills (four at Mansfield and one at Benalla) together cut about 24,900 m^3 of sawlogs from about 330 ha of forest.

6. Minerals

A high ridge in the south-western part of the block has large reserves of high-quality slate. Nickel discovery associated with Cambrian rocks in the south-west is a possibility. Two former gold-fields occur along the Jamieson and Howqua Rivers, but reserves are expected to be low.

7. Water production

Most of the area receives more than 1,200 mm precipitation annually. Main streams include the Delatite, Howqua, and Jamieson Rivers, with mean annual discharges of 135,500 Ml, 195,000 Ml, and 247,800 Ml respectively. These all supply high-quality water. This block falls within the Goulburn basin supplying Lake Eildon (3,390,100-Ml capacity). The alpine village of Mount Buller has a reticulated water supply drawn from a nearby stream.

The capability for water production is high.

D. Hazards

The soil erosion hazard is high on the alpine summits of Mounts Buller, Stirling, Marjorie, and Howitt and The Bluff. It is moderate to high in sub-alpine environments, particularly where soils are derived from Devonian--Carboniferous sediments and the ground cover is sparse (such as at Mount Clear and along the Thorn Range).

The fire hazard is high in this lightning-prone area. Protection of the alpine village at Mount Buller receives particular attention. A fire lookout is located on Mount Buller.

Wild dogs sometimes attack sheep in the Buttercup Creek area. Twelve noxious weed species have been recorded in the block, including ox-eye daisy, St. John's wort, sweet briar, and various thistles. Tutsan is a particular problem in the Howqua valley, and black-berries are common in some localities.

3. COBBLER

A. Location and Land Tenure

Cobbler block covers a total of 66,300 ha, all of which is public land. An area of 8,500 ha in the west is reserved forest, the remainder being unreserved Crown land, except for a small section of the Mount Hotham Alpine Reserve.

County of Delatite: Parishes of Mirimbah, Wallagoot, Koonika, Youpella, Coolungubra, Maharatta, and Harrietville.

B. Nature of the Land

1. Climate

Rainfall mostly originates from the up-lifting of moist westerly air streams over the mountains. Annual rainfall averages between 1,400 and 1,600 mm over most of the region, increasing to more than 1,600 mm at Mounts Stirling and Speculation in the west and the Barry Mountains and Mount St. Bernard in the east.

Low winter temperatures may allow snow to persist on the higher peaks and ridges from June to October, and snowfalls occur regularly above 1,000 m during this period.

2. Geology and physiography

Most of the block is deeply dissected mountainous terrain developed on Ordovician felspathic sandstones and siltstones, overlain in the west by Devonian sedimentary and igneous rocks. Ridges and main streams are aligned in a general northerly direction from the Great Divide, with steep descents of up to 800 m from ridge tops to adjacent valley floors.

The surfaces of the Cobbler plateau (1,200-1,400 m) and the Wabonga plateau (which extends south from Mount Typo into the study area) are formed on the dip slopes of Upper Devonian--Lower Carboniferous sediments. Escarpments of sandstones, conglomerates, and Upper Devonian acid volcanics descend to the King River valley (predominantly Devonian volcanics and granite) and the Rose, Dandongadale, and Catherine River valleys (which are predominantly cut into Ordovician sediments).

The Cobbler plateau is overlooked by Mount Cobbler (1,602 m), one of the most spectacular and distinctive formations in the study area. Another feature formed on conglomerate is the Razor (about 1,400 m) - the north-eastern extremity of a precipitous rocky spur extending east from Mount Despair. The Great Divide continues eastwards from the Barry Saddle (a low point (950 m) just east of the Razor--Viking area) to Mount Selwyn (1,410 m) and on to the Twins (1,701 m) and Mount St. Bernard (1,548 m).

Mount Selwyn is situated on Silurian granite. The granite has intruded the surrounding Ordovician sediments and metamorphosed these at the boundary to form an encircling hornfels aureole.

The lower elevations in the block are approximately 500 m where the three major north-flowing rivers - the King, Buffalo, and Buckland - flow out of the study area.

3. Soils

Limited areas of shallow organic loams occur on the highest areas. The predominant soils on the moist slopes are friable brown gradational soils, with shallow forms or stony loams on drier areas. Stony loams also predominate on dry crests and the steepest slopes.

In the lower valley areas, friable red gradational soils are common on less-steep slopes, and steep valley bottoms have gravelly loams.

Soils on the Cobbler plateau are friable brown gradational soils, with the shallow forms being more common on the steeper slopes and the plateau margins.

Granitic areas have similar soil sequences, but in drier areas massive gradational soils predominate on most slopes.

In the alluvial valley bottoms, red gradational soils with weak structure and yellow gradational soils are found on the terraces, and grey-brown loams and undifferentiated sands and loams occur on the lowest levels.

4. Vegetation

Alpine herbfields and heathlands at 1,550--1,660 m on Mount Speculation include species such as yam daisy, snow grass, yellow kunzea, snow aciphyll, and ivy-leaf violet. Dry heathlands at Mount Misery and the Razor include small crowea and dagger wattle.

Snow gum open forest occupies the higher ridges and spurs from Burnt Hut Knob in the west to Mount St. Bernard in the east at elevations from about 1,300 m up to 1,600 m. Understoreys may be grassy (as at Burnt Hut Knob) or heathy.

Mountain gum--snow gum open forests on the Buckland Spur and Cobbler plateau have grassy to heathy understoreys and are found at elevations ranging from 1,000 m to 1,400 m.

Considerable areas of alpine ash forest occur in the vicinity of Fork Creek and Clear Hills in the west. Most have been harvested. Mature stands have grassy understoreys, becoming more shrubby at lower elevations. Alpine ash forests border the Cobbler plateau and the broad ridge north of Mount Selwyn. Large fire regrowth stands are around Burnt Hut Knob, the Razor, and in the headwaters of the Buckland River (east branch).

This vegetation type occupies elevations ranging from 900 m to 1,350 m.

Narrow-leaf peppermint open forest III is the major vegetation type in this block. Associated trees are manna gum and mountain gum. Understoreys vary from mountain tea-tree, through Victorian christmas-bush in wet gullies, to shrubby or grassy. Manna gums sometimes form pure stands along the river flats, with shrubby understoreys of blackwood, soft tree-fern, prickly currant-bush, austral braken, and common groundfern.

Mountain swamp gum woodlands with an understorey of Ovens wattle, fish-bone water-fern, and red-fruit saw-sedge occupy sections of the main streams. Broad-leaf peppermint, candlebark, and sometimes brittle gum forests occupy the drier ridges and slopes, while open forest I may be found on dry precipitous slopes such as around the Cobbler plateau and King Spur.

5. Fauna

Seventeen native mammal species (two monotremes, two macropodids, six phalangerids, the common wombat, two dasyurids, two rodents, one bat, and the dingo) have been recorded. Introduced mammals recorded here include the sambar deer. Forty-nine native bird, one reptile, and three amphibian species are known to inhabit the block.

Streams provide wetland habitats, the most significant being the major rivers. Riverine forests of manna gum and narrow-leaf peppermint and mountain swamp gum woodlands are associated with major rivers. Alpine heathlands and herbfields are restricted to the highest peaks, such as at Mounts Speculation and Cobbler and the Twins. Sub-alpine woodlands mainly occur on the Cobbler plateau and along the Barry Range. Wet open forests are extensive, and dry open forests are restricted to the steepest driest slopes.

Wetlands support populations of platypus and eastern water rats, and some water-birds.

Riverine forests and woodlands provide habitat for the eastern grey kangaroo, greater glider, common wombat, bush rat, dingo, and other mammals. Birds include the superb blue-wren, pilot bird, rufous fantail, and eastern whipbird.

The 15 birds recorded for alpine heath-lands and herbfields are typical of this block.

Mammals in sub-alpine woodlands include the echidna, ring-tailed and brush-tailed possums, greater glider, common wombat, brown and Swainson's antechinus, bush rat, and dingo. Thirty-five bird species recorded in the woodlands are typical of this habitat, but another two (the pallid cuckoo and noisy friar-bird) are summer visitors typical of lower elevations.

Mammals in wet open forest include two macropodids, three phalangerids, two dasyurids, one rodent, and one bat. All 41 bird species observed were typical of this habitat elsewhere in the alpine study area.

The eight native mammal species and 34 bird species recorded in dry open forest are typical of this habitat elsewhere in the study area.

Only one species of reptile and one of fish - McCoy's skink and the brown trout - are recorded for the block. Recorded amphibians are the common eastern froglet, eastern banjo frog, and Lesueur's frog.

6. Land systems

The Stirling, Tolmie High, King Low, Tolmie, Wermatong High, Dandongadale, Darbalang, Cobbler, Koonika, Buffalo, Speculation, Catherine River, Cambatong, Selwyn, Wandiligong, Barry Mountains, Buller (Sedimentary), and Stanley's Name land systems are represented in the block.

C. Present Use and Capabilities

1. Nature conservation

Capability for nature conservation is high. Environments range from sub-alpine woodlands to riverine forests. The Razor--Viking area has been least disturbed by various land uses.

One of the six significant species of plants in this block - *Olearia frostii*, Bogong daisy-bush - is endemic to the study area. The Baw-Baw berry (*Wittsteinia vacciniacea*) is highly significant as it is endemic to Victoria, being known only in the Baw Baw--Donna Buang--Lake Mountain region and in a gully-head between Mounts Cobbler and Koonika. The lilac berry (*Trochocarpa clarkei*) is endemic to the western half of the Victorian alps, and the Omeo gum (*Eucalyptus neglecta*) is endemic to the Victorian highlands.

2. Recreation

The many recreation attractions here include a number of major streams, Mount Cobbler, Cobber Lake and waterfall, and the Barry Mountains (including the Viking--Razor area). Capabilities are very high for bushwalking (particularly in the Razor--Viking area) and fishing, high for adventure driving, moderate for hunting and cross-country skiing, and low for rock climbing.

The area is popular with many bushwalkers. In the western section, easy access and spectacular natural features, such as Mount Cobbler, the Crosscut Saw, and Mount Speculation - combined with good campsites afforded by the King River and other places where water is plentiful - give the area a high capability for bushwalking. This section is regularly used on weekends and long weekends. The Barry Mountains usually form part of extended trips.

The King River, Cobbler plateau, and Catherine Saddle areas are often used for recreation driving in both four-wheel-drive vehicles and trail-bikes. Many visit the campsites at King River Hut and Cobbler Lake. Tracks up the Buffalo

River and Buckland River valleys are regularly used as links with the Wonnangatta valley and the Tea Tree Range.

Sambar deer are hunted in several locations, particularly along the main river valleys such as those of the King, Catherine, and Buffalo Rivers.

Cobbler block contains several highly regarded trout streams, the more accessible being the King, Buffalo, and Buckland Rivers. The Catherine and Rose Rivers are less accessible.

Cross-country skiing takes place on the Cobbler plateau and the broad ridge south to Mount Speculation. The Cross-cut Saw from Mount Speculation to Howitt is suitable for experienced skiers only, and is infrequently negotiated.

Cliffs in the Razor and Mount Cobbler localities offer some opportunities for rock climbing, but are rarely climbed.

3. Agriculture

Ten graziers regularly use the grazing runs on the public land. About 440 cows with 330 calves and about 200 dry cattle graze the areas west of and including the Cobbler plateau during the summer. With the exception of the narrow-leaf peppermint forests in the King River valley, they mainly graze at the higher elevations through snow gum and alpine ash forests. These cattle, mostly Herefords, come from properties around Mansfield and Merrijig.

In the eastern section of the block, cattle graze the valleys of the Dandongadale, Catherine, Buffalo (East and West branches) and Buckland Rivers the year round, although concentrating on the upper reaches in warmer months and the downstream tracts in the cooler months.

The river flats of open manna gum and swamp gum forests and the lower slopes of narrow-leaf peppermint forest receive most of the grazing. About 260--300 cows with calves have been grazed in recent years. Home properties are downstream along the major river valleys, for example at Brookside and Bowmans Forest.

There is no private land in the block.

Capability for bush-grazing is high at the higher elevations and also in the river valleys. Carrying capacity in some of these valleys has been increased by removal of small trees, application of superphosphate, and introduction of clovers.

4. Apiculture

Access is poor. Main honey flora are snow gum, alpine ash, narrow-leaf peppermint, broad-leaf peppermint, and various ground flora species. The western part of the block receives regular use by a few beekeepers.

5. Wood production

Capability for hardwood production is high in most of the 11,000 ha of regrowth and mature alpine ash stands. Some accessible stands around Mount Stirling in the west and Mount Selwyn in the east of the block have been harvested and regenerated; logging is continuing in the mature stands in the heads of the King and Catherine Rivers. Stands of moist foothill forest, generally adjacent to stands of mountain forest, have moderate to high capabilities. Principal commercial species are messmate, mountain gum, and manna gum.

Each year, the seven mills (five at Mansfield, and one each at Wangaratta and Eurobin) together cut about 27,500 m^3 of sawlogs from 370 ha of forest.

6. Minerals

At its eastern end, the block extends into the Harrietville gold-field, which still has possibilities for further gold production. The Upper Devonian--Lower Carboniferous Avon group of sediments within the block have a low potential for sedimentary copper or uranium mineralization.

7. Water production

The headwater catchments of the Buckland, Buffalo, Catherine, Dandongadale, Rose, and King Rivers are included in the block.

All areas within the block receive at least 1,200 mm of precipitation annually - mostly in winter and spring, as indicated by gaugings on the Ovens River at Wangaratta. These show that peak discharges are between July and October and that 14% of the average annual discharge occurs during the 6 months December to May, including 3.5% in the 3 months January to March. The following table shows mean annual discharge rates. All streams contribute high-quality water with mean salinities of less than 30 mg per l.

River	Gauging station	Mean annual discharge (Ml)
Buckland	Lower Buckland	146,212
Dandongadale	Matong North	67,092
King	Pineapple Flat	86,480
Rose	Matong North	65,293
Catherine	No record	
Buffalo	Abbeyard	127,195

The King River supplies Lake William Hovell (capacity 12,300 Ml), which is used to safeguard rural development on the lower King River. The Rose, Dandongadale, Buffalo, and Catherine Rivers supply Lake Buffalo (24,100 Ml capacity) - which, together with Lake William Hovell, serves about 6,000 ha of irrigation land at present.

The capability for water production is high.

D. Hazards

The soil erosion hazard is highest in the sub-alpine woodlands, particularly where accompanying soils are derived from sandstone, as on the Cobbler plateau. The fire hazard is high. Noxious weeds include blackberry, ox-eye daisy, St. John's wort, tutsan, and sweet briar.

4. LICOLA

A. Location and Land Tenure

Licola block covers a total area of 48,750 ha, of which 44,000 ha (90%) is public land. Most of this is unreserved Crown land except for 875 ha of reserved forest east of a broad strip of freehold land along the Macalister River, and a small reserve beside the Wellington River.

County of Wonnangatta: Parishes of Licola, Doledrook, Sargood, Buragwonduc, Moroka, and Tamboritha.
County of Tanjil: Parishes of Narrobuk, Narrobuk North, Worrowing, and Sargood.

B. Nature of the Land

1. Climate

The prevailing westerly air stream deposits most of its moisture on the windward slopes and higher elevations of the Divide. Less rain falls on the lee side from this source, and consequently a large rain-shadow exists in the Macalister, Wellington, and Dolodrook River valleys. Winter rainfall in the valleys is much less than that for the surrounding peaks.

Average annual rainfall is 741 mm at Licola, rising to more than 1,200 mm along the Great Divide in the west and more than 1,400 mm along the Trapyard Hill--Gable End ridge in the east. Annual rainfall is supplemented in the drier areas by moist southerly and easterly air streams and occasional thunderstorms in summer.

Low winter temperatures may allow snow to persist on the higher areas around Trapyard Hill from June to October, and snowfalls occur regularly above 1,000 m during this period.

2. Geology and physiography

The block is characterized by deeply dissected sediments, with drops of up to 600 m between ridges and adjacent valley floors. The eastern border follows a ridge south from McFarlane Saddle (1,490 m) to Mount Hump (1,591 m), and includes two small plateaux to the west of Mount Wellington and one at Gable End (1,587 m). Lake Tali Karng, a unique feature in the Victorian Alps, lies below the Sentinels (1,480 m) at an elevation of 800 m. It was formed when a landslide dammed Nigothoruk Creek.

The eastern section of the block is composed of Upper Devonian acid volcanics. The main streams - the Macalister and Wellington Rivers - have cut into these and also sedimentary rocks that, to the east of Licola, are predominantly a thick, gently dipping sequence of Upper Devonian--Lower Carboniferous sandstones, slate, and conglomerates. These overlie

Upper Devonian volcanics and conglomerates - outcropping as a north--south band west of Mount Margaret. Further east in the Carey Creek and Dolodrook River, the sediments are Lower Ordovician (shown on the map as Silurian) sandstones and shales cut in an east--west direction by faults that have exposed a band of Cambrian limestones, serpentine, cherts, and shales and also bands of Upper Ordovician sediments.

Cambrian greenstone outcrops on Cob Spur to the west of Licola, but almost the entire topography of this region - including Mount Useful (1,450 m) on the western border of the block - has been formed on Lower Ordovician sandstones and siltstones, which were previously thought to be Silurian in age. Tertiary basalts overlie the sediments at the Spring Hill plateau and west of Burgoynes Gap in the south.

Extensive river flats of Quaternary alluvium adjoin the Macalister River south from Licola.

3. Soils

The dominant soils on most slopes are friable brown gradational soils. At lower elevations, dry slopes have massive gradational soils, moist slopes have friable red gradational soils, and valley bottoms carry gravelly loams. Red duplex soils predominate in lowland valleys on rolling to low hilly topography.

Stream terraces have red gradational soils with weak structure and yellow gradational soils, and the stream flats usually have grey-brown loams and undifferentiated sands and loams.

4. Vegetation

Around Mount Useful at elevations ranging from 1,200 to 1,400 m is a large area covered by low thickets of ash-mallee, snow gum, and black sallee, with an understorey including alpine phebalium, alpine oxylobium, alpine wattle, lilac berry, and sub-alpine beard-heath. This understorey extends into open areas to form heathlands in some drainage lines. Ash-mallee again occurs in mixture with snow gum on a saddle north-east of the Sentinel. Snow gum woodland on the Mount Wellington plateau ranges from about 1,400 to 1,500 m, with grassy to heathy understoreys. Heathlands and herbfields occur on some exposed ridges, and heathlands and grasslands are found in saddles and drainage lines.

Alpine ash forests occur in the headwaters of Serpentine and Mount Useful Creeks and around Green Hills. Some mature stands occur in these localities, above Lake Tali Karng and in the McFarlane Creek headwaters. These forests grow between 800 and 1,250 m elevation at Mount Useful and 1,100--1,400 m above Lake Tali Karng. Shining gum in mixture with alpine ash, mountain ash, and mountain gum occurs in the western sections of the block at similar elevations. Understorey species include mountain tea-tree, silver wattle, rough coprosma, and mother shield-fern.

Open forest III has its main occurrence west of the Macalister River, where the forests are mainly narrow-leaf peppermint and manna gum or mountain gum with shrubby to grassy understoreys. Messmate stringybark forests grow on moist sites at several scattered localities such as Spring Hill and Mount Margaret. Mountain grey gum occurs in mixture, and understoreys include shining cassinia, common cassinia, silver wattle, and austral bracken. Manna gum forests border the Dolodrook and Wellington Rivers.

Most of the lower slopes of these river valleys support open forest II and I. On the driest rockiest slopes, the trees form a woodland. Open forest II includes silvertop and white stringybark with shrubby to heathy understoreys including box-leaf bitter-pea, and shining cassinia. Other areas have broad-leaf peppermint, candlebark, and red stringybark with heathy understoreys. Open forest I includes broad-leaf peppermint, red stringybark, and red box. Understoreys may be heathy or grassy, including golden wattle, sunshine wattle, daphne heath, common heath, and kangaroo grass.

Open woodlands of long-leaf box and candlebark with kangaroo grass, shining cassinia, and golden wattle occur on red calcareous gradational soils derived from Cambrian sedimentary rocks at elevations of 500--700 m near the Dolodrook River.

5. Fauna

Ten mammal, 120 bird, five reptile, nine amphibian, and three fish species are documented. The avifauna is better known here than in many other blocks in the study area. Sambar deer range through the block.

Wetlands include the Macalister and Wellington Rivers, swamps along river flats, and Lake Tali Karng. Riverine forests are associated with most streams. Sub-alpine woodlands occur around Mount Skene and near Mount Wellington, while wet open forests flank the woodlands at lower elevations. Dry open forest predominates in the central sections of the block, and semi-cleared land and farmlands are situated along the Macalister River.

The platypus inhabits major streams, and 19 species of waterbirds have been observed in the wetlands of this block.

Riverine forests are known to be inhabited by the eastern grey kangaroo, black wallaby, sugar glider, greater glider, common wombat, brown antechinus, and bush rat. Of the 45 species recorded in riverine forests, 17 occurred mostly in this habitat, namely pallid cuckoo, azure kingfisher, tree martin, fairy martin, Australian ground thrush, superb blue-wren, large-billed scrub-wren, pilot-bird, southern yellow robin, rufous fantail, eastern whipbird, mistletoe bird, yellow-tufted honeyeater, New Holland honeyeater, eastern spinebill, red-browed finch, and satin bower-bird.

The 19 bird species recorded for sub-alpine woodland are typical of this habitat elsewhere in the study area.

In wet open forest, the six native mammals and most of the 55 native birds are typical of this habitat. Of particular interest, however, are records of the peregrine falcon, brush cuckoo, red-browed tree-creeper, little friar-bird, noisy friar-bird, little lorikeet, pink robin, and rose robin.

The seven mammal species recorded in dry open forest are typical of this habitat.

The 59 native bird species recorded include the painted quail, little cuckoo-shrike, white-winged triller, spotted quail-thrush, jacky winter, restless flycatcher, brown tree-creeper, and regent honeyeater.

Records for the block include five reptiles - the Gippsland water dragon, tree dragon, garden skink, copperhead, and brown snake - and nine amphibians - brown tree frog, Lesueur's frog, Verreaux's tree frog, common eastern froglet, Victorian froglet, spotted grass frog, southern toadlet, leaf green tree frog, and brown-striped frog.

Cox's mountain trout has been recorded in Lake Tali Karng and Nigothoruk Creek.

The brown and rainbow trout inhabit the main streams.

6. Land systems

The Graham, Wongungarra, Buckenderra, Connor's Plain, Traralgon, Ben Cruachan, Barkly, and Snowy Plains land systems are represented in the block.

C. Present Use and Capabilities

1. Nature conservation

Capability for nature conservation is high. Environments range from sub-alpine thickets of ash-mallee to open grassy woodlands. Lake Tali Karng is a unique feature of the study area.

Geology is varied and includes fossiliferous limestone of Cambrian age. The junction of the Barkly and Macalister Rivers is the type locality for the butterfly *Holochila consimilis goodingi*.

Twenty-two species of plants in this block are considered to be significant. In addition, the only Victorian record of a dampiera, closely related to *Dampiera scottiana* in New South Wales, is located just outside the study area near Burgoynes Gap.

Many species are of great significance due to their restriction in Victoria to the Macalister River watershed. These include a boronia previously known only in Tasmania (*Boronia citriodora*); a mint-bush (*Prostanthera* sp. aff. *rotundifolia*, near Mount Margaret), which is closely related to the round-leaf mint-bush; the dense mint-bush (*P. decussata*); three other rare mint-bushes - *Prostanthera rhombea, P.* sp. aff. *rhombea, P.* sp. aff. *howelliae* - and two undescribed guinea-flowers (*Hibbertia* spp.) near Licola; a species regarded as a New South Wales endemic until discovered near Burgoynes Gap - *Goodenia heterophylla*; and the most westerly Victorian record of the pinnate goodenia (*G. grandiflora* var. *macmillanii*).

2. Recreation

This block is one of the most accessible from Melbourne. Its main attractions are the rivers, rugged ranges, Lake Tali Karng, and the chromite mine. Capabilities are very high for bushwalking, high for fishing, moderate for recreation driving, horse-riding, hunting, and canoeing, and low for rock climbing and fossicking.

The major features attracting bushwalkers to this relatively accessible block include Mount Useful, Mount Hump, Gable End, Lake Tali Karng, the Dolodrook River, the chromite mine, and the Wellington River. The area east of the Wellington River has had a long history of intensive use by bushwalkers. Tracks from this River to Lake Tali Karng and Mount Wellington via Mount Margaret and the Carey River are frequently used. More-experienced walkers often use the track from Ben Cruachan to McFarlane Saddle via Mount Hump and Gable End.

Lake Tali Karng and McFarlane Saddle area are popular campsites for walkers as well as other user groups, such as school and youth groups associated with permanent accommodation at Licola and Breakfast Creek.

Organized horse-riding parties of 12 to 20 riders sometimes visit the Lake Tali Karng area.

Recreation driving involved heavy use of the tracks into Tali Karng from McFarlane Saddle and the Wellington River until these were closed to vehicles. Tracks west of the Macalister River, such as the Cob Spur and others providing access to Serpentine Creek, are sometimes used to get to fishing and gemstone sites. Use of tracks by trail-bikes has a similar pattern to four-wheel-drive activities. The Mount Margaret area receives frequent use.

Some deer-hunting occurs in the block - for example around Mount Useful Creek and Lake Tali Karng. Rabbits and foxes are mainly hunted on and around private property.

The Macalister and Wellington Rivers provide trout angling for fishermen, many of whom camp at various sites along the Wellington River. Lake Tali Karng also provides trout fishing.

The section of the Macalister River in this block is a popular canoeing stream that can be consistently used in winter and spring when river levels are high, and at other times after prolonged rain. A popular weekend trip is from Glencairn on the Barkly River to Cheyne Bridge.

Gemstones are sought-after in Serpentine Creek.

The cliffs around the Sentinel and Gable End have been explored by climbers, but are infrequently climbed because of their inaccessible location.

The Wellington River is a popular camping area, and many picnic and camping facilities are provided along it.

3. Agriculture

Six graziers use the public land. One grazier runs cattle in the alpine ash, snow gum, and narrow-leaf peppermint forests between Mount Useful and Spring Hill. About 100 dry cattle graze here from early December until the end of April, being brought to the runs via Licola or from Seaton via Mount Useful.

In the eastern section of the block, cattle graze along the Wellington, Carey, and Dolodrook Rivers in manna gum and narrow-leaf peppermint forest or in open woodland. About 340 dry cattle graze here during the winter, from home properties at Maffra, Glenmaggie, and Licola. The cattle are mainly Angus but some are Herefords.

Areas of private land along the flats of the Macalister River and the adjoining undulating to steep slopes have been developed for agriculture. Undeveloped land is generally steep. Private land at Spring Hill plateau is used for beef production. The fertile river flats, together with the undulating slopes, are used mainly for cattle-grazing, in conjunction with summer and winter grazing runs. Some sheep are also run for wool production.

Average capability for bush grazing is moderate. The alpine ash or shining gum forests, where they are open with grassy understoreys, have a high capability. The eastern section has value for winter grazing. Cattle are brought to these grazing areas directly from home properties or are brought down from the adjacent high country. Capability for agricultural development is low.

4. Apiculture

Access is good in the central and western sections, but poor elsewhere. This block has produced large crops of first-grade honey. Main honey flora are snow gum, ash-mallee, black sallee, messmate, but-but, long-leaf box, red stringybark, red box, yellow box, mountain grey gum, shining gum, narrow-leaf peppermint, silvertop, yellow stringybark, eurabbie, yertchuk, and red ironbark.

5. Wood production

Capability for timber production by regrowth mountain forests is high in the west of the block, where extensive stands of alpine and mountain ash have been mostly logged and regenerated. In the east only scattered stands of alpine ash occur, mostly to the north of Lake Tali Karng. Licola block contains about 3,000 ha of mountain forest. Moist foothill forests of messmate, mountain grey gum, and manna gum adjoin these in the west and have moderate to high timber production capabilities. The balance of the public land carries unproductive dry foothill forest of red stringybark, broadleaf peppermint, and various boxes and gums, with low capability for timber production.

Six sawmills at Heyfield annually cut about 10,800 m^3 of sawlogs from 150 ha of forest. A.P.M. obtains pulpwood supplies from integrated harvesting operations.

6. Minerals

Cambrian rocks have some capability for nickel production. The serpentinite at Licola and the Dolodrook River has some value as an ornamental building stone. Chromite at the Dolodrook River has been mined in the past. It is accompanied by limestone and corundum deposits.

Gravel extraction sites are located along major logging roads in the area.

7. Water production

The Carey and Wellington Rivers form the north-eastern boundary of this block, and it is bisected by a section of the Macalister River.

Rainfall within the block varies from less than 700 mm per annum at the southern end to more than 1,200 mm in the west and north-east. Precipitation has a spring maximum and summer minimum, the Macalister producing 17.5% of its mean annual output in the 6 months December to May, including 4.5% in the 3-month period January to March. Measurements at Licola have shown the Macalister River to have a mean annual discharge of 465,730 Ml. No records exist for other streams in the block.

The Macalister River supplies high-quality water (mean salinity level 47 mg per l) to Lake Glenmaggie, which is outside the study area. Lake Glenmaggie has a capacity of 190,300 Ml and is the source of irrigation water for the Maffra--Sale Irrigation Area, which totalled 19,155 ha in 1973/74.

Capability for water production is moderate.

D. Hazards

The soil erosion hazard is high in the eastern portion of the block, where sub-alpine environments and dry steep lower slopes predominate. The Lake Tali Karng jeep track has been closed because of excessive erosion, and other tracks - such as around Mount Useful in the west - also show evidence of significant erosion. The fire hazard is high, and a number of lightning strikes have been recorded in recent years. A fire tower is situated on Mount Useful. The 18 species of noxious weed recorded include blackberry, St. John's wort, ragwort, and sweet briar.

Rabbits can be a problem around Licola and along the Macalister River.

5. BARKLY

A. Location and Tenure

Barkly block covers a total area of 59,750 ha, of which 54,250 ha (91%) is public land. Most of the public land is unreserved Crown land (48,150 ha), with the remainder as reserved forest, mainly in the north along the Great Divide, and as a small water reserve.

The freehold land is situated along the Barkly and Macalister Rivers.

County of Wonnangatta: Parishes of Licola, Licola North. and Crookayan.

B. Nature of the Land

1. Climate

The lower slopes of the Macalister River valley are in a rain-shadow area, but annual rainfall increases towards higher elevations out of the valley. Average annual rainfall varies from 741 mm at Licola to more than 1,600 mm north and west of Mount Clear on the Divide. The Great Dividing Range on the northern and eastern borders receives high rainfalls from the moist prevailing westerly air stream. Important additions to rainfall in the rain-shadow areas come from moist southerly and easterly air streams and occasional thunderstorms in summer.

Winter snowfalls are regular on the higher elevations throughout the block, and may persist from June to October on the highest parts of the Divide (Mount Clear--Mount McDonald).

2. Geology and physiography

Most of the block is moderately dissected mountainous terrain developed on Upper Devonian--Lower Carboniferous sediments, with drops of up to 600 m between ridges and adjacent valley floors. Mount McDonald (1,626 m) has precipitous escarpments on its north face.

The topography is dominated by a series of north--south ridges, including the Great Divide from Mount McDonald to Spring Hill, the Nobs and Bull Plain Spurs, and the Butcher Country Spur. The main streams flow south and include the Barkly, Macalister, and Caledonia Rivers.

Several small plateaux occupy the interfluves between the main streams, such as those along Middle Ridge, Mountain Ash Spur, Bull Plain Spur, the Butcher Country Spur, and the Macalister Spur. Small Tertiary basalt remnants appear on some plateaux.

A belt of Cambrian volcanics (Howqua greenstone) and Lower Ordovician sediments (shown on the map as Silurian) has been exposed by faulting along the western border of the block. Quaternary sediments are located on the Macalister River upstream from Glencairn.

3. Soils

The predominant soils on most slopes in the block are friable brown gradational soils. The highest areas around the Dividing Range have shallow organic loams with small areas of peats and humified peats.

The drier slopes, and particularly those of the lower valley sides, have massive gradational soils. Gravelly loams are common in steep valley bottoms.

Stony loams are common on narrow crests and very steep slopes at all elevations.

Small, and usually isolated, areas of stream alluvium occur along the main streams, with the largest area at Glencairn having dark cracking clays and grey-brown loams.

4. Vegetation

Snow gum open forests at elevations of 1,500--1,580 m are found from Square Top to Mount McDonald. Understoreys are typically heathy (alpine oxylobium and alpine pepper). Mountain gum--snow gum open forest has its main occurrence on the Pine Creek plateau, Macalister Spur, and Blue Plain Spur at elevations of 1,150--1,400 m. The low understorey includes gorse bitter-pea, snow grass, and clustered everlasting.

A number of scattered stands of alpine ash occur in this block between about 800 m (in sheltered localities) and about 1,200 m. Some mature stands at elevations of 900--1,500 m remain to the south of Square Top and the Nobs. Stands along the Great Divide are mostly logged, except for a fire regrowth stand in McMillans Creek. The understoreys are mainly scrubby. Common plants present include hop bitter-pea, silver wattle, common cassinia, and derwent speedwell.

Mountain ash forest consists mainly of fire regrowth stands located at elevations of about 600--980 m in sheltered sites at Mountain Ash Creek, south of the Low Saddle, and in the Mount Skene branch of Barkly River. Understoreys contain many wet gully species.

The main distribution of open forest III is west of the Bull Plain and the Nobs Spurs. It mainly comprises narrow-leaf peppermint forest in association with manna gum, mountain gum, and candlebark. Understoreys include hop bitter-pea, silver wattle, and austral bracken. There are some limited areas of messmate stringybark and mountain grey gum, such as at the Low Saddle, on the Mountain Ash Spur, and in Tiger Creek. Understorey species include blanket-leaf, soft tree-fern, and musk daisy-bush. Manna gum forests with understoreys of river lomatia, Victorian christmas-bush, hazel pomaderris, mountain correa, blackwood, and sweet bursaria are found along some rivers.

Open forest II predominates in the eastern section of the block where slopes are steep and rainfall is relatively low. The main vegetation unit is broad-leaf peppermint and brittle gum, with low heathy to shrubby understoreys that include narrow-leaf bitter-pea, handsome flat-pea, small-leaf parrot-pea, and (at higher elevations on Pine Creek plateau) mountain banksia. In the south of the block, yellow box, but-but, and red stringybark forests grow on the lower slopes. Understoreys are grassy and include kangaroo grass, tussock grasses, and wallaby grasses.

Open forest I is found on the driest aspects. The main types are broad-leaf peppermint and red stringybark forests with heathy understoreys of daphne heath, guinea-flower, and narrow-leaf bitter-pea.

5. Fauna

Fourteen native mammal, 96 native bird, and five amphibian species have been recorded in the block. Avifauna are well documented around Licola and Glencairn. The sambar deer is known in the area and rabbits and foxes are plentiful.

Wetlands and riverine forests occur mainly along the major streams. Sub-alpine woodlands are restricted to the Butcher Country Spur and the Great Divide and to high ridges in the north of the block, while wet open forest predominates in the west of the block. Dry open forest predominates in the eastern and southern sections.

Seven waterbirds - the little pied cormorant, little grebe, hoary-headed grebe, white-faced heron, black duck, and wood duck - have been recorded in wetlands around Glencairn.

Riverine forests are known to support 12 native mammal species, including the greater glider, feather-tailed glider, and chocolate wattled bat. The 55 native bird species recorded include uncommon ones for this area - the wee-bill, heath-wren, jacky winter, and New Holland honeyeater - as well as typical birds such as the eastern whipbird, southern yellow-robin, and yellow-tufted honeyeater.

Three small terrestrial mammals and one arboreal mammal have been recorded in sub-alpine woodland.

Wet open forest provides habitat for recorded mammals, including the bobuck, that are typical of this habitat elsewhere in the study area. Several birds recorded here are of interest. These are the brush cuckoo, cicada-bird, red-browed tree-creeper, olive-backed oriole, king parrot, horsefield bronze-cuckoo, satin fly-catcher, shrike-tit, mistletoe bird, and noisy friar-bird.

Dry open forest has similar mammal species to wet open forest. Many bird species are also common to both, but additional species recorded in dry open forest include painted quail, spotted quail-thrush, rufous songlark, buff-rumped thornbill, scarlet robin, restless fly-catcher, brown tree-creeper, yellow-tipped pardalote, fuscous honeyeater, diamond firetail, and white-winged chough.

Brown trout, rainbow trout, and river blackfish almost certainly occur in many streams. Lesueur's frog, common eastern froglet, brown tree frog, leaf green tree frog, and Verreaux's frog have been recorded in the block.

6. Land systems

The Mt. Skene, Darbalang, Barkly, Berrmarr (Sedimentary), Connor's Plain, Stanley's Name, and Graham land systems are represented in the block.

C. Present Use and Capabilities

1. Nature conservation

The capability for nature conservation is high. Environments range from sub-alpine woodlands to riverine forests. The north-eastern section is relatively undisturbed. The chocolate wattled bat, seldom observed and with a little-known distribution, has been recorded near Breakfast Creek.

Of the four species of plants in this block considered significant, cat's tail *(Koeleria australiensis)* is highly significant, the only Victorian record for this grass being on the Butcher Country Spur. The Bull Plain Spur is the area where the Bogong gum (*Eucalyptus chapmania*) is found in one of its rare occurrences south of the Great Dividing Range, and is the most westerly locality of the rare mountain leafless bossiaea (*Bossiaea bracteosa*).

2. Recreation

The main features of recreational interest are rugged ranges and major rivers with some inaccessible sections in the north-east of the block. Capabilities are high for adventure driving and fishing, and moderate for bushwalking, hunting, and canoeing.

Apart from the route along the Great Divide, the most popular bushwalking routes include those from the Barkly River bridge to Mount Tamboritha and from Glencairn to Howitt Hut or Mount Tamboritha via the Butcher Country Spur. The Barkly River valley is little used.

Most tracks receive moderate recreation driving use by four-wheel-drive vehicles. They are mainly located on ridges and spurs such as the Great Divide, Butcher Country Spur, Bull Plain Spur, Mountain Ash Spur, and Middle Ridge. Trail-bikes have a similar pattern of usage, although they may use overgrown jeep tracks more often.

Deer-hunting takes place in this area, particularly along the Macalister River and on the Bull Plain Spur and Middle Ridge.

The Barkly, Wellington, Caledonia, and Macalister Rivers provide good trout fishing.

The Macalister River from its junction with the Caledonia River to Licola is often canoed as a weekend trip. Another weekend trip goes from the Mount Skene--Barkly River junction down the Barkly to the Macalister River and thence to Cheyne Bridge. A section of the Barkly River stretching for several kilometres above the Mount Skene Creek junction may be negotiated during limited periods of high stream flow.

3. Agriculture

Six cattlemen regularly run stock on the public land from home properties at Glenmaggie, Heyfield, and Maffra. About 400 beasts (150 cows with calves and 100 dry cattle) graze the area in summer, mainly around the Nobs and Mount Skene to Connors Plain, in alpine ash forests and snow gum woodland. About 300 dry cattle and some 40 cows with calves graze during winter, mainly in the valleys or on some lower ridges and plateaux such as the Bull Plain Spur and Pine Creek plateau. Access to the western section of the block is via the Mount Skene road or via Middle Ridge. Access to the central section is via Bull Plain Spur and to the eastern section from routes off the Bennison Tablelands. The main breeds are Angus and Hereford.

The block contains freehold land north of Licola and at Glencairn, and a small area on the Bull Plain Spur. Some of this land has not been developed, due mainly to its steepness. The main enterprise is beef production, and the private land is used in conjunction with grazing runs. Some sheep are also run for wool.

4. Apiculture

This block is little used. It has some access in southern and central portions, but little suitable access elsewhere. Main honey flora are snow gum, alpine ash, but-but, yellow box, brittle gum, long-leaf box, and red stringybark.

5. Wood production

Capability for timber production is high in the west and north, where alpine and mountain ash forests occur on and below the Dividing Range from Connors Plain to Macalister Spur, and on Bull Plain Spur. Many of these stands have been logged and regenerated, and logging is continuing in this area, mainly in the headwaters of Mount Skene Creek. The block contains about 4,000 ha of mountain forests.

Commercial moist foothill forests adjoining these contain messmate, mountain grey gum, and manna gum. The bulk of the remainder contains forest with low timber-production capability. Six mills at Heyfield annually cut about 27,000 m^3 of sawlogs from 360 ha of forest.

6. Minerals

This block has low prospects for sedimentary copper or uranium deposits and little possibility for other commercial minerals. Limestone and phosphate deposits occur in the south near Violet Hill.

7. Water production

This block contains the Barkly River system and a section of the Macalister River, and is bounded by the Caledonia River to the north-east and the Wellington River to the south-east. Rainfall varies markedly over the block, from less than 800 mm per annum at the southern end to 1,600 mm at the far north.

Discharge rates for the Macalister River are highest in August, September, and October. Details of this river, into which the Barkly, Caledonia, and Wellington Rivers flow, are given in the description of water in the Licola block. No measurements for its tributaries are available.

The Barkly catchment area supplies high-quality water, with a mean annual discharge of 90,839 Ml at the Glencairn Road bridge.

Capability for water production is moderate.

D. Hazards

The erosion hazard is highest on steep dry slopes at the lower elevations and in sub-alpine environments. The fire hazard is high. Fires originating from lightning strikes are difficult to get to in the inaccessible north-east of the block. Blackberry, St. John's wort, ox-eye daisy, and sweet briar are among 12 noxious weed species recorded here. Rabbits are plentiful around the margins of forests and in farmland.

6. BENNISON

A. Location and Land Tenure

Bennison block covers a total area of 86,500 ha, most of which is public land in the form of unreserved Crown land (85,900 ha). Freehold land is in small blocks along the Wonnangatta River, on the Bennison Tablelands at Guy's Hut, and north of Mount Tamboritha.

County of Wonnangatta: Parishes of Moroka, Burgawonduc, Tamboritha, Bolaira, and Billabong.

B. Nature of the Land

1. Climate

The Bennison Tablelands, being elevated plateaux, have high rainfall. They are surrounded on the east and west by rain-shadow valleys (the Macalister and Wonnangatta River valleys). In the north the Great Dividing Range receives a considerable amount of precipitation from the uplifted moist westerly air streams that prevail.

Average annual rainfall varies from 700 mm at Wellington River to 900--1,000 mm on Wonnangatta Flats and more than 1,600 mm on the Howitt Plains and the Divide.

Snowfalls occur regularly above 1,000 m and snow may persist on the colder, higher elevations of the upper Bennison Tablelands and Great Divide from June to October.

2. Geology and physiography

The landscape is dominated by plateaux and tablelands, from Mount Howitt (1,746 m) and Howitt Plains plateau in the north, through the extensive Bennison Tablelands (1,600--1,450 m), to Trapyard Hill (1,607 m) and Mount Tamboritha (1,641 m) in the south. The Bennison Tablelands contain a number of rounded prominences, the highest of which is Mount Reynard (1,707 m). Tertiary basalt caps many plateaux and mountains in the north. Its largest extent is at Howitt Plains and near Bryces Plain.

Streams drain away from the central tablelands in deeply dissected valleys towards the Macalister and Caledonia Rivers in the west, the Wonnangatta and Moroka Rivers in the east, and the Wellington and Carey Rivers in the south.

The north-west border follows a high section of the Great Divide from the Viking and the Razor west to Mount Speculation (1,680 m), and then south to Mount Howitt, Mount Magdala (1,676 m), Mount Clear (1,719 m), and the Macalister Spur.

Geology is dominated by Upper Devonian--Lower Carboniferous sediments in the west and Upper Devonian volcanics overlying Ordovician sediments in the east. Upper Devonian conglomerates are found beneath the volcanics near Mount Darling and Carey Creek, or as an outlier at Mount Short.

Upper Devonian--Lower Carboniferous sediments, which form the north-east part of the Macalister sedimentary basin, are faulted against steeply dipping Ordovician felspathic sandstone and shale in the headwaters of the Wonnangatta River. A small intermontane basin upstream of gorges in the Wonnangatta River is formed on Quaternary alluvium in the Wonnangatta River valley and two of its western tributaries.

The lowest elevation in the block is 330 m at the junction of the Moroka and Wonnangatta Rivers.

3. Soils

The most widespread soils are friable brown gradational soils, which occur on moist slopes at most elevations within the block. Crests and steep dry slopes typically have stony loams, and elsewhere on dry slopes massive gradational soils predominate.

Areas of low relief at high elevation, such as the Howitt plains and Bennison plains, have organic loams, shallow organic loams, peats, and humified peats. High crests may have similar soils, although stony loams are more typical.

Soils of basalt areas on the high plains are similar to those on non-basaltic rocks, but may be more clayey and have higher fertility.

On the acid volcanic rocks in the east of the block, soils at the higher elevations are similar to those on sedimentary rocks, but the drier slopes at lower elevations have massive gradational soils.

In the rolling country of the Wonnangatta valley, soils are mainly red gradational soils with grey-brown loams on the alluvial plains.

4. Vegetation

Alpine herbfields and heaths crown the summit of Mount Howitt at elevations of 1,660 to 1,720 m. Herbfield plants include mountain gentian, snow grass, snow aciphyll, yam daisy, hoary sunray, orange everlasting, silver daisy, and glacial eyebright. Heathland plants include mountain beard-heath, rusty pods, and alpine oxylobium. Sub-alpine open areas comprise grasslands, herbfields, mosslands, and wet heathlands. The largest areas are on the Howitt plains, Racecourse and Snowy plains, at Mount Reynard (1,660--1,700 m), plains along Shaw Creek (such as Holmes and Bennison plains), and plains in the headwaters of the Caledonia River and Conglomerate and Piemans Creeks. Elevations range generally from 1,620 to 1,200 m.

Grassland is the predominant vegetation unit and includes plants such as snow grass, showy violet, and Gunn's buttercup. Common mossland plants are sphagnum moss and candle heath. Wet heathland plants include snow heath and mountain baeckea. Moist heathland plants include alpine grevillea, alpine oxylobium, alpine mint-bush, and rusty pods.

Snow gum woodland and open forest occupy most of the Howitt plains plateau, the Bennison Tablelands, and the ridge summits along the Great Divide and the Mount Darling range at elevations ranging from about 1,400 to 1,650 m. Understoreys vary from dense thickets of mountain plum pine, alpine oxylobium, alpine orites, alpine grevillea, and alpine pepper, through low heaths with rusty pods and alpine oxylobium, to grassy with snow grass and herbs including grass triggerplant.

Mountain gum--snow gum forests generally grow at lower elevations (1,300--1,440 m) and are located mainly around the open plains of Shaw Creek and south of Doolan plain on the Bennison Tablelands. Understoreys are low heathy, with alpine oxylobium as a common species.

Alpine ash forests mainly occupy sheltered slopes around the Howitt plains and Bennison Tablelands, but encroach onto the tablelands between Scrubby Hill and Mount Tamboritha in the south, at Surveyors Creek east of Doolan plain, and the plateau south of Mount Darling. The forests generally occupy elevations ranging from 1,200 m to 1,400 m, but are found up to 1,450 m around Scrubby Hill, and on sheltered sites at about 900 m. Large stands of mature alpine ash occur in the headwaters of the Wonnangatta River and at a few other scattered localities. Understoreys are generally heathy to shrubby.

Open forest III is not extensive in this block. This type includes manna gum forests along river environs, narrow-leaf peppermint forests on moist sheltered slopes such as in the upper Wonnangatta River valley, and pure mountain gum forests on the Bennison Tablelands east of Mount Tamboritha.

Open forest II is much more extensive, occupying all but the most sheltered slopes below about 1,500 m. Broad-leaf peppermint--mountain gum forests predominate at the higher elevations. Understoreys may be heathy and include gorse bitter-pea, pale-fruit ballart, handsome flat-pea, and small-leaf bitter-pea. At lower elevations, red stringybark replaces broad-leaf peppermint. Other associated tree species include long-leaf box and brittle gum. Understoreys are heathy, with species such as daphne heath, narrow-leaf bitter-pea, golden grevillea, and prickly broom-heath.

Open forest I has similar flora and is limited to the steepest driest slopes.

5. Fauna

Twelve native mammal, 78 native bird, five reptile, and four amphibian species and three species of native mountain trout have been recorded. Introduced fauna include the sambar deer, starling, and brown trout.

Wetlands comprise streams and small water bodies on the tablelands and in the valleys. Riverine forests are found along the Wellington, Moroka, Wonnangatta, and Macalister Rivers and some of their tributaries. Sub-alpine open areas and woodlands predominate on the tablelands and higher elevations. Wet open forest mainly flanks the tablelands, but occupies some tableland areas in the south. Dry open forest occupies steep dry slopes surrounding tablelands and plateaux.

The little black cormorant, little pied cormorant, black duck, grey teal, and coot have been recorded along the Wellington River.

Riverine forests support mammals and birds typical of this habitat elsewhere in the study area.

Sub-alpine open areas support native mammals such as brown antechinus, Swainson's antechinus, and bush rat, as well as the introduced hare, rabbit, house mouse, and fox. Birds found here include the emu, black-shouldered kite, peregrine falcon, nankeen kestrel, stubble quail, Japanese snipe, Australian pipit, flame robin, starling (introduced), brown thornbill, white-browed scrub-wren, yellow-faced honeyeater, and white-eared honeyeater.

Mammals in sub-alpine woodlands include five phalangerid species, three small terrestrial mammals, and the dingo and common wombat. The 45 species of birds recorded in this habitat include some not usually observed in sub-alpine woodlands - brush bronzewing, pallid cuckoo, tawny frogmouth, spotted quail-thrush, jacky winter, yellow-tipped pardalote, brown-headed honeyeater, and olive-backed oriole.

The eastern grey kangaroo, three phalangerids, three small terrestrial mammals, the common wombat, and dingo have been recorded in wet open forest. Birds include common species such as the crimson rosella, grey shrike-thrush, red wattlebird, and laughing kookaburra.

Similar mammals and birds to those recorded in wet open forest are found in dry open forest.

Reptiles recorded in the block comprise the water skink (cool-temperate species), Coventry's skink, grass skink, Spencer's skink, and white-lipped snake. Four amphibians - comprising two species of tree frogs and two froglet species - are also recorded. Native fishes comprise Kosciusko mountain trout, ornate mountain trout, and Cox's mountain trout.

6. Land systems

The Barkly, Stanley's Name, Koonika, Howitt Plains, Berrmarr (Sedimentary), Buckenderra, Speculation, Moroka, Bemboka, Snowy Plains, Graham, Barry Mountains, Wonnangatta, and Ben Cruachan land systems are represented in the block.

C. Present Use and Capabilities

1. Nature conservation

The capability for nature conservation is high. Environments range from alpine herbfields at Mount Howitt to riverine forests. Extensive sub-alpine woodlands grow on soils derived from Upper Devonian--Lower Carboniferous sediments. The Mount Darling Range has been little disturbed.

Twenty-five significant plant species occur in this block, of which nine are considered to be highly significant. These include: two rare plants at Conglomerate Creek Falls - the willow-herb (*Epilobium brunnescens*), known otherwise only in New Zealand, and the rare alpine finger-fern (*Grammitis armstrongii*); the only Victorian records of the maidenhair spleenwort (*Asplenium hookeranum*) at Bryces Gorge and the New South Wales dense midge-orchid (*Prosophyllum densum*) in the upper Moroka River; the most westerly record of the moonwort (*Botrychium lunaria*) at Mount Howitt; and the silver carraway (*Oreomyrrhis argentea*) on Bennison Tablelands. The uncommon lilac berry (*Trochocarpa clarkei*), endemic to western parts of the Victorian alps, is found scattered over the Bennison Tablelands. Many predominantly coastal plants have unusual occurrences in the higher elevations of the block; for example, the groundsel *Senecio biserratus* is found east of Mount Speculation.

2. Recreation

The main features are high mountains, the Bennison Tablelands, and Howitt plains; the gorges, cliffs, and water-falls around these; and Wonnangatta station on the Wonnangatta River. Capabilities are high for bushwalking, horse-riding, recreation driving, and cross-country skiing, moderate for hunting and fishing, and low for rock climbing.

The route along the Great Divide is very popular for bushwalking. Other routes frequently used are those between the Wonnangatta valley and Macalister Springs, Howitt Hut, or Guys Hut. Tracks into the Moroka River and between Mount Tamboritha and Mount Reynard receive moderate attention. Routes along the Mount Darling Range to the Wonnangatta and Moroka Rivers are demanding, and are frequently used by experienced walkers. Macalister Springs and various cattlemen's huts make popular camp sites.

Organized horse-riding parties from Merrijig and Valencia Creek use cattlemen's huts or riverside sites for overnight stops here. Parties varying from 10 to more than 20 riders are accompanied by a four-wheel-drive vehicle with equipment and food supplies. Places visited include Howitt plains, Bennison Tablelands, Bryces Gorge, and the Wonnangatta valley.

The Tamboritha road across the Bennison Tablelands is often used for recreation driving as part of a through-route to the Wonnangatta valley or to north-eastern Victoria. It provides access during winter to the snowfields on the tablelands. Features such as Bryces Gorge may also be visited.

Deer are hunted in several localities in the block, such as the Wonnangatta and Moroka River valleys.

The Wonnangatta and Moroka Rivers, together with small sub-alpine streams like Shaw Creek, provide trout angling.

Cross-country skiing across the Bennison Tablelands is increasing. Much of the area does not have as reliable a snow cover as the surrounding mountains, such as Mounts Wellington and Howitt, but it has considerable potential for ski-touring. Some skiers traversing the tablelands include Mount Howitt and Howitt plains in the trip.

Although many cliffs fringe the tablelands and plateau, very few are climbed. There is, however, some potential for this activity.

3. Agriculture

Seven cattlemen use the public land for grazing their stock - predominantly Angus. About 2,200 dry cattle and 200 cows and calves graze the open plains, snow gum woodlands, and alpine ash forests of the plateaux and upper slopes from November to April or May. In winter about 350 dry cattle graze the peppermint--manna gum forests of the Wonnangatta, Moroka, and Macalister River valleys. Home properties are at Licola, Glenmaggie, Heyfield, and Mansfield. Main access to the Howitt plains and the Bennison Tablelands is via the Tamboritha road or Bennison Spur, or via Dry River from Wonnangatta station.

The only areas of private land in this block are at Higgins Hut, Guys Hut, and Wonnangatta station. These are used for beef cattle, in conjunction with the surrounding runs and home properties.

The capability for bush-grazing is high on the Howitt plains and Bennison Tablelands. The river valleys are important winter grazing areas. The area of river flats along the Wonnangatta could be developed for agriculture, but access and remoteness are problems. Most of the block has low capability for agriculture.

4. Apiculture

The main suitable access is on the Bennison Tablelands. Main honey flora are snow gum, alpine ash, black sallee, long-leaf box, red stringybark, and brittle gum.

5. Wood production

Capability for timber production is high. Stands of mature and regrowth alpine ash total about 11,600 ha. They grow at several localities such as in the heads of the Wonnangatta and Macalister Rivers, the headwaters of the streams rising on the Howitt and Bennison Tablelands, and around Mounts Tamboritha and Arbuckle. Extensive stands in the south have been utilized since 1961, and logging is continuing. Large areas of regrowth occur on the areas harvested. Commercial stands of moist foothill forests are not of significant extent. The remainder of the block is largely sub-alpine woodlands and dry foothill forest with low timber-production capability.

Each year the 12 mills (five at Mansfield, six at Heyfield, and one at Benalla) together cut about 51,100 m^3 of sawlogs from 690 ha of forest. A.P.M. obtains pulpwood supplies from integrated harvesting operations.

6. Minerals

The Wonnangatta beds in the north-east may have some potential for gold reef production. The western part of the block has a low potential for sedimentary copper or uranium mineralization. Gravel-extraction sites are located along major logging roads.

7. Water production

The Wonnangatta and Moroka Rivers form most of the eastern boundary, the Carey and Wellington Rivers most of the southern boundary, and the Caledonia River a section of the western boundary of this block. The Macalister River and Caledonia River headwaters are in the north-west of the block. Streams and creeks draining the tablelands are tributaries to those rivers already mentioned. Rainfall varies from 800 mm per annum in the far south of the block to about 1,600 mm per annum at Mount Speculation in the north.

No direct measurements of water yield from this block are available. Stream gaugings of the Macalister and Moroka Rivers and the Mitchell River (into which the Wonnangatta flows) show maximum flows in winter and spring. The water is all of high quality, and the Macalister River and its tributaries supply Lake Glenmaggie, a storage outside the study area.

Capability for water production is high.

D. Hazards

The erosion hazard is moderate to high over much of this block and soil erosion is evident on many tracks and on sub-alpine plains. The vehicular track into Macalister Springs has been closed because of its eroded condition. The area is lightning-prone and the fire hazard is high. St. John's wort, sweet briar, and blackberry are prevalent in the Wonnangatta valley.

7. MOROKA

A. Location and Tenure

Moroka block covers a total area of 85,400 ha, most of which (83,700 ha - 98%) is public land. Apart from a small area of reserved forest (2,060 ha) in the south-west corner and an 8-ha reserve beside the Wonnangatta River, this is all in the form of unreserved Crown land. Small areas of freehold land are scattered along the Wonnangatta River.

County of Wonnangatta: Parishes of Moroka, Wonnangatta, Miowera, and Budgee Budgee.
County of Tanjil: Parishes of Nap-Nap-Narra, Wrixon, Wrathung, and Toolome.

B. Nature of the Land

1. Climate

The block is east of the elevated Bennison Tablelands and well south of the Great Divide, and hence receives a lower rainfall from the prevailing westerly air stream than the uplands.

Average annual rainfall exceeds 1,400 mm at Mount Wellington on the western border, decreasing to about 1,200 mm on the elevated Moroka basin. A marked rain-shadow exists along the Wonnangatta River valley, with less than 700 mm of rainfall on the valley floor.

These low-annual-rainfall areas have a maximum rainfall in spring, with significant additions from moist southerly and easterly air streams and occasional thunderstorms in summer.

Snowfalls occur regularly above 1,000 m between June and October, and low winter temperatures may allow snow to persist on the higher elevations around Mount Wellington and Gable End for this period.

2. Geology and physiography

The block is characterized by a complex drainage pattern and rugged, mountainous terrain. Streams flow south of the highest point, Mount Wellington (1,635 m), and the Moroka Range towards the Avon River and Lake Wellington. The lowest elevation is 160 m on the Wonnangatta River.

The elevated Moroka basin (1,000--1,200 m) occurs along the Moroka River upstream of the Moroka gorge, on Upper Devonian --Lower Camboniferous sediments of the Avon sedimentary basin. The basin is drained by the Moroka River, which flows north from Mount Wellington then east before turning north again.

The eastern edge of the Avon sedimentary basin is flanked by Upper Devonian volcanics and basal conglomerates.

Steeply dipping Ordovician felspathic sandstones and siltstones comprise the rugged slopes dropping from Mount Kent (1,562 m) and Castle Hill (1,448 m) towards the Wonnangatta River.

Some escarpments into the Wonnangatta and lower Moroka Rivers are precipitous and provide interesting exposures of successive bands of basalt, conglomerates, rhyolites, sandstones, siltstones, and mudstones, comprising the Avon River group.

Quaternary alluvium has been deposited along the Wonnangatta River upstream of its junction with the Wongungarra River, and on the Moroka River above the gorge.

3. Soils

The highest areas, such as Mount Wellington and the Moroka Range, have shallow organic loams, stony loams, and limited areas of peats and humified peats.

In areas at intermediate elevations, where rainfall is also fairly high, friable brown gradational soils predominate, but massive gradational soils occur where rainfall is not as high.

Most of the lower areas in this block have red and stony red gradational soils with stony loams on crests and steep slopes. Friable red gradational soils occur on moist sheltered slopes, and gravelly loams are found in steep valley bottoms.

Rolling valley bottoms have red duplex soils on well-drained areas and yellow duplex soils where drainage is poor.

4. Vegetation

Sub-alpine grasslands and wet heathlands are a notable feature of the Wellington plateau. These occur in saddles or drainage lines such as the Wellington and Big Plains. Herbs such as common billy-buttons, silver daisy, and yam daisy are scattered among the grasslands. Heathland plants include alpine bottle-brush, spreading rope-rush, and coral heath in wet sites, with yellow kunzea, alpine grevillea, alpine oxylobium, and scaly everlasting on drier sites. Heathlands near Gable End include mountain needlewood, alpine phebalium, alpine wattle, and alpine westringia.

The plains are fringed by open snow gum woodlands at elevations of about 1,450--1,550 m, on the Wellington plateau. Wet heathlands near Moroka hut at about 1,050 m elevation are fringed by black sallee woodland.

Snow gum woodlands and open forests predominate on the Wellington Tablelands and in the elevated north-eastern section of the upper Moroka River catchment at elevations of about 1,200 to 1,600 m.

Mountain gum and candlebark in mixture with snow gum is the most common vegetation type of the Moroka basin floor at elevations of about 1,000 m to 1,400 m, but also caps ridges such as Cromwell Knob, Bleak Hill, Mount Hump, and Snowy Bluff at elevations up to 1,400 m. Understoreys may include showy violet, ivy-leaf violet, snow grass, bidgee-widgee, and coral heath, or common oxylobium, silver wattle, and gorse bitter-pea.

Alpine ash forests, both fire regrowth and mature, occupy the gully heads of the Avon and Turton Rivers and Valencia and Freestone Creek catchments at elevations of about 800--1,200 m. Sheltered sites in the upper Moroka catchment carry mature or logged alpine ash forests at elevations of 1,200--1,400 m. Understoreys at the higher elevations tend to be fairly open with scattered silver wattle and mountain beard-heath and a field layer of tussock grass, bidgee-widgee, prickly starwort, and tasman flax-lily.

Shining gum forests of advanced fire regrowth and mature stands in mixture with mountain ash at the lower elevations cover large areas in the Mount Hump Creek catchment. Understoreys consist of low to tall shrubs and often comprise dense fern gullies. Common species include silver wattle, Victorian christmas-bush, tree lomatia, musk daisy-bush, mother shield-fern, and scrub nettle. Elevations range from about 400 to 1,200 m. Messmate open forest III to IV (with shrubby understoreys including silver wattle, common cassinia, blue olive-berry, and austral bracken) is associated with these forests.

A complex vegetation pattern related to topography occurs in the southern section of the block, with open forest III of messmate stringybark, mountain grey gum, or narrow-leaf peppermint, yellow stringybark forests on southern aspects, and silvertop forests on ridges. Open forest II predominates on northern slopes and may include yertchuk and red stringybark associated with silvertop, or may include red box. Understoreys tend to be tall and shrubby on moist aspects, and heathy to low and shrubby on drier sites.

The steep slopes of the Wonnangatta and lower Moroka River valleys carry open forest I and II. Tree species include broad-leaf peppermint and candlebark at the higher elevations and red stringybark, long-leaf box, and red box at the lower elevations. Understoreys are usually heathy. Forests of manna gum with gully-type or ferny understoreys occur along some streams.

5. Fauna

Native species recorded here comprise 10 native mammals, 45 birds, eight reptiles, and eight amphibians. Bird surveys in the block are particularly lacking. The sambar deer and brumby have been recorded in the block.

Wetlands are found in the elevated Moroka basin as well as in the lower valleys. Riverine forests border many streams at lower elevations. Open areas are mostly sub-alpine and mostly restricted to the Moroka basin, whereas sub-alpine woodlands are more widespread. Wet open forests are mostly located in the upper Moroka catchment and southern section of the block. Dry open forest occupies most slopes in the north of the block and forms a mosaic with wet open forest in the south.

Birds recorded in riverine forests are typical of this habitat (see p. 74).

Sub-alpine wet heathlands are known to contain the bush rat and common wombat. Birds of sub-alpine open areas include the emu, nankeen kestrel, spur-winged plover, Japanese snipe, welcome swallow, Australian pipit, flame robin, yellow-faced honeyeater, white-backed magpie, and little raven.

Native mammals recorded in sub-alpine woodlands comprise the black wallaby, brush-tailed possum, ring-tailed possum, greater glider, common wombat, brown antechinus, Swainson's antechinus, and bush rat. Native birds include the emu, gang-gang cockatoo, spotted quail-thrush, olive whistler, spotted pardalote, and little raven.

Wet open forests in the block are known to provide habitat for three phalangerids, the black wallaby, common wombat, brown antechinus, and bush rat. Birds include the Australian goshawk, wonga pigeon, king parrot, and powerful owl, as well as more common birds typical of this habitat.

Dry open forests have similar birds to those of wet open forest.

Reptiles recorded in the block comprise the mountain dragon, tree dragon, McCoy's skink, grass skink, Coventry's skink, Spencer's skink, and water skink (both cool- and warm-temperate species).

Amphibians recorded are brown tree frog, Verreaux's tree frog, brown-striped frog, southern toadlet, common eastern froglet, eastern banjo frog, Lesueur's frog, and Victorian froglet. The brown trout has been recorded in the block.

6. Land systems

The Ben Cruachan, Graham, Barkly, Buckenderra, Berrmarr (Sedimentary), Moroka, Snowy Plains, Gelantipy East, Wonnangatta, Eildon, and Marroo Low land systems are represented in the block.

C. Present Use and Capability

1. Nature conservation

The capability for nature conservation is very high. Environments range from alpine heathlands and harbfields at Mount Wellington to riverine forests. Roadless areas exist at Snowy Bluff and in the Avon River--Mount Hump Creek area. Vegetation in the latter area includes snow gum woodland, alpine ash, shining gum, and mountain ash fire-regrowth forests, messmate forests, and dry open forests.

The cliffs at Snowy Bluff provide exposures of a sequence of inter-bedded sedimentary and volcanic rocks for a long vertical distance.

Eight of the 25 significant plant species listed for the block are considered to be highly significant. One of them, the buttercup *Ranunculus eichleranus* observed at McFarlane Saddle, is endemic to the study area. Others are the New South Wales mountain mallee (*Eucalyptus stricta*), which has been recorded in Victoria only at Mount Wellington, and the undescribed plant *Tetratheca* sp. aff. *procumbens* (pink-bells). Many of the other significant species occur on the Mount Wellington--Gable End ridge and at Castle Hill. This block includes the most easterly record of the uncommon lilac berry (*Trochocarpa clarkei*), endemic to western parts of the Victorian alps, and the predominantly coastal small-leaf star-hair, *Astrotriche parviflora*, endemic to Victoria.

2. Recreation

The main features are the elevated Moroka basin, rugged terrain, some of the most inaccessible country in the study area, and attractions such as the Moroka Gorge, Wonnangatta River, and Mount Wellington. Capabilities are high for bushwalking, wilderness recreation (high in the Avon River area and moderate around Snowy Bluff), horse-riding, recreation driving, and hunting; moderate for cross-country skiing and fishing; and low for canoeing, fossicking, and rock climbing.

Most walking routes and tracks receive moderate to frequent use by bushwalkers. The block's popularity derives from the rugged ranges from Mount Hump to Mount Wellington, and from Snowy Bluff to Mount Kent. The Moroka basin (which is bordered in many sections by precipitous terrain) is also an attraction, together with the Wonnangatta River and the gorge and cascades of the Moroka River.

Organized horse-riding parties of 12 to more than 20 people, accompanied by a four-wheel-drive vehicle, use this area several times between October and May. They usually follow the route along the Turton Spur from Valencia Creek. The Moroka valley and the Pinnacles are among the features visited. Cattlemen's huts may be used for overnight stops.

The Moroka, Mount Blomford, and Valencia Creek roads receive some recreation driving use by two-wheel-drive vehicles. Tracks descending to the Wonnangatta River pose challenges to four-wheel-drive enthusiasts.

Sambar deer are often hunted at various localities, including the valleys of the Moroka River and Valencia Creek. There is some rabbiting along the Wonnangatta River flats.

The Moroka and Wonnangatta Rivers and Valencia Creek are used by trout fishermen.

Cross-country skiers make little use of this area at present, although a relatively large area has potential for ski-touring, particularly around Mount Wellington.

Most canoe trips begin on the Wonnangatta River at Waterford or Castleburn Creek junction and continue along the Mitchell River to Iguana Creek, which is a 3-day trip for most canoeists. Also, the Wonnangatta River from Eaglevale to Waterford can be canoed in high-water periods during spring. The type of use is mainly by small touring parties or individual exploration.

Sections of the Freestone Creek may be used for gold panning.

Moroka block has little potential for rock climbing. Some cliffs near Snowy Bluff may prove suitable, but are unlikely to attract climbers because they are inaccessible.

3. Agriculture

Eight graziers run cattle on the public land, during the warmer months - about 500 dry cattle and 30 cows with their calves. Home properties are in Gippsland at Waterford, Briagolong, Valencia Creek, Sale, Licola, and Glenmaggie. Most stock are Angus, Hereford, or crosses between these two. They may be brought up as early as October and taken off as late as May.

In the Moroka basin the areas grazed are predominantly snow gum--mountain gum forest. On the Wellington plateau, snow gum woodlands and grasslands are most used. Some alpine ash stands also provide grazing, particularly for 3--4 years after logging. The main access routes to this high country include the Tamboritha road, Riggalls Spur, Turton Spur, the Mount Blomford road, Billy Goat Bluff Spur, and Castleburn Creek track.

Manna gum, narrow-leaf peppermint, and broad-leaf peppermint forests in the lower valleys of the Moroka and Wonnangatta Rivers and the Valencia Creek provide winter grazing for about 200 dry cattle.

This block contains only small areas of private land along the river flats of the Wonnangatta River. Some beans for seed and for the culinary trade are grown, but the areas are mainly used for cattle grazing.

The capability for bush grazing is moderate in general, but reasonably high on the high country and along some river flats. St. John's wort reduces the capability of the lower country. The capability for agricultural development is low.

4. Apiculture

This block has produced large crops of first-class honey. The main access is in the Moroka basin, along the Wonnangatta River, and some ridge-top roads running south from the Moroka basin.

Main honey flora are snow gum, alpine ash, shining gum, yellow box, red stringybark, but-but, messmate, mountain grey gum, silvertop, yellow stringybark, yertchuk, and eurabbie.

5. Wood production

Capability for timber production is high in the extensive mature stands of alpine ash that occur in the heads of streams running south from the Moroka Range, and in the head of the Moroka River below Cromwell Knob and Mount Kent. Extensive areas of ash regrowth occur in the head of the Avon River and Mount Hump Creek below Mount Wellington, Gable End, and the Razorback. Mountain forests cover 9,300 ha in this block. Capability for timber production is low to moderate in the moist foothill forests. Each year the six mills at Heyfield and one mill each at Briagolong and Stratford together cut about 11,400 m^3 of sawlogs from 150 ha of forest. A.P.M. obtains pulpwood supplies from integrated harvesting operations.

6. Minerals

The eastern part of the block includes part of the former Cobbannah and Crooked River gold-fields, and the Wonnangatta beds have moderate potential for further reef gold deposits. To the west, the block covers part of the Avon sedimentary basin, and its Upper Devonian--Lower Carboniferous beds have a low potential for sedimentary copper or uranium.

7. Water production

Major streams within this block are the Avon and Turton Rivers, Valencia Creek, and a section of the Moroka River. The Wonnangatta River forms the eastern boundary. Rainfall varies from 900 to 1,200 mm per annum and is concentrated in the winter and spring months.

The Wonnangatta River catchment basin produces 21% of its mean annual discharge in the 6 months December to May, including only 5% in the 3 months January to March.

The mean annual discharge of the Wonnangatta River at Gibbs is 355,528 Ml, the Avon River at Buxtons 95,952 Ml, and the Moroka River at Horse Yard 26,961 Ml. Some indication of the flow in the Valencia Creek system is gained by comparing the Avon River's discharge at Buxtons (95,952 Ml) with its average of 112,620 Ml per annum downstream from its junction with the Valencia Creek at Valencia Creek bridge. All water in the block is of high quality.

Capability for water production is moderate to high.

D. Hazards

The erosion hazard is high at Mount Wellington and moderate to high in sub-alpine environments and on steep dry slopes. The fire hazard is high, and large fires have burnt through here in 1961, 1964, and 1965. A fire lookout is situated at the Pinnacles. Blackberry and St. John's wort (both prevalent along the lower Wonnangatta and Moroka Rivers) are among the nine noxious weed species recorded in the block.

8. TEA TREE

A. Location and Tenure

Tea Tree block covers a total of 54,500 ha, most of which is public land as unreserved Crown land (53,900 ha), except for several areas of freehold land along the Wonnangatta River in the south.

County of Wonnangatta: Parishes of Bolaira, Kybeyan, Buckenderra, and Wonnangatta.

B. Nature of the Land

1. Climate

The main rain-bearing air streams from the north-west deposit most of their moisture on the Great Dividing Range, which forms the northern border. Average annual rainfall decreases from more than 1,400 mm in this region - including the Tea Tree Range - to less than 700 mm at the junction of the Wonnangatta and Wongungarra Rivers in the south, where rainshadows form in the lee of prevailing westerly winds. The drier areas receive a maximum rainfall in spring, with significant additions to annual rainfall from moist southerly and easterly air streams and occasional summer thunderstorms.

Snowfalls occur regularly above 1,000 m between June and October, and low winter temperatures may let snow persist on the higher elevations of the Barry Mountains and Tea Tree Range for this period.

2. Geology and physiography

The block is bordered on the west by the Wonnangatta River and on the east by the Wongungarra River - two major tributaries of the Mitchell River. The elevation at their junction is 220 m.

The terrain consists almost entirely of deeply dissected Ordovician felspathic sandstones and siltstones, forming ridges with a generally north--south orientation. The largest of these is the Tea Tree Range, which extends south from Mount Selwyn (1,410 m) on the Great Divide to the highest elevation in the block, Mount Sarah (1,550 m), and further south to Mount Hart (1,250 m) and Mount Von Guerard (1,235 m). The mountain summits are generally rounded - in contrast to the sharply crested ridges and spurs, which have steep descents of up to 800 m to adjacent valley floors.

Mount Selwyn - a Silurian granite intrusion into the Ordovician sediments - metamorphosed these to form a ring of hornfels around the intrusion.

A low gap in the Divide east of the Viking (1,523 m) is known as the Barry Saddle (950 m). Quaternary sediments have been deposited upstream of the junction of the two main rivers, and upstream of gorges in the Wonnangatta River.

3. Soils

The higher-rainfall mountainous areas of the block have predominantly friable brown gradational soils, with shallow forms and stony loams on the steeper slopes and crests. Friable red gradational soils occur on the less-steep lower valley slopes, and massive gradational soils are typical of the drier slopes at lower elevations.

The driest parts of the block have stony red gradational soils and stony loams.

4. Vegetation

At the highest elevations (1,200--1,550 m) along the Tea Tree Range and at Mount Von Guerard, snow gum open forests and thickets predominate. These typically have a grassy understorey of slender tussock-grass and various herbs such as silver daisy, ivy goodenia, grass trigger-plant, prickly starwort, hoary sunray, and glacial eyebright. Scattered shrubs include tasman flax-lily, pink beard-heath, and bush-pea.

Mountain gum--snow gum forests occur on some narrow ridges south of Mount Von Guerard at about 1,200 m elevation.

Mature alpine ash forests border the Tea Tree Range from the Great Divide to Mount Von Guerard, usually on steep slopes at elevations ranging from 900 to 1,200 or sometimes up to 1,400 m. Understoreys may have scattered tall and low shrubs such as austral bracken, common cassinia, hop bitter-pea, elderberry panax, prickly coprosma, and silver wattle. Alpine ash stands also occupy gully heads under the crests of the Barry Mountains at 900--1,100 m elevation.

Messmate stringybark forests or manna gum forests grow in moist situations along the Tea Tree Range, and often have a gully-type understorey including blanket-leaf, musk daisy-bush, and hazel pomaderris. Some trees may be more than 40 m tall.

Narrow-leaf peppermint open forest III is widespread in the block. Understoreys are generally shrubby, and species include silver wattle, austral bracken, handsome flat-pea, and tussock grass.

Tall manna gum forests with shrubby understoreys occur on moist river flats of the major streams. Swampy flats carry mountain swamp gum open forest II.

Dry ridges in the north of the block typically have broad-leaf peppermint, candlebark, or mountain gum forests 15--28 m tall, with heathy understoreys that typically include gorse bitter-pea, narrow-leaf bitter-pea, handsome flat-pea, and prickly broom-heath.

In lower-rainfall areas further south, red stringybark, long-leaf box, and red box come into mixture.

Open forest I commonly occurs on steep dry slopes and includes broad-leaf peppermint and candlebark at the higher elevations and red stringybark, long-leaf box, and red box lower down. Understoreys are heathy and at the lower elevations include grey bush-pea, golden grevillea, and golden wattle.

5. Fauna

Eight native mammal, 57 native bird, seven reptile, and four amphibian species have been recorded in the block. Sambar deer are also known to inhabit this block. Brown trout, rainbow trout, and river blackfish almost certainly live in many of its streams.

Wetlands include the Wonnangatta, Wongungarra, and Humffray Rivers, and riverine forests and woodlands are associated with these and other streams. Sub-alpine woodlands are restricted to the higher ridges, and wet open forest is the predominant habitat in the block. Riverine forests are known to provide a habitat for the bush rat, brown antechinus, greater glider, and common wombat, and for birds such as the buff-rumped thornbill, orange-winged sittella, white-plumed honeyeater, yellow-tufted honeyeater, brown-headed honeyeater, white-naped honeyeater, eastern spinebill, and others typical of this habitat.

Sub-alpine woodlands provide habitat for the bush rat, brown antechinus, and brush-tailed possum. Common birds here include the gang-gang cockatoo, crimson rosella, brown thornbill, white-browed scrub-wren, grey fantail, and yellow-faced honeyeater.

Wet open forest is known to support the rare smoky mouse (endemic to Victoria), brush-tailed possum, bobuck, common wombat, brown antechinus, Swainson's antechinus, and bush rat. Birds are typical of the wet open forest types found elsewhere in the study area.

Many dry open forest birds are similar to those found in wet open forest. The rufous songlark, buff-rumped thornbill, scarlet robin, and white-winged chough are among birds recorded in this habitat.

All reptile fauna recorded were at the higher elevations and comprise the mountain dragon, water skink (cool-temperate species), grass skink, McCoy's skink, Spencer's skink, and southern blue-tongue. Amphibian species are the common eastern froglet, Lesueur's frog, leaf green tree frog, and Verreaux's frog.

6. Land systems

The Darbalang, Graham, Buckenderra, Barry Mountains, Wonnangatta, Selwyn, Koonika, Bemboka, and Eildon land systems are represented in the block.

C. Present Use and Capability

1. Nature conservation

The capability for nature conservation is high. Environments range from sub-alpine woodlands to riverine forests. The southern part of the block is relatively undisturbed. Large stands of mature alpine ash, messmate, and other wet open forest types exist on a range of different aspects around Mount Sarah on soils derived from Ordovician parent materials. The uncommon smoky mouse has been recorded at Galbraith Saddle on the Tea Tree Range.

No particularly significant plant species have been recorded in this block, except for those occurring along the border with neighbouring blocks. Many noteworthy sub-alpine species form a colourful spectacle on the Viking during spring and summer.

2. Recreation

Capabilities are very high for adventure driving, high for hunting and fishing, moderate to high for bushwalking, and low for fossicking, canoeing, and cross-country skiing.

The most popular bushwalking tracks in the block are along the Barry Mountains (the Viking in particular), and from the Crooked River to the Wonnangatta River via the Wombat Spur. Other tracks receiving moderate use are those along the Tea Tree and Mount Cynthia Ranges, Water Spur, and Humffray River, and the track from the Wongungarra to the Tea Tree Range via the spur between Big and Little Running Creeks.

Adventure recreation driving in this area is moderately popular. Main routes used are the Wombat Spur track to Wonnangatta station, the Riley Creek track, and the Tea Tree Range track.

Sambar deer are hunted in several areas, including Riley Creek, Wonnangatta River valley, and the Wombat Spur.

The Wonnangatta, Wongungarra, and Humffray Rivers and Riley Creek are all good trout-fishing streams.

There is some potential for cross-country skiing near Mount Sarah.

The section of the Wonnangatta River from Eaglevale to Waterford can be canoed in high-water periods during spring.

Gold-panning takes place at Howittville.

3. Agriculture

Little use has been made of the public land for bush grazing within the last 5 years, except for recent grazing by about 100 cows (some with calves) in the headwaters of Humffray and Mount Selwyn Creeks during the summer. These cattle graze in the gum and narrow-leaf peppermint forests of the valleys and alpine ash forests of the valley slopes, which they reach from the Buffalo and Buckland River valleys through low gaps in the Dividing Range.

Cattle from a property at Waterford have in the past grazed in the snow gum and alpine ash forests of the Tea Tree Range during summer, and in the Riley and Humffray River valleys in winter. Access was from the Wongungarra and Wonnangatta River valleys.

Usually about 80 head, mainly dry cattle from properties at Valencia Creek and Dargo, run in the forested Wonnangatta and Wongungarra River valleys.

The only private land in this block consists of a few small areas along the Wonnangatta River used for beef production or cropping.

Average capability is low to moderate. The use of the block could be improved by better access. St. John's wort and blackberries in some sections of the river valleys reduce their capability. Some areas - grassy snow gum woodlands and grassy river flats - have high capability, however.

The capability for agricultural development is low.

4. Apiculture

Most of this block is inaccessible to apiarists. Honey flora include snow gum, alpine ash, messmate, red stringybark, long-leaf box, and red box.

5. Wood production

Capability for timber production is high in the north of the block, where extensive stands of mature alpine ash occur along the Tea Tree Range, Barry Range, Mount Sarah, and in the heads of Mount Selwyn Creek and Big Running Creek. These mountain forests cover 4,500 ha. Utilization and regeneration of the northernmost stands has commenced and is continuing.

Moist foothill forests of messmate, manna gum, and candlebark adjoin the stands of mountain forest in Mount Selwyn Creek, the Humffray River, and Riley Creek, and have high to moderate timber-production capabilities.

The forests of the rest of the block have low capabilities.

Each year, two mills (one at Eurobin and one at Porepunkah) together cut about 16,200 m^3 of sawlogs from 220 ha of forest.

6. Minerals

The block contains a large area of uninvestigated and unknown country that could contain reef gold.

7. Water production

This block is bounded on the east by the Wongungarra River, and on the west and south by the Wonnangatta River. The Humffray River, a tributary of the Wonnangatta, flows through the northern section of the block.

Rainfall ranges from less than 700 mm per annum at Crooked River to more than 1,400 mm in the north of the block, with a winter--spring maximum.

The mean annual discharges of the Wongungarra and Wonnangatta Rivers near their junction are 214,625 Ml and 355,528 Ml respectively. All water is of high quality (the mean salinity of the Wonnangatta River at Waterford is 31 mg per l). No measurements for the Humffray River are available.

The capability for water production is high.

D. Hazards

The erosion hazard is highest on the snow gum ridges and is low in the wet mountain forests. Steep dry slopes have a moderate erosion hazard. The fire hazard is high. The seven noxious weed species in the block include blackberries and St. John's wort, occurring mainly along the Wongungarra and Wonnangatta Rivers.

9. DARGO

A. Location and Tenure

Dargo block covers a total area of 121,500 ha, most of which (116,500 ha - 96%) is public land. This is largely in the form of unreserved Crown land, but includes the southern part of the Mount Hotham Alpine Reserve (2,930 ha), a strip of reserved forest along the Great Divide in the east (5,900 ha), and five small reserves at Dargo and Waterford. Freehold land exists on the Dargo Tablelands, in the south around Dargo township, and along the Wonnangatta River.

County of Wonnangatta: Parish of Kybeyan.
County of Dargo: Parishes of Yertoo, Graham, Cooma, Mullawye, Bulgaback, Thornley, Barroworn, Carneek, Kalk Kalk, Birregun, Cowa, Dargo, Tarkeeth, Wongungarra, and Bemboka.

B. Nature of the Land

1. Climate

The Dargo Tablelands receive a generally high rainfall from the main rain-bearing north-westerly air streams. Average rainfall further north on the Great Divide at Mount Hotham exceeds 1,800 mm.

On the tablelands, rainfall decreases from more than 1,600 mm in the north to less than 1,200 mm in the south. The rain-shadow region of the Wonnangatta River valley receives less than 700 mm.

Winter-maximum rainfall in elevated areas changes to spring-maximum in the drier rain-shadow areas.

The highest elevations around Mount Hotham can experience high winds due to their exposed position, and blizzard conditions may bring sub-zero daily temperatures lasting several days. Summer thunderstorms with high-intensity rainfall can cause erosion and also flooding problems outside the study area.

Snow persists for most of the winter and early spring at high elevations (longer in sheltered sites), and occurs regularly above 1,000 m from June to October. Frosts occur throughout the year, with an average frost-free period of 13 days per annum at Hotham Heights.

2. Geology and physiography

Elevations in the block descend from Mount Hotham (1,861 m, sixth-highest peak in the State) on the Great Dividing Range to 160 m on the Wonnangatta River at the southern boundary.

The dominating land forms are the Paw Paw and Dargo Tablelands (believed to be remnants of the Baw Baw Surface). Both are relatively flat, dipping from north to south at elevations of about 1,700 to 1,400 m and 1,600 m to 1,200 m respectively. These tablelands consist of remnants of Oligocene basalt, which overlie earlier valleys (deep leads) filled with Tertiary gravels and fossil plant beds. Remnants of Oligocene basalt also cap small plateaux at Basalt Knob (1,100 m), Mount Tabletop (1,600 m), and Mount Higginbotham (1,800 m). Summits are generally rounded to flat, in contrast to the sharply crested ridges and spurs.

Adjacent to the tablelands are valleys that are deeply incised in the steeply dipping Ordovician felspathic sandstones and siltstones. Relief between ridge tops and adjacent valley floors is up to 800 m.

Streams generally flow south-east, reflecting the underlying Ordovician rock strata and the Kiewa Thrust belt in the east. The Ordovician sediments have been metamorphosed to gneisses and schists (Omeo Metamorphics) along the Thrust belt, which in this area runs parallel to the Great Divide. At Dargo, in the south of the block, a small area of Devonian granite has intruded the Ordovician sediments.

Quaternary sedimentation has occurred along the Crooked River above its junction with the Wongungarra River, and at several localities along the lower Dargo River.

3. Soils

The bulk of this block is mountainous country with predominantly friable brown gradational soils. Shallow forms occur on steep and exposed slopes. The high-elevation areas along the Dividing Range have shallow organic loams and stony loams, with small areas of peats and humified peats in drainage lines.

Extensive basalt-capped plateau areas have soils classified as red gradational soils, although many are more brown than red. Organic loams, peats, and humified peats also occur on the Dargo High Plains.

Less-steep lower valley slopes carry friable red gradational soils and drier slopes have massive gradational soils.

In the south of the block, on granitic foothills, the steeper slopes carry massive gradational soils with coarse sands in many places where soil material can accumulate. On the rolling areas, red duplex soils are predominant where drainage is free and yellow duplex soils occur on less-well-drained areas.

4. Vegetation

Southern aspects on the highest peaks (Mount Murray, the Twins, and Blue Rag Range) have alpine heathlands and herbfields, at elevations from 1,600 to 1,700 m. Species include snow aciphyll, mountain plum pine, alpine oxylobium, twinflower knawell, and hoary sunray. Herbfields and heathlands at Mount Hotham range from about 1,600 m to 1,830 m.

Sub-alpine grasslands, wet heathlands, and mosslands occur in various places on the Dargo and Paw Paw Tablelands - for example, at Lankey Plain (1,600 m), Gows Plain (1,500 m), Omeo Plain (1,500 m), Shepherds Plain (1,300 m), Paw Paw Plain (1,620 m), and J.B. Plain (1,560 m). Wet heathland and mossland plants include sphagnum moss, candle heath, mountain baeckea, snow heath, and alpine bottlebrush.

Snow gum open forest and woodland occupy both steep exposed mountain sides and relatively flat tablelands. Elevations generally range from about 1,400 m to 1,700 m near Mount Hotham. Snow gum canopies may be a few to several metres high on steep rocky slopes. Understoreys vary from dense thicket (leafy bossiaea, royal grevillea, mountain hickory wattle, and alpine wattle) to heathy (mountain beard-heath, leafless bossiaea, and gorse bitter-pea), or may be grassy with scattered shrubs (snow grass, silver daisy, silky daisy-bush, and alpine pepper).

Black sallee woodland with a grassy understorey occurs around some plains such as Shepherds Plain. Mountain gum--candlebark and snow gum open forests occupy substantial areas on tablelands at White Timber (1,250--1,360 m), Fifteen Mile Creek headwaters (1,200--1,360 m), around Shepherds Plain (1,200--1,300 m), south of Mount Tabletop (1,250--1,400 m), and Deep Creek headwaters (1,200--1,400 m). Understoreys may be shrubby (silver wattle), heathy (pink beard-heath), or grassy (kangaroo grass, snow grass, ivy-leaf violet, showy violet, grass trigger-plant, prickly starwort, and bidgee-widgee).

Alpine ash open forest covers considerable areas, mainly in the headwaters of the Dargo and Wongungarra Rivers, Horatio and Frosty Creeks, and the broad ridge running north from Mount Ewen. Large areas of 1939 regrowth are situated in the north of the block. Substantial areas of mature stands occur below the snow gum woodlands surrounding Mount Murray. Mountain gum is sometimes in mixture with alpine ash. Understoreys may be shrubby, heathy, or grassy with scattered shrubs (snow grass, ivy-leaf violet, bidgee-widgee, prickly starwort, orange everlasting, and silver wattle). These forests normally occur at elevations ranging from about 1,000 m to 1,400 m.

Mountain ash regrowth forests, together with some mature stands, occupy substantial areas of moist gully heads and southern slopes south from Mount Ewen to Riley Creek at elevations varying from about 600 to 1,200 m. Understoreys are typical of gullies, and plants include hazel pomaderris, musk daisy-bush, soft tree-fern, and fish-bone water-fern.

Messmate stringybark--mountain grey gum forests have a scattered distribution in the southern part of the block. Understoreys may be shrubby (mountain hickory wattle, austral bracken, and silver wattle) or typical of wet gullies (blanket-leaf and musk daisy-bush).

Open forest III also includes mountain gum forest at the higher elevations, and narrow-leaf peppermint, silvertop, and manna gum forests. Understoreys are usually shrubby.

Steep dry slopes below about 1,400 m may carry open forest II with heathy understoreys. Tree species include broad-leaf peppermint and mountain gum at the higher elevations, and red stringybark, long-leaf box, and red box at the lower elevations. Understoreys are shrubby (tasman flax-lily), heathy (handsome flat-pea), or grassy (snow grass and grass trigger-plant). Some areas in the south have silvertop forest with shrubby understoreys of sunshine wattle, prickly bush-pea, handsome flat-pea, and tussock grasses.

Open forest I has similar plant components and is distributed mainly on steep dry slopes in the Wonnangatta and Crooked River valleys.

5. Fauna

Eleven species of native mammals, 61 native bird, eleven reptile, nine amphibian, and two native fish species have been recorded. The introduced sambar deer inhabits the area, and brown trout, rainbow trout, and river black-fish are almost certainly present in most streams.

Wetlands mostly border streams, and riverine forests are associated with major rivers and creeks. Sub-alpine open areas and woodlands occupy most of the Dargo Tablelands. Wet open forests predominate in dissected topography except for steep dry slopes in the major river valleys, which carry dry open forest.

Mammals recorded in the riverine forests are the sugar glider, common wombat, long-nosed bandicoot, and bush rat. Birds include the bell miner, superb blue-wren, king parrot, shrike-tit, eastern whipbird, and crescent honey-eater.

The broad-toothed rat and brown antechinus have been recorded in sub-alpine mossland and wet heathland. The nankeen kestrel, spur-winged plover, Australian pipit, grey currawong, white-backed magpie, and both ravens are characteristic birds found in sub-alpine grasslands, while small insectivorous birds and two honeyeater species occupy wet heathland.

In sub-alpine woodland, mammals include eastern grey kangaroo, common wombat, brown antechinus, and bush rat. Most birds found in this habitat are typical of sub-alpine woodlands elsewhere in the study area.

Wet open forest is known to provide habitat for the bobuck, common wombat, brown antechinus, and bush rat. Birds recorded in wet open forest are typical of those found in this habitat type elsewhere in the study area.

Mammals in dry open forest include the echidna, eastern grey kangaroo, sugar glider, and eastern pigmy possum. Birds are typical of this habitat type.

Reptiles recorded in the block are the grass skink, Spencer's skink, and water skink (which are found near fallen timber), and the Gippsland water dragon (found along main streams). McCoy's skink and Coventry's skink prefer dense forest, and the mountain dragon is found at the higher altitudes. The southern blue-tongue, garden skink, three-lined skink, and the copperhead have also been recorded.

Mosslands provide breeding grounds for Verreaux's tree frog. The common eastern froglet and the southern toadlet are also found at high altitudes, whereas Lesueur's frog and the leaf green tree frog are restricted to streams at lower altitudes. The Kosciusko mountain trout and ornate mountain trout are found in small streams on the Dargo Tablelands.

6. Land systems

The Barry Mountains, Darbalang, Buller (Sedimentary), Buckenderra, Graham, Feathertop (Sedimentary), Higginbotham, Hotham, Wongungarra, Beloka High, Cabanandra, Mt Phipps, Marroo Low, Tongio-Munjie West, Eildon, Swifts Creek, Theddora, and Jirnkee land systems are represented in the block.

C. Present Use and Capabilities

1. Nature Conservation

The capability for nature conservation is high. Environments range from alpine herbfields at Mount Hotham to riverine forests. Sub-alpine woodlands and alpine ash regrowth forests are extensive. The broad-toothed rat has been recorded near Mount Hotham and the Twins, and the Tasmanian pipistrelle on the Dargo Tablelands. Some areas - for example, Dargo River valley and Wongungarra River headwaters - have few roads or tracks.

Lankey Plain is the site of the only Australian mainland record of the rare willow-herb (*Epilobium willisii*), and is one of two known Victorian localities for the fairy blue-bell (*Wahlenbergia densifolia*). A total of eight plant species in the block are considered significant, one of which - the Bogong daisy-bush (*Olearia frostii*) near the Twins - is endemic to the study area.

2. Recreation

The main rivers, except the Wonnangatta, are relatively inaccessible. Attractions include Mount Hotham and the historic sites of Grant township, Talbotville, Mayford, and other early mining areas. Capabilities are high for cross-country skiing, fossicking, bushwalking, hunting, and wilderness recreation, moderate for fishing and recreation driving, and low for canoeing.

The most popular bushwalking areas here, apart from the Barry Mountains, are the Blue Rag Range, the Hibernia Spur track, and tracks around the townships of Grant, Hogtown, and Talbotville. Mount Murray, Mount Tabletop, Mayford, and the Dargo High Plains are also regularly visited. Other tracks occasionally used are those to the Tablelands from Crooked River, the Gibraltar Spur tracks, and the one from Dargo to the Wonnangatta River via Mount Bruno. The Dargo River valley has considerable potential for extended trips by experienced walkers.

The Dargo road is receiving increasing use in summer for recreation driving and is currently being upgraded. The Grant area is visited frequently, and jeep tracks in the west receive moderate use.

The main hunting in this block is for rabbits around private property at Dargo and in forest clearings. Sambar deer are also hunted regularly at such places as the Wonnangatta and Dargo River valleys and the Dargo Tablelands.

The Dargo, Wonnangatta, Wongungarra, and Crooked Rivers provide trout-fishing.

Little cross-country skiing occurs on the Dargo Tablelands at present, although the sport is increasing in the northern section. A considerable area of suitable terrain is regularly snow-covered in winter.

Downhill skiing at the Mount Hotham ski resort is considered under block 10, Bogong.

For canoeing, the Dargo River from the Little Dargo River junction and the Wongungarra River from above Howittville to the Mitchell River are both suitable in high-water periods during spring. The Dargo River in particular is valuable for small touring groups.

Visitors may fossick for alluvial gold at numerous localities in this block - for example, in the Dargo, Crooked, and Wonnangatta Rivers and smaller streams such as Good Luck and Eldorado Creeks. The Crooked River also provides red zircons for gem seekers.

3. Agriculture

The 17 graziers that run cattle on the public land have home properties at Tawonga in north-eastern Victoria, around Crooked River, Dargo, Castleburn, and the Stratford district in Gippsland, and at Cobungra. They put about 3,650 cattle (of which about 1,550 are cows with calves and 980 are dry) on the runs during summer.

Most are Herefords, although some Angus graze the river flats along the Dargo, Wongungarra, and Crooked Rivers. The cattle graze mostly on open plains and in snow gum forests of the Dargo and Paw Paw Tablelands, but also in some alpine ash forest. They rarely venture into the steep-sided valley of the Dargo River.

The grazing season extends from December to April--May and the cattle are returned to home properties with the onset of winter.

The major part of the private land in this block is in the south near Dargo, and adjoins other private property just outside the study area. Most of the land has been developed, and only the steeper areas have not been cleared. Additional private property comprises about 800 ha, at Treasure's homestead on the Dargo Tablelands and a few small scattered blocks along the Dargo and Wonnangatta Rivers.

Beef production is the major enterprise, with Hereford the main breed. Some sheep are also raised for wool. Beans, both for the culinary trade and for seed, are grown on the river flats and irrigated from the Dargo River. Lucerne for hay and for grazing is also grown on the flats.

Walnuts are grown at Dargo, and in 1975/76 the area produced 4,850 kg - 7% of Victoria's production in that year.

Private land is reasonably developed, although distant from the nearest railhead at Fernbank. This and other private land just outside the study area serve as an important base for the cattle that graze on the Dargo Tablelands during the warmer months.

The average capability for bush grazing is high, especially in snow gum woodland and snow gum--mountain gum forests and on Lankey Plain and numerous smaller plains. Steep slopes along the Dargo, Wongungarra, and Crooked Rivers serve to control stock movements.

Improvements have been made in the form of fencing, dams, stockyards, and holding paddocks. Private property on the Dargo High Plains is used in conjunction with grazing blocks on public land, and several houses are built at one locality on the property.

Weeds - such as sweet briar, blackberries, and ox-eye daisies on the tablelands and blackberries, sweet briar, and St. John's wort in the river valleys - reduce the capability somewhat. Capability for agricultural development is low.

4. Apiculture

This block has been used to produce good crops of high-quality honey. The Dargo road provides the main access for apiarists. Honey flora include snow gum, alpine ash, mountain ash, red stringybark, yellow box, but-but, and silvertop.

5. Wood production

Capability for hardwood timber production is high to very high in the extensive areas of mature alpine ash stands around Mounts Ewen, Murray, and Blue Rag and in the heads of streams rising on the Dargo Tablelands. These total about 8,800 ha. Very extensive areas of alpine ash regrowth resulting from the 1939 fires cover about 16,600 ha, mainly west and north of the Dargo Tablelands.

In the south of the block, stands of moist foothill forest with moderate to high timber-production capability adjoin those of mountain forest.

A mill at Dargo annually cuts about 12,600 m^3 of sawlogs from about 170 ha of forest.

6. Minerals

The former Dargo, Crooked River, and Cobbannah gold-fields cover a large portion of the block. Not all these have been exhausted and, in view of the recent price rises in gold, much of the block may still have potential for gold deposits. This is particularly so for the north-eastern part in the upper Dargo River near the Kiewa Thrust belt, and at the contact of the Wonnangatta beds with the Omeo Metamorphics. The deep leads of the Dargo Tablelands are within the block, but have only a low potential. Part of the Dargo Tablelands overlies a lignite deposit as yet untested, and this may, if of any extent, have potential in the long term.

7. Water production

The major streams of this block are the Wongungarra river, forming the western boundary, and the Dargo and Little Dargo Rivers. Rainfall within the block varies widely, from about 700 mm per annum at Waterford to more than 1,800 mm per annum at Mount Blowhard at the north of the block. Rainfall at Dargo has a spring maximum.

Mean annual discharges of the Wongungarra River (at the Wonnangatta junction) and the Dargo River (at Dargo) are 214,625 Ml and 170,663 Ml respectively. The water is of high quality and the Mitchell River, for which the Wongungarra and Dargo are headwaters, is the source of domestic water for Bairnsdale and irrigation water for the Bairnsdale district.

The capability for water production is high.

D. Hazards

The erosion hazard is highest in alpine environments at Mount Hotham and the Blue Rag Range and on steep dry slopes at lower elevations in the south. The Dargo Tablelands have a low erosion hazard. The fire hazard is generally moderate on the Dargo Tablelands and high elsewhere. The 11 noxious weed species in the block include sweet briar, blackberry (a major problem along the main rivers), St. John's wort (along river valleys in the south), and ox-eye daisy (on the tablelands).

10. BOGONG

A. Location and Tenure

Bogong block covers a total area of 155,600 ha, of which 144,000 ha (93%) is public land. This includes: large tracts of reserved forest north of Mount Fainter and in the west around Mount Wills (total 20,200 ha); an area of 10,040 ha along the Kiewa River East Branch held by the State Electricity Commission under a Crown grant; and 12,260 ha of the Mount Hotham Alpine Reserve: the remainder comprises unreserved Crown land, a small reserve near Tawonga, and land around Mount Beauty owned by the State Electricity Commission. Freehold land exists around Mount Beauty, Shannonvale, Bundara River, Ovens River, and Snowy Creek.

County of Bogong: Parishes of Harrietville, Freeburgh, Bright, Mullindolingong, Mullagong, Boorgunyah, Magorra, Bogong North, Bogong South, Carruno, Darbalang, Nowyeo, Wollonaby, Hotham, Lochiel, Wermatong, and Bundara-Munjie.

B. Nature of the Land

1. Climate

This block receives the highest rainfall in the study area, mainly from prevailing north-westerly air streams that are uplifted by the ranges and lose their moisture as precipitation.

Average annual rainfall exceeds 2,000 mm on most of the Bogong Tablelands, and 2,400 mm around Mount Bogong and Mount Nelse. The east and south-east of the block is in a rain-shadow area in the lee of the mountains, with rainfall decreasing to 700 mm on the Cobungra River near Anglers Rest. These rain-shadow areas receive higher rainfall in spring than during the rest of the year.

Thunderstorms with high-intensity rainfall, prevalent in summer, can contribute to erosion and to flooding outside the study area.

Snowfalls have been experienced over most of the block, occurring regularly above 1,000 m from June to October. Snow may persist on the high plains area and elevated peaks for most of this period - sometimes continuing into early summer on high sheltered sites.

The higher elevations including Mounts Hotham, Feathertop, and Bogong are relatively exposed and can experience high winds.

Blizzard conditions may bring sub-zero daily temperatures lasting several days. Average monthly minimum temperatures at high altitudes in summer may be very low (-1.6°C in January on the Bogong High Plains). Frosts occur throughout the year, with an average frost-free period of 13 days per annum at Hotham Heights.

2. Geology and physiography

The main physiographic feature is the Bogong Tablelands (1,650--1,750 m), which are elevated remnants of the Baw Baw Surface and extend from near Mount Nelse North (1,883 m) in the north to Gray Hill (1,500 m) in the south. The undulating topography includes a few protruding hills such as Mounts Jim (1,838 m), Bundara (1,722 m), and Cope (1,837 m). Remnants of Oligocene basalt are scattered about the tableland surfaces, particularly around Mount Jim and Mount Loch (1,875 m). Overlying Pliocene sediments are associated with the basalt near Mount Jim. A small area of Triassic trachyte appears east of Mount McKay (1,843 m).

The tablelands are drained by the Kiewa, Mitta Mitta (Big), Cobungra, and Bundara Rivers and Middle Creek. The action of these streams has formed deeply dissected mountainous terrain with up to 800 m from ridges to adjacent valley floors surrounding the alpine and sub-alpine tableland country.

The block includes Mount Hotham (1,861 m), a high point in the Great Divide. Mount Bogong (1,986 m), the highest mountain in the State, has a rounded summit and forms part of the Hooker plateau, whereas Mount Feathertop (1,922 m, second-highest Victorian mountain) rises to an abrupt peak from the Ovens and West Kiewa River valleys (1,650 m and 980 m respectively). The Mount Beauty basin at 340 m elevation owes its origin in part to the Tawonga Fault defining its southern boundary.

A wide section of the Omeo Metamorphic belt runs north-west through the block and encompasses the Bogong Tablelands. The schists and gneisses extend eastwards from the West Kiewa Thrust belt to east of Mount Wills, and grade into Ordovician sediments on either side. Lower Silurian granites have intruded the region and are exposed at Mount Wills (1,755 m), Sugarloaf Hill, the East Kiewa headwaters, and various localities on the Bogong Tablelands. Pebbles from these granites are found in the Wombat Creek group of Upper Silurian sediments to the east. Lower Devonian granites are exposed near Bald Hill (1,120 m). Quaternary alluvium has been deposited along the basins of the Kiewa and Ovens Rivers.

3. Soils

The most widespread soils of the Bogong Tablelands are shallow organic loams where drainage is not impeded and peats in permanently wet situations. Fen or bog peats develop according to the type of vegetation producing them. Humified peats are formed from normal peat soils where stream entrenchment has lowered the water table.

Shallow stony loams predominate on steep slopes, exposed ridges, and peaks such as Mount Nelse and Mount Hotham. Bare rock and screes occur on precipitous scarps adjacent to the tablelands. Shallow organic loams become deeper with descending elevation, and are classified as deep organic loams. These in turn are replaced by friable brown gradational soils. A small area of red gradational soil occurs on the basalt of the Paw Paw Tablelands in the south of the block.

On the lower slopes and hills, friable red gradational soils become more common, and may be replaced by gravelly loams in some sheltered gullies. Red gradational soils with fine structure occur on residual hills and old alluvial fans.

Massive gradational soils, which are usually derived from granite rocks, occur on steep slopes near the valley bottoms and on poorly drained slump areas. Red gradational soils are found on alluvial fans on valley sides and the lower slopes, and these grade into yellow-brown forms in less-well-drained depressions.

Red duplex soils are found in drier situations on rolling topography and the less-steep lower valley slopes, with yellow duplex soils in poorly drained areas.

The more recent alluvial fans and terraces have red gradational soils with weak structure, yellow gradational soils, and grey-brown loams. Some gravelly loams also occur on the higher terraces and in steep valley bottoms.

4. Vegetation

This block has by far the greatest area of alpine vegetation compared with any other locality in the Victorian Alps. The largest contiguous area is on the Bogong Tablelands and extends from Timms Lookout in the north to the Bundara headwaters in the south-west. Other areas are at Mounts Bogong, Feathertop, and Loch.

On the Tablelands, the alpine vegetation forms a complex at elevations usually ranging from about 1,700 m to 1,890 m but sometimes descending to about 1,650 m. At Mount Bogong, alpine vegetation extends from about 1,550 m to 1,920 m and at Mount Loch from about 1,650 m to 1,875 m.

The vegetation forms a complex of communities, which includes dwarf herbfield and heathland (silver ewartia, hoary sunray, and snow heath) on the most exposed sites, short herbfield (alpine wallaby-grass, bristle-grass, sedge, leafy daisy, white purslane, and alpine marsh-marigold) where snow remains longest, tall herbfield (silver daisy, snow grass, orange everlasting, mountain gentian, scaly-buttons, yam daisy, variable groundsel, mountain woodruff, and hoary sunray), and grassland (snow grass, yam daisy, sedge, and mountain woodruff). Some slopes may carry moist heathland (rusty pods, alpine grevillea, alpine oxylobium, alpine mint-bush, alpine phebalium, mountain plum pine, alpine pepper, and leafy bossiaea).

Wet heathlands (alpine baeckea, alpine bottle-brush, drumstick heath, thyme heath, swamp heath, and myrtle tea-tree), mosslands (sphagnum moss, candle heath, spreading rope-rush, alpine tuft-rush, and fan tuft-rush), and sedgelands (tall sedge, tall spike-rush, and austral rush) are usually located in drainage lines or wet depressions.

Snow gum woodlands - sometimes in association with small areas of sub-alpine heathlands, mosslands, and grasslands - are widely distributed in the block at elevations generally between 1,400 and 1,700 m, but extend up to elevations of 1,830 m at Mount Cope. The woodlands flank the alpine complex and are also found at Mount Wills. Understoreys are variable. Heathy understoreys, such as those near Mount Fainter, include leafy bossiaea, alpine pepper, alpine mint-bush, royal grevillea, and alpine oxylobium.

Mountain gum--snow gum forests are limited mainly to northerly slopes and in some cases more gentle topography at elevations between about 1,200 m and 1,500 m.

Understoreys may be heathy (leafless bossiaea, alpine oxylobium, dusty daisy-bush, and mountain beard-heath) or grassy with scattered shrubs (leafy bossiaea, rusty pods, and alpine pepper). Black sallee woodlands are generally limited to some streams such as the Cobungra River and the margins of some plains. Understoreys are usually grassy with shrubs and ferns (mountain tea-tree, alpine water-fern, and mountain beard-heath).

Alpine ash forests (both 1939 fire regrowth and mature) are also extensive, particularly in the West and East Kiewa Rivers and in the region about Mounts Bogong and Wills and Sugarloaf Hill. These forests generally grow between elevations of about 900 and 1,400 m, but may extend up to about 1,500 m.

Open forest III predominates on moist sites below about 1,000--1,100 m in the north of the block. The common trees are narrow-leaf peppermint, manna gum, and eurabbie (St. John's blue gum). Understoreys may be wet gully type (blanket-leaf, soft tree-fern, fishbone water-fern, blackwood, and hazel pomaderris), shrubby (silver wattle, common cassinia, austral bracken, and prickly currant-bush), or grassy (kangaroo grass with scattered shrubs).

Open forest II is limited to dry northerly aspects, mainly in the north and east of the block and around Grays Hill in the south-east. Tree species include broad-leaf peppermint, long-leaf box, brittle gum, and candlebark.

Understoreys may be grassy (kangaroo grass), with scattered low and tall shrubs such as handsome flat-pea, cherry ballart, and hop bitter-pea.

Open forest I is mainly limited to dry sites in the south-east of the block. Tree and understorey species are similar to open forest II. Understoreys may be shrubby (hop bitter-pea, mountain hickory wattle, elderberry panax, bootlace bush, common oxylobium, forest lomatia, and mountain tea-tree), heathy (mountain pepper, common oxylobium, and royal grevillea), or grassy (snow grass, prickly starwort, and mother shield-fern).

5. Fauna

Twenty-three native mammal, 146 bird, eight reptile, nine amphibian, and three native mountain trout species have been recorded in the block. Sambar deer, brumbies, foxes, and hares are among the introduced mammals recorded here.

The block includes the most extensive area of alpine grasslands, herbfields, heathlands, and mosslands in Victoria. The largest contiguous area is known as the Bogong High Plains. Sub-alpine woodlands are also extensive on the Bogong Tablelands and at high elevations elsewhere. They are associated with sub-alpine open areas at various localities. Wet open forest is very extensive but dry open forest is mainly confined to the Mitta Mitta valley in the south-east of the block. Wetlands comprise lakes and small streams on these uplands, as well as streams and lakes at lower elevations. Riverine forests border many streams at lower elevations.

Waterbirds in lakes and streams at the higher and mid elevations comprise two species of cormorant, two herons, three ducks, the black swan, and little grebe. Other birds at Mount Beauty include grey teal, musk duck, black-fronted dotterel, Lewin water rail, dusky moorhen, swamp hen, golden-headed fantail warbler, and reed warbler.

Riverine forests have populations of small mammals comprising long-nosed bandicoot, brown antechinus, Swainson's antechinus, and bush rat. Birds are typical of those found in riverine forests elsewhere in the study area.

Alpine and sub-alpine heathlands, in close association with grasslands, mosslands, herbfields, and occasional snow gums, support a unique mammal fauna consisting of up to eight species in some localities. The species are the rare mountain pigmy possum, the widespread but localized broad-toothed rat, and brown antechinus, Swainson's antechinus, bush rat, lesser long-eared bat and little bat.

The mountain pigmy possum was considered to be extinct until 1966. Since its initial discovery at Mount Hotham it has been discovered at Falls Creek and in the Kosciusko National Park in New South Wales. Birds in this habitat seem to be limited to about 15--20 species. Typical ones include the nankeen kestrel, brown hawk, spur-winged plover, Australian pipit, flame robin, and little raven.

Mammals in sub-alpine woodlands include those found in alpine to sub-alpine open areas and also Gould's wattled bat, the feather-tailed glider, sugar glider, greater glider, and brush-tailed and ring-tailed possums. Birds are those typical of this habitat elsewhere in the study area.

The wet open forests are known to contain the black wallaby, common wombat, and arboreal and small terrestrial mammals typical of this habitat. Birds are also typical, and include the wonga pigeon, yellow-tailed black cockatoo, king parrot, superb lyrebird, cicada bird, Australian ground thrush, pilot bird, and satin bower-bird.

Dry open forests support mammals such as the eastern grey kangaroo and greater long-eared bat, and birds such as the eastern rosella, rainbow bee-eater, and yellow-rumped thornbill.

The most common reptile recorded throughout the block is the grass skink. The water skink is common below the tree line and the copperhead below about 1,200 m. The sheoak skink (rare in Victoria) and white-lipped snake are found at the higher altitudes. Verreaux's tree frog, the southern toadlet, and the Victorian froglet are common amphibians over most of the area, while Lesueur's frog is more restricted in distribution.

The ornate mountain trout, Cox's mountain trout, and inland mountain trout are found only in locations inaccessible to introduced trout such as above waterfalls or in small water bodies adjacent to the main stream. Brown and rainbow trout are recorded for the block.

6. Land systems

The Wandiligong, Mullagong High, Wermatong High, Feathertop (Igneous), Hotham, Darbalang, Murray High, Feathertop (Sedimentary), Mt Jim, High Plains, Mirimbah, Cobungra, Barry Mountains, Buller (Sedimentary), Stanley, Braithwaite's Top, Glen Wills, Staleyville, Bundarrah, and Livingstone land systems are represented in the block.

C. Present Use and Capabilities

1. Nature conservation

The capability for nature conservation is very high. Environments vary from alpine dwarf heathlands to riverine forests. A wide range of environments may be encountered in a short distance, such as at Mounts Feathertop and Bogong for example. The block contains the largest extent of alpine environment in Victoria - most of it on tableland topography.

Mature alpine ash forests are extensive and occur mainly on soils derived from metamorphic or granitic parent material. Sub-alpine woodlands are also extensive. The avifauna and mammal species have been well documented and are rich in numbers and diversity. A number of rare and restricted faunal species include the mountain pigmy possum near Mount McKay and Mount Hotham and the board-toothed rat near Tawonga Hut Creek, Mount McKay, Mount Fainter, and Falls Creek.

Much of the insect fauna in alpine and sub-alpine areas is largely or wholly restricted to this habitat type. Some of these insect species are also rare. Insects include species of stonefly and caddis-fly, the alpine silver xenica and orichora brown (two species of butterfly found only at high elevations), alpine grasshoppers, and other typically alpine species. The type locality of the stonefly (*Thaumatoperla alpina*) is at Mount Fainter.

The sheoak skink is a rare species in Victoria that, in the

Alpine area, occurs near Mount Hotham.

A large number of significant plant species (48) have been recorded in this block, mainly because of its rich floral characteristics and comparatively long history of botanical investigation. Of the 21 considered highly significant, seven are endemic to the study area. Many of these 21 are located on the Bogong High Plains (the type locality for 12 species), mostly being smaller herbs on the plains or mountaintops.

On the High Plains are found the only indigenous dandelion in Australia (*Taraxacum aristum*); the stork's bill (*Pelargonium helmsii*); the composite *Parantennaria uniceps* (near Mount Cope); the silver carraway (*Oreomyrrhis argentea*); the Bogong daisy-bush (*Olearia frostii*), endemic to the study area; the mountain mitrewort (*Mitrasacme montana*); the spreading clubmoss (*Lycopodium scariosum*); shining cudweed (*Gnaphalium nitidulum*); an alpine bent-grass (*Deyeuxia (?) setifolia*); a buttercup (*Ranunculus eichleranus*) endemic to the study area; the silky daisy (*Celmisia sericophylla*); and another alpine daisy *Brachycome tenuiscapa*.

A rare sedge endemic to the study area, *Carex paupera*, is believed to exist on Mount Hotham, and the snow willow-herb (*Epilobium tasmanicum*) is restricted to Mount Bogong, in Victoria. A rare alpine sedge (*Carex cephalotes*) and the alpine finger-fern (*Grammitis armstrongii*) have been observed on both Mount Bogong and Mount Hotham. The snow-wort (*Abrotanella nivigena*) occurs on Spion Kopje. Mount Beauty is the locality in which the type collection of the slender parrot-pea (*Dillwynia capitata*) was made. Basalt Hill is noteworthy for the diversity of its alpine lichen flora. The endemic rock grevillea *Grevillea willisii* has been observed at Anglers Rest.

2. Recreation

Its outstanding features make this one of the most significant areas for recreation in the study area. It contains the ten highest peaks in Victoria, the Bogong High Plains, some of the most extensive and spectacular alpine scenery in the State, and two alpine ski villages. Capabilities are very high for bushwalking, fishing, motor touring, cross-country skiing, ice climbing, and downhill skiing, high for horse-riding, recreation driving, and fossicking, and low for hunting, canoeing, and rock climbing.

Bogong block is of prime importance to bushwalkers. The numerous walking tracks and routes in most cases receive frequent to moderate use. They traverse most parts of the Bogong Tablelands and all the major peaks. Walking tracks and routes approach the Bogong High Plains from all points of the compass. The route from Mount Hotham to Mount Wills via the Bogong Tablelands and Mount Bogong is important as part of an extended walking route between the Baw Baws and New South Wales. A number of huts constructed by cattlemen, skiers, and bushwalkers are often used for overnight stops.

For recreation driving, the alpine road over Mount Hotham, the Bogong High Plains road past Falls Creek and Buckety Plains, and the Trappers Gap road are all popular touring routes. Adventure driving along roads on the Bogong High Plains is confined to a few routes. Use of jeep tracks is discouraged in erosion-prone areas, but opportunities for adventure driving exist in the Mount Battery and Mount Wills localities and other areas in the east of the block.

Horse stables situated at Mount Beauty cater for horse treks.

Some hunting of sambar deer takes place at scattered sites such as Glen Wills, the Cobungra River, and Snowy Creek. The Kiewa works protection area controlled by the State Electricity Commission is a sanctuary, and shooting is prohibited.

The block contains many prime angling streams. Trout may be caught in the Mitta Mitta River headwaters and its tributaries, and in the Kiewa and Ovens Rivers and tributaries. Rocky Valley and Pretty Valley pondages also provide fishing for trout anglers.

The Bogong Tablelands and the Mount Hotham area form the premier cross-country skiing region in Victoria. Skis may be hired at Hotham Heights and Falls Creek; skiers often make day trips from these centres and sometimes extended trips between them. Experienced skiers visit Mount Bogong, Mount Nelse, and Mount Feathertop.

Ski resorts at Falls Creek and Mount Hotham also provide for downhill skiing. They cater for more than 3,000 overnight visitors and many day visitors from nearby centres such as Harrietville, Bright, Mount Beauty, and Omeo. In winter Mount Hotham is accessible from both Gippsland and north-eastern Victoria. It has limited scope for beginners and novices, but a large potential for intermediate and advanced skiers. Falls Creek, which is accessible from Mount Beauty, has extensive novice and intermediate slopes, but negligible advanced or beginner slopes. Both resorts, particularly Hotham, have potential for further ski slope development.

In addition, a number of new areas have possibilities for development. These include Mount McKay, Bakers Spur, Mount Fainter, Cobungra Gap--Mount Loch, and Bungalow Spur. Mount Wills, which has a ski lodge and ski run serviced by a rope tow, provides some skiing, but the area has little further potential.

For canoeing, only short sections of the Ovens River can be negotiated at present because of tree blockages. It receives some use, however, mainly during high river flows.

The Ovens River provides opportunities for gold-panning along most of its course. Fossickers also find ribbon jasper and bloodstones here. Other streams where alluvial gold may be panned include Middle and Glen Wills Creeks and the Mitta Mitta and Bundara Rivers.

The Niggerheads and Mount Wills are climbed occasionally, but few other sites are suitable for rock climbing.

During summer, Rocky Valley pondage provides opportunities for water-skiing and sailing sports. Boating also takes place on pondages at Bogong Village and Mount Beauty.

3. Agriculture

About 24 graziers regularly graze their cattle on the public land. About half of these have properties in the Ovens or Kiewa River valleys around Eurobin, Bright, Harrietville, Tawonga, and Dederang, and their main access routes run via the Mount Hotham road to the Paw Paw Tablelands, and via Dungeys track along the West Kiewa River, the Mount Fainter Spur, and East Kiewa tracks to the Bogong Tablelands. Access to the Snowy Creek area from Tawonga is via Trappers Gap. Graziers in the Mitta Mitta valley at Eskdale use the Dorchap Range or Omeo Highway for access to the runs in the north-eastern section of the block.

The several graziers based at Glen Valley, Shannonvale, Bundara River, or in the Omeo area, gain access to the Bogong Tablelands via the Middle, Buckety Plains, and Dinner Plain Spurs.

Four distinct grazing areas can be delineated. One is the Bogong Tablelands, which are predominantly alpine and subalpine herbfields, grasslands, heathlands, and mosslands, or snow gum woodland. About 2,500 cows with 2,000 calves and 150 dry cattle are grazed here during the summer.

Mount Bogong and adjacent areas (Long Spur, and Snowy and Dean Creek headwaters) have been used to run about 240 cows and a similar number of calves. In recent years the co-operation of graziers has been sought and, as a result, cattle have been excluded from Mount Bogong itself but allowed to continue east of Cleve Cole Hut in snow gum woodland and sub-alpine open areas. Elsewhere alpine ash and peppermint--gum forests are predominantly grazed. Some 150 head graze around Glen Valley and north of Mount Wills.

About 25 head graze through alpine herbfields and heathlands and in snow gum woodland in the Mount Feathertop area, while further north, narrow-leaf peppermint forests in the Snowy Creek--Simmonds Gap area provide grazing.

Grazing has been excluded from the summit of Mount Feathertop and south along the Razorback Ridge and from Mounts Hotham and Loch.

The snow gum woodlands of the Paw Paw Tablelands east of Mount Hotham and the fall into the Cobungra River support 450 cows and dry cattle. About 200 calves accompany the cows.

Usually the cattle are taken up in late December and are mustered and taken down about mid April. Most of the grazing is under the control of the Soil Conservation Authority, which is advised by the Bogong High Plains District Advisory Committee.

Two areas of private agricultural land in the Kiewa and

Ovens valleys adjoin larger agricultural regions outside the study area. Properties at Granite Flat, Shannonvale, Glen Valley, and Bundara River in the east are isolated from other private property. Tobacco-growing and dairying are the major agricultural pursuits on the slopes and rich alluvial flats of the Kiewa valley. Tobacco is also grown on a few properties in the upper Ovens valley.

Cattle for beef are run on the remaining private land in these two valleys. About half of the herds are dairy--beef cross animals producing vealers.

The capability for bush grazing has a very high average. It is generally high on the alpine and sub-alpine grasslands, tall herbfields, and grassy snow gum woodlands, but lower on the heathlands. High erosion hazards limit the capability of some areas.

Capability for agricultural development is low.

4. Apiculture

Parts of this block have reasonable access and are near the main bee-keeping centres in north-eastern Victoria. Apiarists often use these areas, the main honey flora being narrow-leaf peppermint, broad-leaf peppermint, candlebark, alpine ash, and snow gum. Other parts could be used if access was improved.

5. Wood production

Capability for timber production is very high. Large areas of alpine ash occur around all the major streams flowing from the Bogong Tablelands, principally the Ovens and Kiewa Rivers and Mountain, Trappers, and Snowy Creeks running to the north, and the Mitta Mitta River, Middle Creek, and Bundara and Cobungra Rivers running to the east. These total 24,500 ha. About 16,300 ha of alpine ash regrowth resulting from the 1939 fires also occur throughout the block, but are concentrated for the most part in the north and west. Some commercial stands of moist foothill forest including species such as blue gum and manna gum adjoin stands of mountain forest in the Ovens and Kiewa Rivers.

Stream	Gauging station	Mean annual discharge (Ml)
Ovens River	Bright	232,420
Kiewa River	Mongans Bridge	512,210
Mitta Mitta River*	Above Jokers Creek	229,568
Snowy Creek	Below Granite Flat	192,830
Bundara River	Bundara	91,507
Cobungra River**	Below Victoria River	135,345

* Also called the Big River within this block
** Includes discharge from the Victoria River (in block 11).

Annually, the five sawmills at Tawonga, Eskdale, Granite Flat, Mitta Mitta, and Bullumwaal together cut about 26,600 m^3 of sawlogs from about 360 ha of forest.

6. Minerals

This block contains two currently operating gold mines. These are the Sambas and Red Robin (below Mount Hotham) mines on the Harrietville gold-fields. In view of this, and of the fact that large quantities of gold were produced here in the past, it can be said that Bogong block has a high potential for economic gold deposits, particularly in view of the recently increased price of gold. Other metallic minerals - including bismuth, tin, and silver - are associated with the gold deposits. Considerable reserves of low-grade tin ore are likely to exist at Mount Wills.

7. Water production

Precipitation levels here range from about 700 mm per annum at Anglers Rest to more than 2,500 mm at Falls Creek. Much of the block is snow-covered for 4--5 months of the year. Major streams within the block and their mean annual discharges are shown on page 257.

With the exception of the Ovens River, these streams are comparatively reliable, being snow-fed. The Mitta Mitta River at Dartmouth yields 21% of its mean annual discharge in the 6 months December to May - including 7% in the 3 months January to March. Equivalent figures for the Kiewa River at Mongans Bridge are 23.5% and 7% respectively. In contrast, the Ovens River yields 14% of its mean annual discharge at Wangaratta in the 6 months December to May, including 3.5% in the period January to March.

The water in this block is of high quality. (For example, the mean T.D.S. measurement for the Kiewa River at Mongan's Bridge is 34 mg per l.) This allows its use not only for generating hydro-electric power, but for domestic water supplies, as indicated in the table below.

The Kiewa River hydro-electric scheme utilizes water from the Rocky Valley and Pretty Valley branches of the East Kiewa River, and from the West Kiewa River.

Township	Water supply source
Harrietville	Ovens River
Hotham Heights	Edelweiss Spring; Swindlers Creek
Mount Beauty	West Kiewa River; Simmonds Creek
Bogong Village	Ferny Creek
Falls Creek	Rocky Valley branch of East Kiewa River
Tawonga	Kiewa River

The three power stations (McKay Creek, Clover, and West Kiewa) have capacity flow rates of 86 Ml, 112 Ml, and 163 Ml per hour respectively. This scheme is used mainly to supplement peak-load supplies of power.

A section of the Mitta Mitta River will be impounded by the Dartmouth Dam project, and the headwaters of this river will contribute to the storage. About 2,000 ha of land is irrigated from the Kiewa River.

The capability for water production is very high.

D. Hazards

The erosion hazard is high at the highest altitudes - that is, Mounts Bogong, Feathertop, Hotham, and Loch and places such as along the Razorback to Mount Feathertop and around Mounts Nelse, Spion Kopje, and Fainter. The hazard is moderate to high on the High Plains generally, especially on north-west slopes and in drainage lines, low in wet mountain forest, and moderate on steep dry slopes at the lower elevations.

The presence of soil particles in streams has caused siltation of tunnels and pondages in the hydro-electric scheme and could cause damage to turbine blades used in the generation of electricity. Activities in the area involving earthworks or causing disturbance to vegetation can result in excessive amounts of silt reaching streams.

The fire hazard is highest in the foothills at the north of the block, where a number of lightning strikes have occurred. Villages at Bogong and Falls Creek and a camp at Howmans Gap are vulnerable to fire, as are the numerous installations of the Kiewa hydro-electric scheme. Fire towers are situated on Mount McKay and at Big Hill, and lookouts at Mounts Hotham and Wills.

The 19 noxious plant species growing in the block include blackberry, St. John's wort, tutsan, and sweet briar. Hares and foxes inhabit the Bogong High Plains and a few brumbies range through the south-east section of the block. The alpine case moth and alpine grass caterpillar kill patches of snow grass.

11. COBUNGRA

A. Location and Tenure

Cobungra block covers a total area of 62,250 ha, of which 37,300 ha (57%) is public land. This includes 14,200 ha of reserved forest, mainly in the south, various reserves at Omeo and around Cobungra, and unreserved Crown land (22,800 ha). (An area of about 100 ha near Omeo is reserved as a public park.) The freehold land is concentrated on areas of low relief throughout the block, as at Cobungra and along the Livingstone Creek valley.

County of Bogong: Parishes of Theddora, Bundara-Munjie, Bingo-Munjie, Bingo-Munjie North, and Bingo-Munjie South.
County of Benambra: Parishes of Omeo, Jirnkee, and Cobungra.

B. Nature of the Land

1. Climate

A large rain-shadow area extends from this block north-east to Benambra and south-east to Swifts Creek. This is caused by the dry prevailing westerly air streams, which have lost their moisture as precipitation on the higher ranges to windward.

Average annual rainfall diminishes from 1,200--1,400 mm on the Great Divide in the west to 676 mm at Omeo in the east. Rainfall peaks occur in spring in the rain-shadow area. Southerly and south-easterly air streams bring rain at any time of the year, and thunderstorms can contribute to summer rainfall. Snowfalls are known to occur throughout the block, and regularly above 1,000 m on the Great Divide in the south and west.

Frosts are common within the block, with an average frost-free period of only 62 days per annum at Omeo.

2. Geology and physiography

Undulating tablelands and basins dominate, with very little dissection of the landscape. Elevations vary - from 1,600 m on the Paw Paw Tablelands in the west and tablelands around Mount Delusion (1,374 m) to elevated basins in the Cobungra region (1,000 - 1,200 m) and the Livingstone basin around Omeo (600--700 m). The lowest point occurs along the Livingstone Creek on the eastern border (600 m).

Stream flow is generally east and north towards the Mitta Mitta River. The Great Divide has three low points (air gaps) at Jirnkee Gap (890 m), Cassilis Gap (760 m), and further east at Tongio Gap (760 m). These were caused by the shift of the Divide because of the capture of the Tambo River headwaters by the Mitta Mitta River.

Steep slopes are found along the Livingstone Fault, particularly at the relatively isolated peak of Mount Livingstone (1,127 m). The north-trending fault has influenced the direction of flow of both Livingstone Creek and a section of the Mitta Mitta River.

The geology of the block is dominated by Ordovician gneisses and schists of the Omeo Metamorphic belt. Scattered outcrops of Lower and Middle Devonian granites occur in the east and central sections, and remnants of Oligocene basalt remain on the Paw Paw Tablelands. There are Tertiary gravels of Pliocene age around Omeo township, and Quaternary alluvium occurs along the upper reaches of Livingstone Creek.

3. Soils

The terrain of the major part of this block is undulating to hilly. Soils are dominated by massive gradational soils. These grade into friable brown gradational soils as rainfall increases in the west, and into red duplex soils on flatter topography in rain-shadow areas. These soils often overlie highly structured red clays, which are relics of older soils.

In the steeper country of the west and south, stony loams appear on steep slopes and exposed crests. Organic loams, which occur on areas above the friable brown gradational soils at higher elevations, become shallower with increasing elevation. Peats occur irregularly in cold, poorly drained situations on the Paw Paw Tablelands and Great Dividing Range. Humified peats may have developed from normal peats where stream entrenchment has lowered the water table. Red gradational soils occur on the basalt of the Paw Paw Tablelands.

Massive gradational soils and red gradational soils occur on the slopes of the basin country south-east of Omeo and grade into red and yellow duplex soils on drier undulating country in the south. Yellow sodic duplex soils occur occasionally on broad ridge-tops and hill-crests to the south of Omeo. Grey brown loams and undifferentiated sands and loams occur on the limited alluvial flats of Livingstone Creek.

4. Vegetation

Sub-alpine grasslands, wet heathlands, and mosslands are found at various localities, usually in drainage lines; they are flanked by sub-alpine forests at elevations from about 1,560 m to 1,100 m, for example in the Livingstone Creek, Spring Creek, and Butchers Creek headwaters. Black sallee woodland often borders these open areas. This vegetation type also crowns Mount Delusion (1,340 m) where the understorey is heathy. An open area of heathland and herbfield adjoins the woodland here.

Snow gum open forests and woodlands are chiefly located on the Paw Paw Tablelands and at Mount Phipps at elevations ranging from about 1,300 to just over 1,500 m. Understoreys may be grassy or heathy (gorse bitter-pea, and mountain beard-heath).

Snow gum also occurs in mixture with candlebark at lower elevations around Omeo such as the Oriental Claims (elevation about 660 m). Here the understorey is predominantly kangaroo grass.

Mountain gum--snow gum open forest predominates west and south of Cobungra. This area has been extensively burnt in the 1939 fires. Mountain gums more than 25 m high sometimes grow above the general canopy levels. Understoreys vary from shrubby to grassy and include species such as snow grass, handsome flat-pea, elderberry panax, and mountain beard-heath. These forests range from about 1,400 m commonly down to about 1,000 m and sometimes to 800 m.

Alpine ash open forest has a scattered distribution among the sub-alpine forests in the western section of Cobungra block at elevations between 1,200 and 1,400 m.

Large areas of alpine ash - mostly logging regrowth from former logging operations - occupy the headwaters of Livingstone and New Rush Creeks at elevations ranging from 900 to 1,400 m. Understoreys are typically shrubby (silver wattle, mountain pepper, mountain beard-heath, and common oxylobium).

Open forest III comprises some messmate stringybark forest with gully-type to shrubby understoreys and narrow-leaf peppermint forest with shrubby to grassy understoreys.

Open forest II occupies some dry slopes. The higher elevations commonly carry broad-leaf peppermint in mixture with mountain gum, with heathy understoreys including gorse bitter-pea, guinea-flower, handsome flat-pea, cluster-flower geebung, and holly lomatia. At lower elevations the predominant trees are red stringybark and long-leaf box.

Open forest I mainly occupies steep rocky slopes north of Mount Gingee Munjie and along the lower reaches of the Cobungra River. Tree species include broad-leaf peppermint, red stringybark, long-leaf box, and candlebark. Understoreys may be heathy and plants may be sparsely distributed.

5. Fauna

The block has not been systematically surveyed for mammals, but more is known about the birds, reptiles, and amphibians. Six species of native mammals, 95 of native bird, eight of reptile, seven of amphibian, and one species of native fish have been recorded.

Sambar deer and brumbies are among the introduced mammals inhabiting the area.

Much of the block in the Omeo and Cobungra station area is cleared. Sub-alpine open areas and woodlands predominate on public land, but wet open forest with limited areas of dry open forest predominate south of Mount Phipps. Wetlands are situated along streams and at numerous small dams.

Nine waterbirds have been recorded in wetlands and include the yellow-billed spoonbill. Other associated bird species are the swamp harrier, coot, spur-winged plover, Japanese snipe, and little grassbird.

Sub-alpine woodlands are known to provide habitat for the eastern grey kangaroo, common wombat, and brown antechinus. The 51 bird species recorded in this habitat include the emu, peregrine falcon, painted quail, owlet nightjar, boobook owl, sacred kingfisher, tree martin, spotted quail-thrush, satin fly-catcher, olive whistler, and crescent honeyeater.

The yellow-bellied glider, common wombat, and brown antechinus have been recorded in wet open forest. Typical birds include the brush cuckoo, king parrot, superb blue-wren, rufous fantail, golden whistler, white-throated tree-creeper, and pied currawong.

Dry open forest supports the eastern grey kangaroo, black wallaby, brown antechinus, and lesser long-eared bat. Birds in this habitat include the sacred kingfisher, spotted quail-thrush, satin flycatcher, rufous whistler, fuscous honeyeater, olive-backed oriole, white-winged chough, and dusky wood swallow.

In cleared and semi-cleared land, 48 bird species were recorded, including eight raptors such as the brown hawk, whistling eagle, wedge-tailed eagle, little falcon, nankeen kestrel, and peregrine falcon. Other birds include the stubble quail, Japanese snipe, pallid cuckoo, galah, sulphur-crested cockatoo, brown songlark, and both species of magpie and raven.

Some reptiles - such as the southern blue-tongue, copperhead, water skink (cool-temperate species), grass skink, and McCoy's skink - are typical of cool-temperate conditions. A few (such as Cunningham's skink) are more typical of warmer conditions. Recorded amphibians comprise Verreaux's tree frog, Lesueur's frog, brown-striped frog, spotted marsh frog, eastern banjo frog, southern toadlet, and common eastern froglet.

Cox's mountain trout is recorded, and brown trout and rainbow trout are also present.

6. Land systems

The Cobungra, Livingstone, Higginbotham, Theddora, Mt Phipps, Omeo, Cassilis, Mirimbah, Staleyville, Graham, and Mt Delusion land systems are represented in the block.

C. Present Use and Capabilities

1. Nature conservation

The capability for nature conservation is high to moderate. Environments range from sub-alpine woodlands to dry open forests. Sub-alpine woodlands are extensive, growing mainly on soils derived from metamorphic parent materials.

Eight plant species occurring here are considered to be highly significant. Most of these - the moonwort *Botrychium* *lunaria*, the daisy *Brachycome tenuiscapa*, the sedges *Carex capillacea* and *C. raleighii*, and the tower mustard (*Turritis glabra*) - are located near Cobungra, which is the type locality of mignonette leek-orchid (*Prasophyllum morganii*), believed to be endemic to the study area. The Mitchell bertya (*Bertya mitchellii*) occurs far from its normal Mallee environment near Anglers Rest. The upper Livingstone Creek is the type locality of the Omeo gum (*Eucalyptus neglecta*), endemic to the Victorian Alps.

2. Recreation

Capabilities are high for fishing and fossicking, moderate for recreation driving, moderate to low for bushwalking, horse-riding, and cross-country skiing, and low for hunting.

Bushwalkers at present mainly use the north-western section. The Precipice Plain--Victoria River tracks are occasionally to moderately used. These may be linked with walking routes to Mount Tabletop or the Dargo High Plains via the Mayford spur. The block has some potential for bushwalking. Much of the forested land is sub-alpine forest with numerous snow plains. Other features include the Cobungra River, Victoria River and Victoria Falls, Livingstone Creek, and Mounts Phipps and Delusion.

A water race may be traced from Cassilis to the Jirnkee Gap in the Great Dividing Range and thence to the eastern branch of the Wentworth River near Mount Baldhead, a distance of 90 km.

Organized horse-riding trips, based at Omeo, occasionally visit areas on public land.

For recreation driving, four-wheel-drive vehicles use some tracks, particularly the Precipice Plain--Victoria River tracks. The Hotham to Omeo road is regularly used for motor touring.

Sambar deer are hunted at several localities in this block, including the area around Mount Phipps.

All tributaries of the Mitta Mitta River including the Cobungra and Victoria Rivers and Livingstone Creek, are good trout waters.

Opportunities for cross-country skiing exist around Precipice Plain and Mount Phipps.

Many streams around Omeo, such as the Livingstone Creek, are gold-bearing. Gold-panning is popular at the Oriental Claims. Common opal is found among the gravels and sands of old river beds around Omeo.

3. Agriculture

Three graziers run cattle on the public land. It is difficult to estimate the number of stock grazing west of Cobungra station, as a number of unfenced privately owned paddocks are grazed in conjunction with public land. Probably about 370 cows with 100 calves and 230 dry cattle graze in the snow gum woodlands and snow gum--mountain gum forests during the summer.

After the cattle are mustered in autumn, the calves are marked, weaned, and marketed and then the remaining stock are taken out from the home paddocks again until the onset of winter. Higher numbers may occupy the public land in this period than during the early autumn.

A similar pattern is followed in the area around the Livingstone Creek and Butcher Creek headwaters. Here about 160 cows with about 120 calves graze through a variety of vegetation types. The home properties are close by, and private property is used in conjunction with the surrounding grazing runs.

About 50% of this block is private land and, apart from higher-elevation areas near Cobungra, is almost all cleared. This - together with private land in the Benambra, Nunniong, and Baldhead blocks - comprises the largest single region of agricultural land in the study area.

Beef production is the major enterprise, with Hereford the most common breed. Sheep raised for wool are also important, with numbers increasing steadily since a slump in 1973.

The capability for bush grazing is moderate on average, but high in some areas close to private holdings. The area is reasonably well watered and capability could be improved with fencing and control of wild horses. The runs currently used are mainly close to private land.

The less-steep public land has moderate capability for development for agriculture.

4. Apiculture

This block does not receive much use by apiarists. Honey flora include snow gum, alpine ash, Gippsland blue gum, red stringybark, and long-leaf box.

5. Wood production

Capability for hardwood production is high in alpine ash stands in the south of the block. Most of these have been utilized and regenerated but logging is continuing north of Mount Phipps. Mountain forests cover about 4,500 ha. The western half of the block contains sub-alpine forest of negligible timber-production capability, and the remainder of the public land contains foothill forest of low to moderate capability.

Annually, two mills (both at Swifts Creek) together cut about 7,600 m^3 of sawlogs from about 100 ha of forest.

6. Minerals

The eastern part of the block includes most of the former

Omeo gold-field, from which large amounts of gold were taken by sluicing and dredging and in which two silver--lead--zinc lodes were worked. The western part includes comparatively inaccessible country that may contain veins bearing gold and other metallic minerals.

7. Water production

The Cobungra River forms most of the northern boundary of this block, and a small section of the Mitta Mitta River completes the northern boundary. Within the block the two major systems are those of the Victoria River and Livingstone Creek.

A rain-shadow area exists in the Omeo--Benambra region, and this causes the low water yield from this central portion of the Mitta Mitta River. The rain-shadow area receives about 600 mm per annum, compared with the 900-1,200 mm per annum in the upper reaches of the Victoria River and Livingstone Creek.

The Cobungra River is supplied to some degree by snow melt. Mean annual discharges for the Mitta Mitta River at Hinnomunjie and for the Cobungra--Victoria Rivers are 471,587 Ml and 135,345 Ml respectively.

Livingstone Creek is the source of domestic water for the township of Omeo. The entire block will contribute to the Dartmouth Dam when this is completed.

The capability for water production is high to moderate.

D. Hazards

The soil erosion hazard is moderate to high, and severe gully erosion is evident around Omeo. The fire hazard is moderate to high. A fire tower is situated on Mount Sam. The 19 noxious weed species include blackberry, St. John's wort, and sweet briar. Brumbies are plentiful to the south of Cobungra station.

12. BALDHEAD

A. Location and Tenure

Baldhead block covers a total area of 63,100 ha, of which 48,400 ha (77%) is public land. This occurs mainly in the south-west, and comprises 19,700 ha of reserved forest and 28,700 ha of unreserved Crown land. Most of the freehold land occurs in the eastern section of the block.

County of Dargo: Parishes of Carneek, Kalk Kalk, Birregun, Binnican, Wentworth, Koomberar, Tabberabbera, Angora, Jirnkee, Tongio-Munjie West, and Cobungra.

B. Nature of the Land

1. Climate

Baldhead block is in the transition zone south of the Great Divide from the high-rainfall montane areas to rain-shadow valleys along the Tambo River and other southern rivers.

Average annual rainfall is moderately high over elevated topography running south-east through the block from the Divide to Mount Delusion and Mount Baldhead. This zone receives more than 1,200 mm annually. Rainfall decreases to less than 800 mm on the Wentworth River and 612 mm at Swifts Creek. Southerly and south-easterly air streams can bring drastic weather changes and rainfall at any time of the year.

The occurrence of snow varies, depending on cold fronts from the westerly or southerly air streams. Snowfalls can be expected at the higher altitudes from June to October.

2. Geology and physiography

Moderately dissected topography predominates in the west, grading into basins and plateaux towards the east. The Tambo basin at Swifts Creek (300--400 m) is at a lower elevation than those north of the Divide, such as the Livingstone basin (600--700 m).

Two low points (air gaps) in the Great Divide occur along the northern border of the block, one at Jirnkee Gap (890 m) and the other at Cassilis Gap (760 m).

The Birregun range in the west includes the highest peak in the block, Mount Birregun (1,463 m). The lowest point occurs at Wentworth River along the southern border (240 m).

The stream pattern is markedly influenced by faulting in the underlying rock, demonstrated by straight courses of streams flowing along the line of the Haunted Stream Fault and Livingstone Fault. A small plateau is situated on the Strobridge Ridge at about 1,100 m elevation.

Ordovician felspathic sandstones and siltstones in the east merge into schists and gneisses of the Omeo Metamorphic belt north of the Angora range.

Outcrops of Lower Devonian granites occur in the east at Mount Baldhead (1,372 m), in small basins near Brookville, and in the Tambo and Livingstone basins. The Wentworth group - Lower--Middle Devonian marine sediments - is exposed in the upper Wentworth River.

Extensive Quaternary alluvial deposition has occurred along Tambo River in the Tambo basin.

3. Soils

Mountainous areas in the north of the block, where rainfall is higher, have friable brown gradational soils on most slopes, but stony loams and stony gradational soils on exposed steep slopes and crests. Sheltered lower valley areas have friable red gradational soils.

In the drier areas, most slopes carry massive gradational or red gradational soils, but sheltered lower valley slopes have friable red gradational soils.

Grey-brown loams occur on alluvium along major streams such as the Tambo River, and rolling to hilly areas in the valleys have red duplex soils.

The main soils on hilly granitic areas are yellow duplex soils, with red duplex soils on lower well-drained areas.

4. Vegetation

Sub-alpine vegetation is represented in this block by herbfield at Mt. Baldhead, snow gum forest south-west of Mt. Phipps, mountain gum--snow gum forest at Mt. Birregun, and heathland, herbfield, and black sallee at Mt. Delusion.

Alpine ash forests, both mature and fire regrowth, are located at the higher elevations (800 to 1,400 m) in the headwaters of the Wentworth River, the Haunted Stream, and Nightmare Creek, and also near Mount Birregun. Understoreys vary from grassy to shrubby, including hop bitter-pea, mountain pepper, and mountain beard-heath.

Fire regrowth and mature mountain ash forests occupy the headwaters of the Nicholson River and Haunted Stream below the alpine ash on moist sites at elevations ranging from about 800 m to 1,200 m. Understoreys are typically shrubby or gully type (bootlace bush, river lomatia, elderberry panax, blackwood, and soft tree-fern).

Narrow-leaf peppermint open forest III is the predominant vegetation type on moist sites below about 1,100 m. Associated trees include manna gum and broadleaf peppermint. Understorey species include silver wattle and austral bracken.

Messmate stringybark forest, sometimes associated with manna gum, grows in small scattered pockets from Mount Gingee Munjie to south of Mount Birregun. Moist gully heads have understoreys that include snowy daisy-bush, common cassinia, Victorian christmas-bush, musk daisy-bush, and silver wattle. Silvertop in mixture with white stringybark - with a shrubby understorey including sunshine wattle, mountain hickory wattle, and prickly bush-pea - is common on ridges south of Mount Birregun.

Open forest II on drier aspects includes broad-leaf peppermint and candlebark with a shrubby to heathy understorey and red stringybark--long-leaf box with similar understorey. Yellow box is sometimes a component of open forest II.

Open forest I occupies the driest sites- which are usually on steep rocky northerly slopes. Forests include silvertop in the Wentworth River catchment and broad-leaf peppermint--candlebark forest (with understoreys including silvertop wallaby grass, prickly broom heath, woolly grevillea, golden bush-pea, and daphne heath) at the higher elevations. White box and long-leaf box forest with a sparse to heathy understorey occupies dry hillsides near Cassilis.

5. Fauna

No detailed surveys have been made in the block. Records exist for species of three native mammals, 55 native birds, one reptile, and nine amphibians. Sambar deer are known to inhabit the area. Wet open and dry open forests predominate. The main streams and their environs provide wetland and riverine forest habitat. Cleared land is centred about Tongio West and Swifts Creek.

The eastern grey kangaroo, black wallaby, and eastern pigmy possum are common to both wet and dry open forest. Typical birds of wet open forest include the emu, common bronzewing, wonga pigeon, southern yellow robin, and grey-breasted silvereye. Those in dry open forest include the spotted quail-thrush, rufous whistler, tree-martin, and black-faced cuckoo-shrike.

Most birds have been recorded in cleared and semi-cleared areas. These include the brown hawk, galah, eastern rosella, sulphur-crested cockatoo, rainbow bee-eater, speckled warbler, hooded robin, brown tree-creeper, mistletoe bird, fuscous honeyeater, regent honeyeater, and diamond firetail.

The red-bellied black snake, five species of tree frog, the brown-striped frog, common eastern froglet, eastern banjo frog, and giant burrowing frog (the only record for the alpine study area) are found in the block.

6. Land systems

The Graham, Buckenderra, Wonnangatta, Jirnkee, Mt Baldhead, Omeo, Tongio-Munjie West, Brookville, Tabberabbera, Bemboka, Cassilis, Mt Phipps, Beloka High, Tubbut, Cabanandra, Swifts Creek, Wentworth, and Mt. Delusion land systems are represented in the block.

C. Present Use and Capabilities

1. Nature conservation

The capability for nature conservation is moderate to high. Environments range from wet open forest to riverine forest. White box woodlands occur around Cassilis. Black sallee woodlands cover a relatively large area on Mount Delusion.

Two of the three significant plant species in this block are considered highly so. They are the tower mustard (*Turritus glabra*) in the Mitchell River sources and the shiny fan-fern (*Sticherus flabellatus*) which is known only in the upper reaches of Pheasant Creek and far eastern Gippsland.

2. Recreation

Features of recreational interest include the Birregun Range, and early mining sites on the Haunted Stream and around Cassilis and Tongio West. Capabilities are moderate for hunting and fossicking, low to moderate for recreation driving, and low for bushwalking and fishing.

Although this block is little used by bushwalkers, it does have some attractions, including the track along the Birregun Range to Mount Steve and thence to Dargo via Grant Junction. Other features of interest include Mounts Baldhead and Delusion, the Wentworth River, and mine workings around Cassilis, Tongio West, Brookville, and the Haunted Stream. An old water race, 90 km long, meanders from the headwaters of the Wentworth River to Tongio West.

The block has some potential for four-wheel-drive vehicles and trail-bikes. Two-wheel-drive vehicles sometimes use the road from Swifts Creek to Bairnsdale via Mount Baldhead.

Sambar deer are regularly hunted at such places as Mount Baldhead and in tributaries of the Wentworth River. Rabbits and foxes are hunted near cleared land. The Wentworth River, Haunted Stream, and Swifts Creek all provide trout angling.

A number of streams may be prospected for alluvial gold. These include Gray Creek near Cassilis, Swifts Creek near Tongio West, and the Haunted Stream.

3. Agriculture

Only two of the several graziers using this block run cattle regularly on public land. These have properties at Iguana Creek and Ensay, and put about 100 cows, 20 calves, and 40 dry cattle into the manna gum--narrow-leaf peppermint forests along the river flats of the Wentworth River. Use of the alpine ash forests at the high elevations is sporadic.

The bulk of the private land is in the east and adjoins similar land in neighbouring blocks. A few small holdings are located on the Wentworth River in the west. Most land has been cleared and developed for agriculture and varies from undulating to steep.

Beef and wool production are the major enterprises, although some prime lambs are produced from come-back flocks. Lucerne - for hay and grazing - is grown on the flats and on gently sloping land. Cereal crops are grown occasionally.

The capability for bush grazing is moderate to low. More use, however, could be made of alpine ash forests in the headwaters of the Wentworth River. Some limited areas of undulating public land have moderate capability for agricultural development.

4. Apiculture

Access is best on the eastern section of this block. It is reasonable in the central section, but poor elsewhere. Public land adjoining private property is frequently used to produce honey crops. Honey flora include alpine ash, mountain ash, messmate, red stringybark, long-leaf box, silvertop, white box, and yellow box.

5 Wood production

Capability for hardwood timber production is high in the 9,500 ha of regrowth and mature alpine and mountain ash forests that occur in the headwaters of the Wentworth River, the Nicholson River, and the Haunted Stream. Moist foothill forests of messmate, mountain grey gum, and manna gum, which adjoin these stands of mountain forest, have high capabilities for timber production. Foothill forests in the north have low to moderate timber-production capabilities.

Each year three mills (one at Bullumwaal and two at Swifts Creek) together cut about 27,000 m^3 of sawlogs from about 360 ha of forest. A.P.M. obtain pulpwood supplies from integrated-harvesting operations.

6. Minerals

The block includes the Cassilis and King Cassilis mines on the Cassilis goldfields, which have operated intermittently in recent years. These mines have lead, zinc, and copper mineralization as well as gold. There are good prospects for gold deposits in the central portion of the block along the continuation of the Kiewa thrust. This area includes the former Haunted Stream gold-field.

7. Water production

Rainfall within the block ranges between 700 mm and 1,200 mm per annum.

The Tambo River, a section of which forms the eastern boundary, has a mean annual discharge of 67,450 Ml at Swifts Creek, and is the source of Swifts Creek township reticulated water supply. The river here has a mean salinity reading of 132 mg per l, which is the highest recorded level in the study area, but still indicates high-quality water.

This block also contains the headwaters of the Wentworth River (tributary of the Mitchell River), the Nicholson River, and the Haunted Stream, which flows into the Tambo south of the study area. Water-yield and water-quality measurements are not available for the Wentworth River or Haunted Stream.

The mean annual discharge of the Nicholson River at Deptford is 33,984 Ml. Gaugings indicate comparatively regular flows throughout the year. It yields 44% of its mean annual discharge in the 6 months December to May, including 7% in the 3 months January to March. The water is of high quality, the mean salinity reading for this river at Deptford being 73 mg per l.

The capability for water production is high.

D. Hazards

The erosion hazard is generally low in the west of the block and moderate to high around Swifts Creek. Salinity readings for the Tambo River at Swifts Creek, while indicating high-quality water, are still the highest recorded in the study area. The fire hazard is high. A number of fires have originated from lightning strikes in the eastern section of the block. The 20 noxious weed species in the block include blackberry, St. John's wort, and sweet briar. Rabbits can be a problem in cleared areas and forest margins.

13. BENAMBRA

A. Location and Tenure

Benambra block covers a total area of 131,600 ha, of which 85,400 ha (65%) is public land. Freehold land is located on the basin and plateau country in the centre of the block, and is surrounded by 54,600 ha of unreserved Crown land and 27,300 ha of reserved forest. Numerous public reserves, including Lake Omeo (750 ha) and a Stone Reserve at Wombat Creek (1,036 ha), amount to 3,500 ha.

County of Benambra: Parishes of Cobungra, Hinno-Munjie, Thorkidaan, Jinderboin, Guttamurra, Enano, Beloka, Mowamba, and Gungarlan.
County of Bogong: Parishes of Tongaro, Wollonaby, Ludrik-Munjie, Bundara-Munjie, and Bingo-Munjie North.

B. Nature of the Land

1. Climate

Most of the block lies in a large rain-shadow area from Omeo to Benambra, with average annual rainfalls of less than 700 mm. Rainfall is highest in spring and is supplemented by southerly and south-easterly air streams at any time of year, and by erratic summer thunderstorms.

Average annual rainfall increases to more than 1,000 mm in the south, and exceeds 1,400 mm north of Glen Wills on the Omeo Highway. Regular snowfalls can be expected above 1,000 m from June to October in the north.

The valleys experience the effect of relatively warm, dry Föhn winds from the north-west, which lift daily maximum temperatures in winter. Frosts are common, with an average frost-free period of only 62 days per annum at Omeo.

2. Geology and physiography

This block lies north of the Great Dividing Range, which has shifted south from the region between Mounts Hotham and Gibbo. The shift resulted from the capture of the Tambo River headwaters by the Mitta Mitta River. This has left air gaps in the Range at Tongio Gap (760 m) and Cassilis Gap (760 m). The peaks on the Range such as Mount Tambo (1,431 m) are lower than the peaks along the north of the block - for example Beloka Range (Johnnie's Top) (1,566 m) - which are closer to the former Great Dividing Range.

Many of the tributary streams flow south before flowing north; for example Front, Benambra, Splitters, Deep, and Morass Creeks. This pattern resulted from the major stream capture mentioned above.

A number of extensive basins have formed. The largest of these is the Morass basin, which is centred around Benambra and Lake Omeo and is about 20 km by 12 km in extent. Others are the Livingstone basin at Omeo, the Beloka basin (12 km by 6 km) situated in the headwaters of Benambra Creek, and the basin east of Mount Leinster. Plateaux occur at the Knocker (1,507 m) and the Fraser Tablelands (600--800 m).

The Omeo Metamorphics cover a major portion of the east of the block. These consist of Ordovician micaceous schists or coarse-grained gneiss. Micaceous schists are associated with Devonian granite intrusions around Mounts Misery (1,575 m) and Pendergast (1,462 m). The Metamorphics grade into an extensive area of Ordovician felspathic sandstones and siltstones. Around Hinnomunjie and Benambra, some of these sedimentary rocks exhibit low-grade metamorphism.

Both the Omeo Metamorphics and Ordovician sediments are intruded by granites and granodiorites of Silurian to Devonian age, and also around Benambra and the Brothers, by a series of syenites and trachytes of Triassic age.

Unconformably overlying the Ordovician sediments at Mount Tambo is a limited area of purple shales, sandstone, conglomerate, and minor rhyolites of Upper Devonian age (Mount Tambo formation).

Extensive areas of Quaternary alluvium occur in the basins. Quaternary alluvium at Hinnomunjie Swamp has been deposited as a result of a Pliocene basalt flow damming Livingstone Creek.

3. Soils

In the high mountainous areas of the north and west of the block, friable brown gradational soils predominate, becoming shallower in sub-alpine areas, where organic loams and stony loams occupy relatively small areas. Friable red gradational soils and red gradational soils with fine structure occur to a limited extent in lower areas.

Red gradational, yellow-brown gradational, and massive gradational soils appear on slopes and freely drained areas at lower elevations. Coarse sands occur on granitic areas in the west of the block, and undifferentiated sands and loams and grey-brown loams occur on the alluvium along streams. In other areas, massive gradational soils often overlie highly structured red clay relics of older soils.

Large areas of dark calcareous clays and non-calcareous dark cracking clays occur on the undulating and flat alluvial country around Lake Omeo and Morass Creek. Lighter-brown forms of calcareous clays are found on well-drained areas such as the lunette of Lake Omeo.

The red gradational soils that have developed on the basalt north of Benambra contain occasional undecomposed basalt boulders throughout the profile.

Red duplex soils occur on rolling to low hilly areas of Ordovician sedimentary rocks, with yellow duplex soils on less well-drained areas. The duplex soils of rolling country around Lake Omeo are commonly overlain by up to 10 cm of younger loam. Yellow sodic duplex soils occur occasionally on broad ridge-tops to the south of Omeo.

4. Vegetation

Snow gum open forest is found in three main localities (the Knocker, Beloka Range, and north from Mount Misery) on broad ridge-tops at elevations ranging from about 1,300--1,400 m to about 1,600 m near Mount Misery. Understoreys are heathy to grassy and include prickly bush-pea, alpine oxylobium, tasman flax-lily, and golden everlasting.

Mountain gum--snow gum open forest occurs on the higher ridges and plateaux (1,200 to 1,400 m). Understoreys may be shrubby, including species such as hop bitter-pea and prickly bush-pea. Mountain gum or candlebark may occur in mixture with snow gum on rocky sites (for example the lower slopes of Pendergast Lookout), and also poorly drained areas at lower elevations, such as along the Buenba Creek (800 to 1,000 m), and along Deep Creek at 920 to 1,000 m.

Alpine ash forests are mainly mature, except for logged areas near the Knocker and Cocky Creek. Stands of 1939 fire regrowth are found around the Knocker and north of the Brothers. The forests are usually between 1,000 and 1,450 m, but may extend down to 950 m and occasionally up to about 1,500 m. Understoreys vary from shrubby through heathy to grassy.

There are considerable areas of open forest III in the block. Tree species include narrow-leaf peppermint, mountain gum, eurabbie, and manna gum. Understoreys may be grassy, but are generally shrubby (including silver wattle, prickly bush-pea, and austral bracken).

Open forest II includes broad-leaf peppermint--candlebark forest with a heathy to shrubby understorey in the higher-rainfall area and red stringybark, narrow-leaf peppermint, brittle gum, broad-leaf peppermint, and candlebark where rainfall is lower. An open woodland of candlebark and mountain swamp gum with a grassy understorey occurs at Morgans Corner on Deep Creek at 720--800 m elevation.

Open forest I occupies dry rocky hillsides and ridge tops in the block. Broad-leaf peppermint and mountain gum with understoreys including narrow-leaf bitter-pea and handsome flat-pea - which are typical of open forest at the higher part of its range - are replaced by red stringybark, broad-leaf peppermint, and candlebark forests with heathy to shrubby understoreys at lower elevations. Understorey species include box-leaf wattle, silver banksia, red-stem wattle, varnish wattle, and handsome flat-pea.

5. Fauna

Some faunal groups in parts of this block have been relatively well documented. Eleven species of native mammal, 111 bird, 23 reptile, nine amphibian, and three native fish species have been recorded.

Wetlands are well represented in the block and consist of mountain streams, swampy flats, dams, and Lake Omeo. Riverine forests are restricted to sections of some streams and sub-alpine woodlands are generally restricted to the higher elevations. Wet open forests and dry open forests are extensive, and there is a considerable area of cleared land around the Benambra--Omeo region.

The 33 bird species recorded in wetlands include numbers of mountain duck, black duck, grey teal, wood duck, and black swans. The blue-winged shoveler, plumed tree-duck, white-eyed duck, musk duck, and black-fronted dotterel have been recorded on Lake Omeo. Two species of cormorant, two ibis species, the little grebe, hoary-headed grebe, white-necked heron, royal spoonbill, yellow-billed spoonbill, dusky moorhen, and eastern swamphen are also found here.

The eastern grey kangaroo, brown antechinus, Swainson's antechinus, and bush rat inhabit riverine forests, while birds include the boobook owl, pilot bird, red-browed treecreeper, and red-browed finch.

Fauna of sub-alpine woodlands have not been well documented.

Mammals in wet open forest include the eastern grey kangaroo, red-necked wallaby, common wombat, brown antechinus, bush rat, and dingo. The 41 bird species recorded in this habitat include the gang-gang cockatoo, crimson rosella, horsfield bronze-cuckoo, golden bronze-cuckoo, golden bronze-cuckoo, superb lyrebird, Australian goshawk, noisy friarbird, and satin bower-bird.

Mammals recorded in dry open forest include the bobuck, greater glider, red-necked and black wallabies, eastern grey kangaroo, common wombat, brown antechinus, and bush rat. Among the birds, which are typical of this habitat elsewhere in the study area, the fuscous honeyeater, sulphur-crested cockatoo, and leaden fly-catcher are of note.

The 38 species of birds in farmland include the whistling eagle, wedge-tailed eagle, peregrine falcon, brown hawk, nankeen kestrel, brown songlark, rufous songlark, magpie-lark, grey butcher-bird, diamond firetail, buff-rumped thornbill, willie wagtail, and both species of magpie.

Reptiles typical of the cold-, cool-, and warm-temperate Bassian zones are found here. Cunningham's skink, copper-tailed skink, and the delicate skink inhabit warm rocky sites, while Spencer's skink, McCoy's skink, and water skink are common in wet open forest. Swamps provide habitat for the tiger snake and copperhead, and for amphibians such as the eastern banjo frog, spotted grass frog, brown-striped frog, common eastern froglet, and two species of tree frog. River systems provide habitat for these amphibians as well as for Lesueur's frog. Fishes comprise the Kosciusko mountain trout, ornate mountain trout, river blackfish, brown trout, and rainbow trout.

6. Land systems

The Omeo, Mt Phipps, Beloka High, Beloka Low, Cassilis, Enano, Wermatong High, Stanleyville, Mirimbah, Glen Wills, Morass Creek, Mowamba, Mt Pendergast, Guttamurra, Mt Leinster, Ben Cruachan, Thorkidaan, Mt Jonas, Terlite-Munjie, Nunniong (Igneous), Livingstone, Darbalang, and Mt. Misery land systems are represented in the block.

C. Present Use and Capabilities

1. Nature conservation

The capability for nature conservation is high. Environments range from sub-alpine woodlands to riverine forests. Geology is varied.

The block has a rich and varied bird, reptile, and amphibian fauna. Lake Omeo and Morass Creek are important for waterbirds. Of the 33 waterbird species recorded, some are abundant during favourable years. The copper-tailed skink recorded for the Mitta Mitta River in this block approaches the south-western limit of its range.

Two of the four significant plant species in this block are considered highly so. The austral cornflower (*Centaurea australis*) is extremely rare and probably now extinct in Victoria, and the groundsel *Senecio georgianus* is known in Victoria only from Lake Omeo and the Macalister River. Hinnomunjie is a noteworthy locality for its abundance of orchid species. Mount Little Tambo is the most westerly record of the greenhood *Pterostylis laxa*.

2. Recreation

Features of recreational interest include rocky prominences at Mount Tambo, McFarlanes Lookout, the Brothers, and Pendergast Lookout; the Gibbo and Mitta Mitta Rivers; Lake Omeo; and sites associated with early mining at Wombat Creek, Nine Mile Creek, Sunnyside, and Glen Wills. Capabilities are very high for fishing and canoeing, moderate for recreation driving, bushwalking, and boating, and low for fossicking, hunting, and rock-climbing.

Bushwalkers do not use the block often, although the area around the Brothers near Benambra receives some attention. Areas with potential for walkers include the Beloka Range, the Knocker, Pendergast and McFarlanes Lookouts, the Bowen Mountains (including Mounts Tambo and Leinster), and the Buenba and Mitta Mitta Rivers.

While little recreation driving occurs on the public land at present, the Beloka Range area has moderate to high capability. Roads to Corryong and Black Mountain from Omeo traverse the block. Some areas are used by commercial four-wheel-drive safaris operating out of Omeo.

Most of the hunting on public land is for rabbits and foxes adjacent to private property. Deer-hunting also occurs along the Mitta Mitta River valley.

The Gibbo and Mitta Mitta Rivers and Morass and Benambra Creeks provide excellent trout angling.

High-standard canoeing is provided by a section of the Mitta Mitta River between Glen Valley and Gibbo Junction. The River is, in fact, one of Australia's best for this sport. Canoeists normally take 3 to 4 days to travel from Glen Valley to the Nine Mile Creek junction. After the construction and filling of the Dartmouth Dam, white-water canoeing will be limited to a point below that junction as the river downstream from here will be impounded when the storage is at full supply level.

Fossickers may find alluvial gold along the Wombat Creek and Gibbo River.

Mount Tambo and McFarlanes Lookout provide some opportunities for rock-climbing.

Boating activities such as water-skiing, power-boat racing, and yachting take place on Lake Omeo when the lake is sufficiently full.

3. Agriculture

Six graziers regularly run cattle on the public land, chiefly in the narrow-leaf peppermint and broad-leaf peppermint forests along the Mitta Mitta River tributaries and in candlebark woodland at Deep Creek and Buenba River. About 100 cows, calves, and dry cattle are run on the grazing blocks during the summer. An additional 300 cows brought down from the Bogong Tablelands are grazed during the autumn.

About 45% of the block is private land, and most of this has been substantially developed for agriculture. The main agricultural areas are in the south, and also along the Morass Creek and Benambra Creek valleys.

The major enterprises are Hereford beef and Merino wool production. There are limited areas of cropping at Benambra and Hinnomunjie.

The average capability for bush grazing is low to moderate. The runs, however, are well watered and most lie close to home properties.

Gently sloping public land in the Beloka--Buenba area has a high capability for development for agriculture.

4. Apiculture

A long perimeter of private land borders the forests in this block, but access within them is poor. Honey flora include snow gum, alpine ash, candlebark, red stringybark, and eurabbie.

5. Wood production

Capability for hardwood production is high in the extensive areas of alpine ash (totalling about 7,700 ha) in the north-east and west of the block.

Smaller areas of alpine ash occur north of the Brothers and around Mount Leinster, but are too isolated to have significant hardwood capability. Some areas of moist foothill forest adjoining alpine ash stands in the Beloka Range area have moderate timber-production capability. The rest of the public land carries forest with low timber capability.

Two mills at Benambra and Bullumwaal annually cut about 6,950 m^3 of sawlogs from about 90 ha of forest.

6. Minerals

The block includes part of the Glen Wills--Sunnyside gold- and tin-field. It also includes the big Mammoth copper lode within the Gibbo River gold-field and a number of significant mineral occurrences such as the uranium mineralization at Sunnyside and traces of uranium at the Brothers. Numerous limestone deposits occur in the Wombat Creek--Gibbo River area, and near Benambra.

7. Water production

This is a relatively dry block, most of it receiving less than 1,000 mm of rain per annum.

The main streams in Benambra block are the Mitta Mitta and Gibbo Rivers and Morass--Benambra Creeks.

The Mitta Mitta River at Hinnomunjie delivers 471,587 Ml mean annual discharge with comparatively high reliability, due partly to the effect of snow-fed streams. Morass Creek at Uplands has a mean annual discharge of 36,650 Ml. It yields 15.5% of this in the 6 months December to May, including 4% in the 3 months January to March.

Water quality has not been recorded for Morass and Benambra Creeks, or the Gibbo River, but the high quality of the Mitta Mitta at Tallandoon, (mean salinity 29 mg per l) suggests that these streams also contribute water of high quality.

Lake Omeo contains significant quantities of water only at irregular intervals. Salinities vary with the volume of water present, but the mean concentration of total dissolved solids during 1967--71 was 1,080 mg per l.

The block contributes water to the Dartmouth Dam project via the Mitta Mitta River, which flows through the western section.

Benambra township derives its water from bores tapping groundwater supplies and from rainwater tanks.

The capability for water production is low.

D. Hazards

The erosion hazard is severe where rainfall is below about 800 mm - that is, in the Omeo, Benambra, and Buenba areas, particularly where slopes are steep.

Much of this is private land, but a severe hazard also exists in the lower foothills west of the Mitta Mitta River. Elsewhere the erosion hazard is moderate to low. The fire hazard is high. The 21 noxious weed species include blackberry, sweet briar, and St. John's wort. Rabbits can be a problem on cleared land and forest margins.

14. DARTMOUTH

A. Location and Tenure

The block covers a total area of 131,000 ha, of which 124,800 ha (95%) is public land. The freehold land is confined to valleys along Nariel, Bucheen, Watchingorra, and Snowy Creeks, and the Mitta Mitta River. The public land includes 7,100 ha of reserved forest north-east of Mount Wills and 6,800 ha along the Mitta Mitta and Dart Rivers to be submerged by the Dartmouth Dam project.

Private property needed for the project was purchased by the State Rivers and Water Supply Commission. The remainder is unreserved Crown land, except for a small reserve near Bucheen Creek.

County of Bogong; Parishes of Tongaro, Bogong North, Bogong South, Magorra, Wollonaby, Wallaby, and Undowa.
County of Benambra: Parishes of Mowamba, Dartella, Malkara, Mitta Mitta, Gibbo, Benambra, Burrungabugge, Keelangie, Welumla, and Nariel.

B. Nature of the Land

1. Climate

Moist north-westerly prevailing air streams deposit their moisture uniformly over most of the block. The Mitta Mitta valley receives a moderately high average annual rainfall of 1,000--1,200 mm, increasing towards the high country to east and west. Rainfall approaches 1,400 mm at Sassafras Gap in the east and exceeds it on the Omeo Highway in the west.

Snowfalls occur regularly above 1,000 m from June to October, persisting only on the higher elevations.

2. Geology and physiography

Moderately dissected mountainous terrain on Ordovician sediments predominates. Several small basins at about 500 m are associated with Silurian or Devonian granite intrusions. Plateaux in the headwaters of northern tributaries to the Dart River are associated with the Mitta Mitta volcanics.

The block lies on the eastern edge of the Omeo Metamorphic belt, with schists grading into Ordovician sediments towards the east. The Mitta Mitta volcanics (Upper Silurian) occupy a north--south belt through the centre of the block from east of Cravensville, south through Mount Benambra (1,461 m, highest point in the block) to the Gibbo River. The rhyodacites and rhyolites are overlain unconformably by the Wombat Creek group of Upper Silurian sediments, which include conglomerates, limestones, and shales. Lower Silurian granites outcrop in various places - for example, from Banimboola to Granite Peak - and are evident as pebbles in the Wombat Creek sediments. Devonian granites and diorite occur near Nariel and at Larsen Creek.

A small remnant of Upper Tertiary basalt overlies the Mitta Mitta volcanics in the south. Quaternary sediments occur mainly along the Mitta Mitta downstream of Banimboola, the lower Dart River, and Watchingorra, Bucheen, and Nariel Creeks.

The Omeo Highway reaches 1,350 m below Mount Wills, descending to less than 300 m at Mitta Mitta.

3. Soils

Organic loams occur on sheltered slopes of high ridges near Mount Wills and Sassafras Gap, and on elevated plateau country north-east of Mount Benambra. Stony loams occur on steep and exposed slopes. Friable brown gradational soils are predominant on most mid-slopes, but friable red gradational and massive and red gradational soils are more widespread at lower elevations. Red gradational soils and red duplex soils occur on the lower hills and slopes in drier areas, with yellow forms in poorly drained sites.

Gently sloping alluvial fans, upper terraces, and associated hill-slopes of the river valleys around Mitta Mitta and Bucheen Creek are dominated by red duplex soils, with areas of friable red gradational soils and red gradational soils on moist and dry steeper slopes respectively. Grey-brown loams and undifferentiated sands and loams occur on alluvium of the stream flats.

4. Vegetation

Snow gum open forest I is limited to the summits of the highest peaks - including Mount Cravensville, Mount Benambra, Granite Peak, and Mount Cooper - at elevations ranging from about 1,200 to 1,450 m. Understoreys may be shrubby (hop bitter-pea) or heathy (gorse bitter-pea, leafy bossiaea, and mountain beard-heath). Mountain gum--snow gum forests, with heathy (prickly bush-pea and handsome flat-pea) to grassy understoreys, grow on plateaux or ridge-tops at elevations between 1,000 and 1,300 m.

Substantial areas of both fire regrowth and mature alpine ash forests are found at several places in the block at elevations ranging from about 850 to 1,250 m. Understoreys may be shrubby (hop bitter-pea, mountain hickory wattle, silver wattle, red-stem wattle, varnish wattle, and tree lomatia) or heathy (prickly bush-pea, handsome flat-pea, and austral bracken).

Some wet gullys associated with alpine ash south-east of Granite Peak carry montane closed forest of southern sassafras, blackwood, and soft tree-fern.

Messmate stringybark stands, uncommon in far north-eastern Victoria, are found in several patches between Harkers Creek and Shearers Spur. The main stand is at Harkers Creek, where associated trees are manna gum and narrow-leaf peppermint and understoreys are typically wet gully type (musk daisy-bush, blanket-leaf, and common cassinia).

Narrow-leaf peppermint open forest III is the predominant vegetation type below about 1,000 m. Associated trees include manna gum, eurabbie, mountain gum, broad-leaf peppermint, and candlebark. Understoreys vary from grassy (kangaroo grass), through shrubby (hop bitter-pea, austral bracken, silver wattle, and common cassinia), to wet gully type (blanket-leaf and hazel pomaderris).

The drier aspects at the higher elevations carry broad-leaf peppermint open forest II, with associated mountain gum, candlebark, and brittle gum, and heathy (gorse bitter-pea and handsome flat-pea) to shrubby understoreys (austral bracken, hop bitter-pea, common cassinia, and prickly bush-pea).

At the lower elevations, broad-leaf peppermint is associated with red stringybark, long-leaf box, and brittle gum. Understoreys are typically heathy (prickly broom-heath, leafless sour-bush, small-leaf parrot-pea, narrow-leaf bitter-pea, handsome flat-pea, guinea-flower, and red-stem wattle).

5. Fauna

The fauna in the environs of the Mitta Mitta River has been surveyed as part of the Dartmouth environmental study. Seventeen native mammal, 127 native bird, 24 reptile, 11 amphibian, and four native fish species have been recorded. Sambar deer have been recorded in the block.

Wetlands comprise streams, of which the Mitta Mitta River is the most important. Its characteristics will be changed with the impoundment of its waters by the Dartmouth Dam. Riverine forests are associated with the main streams and sub-alpine woodlands are restricted to the high ridges and plateaux, while wet open forest is the most extensive habitat. Dry open forests occupy dry aspects in a mosaic with wet open forest.

Five waterbird species have been recorded at the Mitta Mitta River. A more diverse waterbird community at Nariel Creek includes species such as the little black cormorant, white-necked heron, white egret, nankeen night heron, yellow-billed spoonbill, chestnut teal, spotless crake, dusky moorhen, and black-fronted dotterel. The eastern water rat and platypus have been recorded in some streams.

Ten native mammals are known to inhabit riverine forests. These comprise the eastern grey kangaroo, four phalangerids (including the eastern pigmy possum), common wombat, long-nosed bandicoot, two species of antechinus, and the bush rat. The 44 bird species recorded in riverine forest include the dollar-bird, white-eared honeyeater, king parrot, rufous fan-tail, eastern whipbird, red-browed finch, wonga pigeon, and satin bower-bird.

There were no systematic surveys in sub-alpine woodland.

Wet open forests are known to provide habitat for 14 native mammals, including the eastern grey kangaroo, brush-tailed possum, ring-tailed possum, sugar glider, greater glider, eastern pigmy possum, long-nosed bandicoot, broad-toothed rat, Tasmanian pipistrelle, and dingo. Birds are those typical of this habitat. Of particular interest is the common occurrence of the brush cuckoo, satin fly-catcher, red-browed tree-creeper, and satin bower-bird along the Mitta Mitta valley. The cicada bird and large-billed scrub-wren have also been recorded in wet open forest in the block.

The nine mammals recorded in dry open forest comprise the eastern grey kangaroo, black wallaby, brush-tailed possum, greater glider, feather-tailed glider, eastern pigmy possum, brown antechinus, bush rat, and dingo. Some of the 55 bird species in dry open forest show a specific preference for this habitat. These include the painted quail, black-faced cuckoo-shrike, white-winged triller, spotted quail-thrush, white-throated warbler, buff-rumped thornbill, scarlet robin, brown tree-creeper, mistletoe bird, fuscous honeyeater, brown-headed honeyeater, noisy friar-bird, olive-backed oriole, white-winged chough, and dusky wood-swallow.

Birds in the semi-cleared valley at Nariel include the sulphur-crested cockatoo, eastern rosella, and galah. Birds in clearings near Mitta Mitta include the emu, painted quail, willie wagtail, diamond firetail, and Australian pipit.

Reptiles were collected mainly in the Mitta Mitta valley. Of the 24 species, 10 - the tree dragon, large striped skink, copper-tailed skink, three-toed skink, water skink (warm-temperate species), Cunningham's skink, brown snake, small-eyed snake, red-bellied black snake, and blind snake - are typical of warmer environments. This reptile community contrasts markedly with those of surrounding mountain areas, where species more typical of cool- or cold-temperate regions are found.

Nine reptiles were restricted to the wet open forests (narrow-leaf peppermint) of the Mitta Mitta valley, three species were found almost exclusively in dry open forest (broad-leaf peppermint), and five species were found in both these habitat types.

Habitat preferences of six species found in limited numbers were not established.

The amphibian fauna, in common with the reptiles, represent a warm element in the Mitta Mitta valley compared with mountainous surrounding areas. Wetlands and associated rivers in forests are important for many amphibians found there, such as the brown tree frog, Verreaux's tree frog, southern toadlet, brown-striped frog, and eastern banjo frog. The leaf green tree frog, known primarily from east Gippsland streams in Victoria, is found as far north as Dartmouth.

Native fish in the Mitta Mitta River include the river blackfish, Murray cod, trout cod, and Macquarie perch. Of these latter two, the Macquarie perch is uncommon and restricted in Victoria and trout cod is extremely rare. Redfin, carp, brown trout, and rainbow trout also inhabit the Mitta Mitta River.

6. Land systems

The Darbalang, Wermatong High, Murray High, Welumla, Pinnacles, Glen Wills, Adjie, Lucyvale (Sedimentary), and Glendart land systems are represented in the block.

C. Present Use and Capabilities

1. Nature conservation

The capability for nature conservation is very high. Environments range from sub-alpine woodlands to riverine forests. Fossiliferous limestone outcrops near the Mitta Mitta River. Messmate and southern sassafras occur at the northern edge of their range at Granite Peak and a few other localities in the block.

The mammal species, avifauna, and especially the reptile and amphibian fauna are rich and diverse. The broad-toothed rat has been found at several scattered localities at low elevations in the block. The Tasmanian pipistrelle, a seldom-observed bat species, has been recorded near Dartmouth. The large striped skink and copper-tailed skink are among a number of reptiles typical of dry warm environments that occur in the Mitta Mitta valley and contrast markedly with surrounding fauna typical of the mountains.

The Murray cod, the rare Macquarie perch, and the very rare trout cod are found in the Mitta Mitta River. *Litoria maculata,* a rare amphibian found in rocky, fast-flowing mountain streams, has been recorded in Lightning Creek.

Three plant species are considered highly significant. Mitta Mitta is the only known Victorian occurrence of the poverty wattle (*Acacia dawsonii*), and the beard-orchid *Calochilus grandiflorus* occurs in Victoria only at Mitta Mitta and near Mount Beauty. The Victorian endemic catkin wattle *A. dallachiana* has been recorded in the block.

2. Recreation

Features of recreational interest include the Dartmouth Dam project, Mount Benambra, limestone formations, and old mining relics. Capabilities are high for adventure driving and fishing, high to moderate for bushwalking, moderate for horse-riding, and low for hunting and fossicking. Following the completion of Dartmouth Dam, capability will be high for boating but low for white-water canoeing.

This block is little used for bushwalking at present, but has considerable potential. The track from Mount Wills to Sassafras Gap, via Mount Cooper and the Mitta Mitta River, receives moderate use. Features likely to attract walkers include the gold workings along the Dart River, limestone deposits near the Mitta Mitta River, and viewpoints such as Granite Peak, Mount Benambra, and Mount Cravensville.

Horse-riding stables based at Mitta Mitta cater for this form of recreation.

This block is relatively little used for recreation driving, but has high capabilities for four-wheel-drive vehicles and trail-bikes. Tourists use the Omeo Highway and the Corryong to Benambra road.

Infrequent hunting for deer occurs in some localities, including the Mitta Mitta River valley.

Trout and blackfish may be caught in the Mitta Mitta and Dart Rivers, trout in the Gibbo, and Macquarie perch, redfin, Murray cod, and trout cod in the Mitta Mitta. The Dartmouth storage is likely to provide trout and redfin.

The section on the Mitta Mitta River from the Dartmouth Dam-site to above the Gibbo Junction will be flooded by the Dartmouth storage and could be used for flat-water canoeing and other boating activities. White-water canoeing will be limited to the section below the dam-site where difficult rapids give way to quieter water at about 16 km above Mitta Mitta. The river from this point through Mitta Mitta to Eskdale is a quiet stream that is well suited to beginners.

Opportunities for gold-fossicking are provided at several localities, including Granite Flat, Mitta Mitta, Bucheen Creek, and along the Dart and Gibbo Rivers.

3. Agriculture

Few areas of public land are grazed in this block. These are scattered and are mostly in narrow-leaf peppermint forests along the Mitta Mitta River and its tributaries. A grazier at Mitta Mitta runs about 300 cows around Dartmouth throughout the year. Cattle often graze in snow gum--mountain gum forest along the Razorback Spur from Mount Wills during the summer.

Almost all the private land is used for beef production, except for two dairy farms in the Bucheen Creek area and two in the Nariel area. Most herds consist solely of beef cattle, but some herds containing dairy-beef cross animals occupy the river flats near Mitta Mitta, where dairying was carried out until a few years ago.

All the private land is at least semi-improved, and much has had at least 2.5 tonnes of superphosphate spread per hectare. The land on the Mitta Mitta upstream from Bannimboola has been resumed by the State Rivers and Water Supply Commission in connection with the Dartmouth Dam project.

The capability for bush grazing is moderate to low. An area of about 1,400 ha around Dartmouth will be submerged after the construction of Dartmouth Dam. The capability for agricultural development is low.

4. Apiculture

Access is generally poor. Honey flora include alpine ash, manna gum, eurabbie, brittle gum, red stringybark, and long-leaf box.

5. Wood production

Capability for hardwood production is high in the alpine ash stands scattered throughout the block. Several areas of alpine ash regrowth have resulted from the 1939 fires, mainly in the north, where most of the mature stands of alpine ash have been logged and regenerated.

The total area of mountain forest is 10,900 ha. The adjoining areas of moist foothill forest have moderate to high capability.

Each year, four mills (at Eskdale, Granite Flat, Mitta Mitta, and Cudgewa) together cut 12,900 m^3 from about 170 ha of forest.

5. Minerals

The block includes the main belt of the Mitta Mitta volcanics. Lead--zinc--copper mineralization at the Danes Creek deposit 5 km south-east of Dartmouth is similar to that found in a large deposit associated with similar geological formations in New South Wales. Consequently the whole belt of Mitta Mitta volcanics has excellent potential for a major base-metal deposit.

The block also includes the Dart River and part of the Zulu Creek gold-fields, both of which contained copper and lead mineralization. Neither of these fields was adequately prospected or worked, and therefore both have a high potential for economic minerals.

Limestone deposits occur in the Wombat Creek--Gibbo River area.

7. Water production

The Gibbo River, forming part of the southern boundary, flows into the Mitta Mitta River, which flows northwards and then north-westerly through the block. Dartmouth block also contains all of the Dart River system.

Most of this block receives more than 1,000 mm annual rainfall, with considerable areas receiving more than 1,200 mm.

Measurements of salinity of the Mitta Mitta River at Tallandoon indicate that water in this block is all of high quality.

River flow figures are not available for the Dart or Gibbo rivers. The Mitta Mitta River discharges 21.5% of its annual yield between December and May (6 months), including 7.5% in the 3 months January to March.

The Dartmouth Dam, below the junction of the Dart and Mitta Mitta Rivers, is at present under construction and has a projected capacity of 3.77 million Ml.

Dartmouth township has a reticulated water supply, served by a 90-Ml storage on Mount Tabor Creek. This water is not treated. Residents of Mitta Mitta township use separate pumps to draw water from either the Mitta Mitta River or Snowy Creek. Water quality is usually excellent, but heavy rains upstream of the township can cause high turbidity.

The capability for water production is high.

D. Hazards

The erosion hazard is moderate over most of the block. The fire hazard is high. A fire lookout is situated on Mount Benambra. Blackberries are common throughout, particularly along the lower river valleys, while St. John's wort and sweet briar infest parts of the block.

15. PINNIBAR

A. Location and Tenure

Pinnibar block covers a total area of 74,500 ha, most of which (72,800 ha - 98%) is public land in the form of unreserved Crown land. A small reserve is located at Nariel. Freehold land is located on flat country at Nariel, and along the Murray River at Tom Groggin and at Bunroy Creek.

County of Benambra: Parishes of Gunarlan, Mowamba, Malkara, Pinnibar, Moyangul, Kosciusko, Corryong, Burrungabugge, Nariel, and Kancobin.

B. Nature of the Land

1. Climate

The block receives most of its rainfall from prevailing moist north-westerly air streams, which are uplifted over the elevated regions of Mounts Gibbo and Pinnibar.

Average annual rainfall varies from some 1,000 mm near Nariel to more than 1,600 mm around Mounts Pinnibar and Gibbo.

Snowfalls occur regularly above 1,000 m from June to October. Low winter temperatures may allow snow to persist for long periods on the higher elevations. Frosts are prevalent throughout the block.

2. Geology and physiography

Moderately to deeply dissected mountainous terrain on Ordovician sediments predominates, with 400-800 m between ridges and adjacent valley floors. Lower Devonian granite intrusions remain as the Pinnibar plateau and in a small basin north of Mount Barlow (1,188 m). The Pinnibar plateau is situated to the west of Mount Pinnibar (1,771 m; highest point in the block), at between 1,500 and 1,000 m elevation. Other high points are Mount Sassafras (1,588 m), Mount Gibbo (1,757 m), and Mount Anderson (1,650 m).

Shady Creek drains the Pinnibar plateau before flowing into Wheelers Creek. This latter stream flows into Nariel Creek, which, in common with Thowgla Creek, flows northwards to the Murray River.

South of the ridge between Sassafras Gap (1,200 m) and Mount Gibbo, the streams flow into the Gibbo River. The Buenba Fault has directly influenced the direction of flow of the Buenba and Omeo Creeks, which form the southern boundary of the block. A small outcrop of Middle Devonian quartz porphyry caps Mount Morgan (1,091 m) in the north.

River flats of Quaternary alluvium lie along Omeo and Nariel Creeks.

3. Soils

Organic loams and scattered areas of humified peats occur on the Pinnibar plateau and on the higher peaks, and are replaced by friable brown gradational soils and to a lesser extent friable red gradational soils at lower elevations. Stony loams occur on the steep and exposed montane slopes and on narrow ridge-tops. Friable red gradational soils may be very deep in some sheltered gullies and higher-rainfall areas, and may be accompanied by red gradational soils on coarse-textured rocks and by gravelly loams in steep valley bottoms.

In drier areas, massive gradational soils dominate on steeper slopes, together with red duplex soils on the less-steep hills, older alluvial fans, and upper terraces of valleys of the Murray River and Nariel Creek. Yellow-brown gradational soils and yellow duplex soils occur in poorly drained areas. Dark calcareous clays occur in the upper reaches of Buenba Creek. Grey-brown loams and undifferentiated sands and loams occur on younger alluvium of the stream flats.

4. Vegetation

Small areas of heathland occupy the summit of Mount Pinnibar and southern faces of the nearby ridge crests at about 1,800 m elevation. Common plants include alpine grevillea, mountain beard-heath, dusty daisy-bush, mountain woodruff, and snow grass.

Snow gum woodland is found at the highest elevations, but elsewhere the open forest formation is more common. The three north-east-trending ridges culminating in Mounts Sassafras, Gibbo, and Pinnibar carry this vegetation type at elevations ranging from about 1,300 to 1,800 m. Understoreys may consist of tall shrubs including leafy bossiaea, royal grevillea, phebalium, alpine mint-bush, alpine oxylobium, and mountain beard-heath, or may be heathy (rusty-pods, alpine grevillea, silver daisy, and alpine oxylobium). Grassy understoreys include snow grass, bidgee-widgee with scattered shrubs of mountain beard-heath, and alpine pepper.

Mountain gum--snow gum forests are limited to several scattered localities between 1,250 and 1,450 m elevation.

Alpine ash forests, both regrowth and mature, cover about one-third of the block. The largest areas of fire regrowth are south-east of Mount Pinnibar, south-west of Mount Gibbo, and at Hermit Mountain. These forests descend to about 800 m on sheltered aspects and ascend to about 1,500 m. They may have grassy floors (snow grass, ivy-leaf violet, showy violet, prickly starwort, bidgee-widgee, derwent speedwell, and mother shield-fern), or may be shrubby (silver wattle, prickly bush-pea, hop bitter-pea, rough coprosma, elderberry panax, mountain beard-heath, and mountain pepper).

Open forest III, at about 1,000 m, may consist of pure stands of mountain gum with shrubby understoreys (silver wattle, hop bitter-pea, and prickly bush-pea). At lower elevations, however, narrow-leaf peppermint associated with manna gum, mountain gum, and occasionally, broad-leaf peppermint is the predominant vegetation type. Understoreys may be grassy, shrubby (silver wattle, austral bracken, prickly bush-pea, and handsome flat-pea), or wet gully type (blackwood, forest lomatia, hazel pomaderris, soft tree-fern, and southern sassafras).

Open forest II is typically found on steep, dry aspects. Common trees are broad-leaf peppermint, brittle gum, and candlebark. Understoreys are typically heathy (leafless sour-bush, cluster-flower geebung, prickly broom-heath, guinea-flower, and heath pink-bells), but may be shrubby (hop bitter-pea and Mueller's bush-pea).

Open forest I is limited to the driest aspects and has similar flora. Red stringybark and long-leaf box may be occasional associated trees.

5. Fauna

Eight native mammal species, 114 native birds, seven reptiles, five amphibians, and two species of introduced trout have been recorded in the block.

Wetlands consist of streams, and riverine forests are associated with some of these - such as along Wheeler and Buenba Creeks. Sub-alpine woodlands are restricted to the higher ridges and dry open forest to the steep dry slopes. Wet open forest predominates. The 20 bird species recorded for Nariel Creek in wetland habitats include those mentioned previously for block 14.

Riverine forests include tall trees with shrubby understoreys, where the brush bronzewing, Australian ground thrush, satin fly-catcher, eastern whipbird, and red-browed finch may be observed. Tall woodlands associated with open areas at Buenba flat provide habitat for birds such as the Australian goshawk, little falcon, gang-gang cockatoo, crimson rosella, fan-tailed cuckoo, and tree-martin. The black wallaby, common wombat, and bush rat have been recorded in riverine forests.

In sub-alpine woodlands recorded mammals are the eastern grey kangaroo, common wombat, brown antechinus, Swainson's antechinus, and the bush rat. Birds include the emu and olive whistler, and, more commonly, the brown thornbill, white-browed scrub-wren, grey shrike-thrush, yellow-faced honeyeater, white-eared honeyeater, red wattlebird, and pied currawong.

Birds and mammals of wet open forest are those typical of this habitat type. They include the greater glider, brown antechinus, wonga pigeon, superb lyrebird, yellow-tailed black cockatoo, king parrot, and brush cuckoo.

Mammals and birds of dry open forest are also typical of their habitat type. Of note are breeding records for the white-winged triller, white-throated warbler, leaden fly-catcher, orange-winged sittella, fuscous honeyeater, and noisy friar-bird.

Reptiles recorded in sub-alpine woodland are the mountain dragon, Spencer's skink, water skink (cool-temperate species), and grass skink. The wet open forests contain the grass skink, Coventry's skink, garden skink, water skink, and McCoy's skink.

Amphibians recorded are the southern toadlet, common eastern froglet, Victorian froglet, Lesueur's frog, and brown tree frog. Brown and rainbow trout are found in many streams.

6. Land systems

The Darbalang, Wermatong High, Buckenderra, Murray High, Adjie, Beloka High, Pinnibar, Enano, Glen Wills, and Graham land systems are represented in the block.

C. Present Use and Capabilities

1. Nature conservation

The capability for nature conservation is high. Environments vary from sub-alpine woodlands to riverine forests. Large areas of mature alpine ash forest are located in Wheelers Creek on soils derived from Ordovician sediments. Some mature stands are located on soils derived from granitic parent material.

Two significant plant species - *Ranunculus pachycarpus*, the thick-fruit buttercup, which occurs at an unusually high elevation near Mount Pinnibar hut, and the Victorian endemic catkin wattle *Acacia dallachiana* - have been recorded in the block.

2. Recreation

This block has a number of prominences such as Mounts Pinnibar, Gibbo, and Sassafras. Capabilities are high for bushwalking and fishing, moderate for adventure driving, cross-country skiing, and canoeing, and low for hunting, downhill skiing, and fossicking.

This area receives only moderate use for bushwalking. Trips are usually of several days duration. Routes used begin at Tom Groggin, Upper Thowgla, Nariel, Sassafras Gap, or Buenba Hut. Features along a major walking route include Mounts Sassafras, Gibbo, and Pinnibar, and Hermit Mountain. The area has great potential for walkers. Several viewpoints afford panoramic views of the Snowy Mountains. Mining relics at Zulu Creek provide interest for some.

This area receives little use for recreation driving, mainly because of its remoteness. It does, however, have considerable potential for extended trips.

Little hunting is done in this block.

The Murray River and Buenba, Wheelers, Nariel, and Thowgla Creeks all provide good trout fishing.

This area has potential for ski touring, particularly along the high ridge systems and also on the Pinnibar plateau after heavy snowfalls. A ski hut is situated near the plateau.

Mount Pinnibar has some potential for downhill skiing, but is very remote and inaccessible.

The Murray River in New South Wales downstream from Tom Groggin is popular among experienced canoeists. There are several difficult rapids to negotiate before reaching Biggara. Access is very difficult on this section of the Murray.

Wheeler and Zulu Creeks and the Buenba River, while relatively inaccessible, do provide for gold-fossicking.

3. Agriculture

Six graziers run cattle on the public land. The grazier at Tom Groggin has two runs on the southern side of his private land (in Buckwong block) and one on the northern side. Three others from the Corryong area share a run on the Pinnibar plateau and use a logging road from Thowgla Upper for access. This route also serves another grazier using the Surveyors Creek area. A grazier from Benambra runs cattle along the Buenba Flats.

The Pinnibar plateau has potential for greater use, but the distance from private holdings is a limiting factor.

The cattle are mostly Herefords and most of them are found in the grassy alpine ash or narrow-leaf peppermint forests of the Pinnibar plateau. Other minor grazing areas are used around the Buenba River, Murray River, and Surveyors Creek. Up until recently about 210 cows and 70 calves have been put on the runs during summer. In 1975, about 250 cows with their calves were grazed on the Pinnibar plateau instead of the usual 160 cows.

About 100 dry cattle graze along the Murray River valley throughout the year.

Private land is used for beef production for the most part, except for two dairy farmers in the Nariel River valley. Beef cattle are run at Bunroy and Tom Groggin.

The capability for bush grazing is generally low to moderate; it is highest in the grassy alpine ash forests. The area has adequate water.

Capability for agricultural development is generally low.

4. Apiculture

Access for apiarists is limited. Honey flora include snow gum, alpine ash, manna gum, brittle gum, long-leaf box, and red stringybark.

5. Wood production

Capability for hardwood production is very high in the alpine ash regrowth and mature forests, which together total some 22,200 ha. Of this, 2,400 ha is advanced regrowth. Some mature alpine ash forests around Mount Pinnibar have been logged and regenerated, but a large resource remains here and also in the head of Wheelers Creek. Moist foothill forests in the north of the block have moderate to high capabilities.

Each year the four sawmills (comprising two at Corryong and one each at Eskdale and Cudgewa) together cut about 20,300 m^3 of sawlogs from about 210 ha of forest.

6. Minerals

The major part of the Zulu Creek gold-field is within this block. This field was never fully prospected or worked because of its remoteness. Since 1938 the Corryong--Benambra road has provided good access, but it is only since the recent rises in the price of gold that the rich gold-bearing lodes have become economic once more. The field also contains much sulphide, including sulphides of lead and copper, which occur with the gold, and these may prove to be economic. Gold reefs have been worked near Bunroy Creek and minor tin deposits at Surveyors Creek.

7. Water production

Bounded on the north-east by a section of the Murray River, this block contains the catchments of major streams such as Thowgla, Nariel, and Wheeler Creeks. The southern boundary is largely formed by the upper sections of Buenba Creek (that flows south-west then westwards to the Gibbo River) and Omeo Creek (flowing north-eastwards to the Murray).

Most of the block is in a zone receiving about 1,200 mm of rain per annum, but an area around the Wheeler Creek headwaters receives up to 1,600 mm per annum.

The mean salinity value for the Murray River at Jingellic is 29 mg per l, indicating that water from this block is high quality. Measurements on the Nariel Creek at Nariel show a mean salinity reading of 25 mg per l. This stream has a mean annual discharge of 134,480 Ml, with 22% of its yield delivered in the 6 months December to May, including 8% in the 3 months January to March. Equivalent figures for the Murray River at Jingellic (outside the study area) are 23% and 9% respectively.

The capability for water production is high.

D. Hazards

The erosion hazard is low to moderate and the fire hazard is high. Nine species of noxious weeds in the block include blackberry and sweet briar. Phasmatids have defoliated large areas of forest on the Pinnibar plateau.

16. BUCKWONG

A. Location and Tenure

Buckwong block covers a total area of 69,600 ha, of which 68,900 ha (99%) is public land. A large block of reserved forest, including the Limestone Reserve of 2,115 ha, totals 27,500 ha and occurs in the south, the remaining public land being unreserved Crown land (41,400 ha). Freehold land occurs along the Murray River at Tom Groggin and along the Limestone Creek.

County of Benambra: Parishes of Enano, Guttamurra, Beloka, Gungarlan, Indi, Pinnibar, and Moyangul.

B. Nature of the Land

1. Climate

The two main ranges face the prevailing north-westerly air streams. Average annual rainfall exceeds 1,600 mm on Davies Plain Ridge. A slight rain-shadow effect along Limestone Creek is inferred from vegetation patterns, with annual rainfall of less than 1,000 mm indicated.

Low winter temperatures may allow snow to persist on the high ridges from June to October, and snowfalls occur regularly above 1,000 m during this period.

Southerly and south-easterly air streams may contribute to snow or rainfall at any time of the year, and thunderstorms occur erratically in the summer months.

2. Geology and physiography

Land forms and drainage patterns are greatly influenced by a series of faults parallel to and west of the Great Divide, to form ridges trending north-east and deeply incised valleys. The Indi Fault has influenced the flow of Limestone Creek, Indi (Murray) River, and also the Tambo River in Reedy block. The line of the Buenba Fault is closely followed by both Buenba and Omeo Creeks.

The highest elevation in the block is along the Great Divide at Mount Cobberas No. 1 (1,838 m) and the lowest at 510 m at the junction of the Murray River and Omeo Creek. Extensive Quaternary alluvial deposition has occurred along Indi (Murray) River and Omeo Creek, and a basin exists at their junction. Other basins occur along Buenba Creek and in the Mount Murphy area.

The block includes the northern region of the Native Cat Tablelands (1,400--1,500 m) situated on volcanics previously correlated with the Snowy River volcanics of Lower Devonian age but now correlated with the Silurian Mitta Mitta volcanics. A plateau north of Mount Pendergast (1,462 m) and an elevated plateau along Davies Plain Ridge (a broad ridge at about 1,700 m elevation) are both formed largely on Ordovician schists. Lower Devonian granite intrusions responsible for this metamorphism occur throughout the schists - notably at Mount Misery (1,575 m), around Buckwong Creek headwaters, and between Davies Plain and Tom Groggin. Silurian sediments along Limestone Creek and the Murray River are bounded on the west by the Indi Fault.

Many of the limestone outcrops along Limestone Creek are now believed to be of Upper Silurian age, although some are probably Lower--Middle Devonian (Buchan Group). They contain caves in some localities.

3. Soils

This block contains an elevated region along Davies Plain Ridge with similar characteristics to the Bogong Tablelands. Low average temperatures on this ridge aid the formation of organic loams where drainage is not impeded, and fen or bog peats in permanently wet situations. Humified peats are formed from normal peats where stream entrenchment has lowered the water table.

Stony loams occur on exposed ridges and peaks. Organic loams become deeper with descending altitude, and grade into friable brown gradational soils at lower elevations where rainfall is high. Friable red gradational soils and the strongly structured red gradational soils occur on less-steep slopes at lower elevations. Deep red gravelly loams occur in some sheltered gullies.

In drier rain-shadow areas such as the Limestone Creek valley, red or yellow-brown gradational soils and massive gradational soils predominate.

Red and yellow duplex soils occur on lower hills and on older terraces and alluvial fans of river valleys, especially in the basin at the junction of Omeo Creek and the Murray River.

Small areas of Recent alluvium along most streams give rise to red or yellow gradational soils on upper terraces and undifferentiated sands and loams. Dark calcareous clays and dark cracking clays with uniform texture have limited occurrence along Limestone and Buenba Creeks.

4. Vegetation

The Davies Plain Ridge from about 1,400 m to its highest elevation (1,760 m) is predominantly snow gum woodland and open forest, with a grassy understorey interspersed with scattered shrubs and herbs. Common plants include snow grass, gorse bitter-pea, dusty daisy-bush, alpine pepper, rusty-pods, yam-daisy, prickly starwort, and common billy-buttons.

At Mount Misery this vegetation type ranges from about 1,400 m to 1,600 m and along the Great Dividing Range from about 1,440 m to 1,780 m (the Cobberas). Understoreys vary from grassy to heathy (mountain beard-heath, dusty daisy-bush, and alpine pepper).

Sub-alpine grasslands, wet heathlands, and mosslands occur at several scattered localities on the Davies Plain Ridge at elevations ranging from 1,400 m to 1,700 m, including Davies Plain itself (about 1,400 m).

Common plants include snow grass, alpine baeckea, alpine bottle-brush, alpine heath, coral heath, candle heath, spreading rope-rush, and sphagnum moss. Grasslands predominate at Cowombat Flat (1,180 m), whereas wet heathlands are common along Dead Horse Creek (about 1,160 m).

Mountain gum--snow gum open forest grows at several localities, such as on the Dinner Creek plateau, Dead Horse Creek plateau, elevated basins in Macs and Charlies Creek headwaters, and ridge summits between Mount Hope and the Buckwong Creek headwaters. Their largest extent, however, is on the Native Cat Tablelands in the south-eastern section of the block.

This vegetation type is usually found above about 1,200 m elevation and extends to 1,440 m. In some cases, such as at Smoke Oh and Middle Creeks, it descends to about 1,040 m. Understoreys are typically heathy (handsome flat-pea, mountain beard-heath, and alpine oxylobium) or shrubby (hop bitter-pea, prickly bush-pea, and gorse bitter-pea).

Black sallee woodlands are a feature of Limestone Creek (at elevations from 980 to 1,000 m) and the upper Buckwong Creek (1,140 m). Understoreys along Limestone Creek are typically grassy but along the Buckwong (where Omeo gum is common) understoreys also commonly include plants characteristic of wet heathlands (alpine bottle-brush, small-fruit hakea, mountain baeckea, and snow heath).

Alpine ash forests, mainly mature, fringe the Davies Plain Ridge at elevations ranging from about 1,000 m to 1,400 m and occasionally 1,500 m. The main fire regrowth stands are found at the northern end of Davies Plain Ridge, and in the headwaters of Omeo and Buenba Creeks. Extensive stands grow on the divide between Buckwong Creek and the Omeo and Buenba Creeks at elevations ranging between 1,000 and 1,500 m. Near Mount Misery, alpine ash forests ascend from about 1,100 m along Dead Horse Creek to 1,400 m.

Understoreys of fire-regrowth ash are usually shrubby (hop bitter-pea, elderberry panax, silver wattle, and rough coprosma), whereas understoreys of mature stands may be grassy with scattered shrubs such as prickly bush-pea, hop bitter-pea, and gorse bitter-pea. On sheltered or moist sites the understorey includes mountain tea-tree, mountain pepper, and mountain beard-heath.

Open forest III is predominantly narrow-leaf peppermint in mixture with mountain gum, candlebark, and broad-leaf peppermint. Understoreys are typically shrubby (silver wattle, austral bracken, and common cassinia) to heathy (prickly bush-pea and handsome flat-pea). At the lower elevations the understoreys may consist principally of kangaroo grass.

Open forest II is typically composed of broad-leaf peppermint, usually in mixture with candlebark and mountain gum, but sometimes with narrow-leaf peppermint or red stringybark. Understoreys are usually heathy (narrow-leaf bitter-pea, prickly bush-pea, and handsome flat-pea), but may be shrubby or grassy.

5. Fauna

Nine native mammal species, 72 native bird species, 15 reptile species, six amphibian species, and two species of native fish have been recorded in the block. Brumbies are common throughout the area.

The main streams and their environs provide wetlands and riverine forest habitats. Small sub-alpine open areas are scattered among sub-alpine woodlands, which cover considerable areas at the higher elevations. Wet open forests predominate at the lower elevations, and dry open forests are confined to dry aspects.

Birds of wetlands include the little pied cormorant, white-necked heron, wood duck, and spur-winged plover.

Mammals in riverine forests include the black wallaby, common wombat, Swainson's antechinus, and bush rat. Birds include the little falcon, Australian goshawk, tree martin, shrike-tit, and red-browed tree-creeper.

Sub-alpine open areas - comprising wet heathlands, mosslands, and grasslands - are known to provide habitat for the eastern grey kangaroo, brown antechinus, Swainson's antechinus, bush rat, and dingo.

Birds recorded here are typical of this habitat type elsewhere in the study area, and include the emu, nankeen kestrel, spur-winged plover, flame robin, white-backed magpie, little raven, brown thornbill, and white-browed scrub-wren.

Mammals in sub-alpine woodlands include the eastern grey kangaroo, red-necked wallaby, black wallaby, ring-tailed possum, common wombat, brown antechinus, Swainson's antechinus, bush-rat, and broad-toothed rat (in locally wet heathland areas). Most of the 43 birds recorded here are typical of this habitat.

Three macropodids, the common wombat, and three small terrestrial mammals are known to inhabit wet open forest. Birds are typical of this habitat type elsewhere in the study area. Characteristic species include wonga pigeon, superb lyrebird, superb blue-wren, striated thornbill, pilot bird, southern yellow robin, rufous fantail, eastern whipbird, and satin bower-bird.

Similar mammal populations occur in dry open forest, and the many birds include the spotted quail-thrush, scarlet robin, leaden fly-catcher, rufous whistler, brown tree-creeper, and diamond firetail.

Most reptiles recorded (such as the mountain dragon, McCoy's skink, Coventry's skink, Spencer's skink, and the copperhead) are typical of the highlands. The rare alpine water skink is found in mosslands and wet heathland adjacent to sub-alpine woodland.

Most amphibians are also typical of these mountain forests. The leaf green tree frog recorded here is mainly distributed in Gippsland in Victoria.

Both the native ornate and Kosciusko mountain trout and the introduced brown and rainbow trout have been recorded in the block.

6. Land systems

The Graham, Darbalang, Beloka High, Enano, Murray High, Mt. Misery, Cassilis, Buckenderra, Glen Wills, Mirimbah, Davies Plain (Igneous), Davies Plain (Sedimentary), Reefton Spur, Indi, Limestone Creek, Cobberas, Mt. Phipps, and Nunniong (Igneous) land systems are represented in the block.

C. Present Use and Capabilities

1. Nature conservation

The capability for nature conservation is very high. Environments vary from sub-alpine woodlands to riverine forests. Some areas - such as in the Buckwong Creek and Murray River valleys - are remote from tracks. Limestones and siltstones containing corals of Silurian age outcrop on Cowombat Flat. An unconformity between the Snowy River volcanics and Silurian shales (Cowombat group) is exposed in a road cutting on the Cowombat Flat track. Limestone deposits at Limestone Creek contain fossils, and the associated limestone caves contain an important cave fauna.

The broad-toothed rat has been recorded near Bulley Creek, and the rare and restricted alpine water skink on Davies Plain ridge.

Two of the 15 significant species in the block are considered to be highly significant: the Omeo gum (*Eucalyptus neglecta*), which is endemic in the eastern Victorian highlands, and an undescribed pennywort at Buenba (*Hydrocotyle* sp. aff. *sibthorpioides*). Mount Cobberas is the type locality for at least 16 species, including the knawel (*Scleranthus singuliflorus*), and is one of the most highly significant botanical areas in the State.

2. Recreation

The block is remote and inaccessible. Davies Plain Ridge overlooks the Snowy Mountains in New South Wales. Capabilities are high for bushwalking, adventure driving, fishing, wilderness recreation, and cross-country skiing, moderate for caving, and low for hunting, canoeing, and fossicking.

This block has great potential for bushwalking, although most areas are little used at present. It is more suited to longer trips by experienced walkers. The main features include Cowombat Flat, Limestone Creek caves, Davies Plain Ridge, Buckwong River, the Murray River, Tom Groggin station, and mining relics at Mount Murphy. The Cowombat Flat track is a popular walking route from the Benambra--Black Mountain road into the Kosciusko National Park. The area around Davies Plain Ridge has many wilderness attributes.

For recreation driving, the area receives moderate use by four-wheel-drive vehicles and trail-bikes. Tracks in the Limestone Creek area, in particular, are often used.

There is little hunting activity here.

The Murray River headwaters - and its tributaries, such as Buckwong and Limestone Creeks - provide excellent angling for brown and rainbow trout.

Davies Plain Ridge provides excellent opportunities for cross-country skiing. This area, because of its remoteness, would tend to be used mainly for extended trips.

Although not used for canoeing at present, the section of the Murray River from Tom Groggin upstream to about the Rough Creek junction would have some seasonal potential. This area, however, is extremely inaccessible.

Limestone, Smoke Oh, Dead Horse, Mac, and Charlie Creeks yield some alluvial gold.

Limestone caves at Limestone Creek provide some opportunities for caving exploration.

3. Agriculture

Five graziers use the public land. They graze cattle on a variety of country, including black sallee or swamp gum woodlands along the Limestone and Buckwong Creeks, snow gum woodlands on Davies Plain Ridge, and narrow-leaf peppermint forests, snow gum--mountain gum forests, and alpine ash forests. In the past, up to 400 cows and dry cattle and 200 calves from Tom Groggin have been run at Davies Plain and in the snow gum woodlands on the plateau during summer, while the narrow-leaf peppermint forests along the Murray supported 400 cattle in winter. This pattern has continued, but with a recent change of ownership the number has been reduced to about 150 cows with 40 calves and 35 dry cattle.

Access routes from Tom Groggin are via Davies Plain.

Graziers using the southern portion of the blocks have home properties around Benambra, and gain access from the south via Mount Murphy or the Benambra--Black Mountain road. Cattle put out in summer from Benambra number about 250 cows with 100 calves and 340 dry cattle. In winter about 300 cows and 100 dry cattle graze at the lower elevations around Limestone and Dead Horse Creeks. The Cowombat Flat area has no natural boundary with New South Wales, and grazing is limited because of the non-grazing policy in the adjacent Kosciusko National Park.

The only private land in this block is in the north at Tom Groggin, except for a very small area on Limestone Creek. These areas are used to graze cattle in conjunction with grazing on public land.

The average capability for bush grazing is high. Most grazing takes place in grassy snow gum woodlands, mountain gum--snow gum forests, and narrow-leaf peppermint forests. Capability for further agricultural development is low.

4. Apiculture

This block has little suitable access for apiarists and is remote. Honey flora include snow gum, alpine ash, and black sallee.

5. Wood production

Capability for hardwood production is high in the 2,300 ha of regrowth alpine ash forest and 10,600 ha of mature and harvested alpine ash forests distributed at various localities. Capability of moist foothill forest is moderate in small isolated areas, but is otherwise low.

One mill at Benambra annually cuts about 9,600 m^3 of sawlogs from about 130 ha of forest.

6. Minerals

The Limestone Creek gold-fields are situated in the southern portion of the block. Silver, lead, and copper deposits are found in the vicinity of Limestone Creek, and a major lead geochemical anomaly has recently been discovered in this area. The block also includes the Mount Murphy deposit of tungsten ore, although reserves are not considered to be substantial. Limestone and marble deposits occur along Limestone Creek and its tributaries. Marble at Painter and Stony Creeks is of high quality.

7. Water production

Bordered to the north by Buenba and Omeo Creeks and to the east by a section of the Murray River, this block contains the drainage systems of Buckwong and Limestone Creeks, both tributaries of the Murray. Rainfall in the block varies from more than 1,000 mm to 1,600 mm per annum. The mean annual discharge of the Murray River at Tin Mine Creek is 158,200 Ml, of which 20% is delivered in the 6 months December to May, including 6% in the 3 months January to March.

No records of water quality are available, but the high quality of the Murray River at Jingellic (average salinity 29 mg per l) points to high-quality water being contributed by streams in this block.

The capability for water production is high.

D. Hazards

The erosion hazard is moderate to low and the fire hazard is high. There are few noxious weeds in the block. Insects have caused severe die-back in snow gums on Davies Plain Ridge. Brumbies are prevalent throughout.

17. SUGGAN BUGGAN

A. Location and Tenure

Suggan Buggan block covers a total area of 45,600 ha, of which 41,200 ha (90%) is public land. This includes part (2,400 ha) of the Rocky Range Wildlife Reserve and a 460-ha camping and recreation reserve at Willis on the Snowy River. The remaining public land is unreserved Crown land. The freehold land surrounds the settlement of Suggan Buggan.

County of Tambo: Parishes of Karawah, Toonginbooka, Ingeegoodbee, Suggan Buggan, Chilpin, and Woongulmerang East.

B. Nature of the Land

1. Climate

Rainfall diminishes from west to east across the block, and a marked rain-shadow extends from Mount Stradbroke to the Snowy River. Average annual rainfall may exceed 1,600 mm at the Cobberas on the Great Dividing Range, which receives rainfall mostly from the prevailing moist north-westerly air streams and from southerlies. The rain-shadow region receives less than 700 mm, with a maximum in late spring and early summer.

The main rain-bearing air streams here - southerlies and south-easterlies - bring rain at any time of the year. Thunderstorms may bring heavy summer showers, but are erratic. Snow falls regularly from June to October on the higher elevations (above 1,000 m) in the west.

2. Geology and physiography

Deeply dissected valleys descend from elevated plateau country and the Great Divide towards the Suggan Buggan and Snowy Rivers, with 600--700 m between ridge tops and adjacent valley floors. Elevations in the block range from 1,838 m at Mount Cobberas No. 1 to 160 m in the south on the Snowy River. The southern border follows a ridge on the edge of the Wulgulmerang Tablelands - from Rocky Plains plateau, Mount Stradbroke, Mount Hamilton (1,030 m), to Black Mountain (1,000 m) in the south.

From Mount Stradbroke (1,280 m) there is a spectacular drop of more than 900 m in 2 kilometres to the Suggan Buggan River. Small basins exist at Berrima River and McFarlane Flat, and a small plateau lies above the Snowy River in the east.

A belt of Lower Devonian rhyolite (Snowy River volcanics) runs south-east of the Cobberas to form most of the Wulgulmerang Tablelands. Rhyolites have formed periglacial rock rivers near the Cobberas. Silurian sediments appear north of the volcanics at Forest Hill (the source of the Murray), and in the south-east at Buchan River. Lower Devonian granite east of the tablelands in the Suggan Buggan valley is associated with Ordovician schists, especially around Mount Menaak. Tertiary basalt remnants in the south around Black Mountain overlie Oligocene--Eocene sediments in places.

3. Soils

Stony loams predominate in the highest region of the block around Mount Cobberas. The rugged mountainous terrain confines organic loams and peats to more sheltered and less-steep slopes further east. Some peats have become humified where stream entrenchment has lowered the water table. Organic loams are mainly shallow, and grade into friable brown gradational soils at lower elevations, or stony loams on exposed ridges or steep slopes.

On the lower hills and alluvial terraces of drier areas, for example rain-shadow areas of Suggan Buggan valley, red or yellow-brown gradational soils and red duplex soils predominate, with yellow duplex soils in less-well-drained areas.

The lower slopes of steep hills have massive gradational soils, and coarse sands are common on the granitic slopes east of Suggan Buggan.

4. Vegetation

Vegetation in this block is among the most diverse in the study area. Snow gum open forest I caps the Cobberas and Rams Head Ranges, Buchan Rock, Blue Hill, and Big Hill. Elevations range from about 1,350 m up to 1,800 m at Mount Cobberas. Snow gum forests have grassy (snow grass and prickly starwort) to heathy (mountain beard-heath, rough coprosma, and mountain plum pine) understoreys.

Mountain gum--snow gum forests cover extensive areas on exposed slopes flanking the highest mountains in the west of the block at elevations ranging between about 1,200 and 1,500 m. In the Berrima River basin, however, this vegetation type descends to about 900 m. Understoreys may consist of low shrubs (handsome flat-pea, hop bitter-pea, and prickly bush-pea) or may be grassy (snow grass, prickly starwort, and common billy-buttons).

There are a number of small flats consisting of grasslands, wet heathlands, and sedgelands at various localities. Most sub-alpine open areas (such as Native Dog Plain and Rocky Plain; Dingo, Square, and James Flats; and the Playgrounds) lie at elevations between 1,140 and 1,400 m. Common plants include snow grass, ivy-leaf violet, sedges, mountain baeckea, small-fruit hakea, and drumstick heath. Black sallee woodlands with grassy understoreys are commonly associated with sub-alpine open areas at elevations ranging between about 1,000 m and 1,320 m.

Alpine ash forests are restricted to sheltered sites at elevations between 1,000 and 1,500 m. Understorey shrubs include mountain beard-heath, mountain pepper, silver wattle, and rough coprosma.

Open forest III is restricted to sheltered sites below about 1,200 m. Tree species include mountain gum, candlebark, eurabbie, and narrow-leaf peppermint. Understoreys are shrubby.

Open forest II commonly consists of red stringybark, long-leaf box, candlebark, brittle gum, and broad-leaf peppermint. Understoreys are typically heathy to shrubby (daphne heath, handsome flat-pea, twin-flower beard-heath, red-stem wattle, and prickly bush-pea). Silvertop is a component of open forest II near Black Mountain.

Open forest I is common on dry sites above about 600 m. Tree species are similar and understoreys include daphne heath, kangaroo grass, matted bossiaea, and lightwood.

On dry rocky sites, dense scrubs of red wattle, rock wax-flower, and shiny phebalium may be found. Similar sites may also carry thickets of tingaringy gum.

White box woodland occupies extensive tracts below about 700 m on steep slopes, plateaux, and gentle basins. Understoreys may be sparse or grassy (kangaroo grass, bent-grasses, and cane wire-grass) with scattered low shrubs (cranberry heath, daphne heath, boomerang wattle, grey everlasting, and pepper everlasting). Associated trees are yellow box and manna gum near watercourses and black and white cypress pine or long-leaf box on drier sites. Cypress pine stands predominate on exposed aspects along the Suggan Buggan and Snowy River valleys below about 540 m. Ground cover is usually sparse.

5. Fauna

Fourteen native mammal species, 77 native bird species, 19 reptile species, six amphibian species, and seven species of native fish have been recorded.

Habitats range from woodlands and riverine forests at the lower elevations near Suggan Buggan through dry open forest to wet open forest and extensive areas of sub-alpine woodland near the Cobberas and Mount Wombargo. Sub-alpine open areas occur as small plains at several localities. Wetlands vary from the Snowy River to small mountain streams.

Mammals in riverine forests include the yellow-bellied glider, sugar glider, feather-tailed glider, common wombat, and bush rat. Bird populations are relatively diverse in this habitat.

Records include the collared sparrow-hawk, olive-backed oriole, superb blue-wren, southern yellow robin, rufous fantail, golden whistler, eastern whipbird, yellow-tufted honeyeater, and red-browed finch.

Sub-alpine woodlands are known to provide habitat for the eastern grey kangaroo, red-necked wallaby, black wallaby, ring-tailed possum, brown antechinus, and bush rat. Few records are available for birds.

Mammals in wet open forest include the red-necked wallaby, black wallaby, common wombat, and bush rat. Typical species include the gang-gang cockatoo, crimson rosella, laughing kookaburra, red wattle-bird, superb lyrebird, white-browed scrub-wren, brown thornbill, southern yellow robin, grey fantail, golden whistler, grey-breasted silvereye, and yellow-faced honeyeater.

The four macropodids recorded in dry open forest include the rare and restricted brush-tailed rock-wallaby, which prefers rugged cliffs with sunny aspects. Birds in this habitat include the buff-rumped thornbill, scarlet robin, spotted pardalote, fuscous honeyeater, and red wattle-bird.

The 10 mammals recorded in white box--black cypress pine woodlands include the eastern grey kangaroo, yellow-bellied glider, feather-tailed glider, brown antechinus, and eastern horseshoe bat. Typical birds include the rainbow bee-eater, weebill, striated thornbill, willie wagtail, scarlet robin, hooded robin, rufous whistler, brown tree-creeper, eastern striated pardalote, white-winged chough, pied currawong, mistletoe bird, and orange-winged sittella.

Reptiles found in woodlands and wetlands at lower elevations are the small-eyed snake, tree dragon, three-lined skink, copper-tailed skink, Cunningham's skink, rock skink, garden skink, White's skink, water skink, and Gippsland water dragon. At the higher elevations the reptiles found were grass skink, mountain dragon, Coventry's skink, McCoy's skink, Spencer's skink, water skink (cold-temperate species), copperhead (highland form), southern blue-tongue, and white-lipped snake.

Amphibians are brown tree frog, Verreaux's tree frog, Lesueur's frog, eastern banjo frog, southern toadlet, and common eastern froglet.

Records for fish include the Kosciusko mountain trout, short-finned eel, brown trout, and rainbow trout. The short-headed lamprey, Victorian smelt, long-finned eel, congolli, and river blackfish are listed for the Snowy River.

6. Land systems

The Nunniong High, Enano, Cobberas, Wat Wat High, Berrmarr (Igneous), Bemboka, Graham, Jingallala, Maroo High, Wulgulmerang, Buckenderra, and Gelantipy East land systems are represented in the block.

C. Present Use and Capabilities

1. Nature conservation

The capability for nature conservation is very high. Environments are very diverse, ranging from sub-alpine woodlands to white box--cypress pine woodlands. Periglacial rock rivers occur around the Cobberas. Richly fossiliferous Silurian shales overlain by blue-grey fossiliferous limestone outcrop at Native Dog Plain.

The brush-tailed rock wallaby has been recorded on the Rocky Range. The eastern horseshoe bat recorded near McKillops Bridge is a rarely observed species. Bird species in the Snowy River valley are typical of dry woodlands, and some are rarely found elsewhere in the study area. Reptiles also include those typical of warm dry climates, such as the copper-tailed skink and rock skink. The congolli is a rare species of native fish recorded for the Snowy River.

Of the 49 species of plants recorded as significant here, 22 are considered highly significant, and two of those are endemic to the study area. Many are very rare in Victoria. These include, for example, the hoary ray-flower (*Anthocercis albicans*), sticky bertya (*Bertya cunninghamii*), moonwort (*Botrychium lunaria*), the sedge *Carex capillacea*, and an undescribed bent-grass (*Deyeuxia* sp. aff. *augustifolia* from the Ballantyne Hills, unknown elsewhere in Victoria. Species known at only one site in Victoria are the hyacinth orchid (*Dipodium hamiltonianum* - near Mount Wheeler), mountain cress (*Drabastrum alpestre* - Suggan Buggan), glossogyne (*Glossogyne tenuifolia* - Suggan Buggan), the greenhood orchid *Pterostylis coccinea* (near old Black Mountain station), the bush-pea (*Pultenaea subspicata* - Wulgulmerang and Mount Hamilton area), and wild sorghum *Sorghum leiocladum* - in the Suggan Buggan--Ingeegoodbee area.

Species with very disjunct habitat range are the skeleton fork-fern *Psilotum nudum* (Ballantyne Hills and southern Wimmera); the desert cassia *Cassia nemophila* (at Suggan Buggan, typical of sandy Mallee habitats); and the midget greenhood (*Pterostylis mutica*), narrow thread-petal (*Stenopetalum lineare*), and variable swainson-pea (*Swainsonia oroboides*) - all at Suggan Buggan, but typically of dry regions of north-western Victoria. Two species endemic to the study area are a guinea-flower (*Hibbertia spathulata*) at Suggan Buggan and the greenhood *Pterostylis aestiva* at Mount Stradbroke and the Suggan Buggan Range.

2. Recreation

The main features are the Cobberas Range, the cypress pine--box woodlands around Suggan Buggan, and the Snowy River. Capabilities are high for bushwalking, recreation driving, and canoeing, moderate for wilderness recreation and fishing, and low for hunting, cross-country skiing, and rock climbing.

The principal attraction for bushwalkers is the rocky Cobberas Range which receives frequent use during the warmer months. Most walking trips in this area would take several days at least. The Snowy River, with its sandy beaches and interesting rock formations, attracts a number of walking parties each year. Other areas visited include McFarlanes Flat, the Playgrounds, Native Dog Plain, the Rams Horn, Hanging Rock, and the Suggan Buggan River. The area generally receives moderate use at present and has great potential for walking.

Some recreation driving occurs on the Buchan--Jindabyne road, a section of which passes through the block. Jeep tracks receive moderate to frequent use, particularly in the Playground and McFarlanes Flat areas.

Some hunting for red deer occurs around Suggan Buggan, the Snowy River, and other localities.

The Snowy River and its tributaries such as the Suggan Buggan River provide trout angling.

The Cobberas area has some potential for cross-country skiing.

Canoeists use the Snowy River from Willis to McKillops Bridge, which consists of small rapids followed by quiet stretches. The river distance is 35 km and takes about 6 hours to canoe. It can be negotiated throughout the year, but water levels are usually low during summer and autumn. The sandy beaches, warm water, and spectacular scenery make the Snowy one of the most popular streams in Victoria during the summer.

Camp sites along the Snowy River near Willis are popular.

Hanging Rock and the cliffs around Mount Stradbroke offer challenges to rock climbers, but are not used due to distance from population centres and the inaccessible nature of the block. Rams Horn (Buchan Rock) is climbed occasionally.

3. Agriculture

Four graziers use the public land. Three have properties on the Wulgulmerang Tablelands; the other is at Buchan. In summer the higher elevations around the Playgrounds, Rams Head Range, and in the headwaters of the Berrima River are grazed by 200 cows with their calves and 200 dry cattle.

Other public land at Forlorn Hope and Native Cat Plains (both in block 18) is used during summer in conjunction with home properties on the Wulgulmerang Tablelands.

During the winter about 380 dry cattle and 50 cows graze the white box--cypress pine woodlands, and red stringybark forests. Other cattle from Wulgulmerang are grazed in block 20 on the tablelands close to home properties.

The Snowy River forms a natural boundary for cattle movements in the east, but in the north the block adjoins the Kosciusko National Park, and has no distinct physical boundary to stock movement. This reduces the level of use that can be attained on runs bordering the Park, where cattle-grazing is prohibited.

The only private land in this block is at Suggan Buggan on either side of the Suggan Buggan River. Relatively little has been cleared and sown to pasture, but in some localities the trees have been ring-barked to allow better growth of native pasture species.

The lack of development of freehold land in the area can be attributed to its isolation, steepness, and susceptibility to erosion. However, control of rabbits and the recent establishment of deep-rooting perennial species have shown that productive pastures can be developed. The main enterprise is beef production, but some sheep are run.

The block is important as summer range at the high elevations and as winter range at the lower elevations. Average capability for bush grazing is high to moderate.

The capability of public land for agricultural development is low.

4. Apiculture

Access is very poor. Honey flora include snow gum, black sallee, red stringybark, long-leaf box, brittle gum, and white box.

5. Wood production

Capability for hardwood production is high in alpine ash stands, but these are small and isolated and total only 1,600 ha. Capability of moist foothill forest is moderate in small areas adjacent to alpine ash stands, and elsewhere is low. Extensive stands of white box and cypress pine occur in the east of the block and are lightly utilized for durable timber products such as fence posts and farm shed-poles.

No sawlogs are cut from this block.

6. Minerals

This block includes a substantial area of Snowy River volcanics, which may contain disseminated base-metal deposits. Gravel-extraction sites are located along major access roads.

7. Water production

Suggan Buggan block contains sections of the Ingeegoodbee River and the Berrima River - which becomes the Suggan Buggan River. A section of the Snowy River forms the eastern boundary, and the south-western boundary is formed by a section of the Buchan River.

Rainfall in the block varies from less than 700 mm near the Snowy River to more than 1,600 mm in the Rams Horn--Mount Cobberas No. 1 area. Run-off flows into tributaries of the Buchan, Berrima, Suggan Buggan, and Ingeegoodbee Rivers. Mean annual discharges of the Buchan (at Glenmore), Suggan Buggan, and Ingeegoodbee Rivers are 102,249 Ml, 57,238 Ml, and 12,806 Ml respectively. All of these flow with reasonable reliability, yielding about 25% of their mean annual discharge in the 6 months December to May, including 7--8% in the 3-month period January to March.

Although still of high quality, the salinity readings for the Suggan Buggan River average 67 mg per l and for the Buchan River at Buchan 68 mg per l. This is high when compared with most streams in the study area.

The capability for water production is high.

D. Hazards

The erosion hazard is moderate at the higher elevations and high around Suggan Buggan, where rainfall is low and most soils are derived from granite. The fire hazard is high. Blackberries and sweet briar are among seven noxious weed species in the area. Brumbies range throughout.

18. REEDY

A. Location and Tenure

Reedy block covers a total area of 42,400 ha, of which 39,800 ha (94%) is public land. Reserved forest (1,300 ha) occurs in the east along the Bowen Mountains and in the north, the remaining public land being unreserved Crown land. Freehold land occurs south of Mount Leinster and north-east of Mount Tambo.

County of Tambo: Parishes of Eucambene, Bindi, Nunniong, Glenmore, Woongulmerang West, Berrimar, Karawah, and Toongin-booka.
County of Dargo: Parishes of Moonip and Thorkidaan.

B. Nature of the Land

1. Climate

High rainfall, mainly from the prevailing westerly air stream, is associated with the generally high elevation of the block. Southerly and south-easterly air streams may bring rain at any time of the year. Thunderstorms contribute to summer rainfall, but occur erratically.

The Bowen Mountains in the west are on the edge of the Ben-ambra rain-shadow area, and receive in excess of 1,000 mm average rainfall. This increases to more than 1,600 mm in the south of the Native Cat Tablelands, and diminishes to less than 900 mm in the valley of the Buchan River in the east.

Low winter temperatures may allow snow to persist on the higher peaks and ridges from June to October, with snowfalls occurring regularly above 1,000 m during this period.

2. Geology and physiography

The Native Cat Tablelands, which are the dominating land form, extend south from the Cobberas region to Mount Nunniong (1,620 m) in the Nunniong block. These Tablelands are at about 1,400 m elevation and are separated from the Nunniong Tablelands to the south by a gentle escarpment that descends from about 1,420 m to 1,180 m. Gentle prominences on the Tablelands rise to 1,570 m at Brumby Hill and to 1,550 m south of Native Cat Flat. On the west flank of the Table-lands, the Tambo River descends from a basin at about 1,000 m elevation near Mount Leinster (1,400 m) through a deeply dissected valley. On the east the Buchan River also flows through deeply dissected topography.

A series of faults running parallel to the Great Divide forms a feature of the block. A central north-east-trending belt of Silurian volcanics - now regarded as equivalent to the Mitta Mitta volcanics - is flanked by Silurian sediments and Devonian granite intrusions. Ordovician sediments appear on the Bowen Mountains and Black Range. There is a Triassic syenite intrusion in the Mount Leinster region, and Quaternary alluvium has been deposited along Reedy Creek upstream of the Reedy Creek chasm.

3. Soils

The elevated Native Cat Tablelands and adjacent high mountainous terrain have shallow organic loams that become deeper at lower elevations. Associated with these are peats, which are often humified where stream entrenchment has lowered the water table. Friable brown gradational soils become dominant at lower elevations. Friable red gradational soils attain dominance on less-steep slopes where annual rainfall decreases to about 1,000 mm.

Stony loams occur on exposed ridges, peaks, and steep slopes. Slopes south of Mount Leinster carry yellow-brown gradational soils, along with massive gradational soils. Yellow duplex soils occur on valley slopes where drainage is poor.

4. Vegetation

Snow gum open forest is limited to the highest ridges in this block, at elevations generally between 1,400 and 1,560 m. The understorey is usually grassy with scattered low shrubs (snow grass, gorse bitter-pea, alpine oxylobium, and diggers' speedwell).

An unusual complex occurs at Brumby Point, where at elevations between 1,200 and 1,460 m bands of heathland (mountain banksia, leafless sour-bush, and gorse bitter-pea) alternate with mallee thickets (snow gum and ash-mallee) that have a heathy understorey (leafy bossiaea and alpine oxylobium).

Mountain gum--snow gum open forests flank the snow gum forests of the Native Cat Tablelands between 1,200 and 1,500 m elevation. Mountain gum--snow gum also occurs in the headwaters of the Tambo River down to elevations of 900 m. Candlebark and occasionally broad-leaf peppermint are associated trees. Understoreys may be shrubby (hop bitter-pea, prickly bush-pea, and mountain hickory wattle), heathy (gorse bitter-pea and handsome flat-pea), or grassy (snow grass and bidgee-widgee).

Wet heathlands, grasslands, and herbfields are principally located at Native Dog, Native Cat, Billy, and Forlorn Hope Plains, and at Diggers Holes. Plants include mountain baeckea, alpine bottle-brush, snow heath, small-fruit hakea, spreading rope-rush, snow grass, tiny violet, creeping cudweed, and yellow eyebright. Elevations are between 1,140 and 1,500 m.

Alpine ash stands are restricted to sheltered sites between about 1,100 and 1,400 m, and are mostly mature, although some are regrowth following a wildfire in 1965. Understoreys tend to be shrubby (silver wattle, elderberry panax, rough coprosma, and prickly bush-pea).

Open forest III commonly includes narrow-leaf peppermint, mountain gum, and broad-leaf peppermint. Understoreys are typically shrubby (prickly bush-pea, silver wattle, austral bracken, and handsome flat-pea).

Open forest III occupies the more sheltered aspects below the Native Cat Tablelands.

Open forest II occupies drier sites. At the higher elevations broad-leaf peppermint, mountain gum, candlebark, and brittle gum are the common trees. Understoreys are often grassy with scattered shrubs (prickly bush-pea, handsome flat-pea, and mountain hickory wattle) or heathy. At lower elevations common trees are red stringybark, brittle gum, and broad-leaf peppermint. Understoreys may be grassy to heathy.

Open forest I occurs on dry sites over a considerable range in elevation. Broad-leaf peppermint, brittle gum, and mountain gum are common at the higher elevations. Understoreys are often heathy (mountain banksia, pale-fruit ballart, box-leaf wattle, daphne heath, gorse bitter-pea, and spiny-headed mat-rush). Red stringybark is present at the lower elevations, where understoreys may be grassy with scattered shrubs (guinea-flower and small-leaf parrot-pea).

5. Fauna

Little survey work has been done in this block and only five native mammal species, 31 native bird species, and five reptile species have been recorded. Brumbies occur in the block.

Wetlands are mountain streams. Riverine forests mainly border the major streams. Tableland areas are predominantly sub-alpine woodlands with small open areas of wet heathland, mossland, and grassland. The escarpments are wet open forest or dry open forest, depending on aspect.

Birds in riverine forests are typical of this habitat type.

The brown antechinus, Gould's wattled bat, and smoky mouse have been recorded in sub-alpine woodland.

Birds in sub-alpine woodlands, wet open forest and dry open forest are all typical of the respective habitats elsewhere in the study area.

Reptiles, all recorded at the lower elevations, are the tree dragon, copper-tailed skink, Cunningham's skink, Gippsland water dragon, and southern blue-tongue.

6. Land systems

The Buckenderra, Ben Cruachan, Mt Phipps, Nunniong (Igneous), Berrmarr (Igneous), Limestone Creek, Cobberas, Graham, Barry Mountains, Wongungarra, Nunniong High, Gelantipy East, Wat Wat Low, Mt Leinster, and Wat Wat High land systems are represented in the block.

C. Present Use and Capabilities

1. Nature conservation

The capability for nature conservation is very high. Environments vary from sub-alpine woodlands to riverine forests. A rocky outcrop near Brumby Hill shows a typical development sequence of Silurian conglomerates. An unusual vegetation complex of alternating bands of heath and mallee thicket occurs on soils derived from sedimentary parent materials at Brumby Point. Much of the block has been little disturbed by various land uses.

The uncommon smoky mouse has been recorded on the Native Cat Tablelands, and the copper-tailed skink (at the southern edge of its range) in the Buchan River valley. Colonies of the brush-tailed rock wallaby were recorded on rocky cliffs by the Buchan River several years ago.

Of the 27 species recorded as significant in Reedy block, ten are considered highly significant, of which two are endemic to the study area. These are the thready beard-heath (*Leucopogon pilifer*) on Forlorn Hope Plain and the trailing monotoca (*Monotoca rotundifolia*) near Brumby Point. Forlorn Hope Plain is also one of the several recorded Victorian localities for the moonwort *Botrychium lunaria,* one of two localities in Victoria for an undescribed mountain mud-mat (*Glossostigma* sp.), and a disjunct occurrence of the marsh leek-orchid (*Prasophyllum rogersii*). An undescribed *Grevillea* species occurs near the Reedy and Buchan Rivers, and an undescribed *Dampiera* species in the upper Buchan River area.

2. Recreation

Capability is high for wilderness recreation and bushwalking, moderate for adventure driving and cross-country skiing, and low for hunting and fishing.

The block is little used by bushwalkers at present, mainly because of its distance from large population centres, although the Reedy Creek chasm and Forlorn Hope Plain are occasionally visited. Most walkers traverse it along the main ridge between the Nunniong Tablelands and the Black Mountain --Benambra road near Mount Pendergast. The block has considerable potential for bushwalkers because of the undulating sub-alpine ridges and steep rugged terrain falling to the Buchan River, Tambo River, and Reedy Creek. Wilderness attributes are considerable.

Most of this block is little used for recreation driving by four-wheel-drive vehicles or trail-bikes. The Nunniong road through the centre, however, carries moderate traffic.

Limited hunting for red deer occurs here.

The headwaters of the Buchan and Tambo Rivers provide trout angling.

The Native Cat Tablelands, which cover a considerable area, have some potential for cross-country skiing.

3. Agriculture

Five graziers hold grazing runs on the public land. Those areas used regularly are at Forlorn Hope Plain, Native Cat Creek, and Diggers Holes. An area in the headwaters of the Tambo River is also used from time to time.

During the summer about 100 cows with their calves and 50 dry cattle graze in the snow gum woodlands, small plains, or mountain gum--snow gum forests. Two areas - one of about 40 ha at Forlorn Hope Plain and one of about 120 ha at Diggers Holes - are fenced. Water is adequate.

The two relatively small areas of private land are both extensions of private property in the Benambra block. A small area just east of Mount Tambo has been developed, while a larger one south-east of Mount Leinster is still largely undeveloped.

The capability for bush grazing is generally low, but is moderate at Diggers Holes and Forlorn Hope Plain, although they are remote.

The capability for further development of public land for agriculture is generally low.

4. Apiculture

Access for apiarists is very poor. Honey flora include snow gum, alpine ash, red stringybark, and brittle gum.

5. Wood production

Capability for hardwood production is high in alpine ash stands in Garrons Creek and the head of Reedy Creek. Regrowth and mature alpine ash stands total about 4,100 ha. Capability of moist foothill forest is generally low.

No sawlogs are cut from this block.

6. Minerals

The block includes a large area of Mitta Mitta volcanics, which contain a number of good prospects for large-scale disseminated copper or lead deposits.

7. Water production

The main streams in this block are the Buchan River on the eastern boundary, the Tambo Riber, and Reedy Creek. Rainfall over the most of the block varies from 900 mm per annum at the eastern and western extremities to 1,400 mm per annum on the tablelands.

The mean annual discharge for the Tambo River at Bindi (in Nunniong block) is 46,358 Ml. Of this, 21% is delivered in the 6 months December to May, including 7% in the 3 months January to March. Reedy Creek flows eastwards through the block and into the Buchan River, which has a mean annual discharge at Glenmore of 102,249 Ml, and delivers 24% of this in the 6 months December to May, including 7% in the 3 months January to March.

An average salinity of 68 mg per l for the Buchan River at Buchan is relatively high, compared with other streams in the study area.

The Tambo River at Swifts Creek has a higher mean salinity value of 132 mg per l, but this still represents good-quality water. The Tambo is the source of domestic water supply to the township of Swifts Creek.

The capability for water production is high.

D. Hazards

The erosion hazard is moderate and the fire hazard high. There are few noxious weeds in the block. Brumbies range throughout.

19. NUNNIONG

A. Location and Tenure

Nunniong block covers a total of 113,110 ha, of which 91,700 ha (81%) is public land. The large area of reserved forest (37,900 ha) is distributed in three parcels; two are west of the Buchan River, on the Mia Mia Creek and around Mount Nugong, and the other is along the Great Divide south of Mount Tambo. The remaining public land is unreserved Crown land (53,800 ha). Freehold land occurs in the Tambo and Bindi basins in the west, and at Timbarra, Gillingall, and east of Green Hill.

County of Tambo: Parishes of Bindi, Nunniong, Glenmore, Woongulmerang West, Gelantipy West, Murrindal West, Mellick-Munjie, Nappa, Noyong, Ensay, and Tongio-Munjie East.
County of Dargo: Parishes of Moonip, Terlite-Munjie, and Tongio-Munjie West.

B. Nature of the Land

1. Climate

The Nunniong Tablelands receives most of its rain from southerly and south-easterly air streams that bring rain at any time of the year. Average annual rainfall exceeds 1,600 mm around Mount Nunniong, diminishing to less than 900 mm on the southern end of the Tablelands and along the Buchan River valley.

The rain-shadow area around Omeo extends from Tongio up the Tambo River valley north of Bindi, receiving less than 700 mm rainfall. Rainfall tends to be higher in spring in these rain-shadow areas, and thunderstorms can be important additions to summer rainfall, although these are erratic. The prevailing westerly air stream has lost most of its moisture before reaching this block.

Low winter temperatures may allow snow to persist on the high peaks (e.g. Mount Nunniong) from June to October, snowfalls occurring regularly above 1,000 m in this period.

2. Geology and physiography

The Nunniong Tablelands, in common with the Native Cat Tablelands, are a remnant of the Baw Baw Surface and dominate the landscape in the east of the block. Successive flows of Oligocene basalt have formed a stepped topography on the Tablelands, which descend from 1,200 m to 800 m, north to south. A fault line along the south-western edge, near Mount Nugong (1,482 m), is the continuation of the Indi Fault. Mount Nunniong (1,620 m) at the northern border is the highest point in the block.

Stream flow is generally south from the Great Divide, with a low point of 240 m on the Buchan River at the southern border. Two basins occur in the vicinity of the Tambo River in the west: the Bindi (400--500 m) and Tambo (300--400 m) basins.

Ordovician sediments have generally been metamorphosed to schists or gneisses, except for a belt of sandstones and siltstones extending north from Mount Walterson to Mount Cook on the Great Divide. Ordovician rocks in the upper Timbarra River region have been metamorphosed to low-grade gneisses, although this is not indicated on the geology map. Lower Devonian granite occupies a major portion of the block, particularly on the Nunniong Tablelands.

The Bindi basin is largely a remnant of Middle Devonian limestone (Buchan group) preserved from erosion by down-faulting. Another example of this occurs at Gillingall, north of Buchan.

Triassic syenite intrudes Upper Devonian--Lower Carboniferous sediments along the Bowen Mountains near Mount Tambo (1,431 m). To the east, a Lower Devonian (or Upper Silurian) rhyolite flow overlies Silurian sediments that are exposed north-east of the Bindi basin. Quaternary alluvial deposition has occurred along the Bindi and Scrubby Creeks, Timbarra River, and many small streams on the Nunniong Tablelands.

3. Soils

Peats are not common, except near the highest elevations near Mounts Nunniong and Nugong. Organic loams occur on the tablelands, but friable brown gradational soils predominate. Stony loams occur throughout the mountainous areas on exposed ridges and steep slopes. Friable brown gradational soils grade into red or yellow-brown gradational soils at lower elevations, where massive gradational soils also occur (the latter being more common on coarse-textured rocks). Red gradational soils occur on basalt on the Nunniong Tablelands.

Mountainous areas in the west have similar soil sequences. Areas of stream alluvium, such as occur in the Bindi and Tambo basins, have red gradational soils with weak structure, grey-brown loams, and undifferentiated sands and loams. Red and yellow duplex soils occur on the rolling topography of the valleys. Red calcareous clays are found on limetstone formations near Bindi, and also near Gillingall in the east.

4. Vegetation

Snow gum woodland and open forest is mostly confined to the highest elevations (1,400--1,600 m) of the Tablelands, such as at Mounts Nunniong and Nugong. Understoreys may be grassy (snow grass, ivy-leaf violet, and prickly starwort) to heathy (leafy bossiaea, alpine pepper, mountain beard-heath, and alpine oxylobium). An unusual complex of alternating bands of heathland and mallee-like thickets similar to that at Brumby Point in Reedy Block is situated on a ridge in the far north-east of the block.

Mountain gum--snow gum open forest covers extensive areas of the Nunniong Tablelands between 1,000 and 1,400 m. Understoreys are typically grassy with scattered shrubs (snow grass, prickly starwort, ivy-leaf violet, common cassinia, silver wattle, gorse bitter-pea, and bush-pea).

Large open plains are a feature of these tablelands. Nunniong Plain (1,160--1,220 m), Low Plain (1,140--1,160 m), and Nunnett Plain (1,080--1,100 m) are mainly grasslands (snow grass, ivy-leaf violet, and bidgee-widgee), or grasslands with scattered shrubs (for example small-fruit hakea at Lake Hill). Other areas have wet heathlands (alpine baeckea, alpine bottle-brush, alpine heath, and snow heath) as at Bentleys Plain or mosslands (sphagnum moss, spreading rope-rush, candle heath, and silver astelia) as major components.

Most of the alpine ash forests are on the tablelands, where considerable areas of these extensive stands have been harvested and regenerated. Mature and fire regrowth forests are also found adjacent to and below snow gum and mountain gum--snow gum forests on the Bowen Range at elevations between 1,000 and 1,200 m.

On the tablelands, alpine ash forests range between 1,000 and 1,400 m. Mountain gum is often associated with alpine ash and understoreys may be grassy with scattered shrubs (derwent speedwell, snow grass, ivy-leaf violet, bidgee-widgee, prickly starwort, orange everlasting, silver wattle, austral bracken, and bush-pea) or sometimes heathy (gorse bitter-pea, mountain beard-heath, and bush-pea).

Mountain ash forests with a shrubby to wet-gully-type understorey (silver wattle, austral mulberry, common cassinia, shining cassinia, mountain correa, woolly tea-tree, soft tree-fern, musk daisy-bush, blanket-leaf, and southern sassafras) grow at Ah Chows Creek between 700 and 1,000 m elevation.

Open forest III includes extensive messmate stringybark stands on the eastern side of the tablelands and bordering the southern escarpments as well as at scattered localities along the Bowen Mountains. Some stands exceed 40 m in height.

Messmate stringybark is mixed with manna gum, Gippsland blue gum, and sometimes mountain grey gum. Understoreys are typically shrubby (silver wattle, common cassinia, daisy-bush, bootlace bush and austral bracken) or wet-gully-type (Victorian christmas-bush, musk daisy-bush, blanket-leaf, and hazel pomaderris).

Narrow-leaf peppermint, mountain gum, and manna gum are the main tree species of open forest III. Understoreys are usually shrubby (silver wattle, common cassinia, and prickly bush-pea) to wet-gully-type (mountain correa, river lomatia, and hazel pomaderris).

Some southern sections of the block have silvertop and white stringybark forests with shrubby to heathy understoreys (prickly bush-pea, and handsome flat-pea).

Open forest II on moister sites includes broad-leaf peppermint, mountain gum, candlebark, and narrow-leaf peppermint. Understoreys may be heathy (handsome flat-pea and gorse bitter-pea) to grassy with shrubs (kangaroo grass, austral bracken, and pale-fruit ballart).

On drier sites red stringybark, long-leaf box, and sometimes red box are more common. Understoreys are usually heathy (honey-pots, guinea-flower, woolly grevillea, cluster-flower geebung, common beard-heath, and prickly bush-pea).

Open forest I includes similar tree species, but red stringybark, candlebark, broad-leaf peppermint, brittle gum, and red box are more common. Understoreys may be grassy (tussock grass and handsome flat-pea), heathy (daphne heath, prickly broom-heath and guinea-flower), or shrubby (box-leaf wattle, hop bitter-pea, golden wattle, red-stem wattle, leafless sour-bush, and handsome flat-pea).

5. Fauna

Nine native mammal species, 67 native bird species, three reptile species, eight amphibian species, and one species of native fish have been recorded. Sambar deer and brumbies occur here.

Wetlands comprise streams and small water bodies on the tablelands. Riverine forests border most streams at the lower elevations. Extensive sub-alpine woodlands and wet open forests cover the tablelands which also include many small and some relatively large sub-alpine grassland areas. Dry open forests are distributed mainly on the escarpments. Cleared land is situated in the Tambo River valley at Bindi and Swifts Creek.

Waterbirds in wetlands include the white-faced heron, black duck, grey teal, dusky moorhen, spur-winged plover, and reed warbler.

Birds of riverine forests include the southern yellow robin, yellow-tufted honeyeater, eastern spinebill, and red-browed finch.

Birds recorded in sub-alpine open areas are the emu, spur-winged plover, welcome swallow, Australian pipit, white-backed magpie, and little raven.

Mammals recorded in sub-alpine woodland are the common wombat, brown antechinus, Swainson's antechinus, and bush rat. Most birds are typical of this habitat.

Wet open forests are known to provide habitat for the black wallaby, greater glider, common wombat, brown antechinus, Swainson's antechinus, and bush rat. Most birds are typical of this habitat elsewhere, but include also the peaceful dove, pallid cuckoo, white-plumed honeyeater, and bell miner.

The eastern grey kangaroo, brush-tailed possum, ring-tailed possum, and common wombat are known to inhabit dry open forest. Birds (such as the laughing kookaburra, scarlet robin, buff-rumped thornbill, red wattle-bird, and grey butcher-bird) are mostly typical of dry open forest.

The Gippsland water dragon has been recorded in the Tambo River, and McCoy's skink, water skink, common eastern froglet, and eastern banjo frog on the tablelands. Other recorded amphibians are the brown-striped frog, southern toadlet, and four species of tree frog. The Australian grayling, a rare fish restricted in its distribution, has been recorded in the Tambo River.

6. Land systems

The Terlite-Munjie, Jirnkee, Mt Jonas, Omeo, Tongio-Munjie West, Swifts Creek, Bemboka, Buckenderra, Jingallala, Graham, Marroo Low, Gelantipy East, Wat Wat High, Beloka High, Thorkidaan, Moroka, Wulgulmerang, Bindi, Ben Cruachan, Yalmy, Marroo High, Nunniong High, Wongungarra, Higginbotham, Traralgon, and Detarka land systems are represented in the block.

C. Present Use and Capabilities

1. Nature conservation

The capability for nature conservation is high. Environments vary from sub-alpine woodlands to riverine forests. An unusual vegetation complex of alternating bands of heath and mallee thicket on soils derived from sedimentary parent materials is located in the north-east of the block. Fossiliferous limestone outcrops at Bindi. The Australian grayling, a rare and restricted native fish, has recently been recorded in the Tambo River upstream of Swifts Creek.

Twenty-six plant species in the Nunniong block are considered significant. The 13 highly significant ones include an undescribed *Dampiera* species in the upper Buchan River, two rare bent-grasses (*Deyeuxia microseta* and *D. parviseta*), an undescribed wax flower of uncertain affinity (*Eriostemon* sp.) at Mount Stewart, an intriguing association of rare isolated species including the everlasting shrub *Helichrysum adnatum* and diosma rice-flower (*Pimelea dichotoma*) above Marble Creek near Bindi, silver carraway (*Oreomyrrhis argentea*) and fairy bluebell (*Wahlengergia densifolia*) on the Nunniong Plain, the austral toad-flax (*Thesium australe*) at Gillingal, an undescribed *Grevillea* species near Reedy track, and an undescribed pennywort (*Hydrocotyle* sp. aff. *sibthorpiodes*) on the Nunniong Plain. Two species endemic to the study area are the thready beard-heath (*Leucopogon pilifer*) and greenhood (*Pterostylis aestiva*).

2. Recreation

The Nunniong Tablelands and its forested escarpments into the Tambo, Buchan, and Timbarra Rivers comprise the dominant feature. In the north-western section, rocky prominences on the Great Dividing Range (Mount Tambo and the Sisters) are also notable recreation features. Capabilities are moderate for bushwalking, recreation driving, cross-country skiing, hunting, and fishing, and low for canoeing and fossicking.

Bushwalkers make little use of this block, mainly because of its distance from the main population centres. They occasionally use the track from Mount Nugong to the Benambra--Black Mountain road via Nunniong Plain. The area has considerable potential, however. The sub-alpine to montane Nunniong plateau is well watered, good camp sites are plentiful, and walking is relatively easy. Features likely to attract walkers include numerous sub-alpine plains, Mounts Nunniong and Nugong, Lake Hill, and the Timbarra, Buchan, and Tambo Rivers.

Recreation drivers use some logging roads on the Nunniong Tablelands as well as jeep tracks on the escarpments and to the west of Bindi.

Red deer and sambar deer populations appear to be sparse and support little hunting. Rabbits and foxes are hunted around the margins of private property.

The Tambo, Timbarra, and Buchan Rivers, and many small streams, provide for trout angling.

The northern section of the Nunniong Tablelands provides some opportunities for cross-country skiing.

Canoeists make some use of the Tambo River from Ezards logging road near Bindi to Swifts Creek and beyond, but its potential is limited to periods of the year when river levels are high.

The Tambo River near Tongio provides gold-panning for fossickers. Gemstones are sometimes sought from around basalt areas on the Nunniong Tablelands.

3. Agriculture

Four graziers run their cattle on the Nunniong Tablelands. These have properties at Ensay, Tongio, and Bindi, and gain access via Ezards logging road from the west, via a logging road from Ensay in the south, and by a jeep track from Bindi. They take some of their cattle up in October--November, although most are taken up in December and January. They bring them down again during April and May in several mobs. At one area (Low Plain), however, the stock are left more or less throughout the year, with additions or removals according to range conditions and the market situation.

Management of stock is facilitated by fencing of prime grazing areas in two localities - Nunniong Plain (200 ha) and Low Plain (150 ha). The Nunniong area is used in conjunction with a fenced area of 120 ha at Diggers Holes (in block 17). Cattle are Herefords, and on the average have comprised about 700 cows, 220 calves, and 180 dry cattle. Graziers from Timbarra, Gillingall, and Buchan graze cattle around their properties. Their runs are used intermittently, perhaps for a month at a time, by a total of about 70 cattle.

The major part of the private land in this block is in the west adjoining similar land in the Baldhead block and to the south of the study area. Nearly all the private land has been cleared and developed for agriculture. The main products are beef and wool. Access to the area is good, and development has in most cases reached an advanced stage. Three small areas at Timbarra and Gillingall in the south-east of the block have been partially developed.

The capability for bush grazing is generally high to moderate. It is high on well-watered plains and on open snow gum --black sallee woodland, but lower on dry and scrubby plains and in snow gum--mountain gum forest. It is also lower in dry valleys, where shrubs are common in the understorey. Blackberries have reduced the area suitable for grazing and made access to water difficult.

The capability for agricultural development is generally low.

4. Apiculture

Access for apiarists is reasonable, and substantial crops of high-quality honey have been obtained. Honey flora include snow gum, alpine ash, mountain grey gum, messmate, silvertop, white stringybark, candlebark, brittle gum, red stringybark, and red box.

5. Wood production

The capability for hardwood timber production is very high. The 2,200 ha of regrowth and 12,900 ha of mature and harvested alpine and mountain ash forests are mainly concentrated on the Nunniong Tablelands and the Nunnett Ridge. Some adjacent extensive areas of moist foothill forest (mainly messmate) have a high capability, notably on the Nunnett Ridge and in the Little River. Elsewhere capability is moderate to low.

Seven mills (three at Nowa Nowa and one each at Ensay North, Swifts Creek, Buchan South, and Buchan) annually cut 66,100 m^3 of sawlogs from about 890 ha of forest.

6. Minerals

This block contains a number of silver--lead--zinc prospects, and the former Tongio gold-fields around Mount Stawell. Extensive limestone deposits occur near Bindi, and gravel extraction sites are located along major logging roads.

7. Water production

This block contains a section of the Tambo catchment and the headwaters of the Timbarra River and Mellick Munjie Creek, and is bordered on the east side by the Buchan River. Rainfall over the block varies from less than 700 mm per annum to about 1,600 mm per annum near Mount Nunniong.

Mean annual discharges of the Tambo River at Swifts Creek, the Timbarra River at Timbarra, and the Buchan River at Buchan are 67,450 Ml, 52,063 Ml, and 157,260 Ml respectively.

Of these, the flow of the Tambo River is the least reliable, yielding 18% of its annual discharge in the driest 6 months January to June, including 7% in the 3 months January to

March. The Buchan River is a little more reliable, with equivalent values of 24% and 8% respectively, and the Timbarra still better with values of 29% and 13% respectively.

Mellick Munjie Creek delivers 34% of its annual discharge (13,781 Ml) in the 6 months January to June, including 12% in the 3 months January to March.

Swifts Creek township uses the Tambo River as a source of domestic water.

The capability for water production is high.

D. Hazards

The erosion hazard is low to moderate on the tablelands and moderate elsewhere, except in the lower-rainfall areas around Bindi and Ensay North, where the hazard is high. Salinity readings for the Tambo River at Swifts Creek, while indicating high-quality water, are still the highest recorded for the study area. The fire hazard is high. A tower on Mount Nugong is used for fire spotting. The area has a history of fires originating from lightning strikes. The 20 noxious weed species include blackberry, sweet briar, and tutsan. Brumbies are found on the tablelands. Cimmamon fungus has attacked a small area of forest in the south-east. Ambrosia beetles have degraded alpine ash timber in some areas. Rabbits can be a problem in cleared land, forest margins, and in open areas on the Nunniong Tablelands.

20. WULGULMERANG

A. Location and Tenure

Of the total area of 80,250 ha in the block, the greater part is occupied by the Wulgulmerang Tablelands. Most of the freehold land is situated on the tablelands from north to south between the Buchan and Snowy Rivers. Of the public land, 1,100 ha is reserved forest (west of Wulgulmerang), 2,050 ha is part of the Rocky Range Wildlife Reserve, 44 ha is public reserve, and the remainder unreserved Crown land (57,000 ha).

County of Tambo: Parishes of Murrindal East, Murrindal West, Detarka, Marroo, Gelantipy East, Gelantipy West, Woongulmerang East, Woongulmerang West, Chilpin, Berrmarr, Suggan Buggan, and Karawah.

B. Nature of the Land

1. Climate

Most of the block receives moderately high rainfall from southerly and south-easterly air streams that bring rain at any time of the year. A large rain-shadow exists to the east and north of Wulgulmerang, in an area sheltered from both the prevailing westerly and southerly winds.

Average annual rainfall is 650 mm at Wulgulmerang and 726 mm below Mount Hamilton, compared with 943 mm at Gelantipy and in excess of 1,000 mm on central areas of the Wulgulmerang Tablelands and in the south-east of the block. Rainfall is at a maximum in spring in the rain-shadow areas. Summer rainfall may be supplemented by thunderstorms.

Snowfalls are not common in the block, but may occur in the northern areas of the tablelands above 1,000 m from June to October.

2. Geology and physiography

The main physiographic feature is the Wulgulmerang Tablelands (1,400--600 m) bounded on the east by the precipitous Snowy River valley. The northern extremity terminates near Mount Wombargo (1,640 m), noted for its "rock rivers", and the western boundary at a range that includes Mounts Seldom Seen (1,300 m) and Statham (1,220 m).

The Buchan River further west flows south along a deeply dissected valley.

The Wulgulmerang Tablelands, which dip gently to the south from Wulgulmerang through Gelantipy to Butchers Ridge, are believed to be part of the Kinglake Surface.

The geology of the area includes Snowy River volcanics several thousand metres thick, which are Lower Devonian in age, and consist of acid volcanics (lavas and tuffs) with interbedded conglomerates and sandstones. Lower Devonian granodiorite underlies the volcanics, and is exposed in the Buchan and Snowy River valleys. In the southern part of the block, Buchan limestone conformably overlies the Snowy River volcanics in one small area.

Small areas of Tertiary gravels and sands unconformably overlie the Snowy River volcanics on the tablelands. The sediments are overlain in turn by Tertiary basalt flows.

3. Soils

Friable brown gradational soils are the most common soils, with stony loams occurring in the mountainous regions of the north on exposed ridges and steep slopes. Drier slopes at lower elevations have massive gradational and shallow friable brown gradational soils. Along the Buchan River on the western border, coarse sands and massive gradational soils are found on granitic rocks.

Red gradational soils occur on the basalt in the middle and south of the Wulgulmerang Tablelands, with yellow-brown forms in poorly drained areas. Red and yellow duplex soils and red gradational soils appear on the rolling topography of the drier areas in the south of the block. Red calcareous clays occur on limestone east of Gillingall.

4. Vegetation

Snow gum woodlands and open forest occur principally at Mount Wombargo between 1,300 and 1,600 m and at Mount Seldom Seen (1,200--1,300 m). Understoreys are grassy with scattered shrubs or heathy (mountain beard-heath and rough coprosma).

The vegetation on the Wulgulmerang Tablelands grades from mountain gum--snow gum with scattered pockets of alpine ash in the north, to broad-leaf peppermint open forest II in the central section, and then to messmate stringybark and narrow-leaf peppermint open forest III with some pockets of mountain ash in the south.

Mountain gum--snow gum forests grow between 1,440 and 900 m generally, but follow some drainage lines down to about 700 m. Understoreys are usually shrubby (hop bitter-pea, handsome flat-pea, and common heath).

Open forest II on the tablelands is mainly composed of broad-leaf peppermint, mountain gum, candlebark, and brittle gum, with a heathy to shrubby understorey including mountain banksia, prickly broom-heath, common heath, heath pink-bells, shrubby platysace, and matted parrot-pea.

Open forest IV occurs as scattered stands of alpine ash near Mount Wombargo (1,100--1,300 m) and Mount Statham (1,000--1,200 m), as messmate stringybark stands in some localities, or as mountain ash forest. Mountain ash forests are mainly mature in age and are limited to moist sites at 500 to 860 m. Mountain ash sometimes grows in mixture with manna gum and understoreys are wet-gully-type (Victorian christmas-bush, rough tree-fern, soft tree-fern, southern sassafras, stinkwood, blanket-leaf, and spreading fan-fern).

Open forest III includes extensive areas of messmate stringybark in mixture with narrow-leaf peppermint, manna gum, and mountain grey gum between about 600 and 1,100 m elevation. Understoreys may be shrubby (austral bracken, silver wattle, prickly tea-tree, narrow-leaf wattle, river lomatia, common cassinia, and shining cassinia) to wet-gully-type (Victorian christmas-bush, musk daisy-bush, blanket-leaf, elderberry panax, hazel pomaderris, and coast pomaderris).

Narrow-leaf peppermint in mixture with mountain grey gum, manna gum (some pure stands present), and mountain gum may have a grassy understorey with scattered shrubs (silver wattle, austral bracken, and prickly tea-tree) or a shrubby understorey.

Silvertop open forest III includes white stringybark and mountain grey gum, with a shrubby understorey that includes narrow-leaf wattle, sunshine wattle, austral bracken, and prickly tea-tree.

The vegetation on the tableland escarpments is usually open forest II or I except on the most sheltered sites, where open forest III is typical. Open forest II includes river peppermint, broad-leaf peppermint, red stringybark, silvertop, long-leaf box, candlebark, and brittle gum. Understoreys are generally heathy to grassy.

Open forest I comprises similar species. Understoreys are usually heathy (diggers' speedwell, shrubby platysace, grey everlasting, small crowea, daphne heath, and box-leaf wattle), but may be grassy with scattered heathy plants. Some dry precipitous slopes have scrublands and some heathlands, including species such as tingaringy gum, shrubby platysace, box-leaf wattle, and shiny phebalium.

Woodlands bordering the Snowy River valley may be yellow box, red box, and kurrajong with a grassy (kangaroo grass) to shrubby understorey (austral grass-tree and sweet pittosporum) developed on soils derived from limestone, or white box with a grassy to sparsely shrubby ground cover.

Closed forests ("jungle") occupy some gullies in the south-east of the block. Species include lilly-pilly, sweet pittosporum, mutton-wood, austral sarsparilla, milk-vine, fishbone water-fern, and soft water-fern.

5. Fauna

Twenty native mammal species, 69 native bird species, 17 reptile species, and nine species of amphibians are recorded for the block.

Wetlands consist of streams and numerous farm dams. Riverine forests occupy some stream environs, such as along sections of the Buchan River. A considerable area of the tablelands has been cleared for agriculture. Sub-alpine woodlands predominate in the north, and the southern tablelands carry mostly wet open forest. Dry open forests predominate on the escarpments into the Buchan and Snowy Rivers.

The only wetlands surveyed were farm dams on the Wulgulmerang Tablelands. During an influx of waterbirds into Gippsland in 1958 due to drought, 15 species were recorded on one single water body. These included the white-necked heron, yellow-billed spoonbill, black swan, blue-winged shoveler, white-eyed duck, and coot.

The 10 mammals known to inhabit sub-alpine woodland are the echidna, red-necked and black wallabies, brush-tailed possum, bobuck, ring-tailed possum, eastern pigmy possum, brown antechinus, Swainson's antechinus, and bush rat. Birds are not well documented, but those recorded are typical of this habitat. The 11 mammals recorded in wet open forest are the eastern grey kangaroo, sugar glider, greater glider, feather-tailed glider, tiger cat, brush-tailed phascogale, brown antechinus, Swainson's antechinus, bush rat, lesser long-eared bat, and the white-striped bat. Most birds are those commonly found throughout this habitat in the study area. Unusual species in this block are the southern emu-wren and large-billed scrub-wren.

Mammals in dry open forest have not been systematically surveyed, but the eastern grey kangaroo and brush-tailed rock-wallaby are known to occupy this habitat in the block. Most birds are typical of this habitat type where it occurs elsewhere in the study area.

Birds in cleared and semi-cleared agricultural land on the plateau are those typical of this habitat. They include the nankeen kestrel, spur-winged plover, galah, Australian pipit, yellow-rumped thornbill, white-backed magpie, eastern rosella, and the raven.

Some reptiles are typical of warm and dry environments (including the brown snake, tree dragon, Gippsland water dragon, water skink (warm-temperate species), Cunningham's skink, rock skink, tree goanna, and red-bellied black snake). Those commonly found in warm- to cool- or cold-temperate regions are the three-toed skink, grass skink, garden skink, weasel skink, water skink (cool-temperate species), McCoy's skink, Coventry's skink, southern blue-tongue, and copperhead (highlands form).

Amphibians recorded are Lesueur's frog, brown tree frog, Verreaux's tree frog, eastern banjo frog, spotted grass frog, brown-striped frog, Victorian froglet, common eastern froglet, and southern toadlet. No fishes apart from the brown trout have been recorded in the block, but the comments for the Snowy River in block 17 would apply here also.

6. Land systems

The Berrmarr (Igneous), Cobberas, Marroo High, Graham, Buckenderra, Higginbotham, Wulgulmerang, Yalmy, Moroka, Bindi, Bemboka, Detarka, Gelantipy East, Jingallala, and Wat Wat Low land systems are represented in the block.

C. Present Use and Capabilities

1. Nature conservation

The capability for nature conservation is very high. Environments range from sub-alpine woodland to jungle gullies. Periglacial rock rivers at Mount Wombargo and cave fauna in limestone caves at New Guinea spur are important features. Several colonies of the rare brush-tailed rock wallaby have been sighted in recent years on rocky escarpments in the Snowy River valley. The tiger cat, a widespread but uncommonly observed species, has been recorded near Gelantipy and the white-striped bat, also widespread but rarely observed, has been recorded at W Tree.

Among the 50 species of plants recorded as significant in Wulgulmerang block, 20 are considered highly significant and, of these, four are endemic to the study area and a further two are endemic to the Snowy River gorge bordering the East Gippsland study area. The many rare species located in gorges of the Snowy and Little Rivers include the rare wattle *Acacia subtilinervis*, hoary ray-flower (*Anthocercis albicans*), showy boronia (*Boronia ledifolia*), Snowy River daisy (*Brachycome riparia*), and the rock daisy (*Brachycome petrophila*), endemic to the study area. The Snowy River westringia (*Westringia cremnophila*) and river beard-heath (*Leucopogon riparius*) are endemic to the Snowy River gorge.

Other highly significant species occur near mountain-tops. For example, Mount Stradbroke carries the endemic slender parrot-pea *Dillwynia capitata*, an undescribed *Grevillea* species, and the typically coastal parsnip trachymene *Trachymene anisocarpa*; Mount Hamilton area contains a rare greenhood (*Pterostylis coccinea*) and a rare bush-pea (*Pultenaea subspicata*); and Mount Wheeler has the hyacinth orchid (*Dipodium hamiltonianum*) and pinnate goodenia (*Goodenia grandiflora* var. *macmillanii*).

The Wulgulmerang Tablelands support a number of noteworthy species, including the orchids *Pterostylis laxa* and *P. aestiva*, the latter being endemic to the study area. A rare guinea-flower, *Hibbertia spathulata*, is endemic to a small region in the east of the study area.

2. Recreation

The rugged valleys of the Snowy and Tambo rivers flanking the Wulgulmerang Tablelands and the rivers themselves are the main recreational features of the block. Specific attractions include the Little River Gorge, Tulach Ard Gorge, and Mount Seldom Seen. Capabilities are very high for bushwalking, particularly that of a rugged wilderness nature, and canoeing, high for fossicking and rock climbing, moderate for recreation driving, fishing, and caving, and low for hunting and cross-country skiing.

This block offers great potential for walkers. Because of its distance from the main population centres it is not well known at present. The Tulach Ard Gorge and the Currie Creek, Boundary Creek, and Little River Gorges are occasionally visited, and provide challenging and exciting experiences to those prepared to explore them. Other places visited include the rock rivers on Mount Wombargo; Mount Stradbroke and Stradbroke Chasm; Mount Seldom Seen; and the New Guinea range.

For recreation driving, the Buchan--Jindabyne road, Black Mountain--Benambra road, and the road to McKillops Bridge traverse the area. A commercial four-wheel-drive tour visits Campbells Knob and Mount Seldom Seen. Other tracks are used infrequently.

Apart from rabbit- and fox-shooting around the margins of cleared land, little hunting is done except for occasional hunting of red deer.

The Buchan River and tributaries of the Snowy River such as Little River and Butchers Creek provide trout angling. The warmer waters of the Snowy River also provide for anglers.

The Mount Wombargo area offers some opportunities for cross-country skiing.

The Snowy River between McKillops Bridge and Dargans (upstream of Lucas Point) is popular among experienced canoeists.

Small rapids and rapids with pressure waves are characteristic of this section. Dangerous rapids, however, are encountered through the Tulach Ard Gorge. These can be portaged except when the river is in flood. The total section takes about 3 days to canoe.

The Gelantipy district is a well-known gem-field that attracts fossickers from Melbourne and other areas for visits of a few days, such as long weekends. Deposits of common opal may be found at the base of the basalt capping in various localities. In some areas the basalt is highly vesicular, and many of the cells are filled with chalcedony. Along the Snowy River valley between Buchan and Deddick, the Snowy River volcanics contain veins of jasper, quartz, and calcite and deposits of agates.

The Little River Gorge presents challenges to rock-climbers, who occasionally tackle it. The Tulach Ard Gorge, which is very inaccessible, has some potential for rock-climbing.

Limestone caves at New Guinea Ridge are unspoilt and important to speleologists.

3. Agriculture

Five graziers run cattle regularly on the public land - four of them are located on the Wulgulmerang Tablelands, and one at Tubbut. The runs are close to home properties or isolated paddocks, and are mainly used during the cooler months. About 420 cows and 180 dry cattle graze through the candlebark--mountain gum and mountain gum--snow gum forests of the tablelands. Another 200 dry cattle graze in the white box woodlands of the Snowy River valley and in manna gum and red stringybark forests along the Buchan River valley.

A large area of private land runs from north to south through the centre of this block. Most of this land has been developed for agriculture. Access is good, although the northern areas are a long way from the rail-head at Nowa Nowa. Beef production is the major enterprise, although a few sheep are run - for both wool and prime lamb production. The beef herds are mainly cows, steers and surplus heifer weaners being sold at the autumn calf sales.

The rainfall is higher here than in the Omeo area, and pastures are mainly perennial. Low winter temperatures reduce the growing season in the northern parts of the block, but most of the graziers have access to grazing runs and (with careful management) can maintain relatively high stocking rates.

The capability for bush grazing is generally high to moderate. The runs around private property on the tablelands are valuable as winter grazing areas.

Capability for agricultural development is low.

4. Apiculture

Access is generally good, and this area has produced good yields of honey. Honey flora include snow gum, Gippsland blue gum, silvertop, red stringybark, brittle gum, and long-leaf box.

5. Wood production

Capability for hardwood production is high in alpine and mountain ash stands but these are small (total 1,700 ha) and scattered. Alpine ash grows in the north of the block around Mount Wombargo, and in the centre south of Mount Statham. Small stands of mountain ash occur in the south-east around New Guinea Gap. Extensive areas of moist foothill forest (mainly messmate) south of Mount Statham, around New Guinea Gap, and generally adjoining other scattered mountain forest stands have moderate to high capabilities. Other forest in the block has low capability. Areas of white box in the north are lightly utilized for small quantities of domestic durable timber products such as posts and farm timbers.

A mill at Buchan annually cuts 5,800 m^3 of sawlogs from about 80 ha of forest.

6. Minerals

This block contains a large area of Snowy River volcanics; these contain substantial lead--silver--zinc deposits, some of which (for example, at Gelantipy) have been worked. Others may be present. Barytes, manganese, and copper deposits are known, and limestone outcrops at a number of localities around W Tree and the Snowy River.

7. Water production

This block is bordered by the Buchan River to the west and the Snowy River to the east. Little River and Butchers Creek are the other major catchments in the block. This is a relatively dry block, with rainfall varying from less than 700 mm to 1,000 mm per annum.

In the 6 months December to May, the Snowy River near Buchan delivers 29% of its mean annual discharge (1,683,270 Ml) including 11% in the 3 months January to March. The Buchan River is slightly less reliable, yielding 27% of its 157,260-Ml mean annual discharge in the 6 months December to May, including 8% in the 3 months January to March. No measurements are available for the Little River, a tributary to the Snowy River, or Butchers Creek, which flows into the Buchan River.

Salinity measurements of 68 mg per l for the Buchan River at Buchan and 73 mg per l for the Snowy River at Jarrahmond indicate good-quality water.

The capability for water production is moderate.

D. Hazards

The erosion hazard is moderate in most areas, but low on the southern tablelands. The fire hazard is high. A fire tower is located at Mount Seldom Seen. Eight noxious weed species include blackberry, Italian blackberry, and sweet briar. Brumbies inhabit the northern part of the block.

PART V

APPENDICES

APPENDIX 1A

AVERAGE RAINFALL (MILLIMETRES)

STATION	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR	NO. YEARS
Aberfeldy	67	66	78	94	101	94	96	116	[illegible]	118	94	90	1,[illegible]	67
Benambra	45	52	46	45	58	46	56	51	45	55	74	61	635	34
Bindi	56	47	50	43	48	[illegible]	52	51	58	63	59	57	634	59
Bindi (Tongio West)	64	41	59	50	56	62	71	58	52	62	54	59	110	18
Black Mountain	68	65	60	52	51	66	67	64	64	58	79	76	[illegible]	51
Bonang	75	81	91	117	184	147	157	210	157	214	115	93	1,591	18
Buchan (Tillicoutry)	83	66	69	80	67	39	75	65	76	86	77	62	861	55
Butchers Ridge P.O.	79	38	71	75	73	98	84	77	86	89	91	69	902	77
Callaghan Creek	58	55	64	71	92	103	136	129	98	199	75	87	1,1[illegible]	10
Cobungra	44	59	53	55	41	54	44	56	[illegible]	70	65	61	[illegible]	22
Cravensville	43	54	69	62	79	131	157	114	75	93	58	62	917	75
Dargo (not P.O. or Hospital)	56	63	58	54	51	60	64	65	[illegible]	73	62	61	71	58
Dartmouth	55	64	69	73	91	127	111	143	105	11[illegible]	65	71	1,014	19
Ensay	65	57	51	58	55	65	52	48	57	64	79	77	[illegible]	6[illegible]
Falls Creek	105	96	112	197	270	185	333	337	317	284	200	147	2,[illegible]	26
Gelantipy East	77	72	76	73	57	80	67	72	78	91	100	94	903	30
Gibbo River	61	48	62	70	103	119	144	142	12[illegible]	125	86	80	1,151	44
Harrietville	66	72	75	91	118	164	171	170	150	133	96	87	1,430	73
Hawkhurst	56	55	54	58	60	61	68	69	65	75	67	67	740	18
Hinnomunjie	43	47	53	44	46	50	50	52	52	53	52	54	627	69
Hotham Heights	85	86	107	127	173	167	161	190	177	152	131	[illegible]	[illegible]	[illegible]
Howqua Hills	59	64	71	119	135	157	163	160	135	115	86	[illegible]	1,[illegible]	[illegible]
Jamieson	55	52	70	82	110	140	140	142	109	101	70	71	1,1[illegible]	73
Licola	59	42	51	56	64	72	75	74	71	70	64	70	781	11
Merrijig	33	29	51	70	73	69	8[illegible]	87	79	71	57	57	799	[illegible]
Mitta Mitta	58	55	67	65	90	125	125	114	90	104	71	67	1,014	64
Mount St. Bernard	95	74	121	151	117	257	196	254	[illegible]	181	9[illegible]	51	1,[illegible]	19
Myrtle Creek	55	51	60	67	91	127	115	116	95	103	77	71	1,034	88
Omeo	51	54	58	46	58	47	52	45	[illegible]	71	[illegible]	[illegible]	676	9[illegible]
Omeo Valley	49	51	58	51	52	57	49	52	57	75	60	60	686	86
Shannonvale	55	50	58	76	76	76	81	106	125	[illegible]	90	[illegible]	983	11
Seaka	57	61	68	80	114	126	173	147	140	115	79	69	1,2[illegible]	56
Swifts Creek	50	51	49	44	49	53	46	41	44	49	69	64	61	87
Suggan Buggan	48	54	49	35	45	47	41	50	46	68	7[illegible]	72	627	16
Tambo Crossing	51	52	56	44	72	59	56	66	75	75	90	99	794	16
Tawonga	56	55	64	87	109	108	142	135	97	116	86	65	1,127	23
Thowgla Upper	51	46	61	55	69	100	91	83	69	79	57	63	824	85
Tintaldra	55	51	57	78	115	95	109	125	105	102	81	65	1,0[illegible]	1[illegible]
Tongio	52	52	50	48	52	54	50	51	55	71	67	79	669	56
Wonga Point	72	64	83	104	135	167	170	190	157	155	109	103	1,486	74
Wulgulmerang	61	54	56	50	46	57	44	47	52	66	68	62	650	71

APPENDIX 10

VARIABILITY OF RAINFALL

Data for 30, 50 (median), and 70 percentiles (mm)

STATION		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
	30	35	36	24	23	21	29	22	27	34	50	35	37	5-2
Wulgulmerang	50	53	45	35	39	40	45	32	38	46	58	44	58	649
	70	80	76	79	57	52	69	52	51	64	79	68	79	712
	30	36	29	31	34	33	49	39	45	54	67	46	50	857
Butchers Ridge P.O.	50	71	60	51	65	59	58	59	56	70	81	70	74	943
	70	104	94	84	98	97	105	106	88	97	102	105	107	1,074
	30	27	32	27	25	26	30	28	39	44	57	41	39	619
Dargo	50	50	50	44	37	39	41	40	47	51	71	59	62	687
	70	66	70	71	58	57	67	62	62	73	94	70	92	761
	30	45	40	39	48	62	74	69	85	75	79	66	51	570
Aberfeldy	50	58	51	61	72	96	94	97	100	102	117	85	66	1,062
	70	81	76	78	90	117	109	123	125	120	142	110	104	1,170
	30	28	17	20	23	26	31	29	33	41	45	36	34	564
Bindi	50	57	42	32	38	38	44	38	47	54	62	53	48	646
	70	65	59	51	55	58	76	59	60	66	74	76	72	700
	30	21	17	28	35	53	90	77	82	71	65	41	44	882
Dartel Creek	50	48	42	53	58	75	128	114	106	99	97	76	66	970
	70	70	68	75	81	103	162	138	137	114	124	103	93	1,157
	30	26	25	24	28	28	31	33	41	46	53	38	37	602
Omeo	50	44	44	43	38	39	46	42	51	57	70	53	58	684
	70	60	66	70	55	65	71	68	63	72	82	74	74	753
	30	34	36	35	47	77	108	123	113	107	99	56	50	1,189
Harrietville	50	53	59	61	66	111	159	167	159	134	134	77	63	1,386
	70	85	86	115	112	169	212	208	219	164	165	106	114	1,538
	30	26	19	28	37	63	98	107	104	75	72	43	37	1,008
Jamieson	50	42	33	51	70	93	145	133	135	105	108	80	61	1,120
	70	72	59	75	103	152	151	169	163	139	147	101	86	1,278
	30	26	29	25	10	21	29	27	29	40	51	38	46	632
Ensay	50	61	53	44	40	38	37	42	37	47	66	60	63	683
	70	95	73	65	61	65	69	53	51	63	89	96	85	755

APPENDIX 1C

AVERAGE RAINFALL PER WET DAY (MILLIMETRES)

STATION	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Aberfeldy	9.0	10.1	9.0	8.6	7.8	7.8	6.2	7.6	6.9	8.3	9.6	8.9
Butchers Ridge	11.1	11.8	10.8	9.5	8.1	11.2	8.6	7.8	8.7	8.6	9.6	9.9
Dargo	7.3	8.3	8.1	5.9	4.6	6.0	4.4	4.1	5.0	6.3	6.6	7.3
Harrietville	13.3	15.6	14.1	14.2	12.7	13.1	14.0	13.0	13.3	13.4	12.7	13.0
Hinnomunjie	10.3	10.5	9.8	6.6	5.6	6.2	5.4	5.6	6.1	7.6	8.2	8.3
Hotham Heights*	9.6	11.9	13.5	11.7	10.6	9.6	8.4	9.1	10.1	10.4	11.4	10.4
Jamieson	10.0	11.7	11.5	10.6	9.7	10.6	10.0	10.1	8.9	9.4	9.9	8.7
Mitta Mitta	8.9	10.6	10.2	9.5	8.3	9.6	8.3	8.6	7.6	8.9	9.5	7.8
Omeo	7.2	9.1	8.1	5.8	4.8	5.2	4.4	4.8	5.1	6.2	7.4	6.9
Woods Point	10.1	9.1	10.3	10.4	9.2	9.7	9.1	10.2	9.2	8.9	9.8	9.7
Wulgulmerang	12.6	10.4	12.1	8.3	6.5	9.8	8.5	6.9	7.6	9.0	9.6	9.1

Sources: Bureau of Meteorology. * Rowe (1967)

APPENDIX 1D

AVERAGE MONTHLY MAXIMUM, MINIMUM, AND MEAN TEMPERATURES (°C)

STATION & ALTITUDE	NO. YEARS RECORD		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
HOTHAM HEIGHTS 1,755 m	18	Maximum	15.9	15.4	13.4	8.4	4.7	1.7	0.2	1.1	3.6	7.3	11.1	14.1
		Minimum	6.6	6.8	5.6	1.6	-0.7	-3.2	-4.2	-3.8	-2.1	0.4	2.9	5.3
		Mean	11.3	11.1	9.5	5.0	2.0	-0.7	-2.0	-1.3	0.8	3.9	7.0	9.7
KOSCIUSCKO HOTEL* 1,530 m	27	Maximum	18.4	18.8	15.9	11.2	7.8	4.7	3.8	4.6	7.8	11.5	14.7	17.1
		Minimum	5.8	6.1	4.4	1.3	-1.2	-3.0	-3.9	-3.3	-1.0	1.2	3.0	4.9
		Mean	12.1	12.5	10.2	6.2	3.3	0.8	-0.1	0.6	3.4	6.4	8.8	11.1
KIANDRA* 1,396 m	30	Maximum	20.3	20.8	18.1	12.8	8.8	5.3	4.2	5.9	9.2	12.9	16.1	18.9
		Minimum	5.9	6.3	4.1	1.1	-1.3	-3.3	-4.4	-3.9	-1.1	0.8	3.2	5.0
		Mean	13.2	13.5	11.1	6.9	3.7	1.0	-0.1	1.0	3.9	6.8	9.6	11.9
MOUNT BUFFALO* 1,332 m	28	Maximum	19.5	18.9	16.3	11.3	8.2	4.8	3.6	4.7	7.6	10.9	14.5	17.4
		Minimum	10.8	11.0	8.9	5.1	2.8	0.1	-0.8	-0.3	1.6	3.8	6.7	9.2
		Mean	15.2	14.9	12.7	8.2	5.6	2.4	1.4	2.2	4.6	7.4	10.6	13.3
BOGONG VILLAGE 655 m	18	Maximum	25.3	24.5	22.5	16.7	12.8	9.6	8.4	9.8	13.4	15.8	18.8	22.4
		Minimum	11.4	11.4	10.0	6.8	4.0	1.9	1.3	1.6	3.3	5.2	7.5	9.4
		Mean	18.4	18.0	16.3	11.8	8.4	5.8	4.8	5.7	8.4	10.5	13.2	15.9
OMEO 643 m	28	Maximum	25.4	25.9	22.8	18.4	14.4	10.8	10.3	12.2	15.4	18.6	21.8	24.4
		Minimum	9.1	9.4	7.7	4.6	2.1	0.6	-0.1	0.7	2.9	4.3	6.2	8.4
		Mean	17.2	17.7	15.2	11.5	8.2	5.7	5.3	6.5	9.2	11.4	14.0	16.4
MANSFIELD 316 m	17	Maximum	29.7	29.4	26.1	21.1	15.9	12.6	11.4	13.5	17.4	20.9	24.7	27.6
		Minimum	10.2	9.8	7.8	4.2	2.1	1.9	0.2	1.7	2.9	4.6	6.4	8.6
		Mean	19.9	19.6	16.9	12.6	9.0	7.3	5.8	7.6	10.2	12.7	15.6	18.1

Source: Bureau of Meteorology. * Outside the study area.

APPENDIX 1E

VARIATION IN METEOROLOGICAL CONDITIONS WITH ELEVATION

The table shows weather conditions at 15.00 hours on selected summer days at Mansfield (316 m) and Mount Buller (1,950 m)

Station		Temperature °C	Relative humidity %	Wind (km/hr)	Date
(i)	Mansfield	38	38	16	
(ii)	Mount Buller	24	45	40	17.1.1965
(i)	M	31	10	16	
(ii)	Mt. B.	19	17	8	9.2.1965
(i)	M.	40	11	32	
(ii)	Mt. B.	27	60	40	31.1.1968
(i)	M	33	29	32	
(ii)	Mt. B.	18	70	65	21.2.1968
(i)	M	32	38	16	
(ii)	Mt. B.	19	45	40	29.1.1974

Source: Forests Commission of Victoria. Mansfield Forest District - Weather records

APPENDIX 2A

COMMON AND SCIENTIFIC NAMES OF NATIVE PLANTS MENTIONED IN THE TEXT

Common Name	Scientific Name
A.	
Alpine ash	*Eucalyptus delegatensis*
Alpine baeckea	*Baeckea gunniana*
Alpine bottle-brush	*Callistemon sieberi*
Alpine finger-fern	*Grammitis armstrongii*
Alpine grevillea	*Grevillea australis*
Alpine leek-orchid	*Prasophyllum alpinum*
Alpine marsh-marigold	*Caltha introloba*
Alpine mint-bush	*Prostanthera cuneata*
Alpine orites	*Orites lancifolia*
Alpine oxylobium	*Oxylobium alpestre*
Alpine pennywort	*Schizeilema fragoseum*
Alpine pepper	*Drimys xerophila*
Alpine phebalium	*Phebalium phylicifolium*
Alpine podolepis	*Podolepis robusta*
Alpine spear-grass	*Stipa nivicola*
Alpine stackhousia	*Stackhousia pulvinaris*
Alpine star-bush	*Asterolasia trymalioides*
Alpine trachymene	*Trachymene humilis*
Alpine tuft-rush	*Oreobolus pumilio*
Alpine wallaby-grass	*Danthonia nudiflora*
Alpine water-fern	*Blechnum pennamarina*
Alpine wattle	*Acacia alpina*
Alpine westringia	*Westringia senifolia*
Ash-mallee	*Eucalyptus kybeanensis*
Austral bear's ear	*Cymbonotus preissianus*
Austral bracken	*Pteridium esculentum*
Austral bugle	*Ajuga australis*
Austral cornflower	*Centaurea australis*
Austral dandelion	*Taraxacum aristum*
Austral grass-tree	*Xanthorrhoea australis*
Austral mulberry	*Hedycarya angustifolia*
Austral rush	*Juncus australis*
Austral sarsparilla	*Smilax australis*
Austral toad-flax	*Thesium australe*
Australian buttercup	*Ranunculus lappaceus*
Australian carraway	*Oreomyrrhis eriopoda*
Australian clematis	*Clematis aristata*
B.	
Bat's-wing fern	*Histiopteris incisa*
Baw Baw berry	*Wittsteinia vacciniacea*
Beard-orchid	*Calochilus* sp.
Bedstraw	*Galium* sp.
Bent-grass	*Deyeuxia* sp.
Bidgee-widgee	*Acaena anserinifolia*
Black-anther flax-lily	*Dianella revoluta*
Black cypress pine	*Callitris endlicheri*
Black sallee	*Eucalyptus stellulata*
Blackwood	*Acacia melanoxylon*
Blanket-leaf	*Bedfordia salicina*
Blue olive-berry	*Elaeocarpus reticulatus*
Blunt-leaf guinea-flower	*Hibbertia obtusifolia*
B. (contd.)	
Bog buttercup	*Ranunculus pimpinellifolius*
Bogong daisy-bush	*Olearia frostii*
Bogong gum	*Eucalyptus chapmaniana*
Boomerang wattle	*Acacia amoena*
Bootlace bush	*Pimelea axiflora*
Box-leaf bitter-pea	*Daviesia buxifolia*
Box-leaf wattle	*Acacia buxifolia*
Bristle-grass	*Trisetum spicatum*
Brittle gum	*Eucalyptus mannifera*
Broad-leaf hop-bush	*Dodonaea rhombifolia*
Broad-leaf peppermint	*Eucalyptus dives*
Bulbine lily	*Bulbine bulbosa*
Burgan	*Leptospermum phylicoides*
Bush-pea	*Pultenaea* sp.
But but	*Eucalyptus bridgesiana*
Buttercup	*Ranunculus* sp.
C.	
Candlebark	*Eucalyptus rubida*
Candle heath	*Richea continentis*
Cane wire-grass	*Aristida ramosa*
Carpet heath	*Pentachondra pumila*
Carraway	*Oreomyrrhis* sp.
Cascade everlasting	*Helichrysum secundiflorum*
Catkin wattle	*Acacia dallachiana*
Cat's claws	*Grevillea alpina*
Cat's tail	*Koeleria australiensis*
Cherry ballart	*Exocarpus cupressiformis*
Clustered everlasting	*Helichrysum semipapposum*
Cluster-flower geebung	*Persoonia confertiflora*
Coast pomaderris	*Pomaderris oraria*
Common billy-buttons	*Craspedia glauca*
Common beard-heath	*Leucopogon virgatus*
Common bog-rush	*Schoenus apogon*
Common cassinia	*Cassinia aculeata*
Common correa	*Correa reflexa*
Common ground-fern	*Culcita dubia*
Common heath	*Epacris impressa*
Common lagenophora	*Lagenophora stipitata*
Common oxylobium	*Oxylobium ellipticum*
Common raspwort	*Haloragis tetragyna*
Common reed	*Phragmites australis*
Common wheat-grass	*Agropyron scabrum*
Coral heath	*Epacris microphylla*
Cranberry heath	*Astroloma humifusum*
Crane's bill	*Geranium* sp.
Creamy stackhousia	*Stackhousia monogyna*
Creeping cudweed	*Gnaphalium gymnocephalum*
Creeping fan-flower	*Scaevola hookeri*
Cushion carraway	*Oreomyrrhis pulvinifica*

Common Name	Scientific Name	Common Name	Scientific Name
D.			
Dagger wattle	*Acacia siculiformis*	Gunn's alpine buttercup	*Ranunculus gunnianus*
Daisy-bush	*Olearia* sp.	Gunn's willow-herb	*Epilobium gunnianum*
Dampiera	*Dampiera* sp.		
Daphne heath	*Brachyloma daphnoides*	H.	
Dense midge-orchid	*Prasophyllum densum*		
Dense mint-bush	*Prostanthera decussata*	Hairy pennywort	*Hydrocotyle hirta*
Derwent speedwell	*Veronica derwentiana*	Handsome flat-pea	*Platylobium formosum*
Desert cassia	*Cassia nemophila*	Hard water-fern	*Blechnum procerum*
Diggers' speedwell	*Veronica perfoliata*	Hazel pomaderris	*Pomaderris aspera*
Dioama rice-flower	*Pimelea dichotoma*	Heath pink-bells	*Tetratheca ericifolia*
Drooping mistletoe	*Amyema pendulum*	Hedgehog-grass	*Echinopogon ovatus*
Drooping sheoak	*Casuarina stricta*	Hedge wattle	*Acacia armata*
Drumstick heath	*Epacris breviflora*	Helmet-orchid	*Corybas* sp.
Dusty daisy-bush	*Olearia phlogopappa*	Hoary ray-flower	*Anthocercis albicans*
Dwarf buttercup	*Ranunculus millanii*	Hoary sunray	*Helipterum albicans*
Dwarf geebung	*Persoonia chamaepeuce*	Holly lomatia	*Lomatia ilicifolia*
Dwarf sour-bush	*Choretrum pauciflorum*	Honey-pots	*Acrotriche serrulata*
		Hop bitter-pea	*Daviesia latifolia*
E.			
		I.	
Elderberry panax	*Tieghemopanax sambucifolius*		
Eurabbie	*Eucalyptus st. johnii*	Ivy goodenia	*Goodenia hederacea*
Everlasting	*Helichrysum* sp.	Ivy-leaf violet	*Viola hederacea*
F.		K.	
Fairy blue-bell	*Wahlenbergia densifolia*	Kangaroo grass	*Themeda australis*
Fan tuft-rush	*Oreobolus distichus*	Kidney-weed	*Dichondra repens*
Fishbone water-fern	*Blechnum nudum*	Knawell	*Scleranthus* sp.
Forest clematis	*Clematis glycinoides*	Kurrajong	*Brachychiton populneum*
Forest mint	*Mentha laxiflora*		
Forest pennywort	*Hydrocotyle geraniifolia*	L.	
Forest starwort	*Stellaria flaccida*		
Fringe-myrtle	*Calytrix* sp.	Leafy bossiaea	*Bossiaea foliosa*
		Leafy daisy	*Brachycome rigidula*
G.		Lightwood	*Acacia implexa*
		Lilac berry	*Trochocarpa clarkei*
Giant mountain grass	*Dryopoa dives*	Lilly pilly	*Eugenia smithii*
Gippsland blue gum	*Eucalyptus pseudoglobulus*	Long-leaf box	*Eucalyptus goniocalyx*
Glacial eyebright	*Euphrasia glacialis*		
Glossogyne	*Glossogyne tenuifolia*	M.	
Golden bush-pea	*Pultenaea gunnii*		
Golden grevillea	*Grevillea chrysophaea*	Manna gum	*Eucalyptus viminalis*
Golden everlasting	*Helichrysum bracteatum*	Maidenhair spleenwort	*Asplenium hookeranum*
Golden wattle	*Acacia pycnantha*	Marsh leek-orchid	*Prasophyllum rogersii*
Gorse bitter-pea	*Daviesia ulicina*	Matted bossiaea	*Bossiaea buxifolia*
Granite buttercup	*Ranunculus graniticola*	Matted parrot-pea	*Dillwynia prostrata*
Grass trigger-plant	*Stylidium graminifolium*	Matted rice-flower	*Pimelea biflora*
Greenhood	*Pterostylis* sp.	Mauve leek-orchid	*Prasophyllum suttonii*
Grevillea	*Grevillea* sp.	Messmate (stringybark)	*Eucalyptus obliqua*
Grey bush-pea	*Pultenaea cunninghamii*	Midget greenhood	*Pterostylis mutica*
Grey everlasting	*Helichrysum obcordatum*	Mignonette leek-orchid	*Prasophyllum morrisii*
Groundsel	*Senecio* sp.	Milk-vine	*Marsdenia rostrata*
Guinea flower	*Hibbertia* sp.	Moonwort	*Botrychium lunaria*

APPENDIX 7A (contd.)

Common Name	Scientific Name
M. (contd.)	
Mint-bush	*Prostanthera* sp.
Mitchell bertya	*Bertya mitchellii*
Mother shield-fern	*Polystichum proliferum*
Mountain ash	*Eucalyptus regnans*
Mountain baeckea	*Baeckea utilis*
Mountain banksia	*Banksia canei*
Mountain beard-heath	*Leucopogon suaveolens*
Mountain correa	*Correa lawrenciana*
Mountain cotula	*Cotula filicula*
Mountain cress	*Drabastrum alpestre*
Mountain gentian	*Gentianella diemensis*
Mountain grey gum	*Eucalyptus cypellocarpa*
Mountain gum	*Eucalyptus dalrympleana*
Mountain hickory wattle	*Acacia obliquinervia*
Mountain leafless bossiaea	*Bossiaea bracteosa*
Mountain mallee	*Eucalyptus stricta*
Mountain milkwort	*Comesperma retusum*
Mountain mirbelia	*Mirbelia oxylobioides*
Mountain mitrewort	*Mitrasacme montana*
Mountain needlewood	*Hakea lissosperma*
Mountain pepper	*Drimys lanceolata*
Mountain plantain	*Plantago antarctica*
Mountain plum pine	*Podocarpus lawrencei*
Mountain swamp gum	*Eucalyptus camphora*
Mountain tea-tree	*Leptospermum grandifolium*
Mountain woodruff	*Asperula gunnii*
Mud-mat	*Glossostigma* sp.
Mud pratia	*Pratia surrepens*
Mueller's bush-pea	*Pultenaea muelleri*
Musk daisy-bush	*Olearia argophylla*
Mutton-wood	*Rapanea howittiana*
Myrtle tea-tree	*Leptospermum myrtifolium*
N.	
Narrow-leaf bitter-pea	*Daviesia virgata*
Narrow-leaf peppermint	*Eucalyptus radiata*
Narrow-leaf wattle	*Acacia mucronata*
Narrow thread-petal	*Stenopetalum lineare*
O.	
Omeo gum	*Eucalyptus neglecta*
Orange everlasting	*Helichrysum acuminatum*
Ovens wattle	*Acacia pravissima*
P.	
Pale-fruit ballart	*Exocarpos strictus*
Pale sundew	*Drosera peltata*
Pale vanilla-lily	*Arthropodium milleflorum*
Plantain	*Plantago* sp.
Parsnip trachymene	*Trachymene anisocarpa*
Pennywort	*Hydrocotyle* sp.
Pepper everlasting	*Helichrysum conditum*
P. (contd.)	
Pink beard-heath	*Leucopogon ericoides*
Pink-bells	*Tetratheca ciliata*
Pinnate goodenia	*Goodenia grandiflora* var. *macmillanii*
Ploughshare wattle	*Acacia gunnii*
Poverty wattle	*Acacia dawsonii*
Prickly broom-heath	*Monotoca scoparia*
Prickly bush-pea	*Pultenaea juniperina*
Prickly currant-bush	*Coprosma quadrifida*
Prickly starwort	*Stellaria pungens*
Prickly tea-tree	*Leptospermum juniperinum*
Purple coral-pea	*Hardenbergia violacea*
Purple eyebright	*Euphrasia collina*
R.	
Red box	*Eucalyptus polyanthemos*
Red-fruit saw-sedge	*Gahnia sieberana*
Red-stem wattle	*Acacia rubida*
Red stringybark	*Eucalyptus macrorhyncha*
Red wattle	*Acacia silvestris*
River beard-heath	*Leucopogon riparius*
River lomatia	*Lomatia myricoides*
Rock daisy	*Brachycome petrophila*
Rock grevillea	*Grevillea willisii*
Rock poa	*Poa petrophila*
Rock wax-flower	*Eriostemon trachyphyllus*
Rosy baeckea	*Baeckea ramosissima*
Rough coprosma	*Coprosma hirtella*
Rough tree-fern	*Cyathea australis*
Royal bluebell	*Wahlenbergia gloriosa*
Royal grevillea	*Grevillea victoriae*
Rusty-pods	*Hovea longifolia*
S.	
Scaly buttons	*Leptorhynchos squamatus*
Scaly everlasting	*Helichrysum hookeri*
Scented daisy-bush	*Olearia adenophora*
Scrub nettle	*Urtica incisa*
Self-heal	*Prunella vulgaris*
Shade nettle	*Australina muelleri*
Sheep's burr	*Acaena ovina*
Shining cassinia	*Cassinia longifolia*
Shining cudweed	*Gnaphalium nitidulum*
Shining gum	*Eucalyptus nitens*
Shiny fan-fern	*Sticherus flabellatus*
Shiny phebalium	*Phebalium lamprophyllum*
Showy boronia	*Boronia ledifolia*
Showy violet	*Viola betonicifolia*
Shrubby platysace	*Platysace lanceolata*
Sickle fern	*Pellaea falcata*
Silky daisy	*Celmisia sericophylla*
Silky daisy-bush	*Olearia myrsinoides*
Silky guinea-flower	*Hibbertia sericea*

Common Name	Scientific Name
S. (contd.)	
Silver astelia	*Astelia alpina*
Silver banksia	*Banksia marginata*
Silver carraway	*Oreomyrrhis argentea*
Silver cudweed	*Gnaphalium argentifolium*
Silver daisy	*Celmisia astelliifolia*
Silver ewartia	*Ewartia nubigena*
Silvertop	*Eucalyptus sieberi*
Silvertop wallaby-grass	*Danthonia pallida*
Silver wattle	*Acacia dealbata*
Skeleton fork-fern	*Psilotum nudum*
Sky lily	*Herpolirion novae-zelandiae*
Slender dodder-laurel	*Cassytha glabella*
Slender myoporum	*Myoporum floribundum*
Slender parrot-pea	*Dillwynia capitata*
Slender rice-flower	*Pimelea linifolia*
Slender tick-trefoil	*Desmodium varians*
Slender tussock grass	*Poa tenera*
Slender wallaby-grass	*Danthonia penicillata*
Small crowea	*Crowea exalata*
Small-flower mat-rush	*Lomandra micrantha* var. *sororia*
Small-fruit hakea	*Hakea microcarpa*
Small-leaf bramble	*Rubus parvifolius*
Small-leaf parrot-pea	*Dillwynia capitata*
Small-leaf star-hair	*Astrotricha parviflora*
Small-leaved clematis	*Clematis microphylla*
Smooth nettle	*Australina muelleri*
Snow aciphyll	*Aciphylla glacialis*
Snow coprosma	*Coprosma nivalis*
Snow grass	*Poa australis* (s. agg.)
Snow gum	*Eucalyptus pauciflora*
Snow heath	*Epacris petrophila*
Snow willow-herb	*Epilobium tasmanicum*
Snow-wort	*Abrotanella nivigena*
Snowy daisy-bush	*Olearia lirata*
Snowy River daisy	*Brachycome riparia*
Snowy River wattle	*Acacia boormanii*
Snowy River westringia	*Westringia cremnophila*
Soft tree-fern	*Dicksonia antarctica*
Soft water-fern	*Blechnum minus*
Solenogyne	*Solenogyne bellioides*
Southern sassafras	*Atherosperma moschatum*
Sphagnum moss	*Sphagnum cristatum*
Spinning gum	*Eucalyptus perriniana*
Spiny-headed mat-rush	*Lomandra longifolia*
Spreading clubmoss	*Lycopodium scariosum*
Spreading fan-fern	*Sticherus lobatus*
Spreading rope-rush	*Calorophus lateriflorus*
Star plantain	*Plantago muelleri*
Sticky bertya	*Bertya cunninghamii*
Sticky everlasting	*Helichrysum thyrsoideum*
Stinking pennywort	*Hydrocotyle laxiflora*
Stinkwood	*Zieria arborescens*
St. John's blue gum	*Eucalyptus st.-johnii*
Stork's bill	*Pelargonium* sp.
S. (contd.)	
Sub-alpine beard-heath	*Leucopogon maccraei*
Sunshine wattle	*Acacia botrycephala*
Swamp gum	*Eucalyptus ovata*
Swamp heath	*Epacris paludosa*
Sweet bursaria	*Bursaria spinosa*
Sweet pittosporum	*Pittosporum undulatum*
T.	
Tall bluebell	*Wahlenbergia stricta*
Tall rice-flower	*Pimelea ligustrina*
Tall sedge	*Carex appressa*
Tall spike-rush	*Eleocharis sphacelata*
Tasman flax-lily	*Dianella tasmanica*
Thick-fruit buttercup	*Ranunculus pachycarpus*
Thick-leaf star-hair	*Astrotricha crassifolia*
Thready beard-heath	*Leucopogon pilifer*
Thyme heath	*Epacris serpyllifolia*
Tingaringy gum	*Eucalyptus glaucescens*
Tiny violet	*Viola sieberiana*
Tough rice-flower	*Pimelea axiflora*
Tower mustard	*Turritis glabra*
Trailing monotoca	*Monotoca rotundifolia*
Tree lomatia	*Lomatia fraseri*
Tree violet	*Hymenanthera dentata*
Tussock grass	*Poa* sp.
Twining glycine	*Glycine clandestina*
Twin-flower beard-heath	*Leucopogon biflorus*
Twin-flower knawel	*Scleranthus biflorus*
U.	
Urn heath	*Melichrus urceolatus*
V.	
Variable groundsel	*Senecio lautus*
Variable plantain	*Plantago varia*
Variable swainson-pea	*Swainsona oroboides*
Variable sword-sedge	*Lepidosperma laterale*
Variable willow-herb	*Epilobium cinereum*
Varnish wattle	*Acacia verniciflua*
Victorian christmas bush	*Prostanthera lasianthos*
W.	
Wallaby-grass	*Danthonia* sp.
Wattle	*Acacia* sp.
Wax-flower	*Eriostemon* sp.
Wedge-leaf hop-bush	*Dodonaea cuneata*
White box	*Eucalyptus albens*
White cypress pine	*Callitris columellaris*
White elderberry	*Sambucus gaudichaudiana*
White purslane	*Montia australasica*

APPENDIX 2A (contd.)

Common Name	Scientific Name	Common Name	Scientific Name
W. (contd.)		Y.	
White mallee	*Eucalyptus pauciflora*	Yam-daisy	*Microseris scapigera*
White stringybark	*Eucalyptus globoidea*	Yellow box	*Eucalyptus melliodora*
Willow-herb	*Epilobium* sp.	Yellow eyebright	*Euphrasia scabra*
Wild sorghum	*Sorghum leiocladum*	Yellow Kunzea	*Kunzea muelleri*
Woolly grevillea	*Grevillea lanigera*	Yellow stringybark	*Eucalyptus muellerana*
Woolly tea tree	*Leptospermum lanigerum*	Yertchuk	*Eucalyptus consideniana*

Appendix 2B

SIGNIFICANT PLANTS

(Prepared by J.H. Willis and A.C. Beauglehole)

Significant species are listed in alphabetical order by blocks, with locations noted in brackets. A species may be of significance because it is extremely rare and localized, endemic to the study area or adjacent areas, in an unusual environment compared with its normal environment, or in the type locality for that species. Of the 170 species of vascular flora listed here, 88 are considered highly significant.

Note: * = highly significant species # = endemic to study area

1. Skene

Eucalyptus chapmaniana - Bogong gum (south-west of Mount Sunday) - scattered through the mountains of eastern Victoria.

Eucalyptus kybeanensis - Ash-mallee - most westerly record of a species having restricted and very disjunct occurrences on Victorian mountain summits.

* *Lomandra micrantha* var. *sororia* - Small-flower mat-rush - one of the several known occurrences of this rare variety (or perhaps distinct species), endemic to Victoria.

Oreomyrrhis brevipes - Carraway - very isolated and most-westerly occurrence of this rare high mountain species.

* *Trochocarpa clarkei* - Lilac berry - uncommon and endemic to western parts of Victorian Alps.

2. Buller

Caesia alpina - Alpine grass-lily (Mount Clear) - most westerly occurrence of this small lily.

Coprosma pumila - Creeping coprosma (Mount Lovick and the Bluff) - the only Victorian records other than Baw Baws and Mount Wellington; always uncommon.

Cystopteris filix-fragilis - Brittle bladder-fern (Mounts Buller and Clear) - most westerly occurrence of a very rare mountain fern.

* *Deyeuxia parviseta* - Bent-grass (Mount Buller) - a rare alpine grass, known otherwise in Victoria only from the Nunniong area and Mount Wellington.

* *Eucalyptus neglecta* - Omeo gum (Mitchell Creek) - localized eucalypt endemic to the eastern Victorian highlands.

* *Galium biniflorum* - Bedstraw (near junction of Howqua River and Eight Mile Creek) - except for an isolated record from the Grampians, the most westerly occurrence of an East Gippsland plant, unusual in mountain country.

* *Grammitis armstrongii* - Alpine finger fern (Mount Buller near summit) - rare and very localized alpine fern.

* *Poa petrophila* - (Mount Clear) - uncommon alpine grass, known elsewhere in Victoria only from the Nunniong Tablelands.

*# *Ranunculus eichlerianus* - Buttercup (the Bluff) - most westerly locality for this rare alpine buttercup.

Ranunculus pachycarpus - Thick-fruit buttercup (junction of Howqua River and Eight Mile Creek) - unusual mountain occurrence of a lowland buttercup.

Spiranthes sinensis - Austral ladies' tresses (Wren's Flat on Jamieson River) - uncommon orchid in the eastern highlands of Victoria.

Trochocarpa clarkei - Lilac berry (Mounts Buller and McDonald) - most westerly occurrence of this heath, which is endemic to western parts of the Victorian Alps.

3. Cobbler

Caesia alpina - Alpine grass-lily (Mounts Cobbler and Speculation) - rare alpine lily.

Eucalyptus chapmaniana - Bogong gum (upper Buckland River valley) - scattered through mountains of eastern Victoria.

* *Eucalyptus neglecta* - Omeo gum (upper Buckland River valley) - very localized eucalypt endemic in the eastern Victorian highlands.

** *Olearia frostii* - Bogong daisy-bush (the Twins) - endemic to alps between here and Mount Bogong.

* *Trochocarpa clarkei* - Lilac berry (Mount Speculation) - endemic to western Victorian Alps.

* *Wittsteinia vacciniacea* - Baw-Baw berry (gully-head between Mounts Cobbler and Koonika) - very localized occurrence of this endemic Victorian genus, which is otherwise known only from the Baw Baws--Donna Buang--Lake Mountain region, about 105 km to the south-west.

4. Licola

* *Astrotricha parvifolia* - Small-leaf star-hair (near Mount Margaret) - unusual mountain occurrence of an endemic Victorian species, otherwise known only from Valencia Creek, and between Seaspray and Bairnsdale.

* *Boronia citriodora* - Boronia (near Mount Margaret) - regarded as a Tasmanian endemic until found recently in the Macalister River watershed, where very localized.

Eucalyptus chapmaniana - Bogong gum (Echo Point area near Lake Tali Karng) - scattered through mountains of eastern Victoria, where almost endemic, and quite rare south of Great Dividing Range.

Eucalyptus kybeanensis - Ash-mallee (Mount Useful, the Sentinel, and Gillo's Track near Lake Tali Karng) - mountain mallee of disjunct occurrence.

* *Goodenia grandiflora* var. *macmillanii* - Pinnate goodenia (Macalister River south of Burgoyne's Gap) - most westerly Victorian record and very disjunct occurrence of this rare, localized species.

* *Goodenia heterophylla* - Goodenia (Macalister River south of Burgoyne's Gap) - regarded as a New South Wales endemic until discovery of this very localized Victorian occurrence.

Helichrysum rogersianum - Everlasting (south of Licola, west of Macalister River, and near Lake Tali Karng) - endemic in Victoria, where of very disjunct occurrence in three separate districts.

* *Hibbertia* sp., undescribed - Guinea-flower (near Licola, east side of Wellington River) - apparently endemic here and extremely localized.

* *Hibbertia* sp., undescribed - Guinea-flower (Licola area) - apparently endemic and very localized.

Olearia adenophora - Scented daisy-bush (near Burgoynes Gap) - most westerly occurrence of this rare, localized daisy-bush.

Oreobolus oxycarpus - Tuft-rush (Mount Wellington--Gable End) - small matted rush of alpine bog, locally frequent.

Plantago muelleri - Star plantain (Mount Wellington) - very localized alpine plantain.

* *Prostanthera decussata* - Dense mint-bush (about 6.5 km south of Licola; Lake Tali Karng area) - very restricted mint-bush, the type being from Macalister River area.

* *Prostanthera rhombea* - Mint-bush (near Licola, east of Wellington River) - regarded as a New South Wales endemic until found here recently.

* *Prostanthera* sp. aff. *[illegible]* - Mint-bush (near Licola) - scattered in Macalister watershed, but uncommon and unknown elsewhere, except for one record in Rosedale Shire; apparently undescribed.

* *Prostanthera* sp. aff. *rhombea* - Mint-bush (Licola--Mount Margaret area) - very restricted and apparently undescribed.

* *Prostanthera* sp. aff. *rotundifolia* - Mint-bush (the Serpentine area between Mount Margaret and Lake Tali Karng) - very restricted and apparently undescribed.

Pseudanthus ovalifolius - Oval-leaf pseudanthus (near Licola) - a plant of lowland heath, unusual in mountains.

Thelymitra retecta - Sun-orchid (Gillo's Track, Lake Tali Karng) - uncommon orchid of very disjunct occurrence in Victoria.

Trachymene anisocarpa - Parsnip trachymene (the Sentinel and 2.5 km north-west of Mount Wellington) - a typically coastal species, very scattered in alps.

* *Trochocarpa clarkei* - Lilac berry (Lake Tali Karng area) - endemic in western Victorian Alps.

Zieria sp. aff. *robusta* - Zieria (near Licola) - uninvestigated but, if the same as this New South Wales species, a new record for Victoria.

5. Barkly

Bossiaea bracteosa - Mountain leafless bossiaea (Bull Plain Spur) - most westerly record of this leafless and localized mountain pea.

Eucalyptus chapmaniana - Bogong gum (Bull Plain Spur) scattered through mountains of eastern Victoria where almost endemic, and quite rare south of Great Dividing Range.

* *Koeleria australiensis* - Cat's tail (Butchers Spur between the Caledonia and upper Macalister Rivers) - only Victorian record for this grass.

Prasophyllum flavum - Yellow leek-orchid (Mountain Ash Creek area) - uncommon orchid, of scattered range in eastern highlands.

6. Bennison

* *Asplenium hookerianum* - Maidenhair spleenwort (Bryces Gorge) - only known locality for Victoria, where extremely rare.

* *Botrychium lunaria* - Moonwort (Mount Howitt) - most westerly occurrence in Victoria for this very rare fern.

Caesia alpina - Alpine grass-lily (Waterhole Saddle, Pieman Creek Plain, Bennison Plain).

Carex capillacea - Sedge (Snowy Range) - favours bogs on high plains; westernmost record of this alpine species.

* *Carex raleighii* - Sedge (Pieman Creek Plain) - apart from Cobungra and Upper Delegate River, the only known locality in Victoria for this very rare sedge.

Colobanthus apetalus - Coast colobanth (Snowy Range and Howitt Plain) - only known locality in mountains for this predominantly coastal plant.

Cystopteris filix-fragilis - Brittle bladder-fern (Conglomerate Creek Falls) - a very rare mountain fern.

Deyeuxia contracta - Bent-grass (Bryce Plain, Snowy Range) - rare grass of mountain forests.

* *Epilobium brunnescens* - Willow-herb (Conglomerate Creek Falls) - restricted to wet rocks under these falls and very rare, otherwise known only in New Zealand.

Eucalyptus perriniana - Spinning gum (Shaw's Creek, Pieman Creek, Bryce Gorge, and Bryce Plain) - an uncommon tree of scattered range in the eastern highlands of Victoria.

* *Grammitis armstrongii* - Alpine finger-fern (Conglomerate Creek Falls) - one of the few known localities for this rare fern in Victoria - including Mounts Buller, McKay, Bogong, and Hotham.

Lepidosperma lineare - Little sword-sedge (Bryce and Pieman Creek Plains) - rare sedge in Victorian Alps.

Oreobolus oxycarpus - Tuft-rush (Snowy Range) - matted rush of alpine bogs, locally abundant.

* *Oreomyrrhis argentea* - Silver carraway (Bennison Plain) - most westerly occurrence in Victoria of a rare carraway that extends otherwise only to Nunniong Plain and Bogong High Plains.

* *Poa petrophila* - Poa (Mount Clear) - uncommon alpine grass known elsewhere in Victoria only on the Nunniong Tablelands.

Poa saxicola - Rock pea (Holmes Plain) - most westerly occurrence of this uncommon alpine grass.

* *Prasophyllum densum* - Dense midge-orchid (Snowy Range and upper Moroka River) - only known locality in Victoria for this New South Wales orchid.

Prasophyllum flavum - Yellow leek-orchid (Moroka River) - uncommon orchid of eastern highlands.

Pultenaea paleacea - Chaffy bush-pea (upper Wonnangatta River) - unusual mountain occurrence of a bush-pea typical of coastal heathlands.

Ranunculus pachycarpus - Thick-fruit buttercup (north-east of Mount Speculation) - unusual mountain occurrence of a lowland buttercup.

Senecio biserratus - Groundsel (east of Mount Speculation) - only known locality in mountains for this predominantly coastal groundsel.

Sparganium antipodum - Floating bur-reed (Wonnangatta River) - a localized and uncommon plant of Victorian eastern highlands.

Spiranthes sinensis - Austral ladies' tresses (upper Wonnangatta River) - uncommon orchid in highlands of eastern Victoria.

Stipa nivicola - Alpine spear-grass (Bennison Tablelands and Macalister Springs) - most westerly occurrence of uncommon alpine grass.

* *Trochocarpa clarkei* - Lilac berry (Mount Marjorie, Snowy Range, and Bennison Tablelands) - uncommon heath, endemic to western parts of Victorian Alps.

7. Moroka

* *Astrotricha parviflora* - Small-leaf star-hair (Valencia Creek area) - unusual mountain occurrence of an endemic Victorian species, otherwise known on Mount Margaret and between Seaspray and Bairnsdale.

Botrychium australe - Austral moonwort (Moroka River near Mount Wellington) - rare fern of eastern highlands.

Caesia alpina - Alpine grass-lily (Wellington Plain, Mount Wellington).

Coprosma pumila - Creeping coprosma (Mount Wellington area) - uncommon species, restricted in Victoria to this locality, Mount Lovick, the Bluff, and Baw Baws.

Danthonia nivicola - Snow wallaby-grass (Mount Wellington and Wellington Plain) - uncommon alpine grass, otherwise in Victoria only on Bogong High Plains, Mount Buffalo, and Baw Baws.

* *Deyeuxia parviseta* - Bent-grass (summit of Mount Wellington) - rare alpine grass, known otherwise in Victoria only from Mount Buller and Nunniong area.

Eucalyptus kybeanensis - Ash-mallee (Mount Wellington and Castle Hill) - alpine mallee of very disjunct occurrence on eastern summits.

* *Eucalyptus stricta* - Mountain mallee (Mount Wellington) - only recorded Victorian occurrence of this New South Wales mountain mallee.

Gahnia subaequiglumis - Saw-sedge (Castle Hill area) - most westerly occurrence of an uncommon sedge, otherwise found in Victoria only along Delegate River in East Gippsland.

Galium binifolium - Bedstraw (junction of Valencia and Little Scott Creeks) - unusual mountain occurrence of an East Gippsland coastal bedstraw.

Helichrysum rogersianum - Everlasting (near Miller's Hut and Lake Tali Karng) - endemic in Victoria, where of very disjunct occurrence in three separate districts.

Lepidosperma lineare - Little sword-sedge (Mount Wellington) - rare sedge in Victorian Alps.

* *Lomandra micrantha* var. *sororia* - Small-flower mat-rush (Mount Wellington) - one of the several known occurrences of this rare variety or distinct species, endemic to Victoria.

Olearia adenophora - Scented daisy-bush (Valencia Creek, Little Scott Creek junction area, Turton Spur) - a rare localized daisy-bush.

Oreobolus oxycarpus - Tuft-rush (Mount Wellington--Gable End) - small tuft-rush of alpine bogs, locally frequent.

Plantago muelleri - Star plantain (Mount Wellington) - very localized alpine plantain.

Prasophyllum flavum - Yellow leek-orchid (Moroka River) - uncommon orchid of scattered range in eastern highlands.

Pratia gelida - Snow pratia (Mount Wellington) - one of the two Victorian localities for this mat-plant of wet ground in the alps, the other being on Mount Buffalo.

* *Prostanthera* sp. aff. *rhombea* - Mint-bush (Valencia Creek road south of Mount Wellington) - apparently undescribed, very rare, and restricted.

*# *Ranunculus eichlerianus* - Buttercup (McFarlane Saddle) - rare alpine buttercup.

Stipa nivicola - Snow spear-grass (Mount Wellington and Gable End) - uncommon and disjunctly occurring alpine grass.

* *Tetratheca* sp. aff. *procumbens* - Pink-bells (near Moroka River Hut) - only known occurrence in Victoria of this remarkable mat-plant.

Trachymene anisocarpa - Parsnip trachymene (Gable End) - typically coastal species, very scattered in alps.

* *Trochocarpa clarkei* - Lilac berry (Mount Wellington, Gable End, Miller's Hut, Moroka Range, and Mount Kent) - most easterly occurrences known for this endemic and uncommon mountain heath.

Uncinia flaccida - Mountain hook-sedge (Mount Wellington) - one of the few Victorian occurrences of this rare alpine sedge.

8. Tea Tree

No significant species recorded.

9. Dargo

Bossiaea bracteosa - Mountain leafless bossiaea (Lightbound Creek--King Spur areas on Dargo tablelands) - localized, leafless mountain pea.

Caesia alpina - Alpine grass-lily (Lankey Plain).

* *Epilobium willisii* - Willow-herb (Lankey Plain, Dargo tablelands) - only known Victorian record for this rare plant.

* *Eucalyptus neglecta* - Omeo gum (south-east of Treasures' Homestead on Dargo tablelands) - very localized eucalypt endemic in the eastern highlands of Victoria.

*# *Olearia frostii* - Bogong daisy-bush (the Twins) - endemic to alps between the Twins and Mount Bogong.

Pterostylis fischii - Summer greenhood (near Dargo) - rare orchid of montane eastern Victoria and southern New South Wales.

Pultenaea cunninghamii - Grey bush-pea (Crooked River area) - unusual and striking bush-pea, typically of north-eastern Victoria.

* *Wahlenbergia densifolia* - Fairy blue-bell (Lankey Plain) - one of only two localities known in Victoria for this rare alpine bluebell, the other being Nunniong Plain.

10. Bogong

* *Abrotanella nivigena* - Snow-wort (Spion Kopje at source of Mitta Mitta River) - only known locality in Victoria, where very rare, otherwise on Kosciusko Plateau, N.S.W.

* *Acacia dallachiana* - Catkin wattle - rare and endemic Victorian species.

Brachycome obovata - Daisy (Buckety Plain , Bogong High Plains) - rare in Victoria, where restricted to the alps at this locality, on the Cobberas, and in the Baw Baw--Lake Mountain area.

* *Brachycome tenuiscapa* - Daisy (Bogong High Plains at Pretty Valley - very rare in Victoria, where known only from here and nearby Cobungra (with an old, dubious record for Ballarat).

Caesia alpina - Alpine grass-lily (Bogong High Plains) - scattered in several places from Mount Fainter to Wild Horse Creek, but a localized lily.

Carex archeri - Sedge (Bogong High Plains; Mounts Bogong and Hotham) - scattered between Mounts Bogong and Hotham, elsewhere in Victoria apparently only near Cravensville to the north-east.

Carex capillacea - Sedge (Bogong High Plains) - favours bogs on high plains.

* *Carex cephalotes* - Sedge (Mounts Hotham and Bogong) - an extremely rare high alpine sedge, last noted in Victoria at Mount Bogong in 1923.

*# *Carex paupera* - Sedge (Mount Hotham) - extremely rare, and known only by the type, collected at about 1,800 m in 1940.

*# *Celmisia sericophylla* - Silky daisy (Bogong High Plains; Mount Bogong) - a handsome tussock-forming daisy, localized on rocky stream-banks above 1,650 m and endemic between Mounts Bogong and Cope.

Cystopteris filix-fragilis - Brittle bladder-fern (Wotan Creek on Mount Bogong) - a very rare fern, known from only a few mountain habitats in eastern Victoria, otherwise almost cosmopolitan.

Danthonia nivicola - Snow wallaby-grass (Mount Feathertop and Bogong High Plains) - uncommon alpine grass, otherwise known in Victoria only from Mount Buffalo, the Baw Baws, and Mount Wellington.

Deyeuxia carinata - Bent-grass (Mount Hotham and Pretty Valley) - rare and localized grass, otherwise known in Victoria only from Mount Buffalo and the Cobberas.

Deyeuxia contracta - Bent-grass (near Mount Feathertop) - uncommon grass of mountain forests.

* *Deyeuxia* (?) *setifolia* (not confirmed) - Bent-grass (Bogong High Plains) - uncommon alpine grass, unknown elsewhere in Victoria.

*# *Dillwynia capitata* - Slender parrot-pea (near Mount Beauty) - very rare shrub, the typical form known only by the type collection from this locality.

* *Epilobium tasmanicum* - Snow willow-herb (Mount Bogong) - rare willow-herb of higher alps, apparently unknown elsewhere in Victoria.

Eucalyptus chapmaniana - Bogong gum (near Bogong township) - the type locality, otherwise scattered through north-eastern Victoria.

* *Gnaphalium nitidulum* - Shining cudweed (Pretty Valley on Bogong High Plains) - extremely rare in Victoria, where known only from this restricted locality.

* *Grammitis armstrongii* - Alpine finger-fern (Mounts Hotham, McKay, and Bogong) - a small alpine fern, restricted in Victoria to crevices on these mountains, Mount Buller, and Conglomerate Creek on the Snowy Range.

*# *Grevillea willisii* - Rock grevillea (Angler's Rest, extreme south-eastern border of block) - endemic in north-eastern and eastern Victoria, where scattered in rocky places between 600 m and 1,200 m altitude.

Juncus antarcticus - Cushion rush (Bogong High Plains) - restricted in Victoria to bogs between Mounts Bogong and Cope.

Leucopogon montanus - Snow beard-heath (Bogong High Plains) - restricted in Victoria to higher parts of this region - on Mounts Loch, Feathertop, Nelse, and Bogong, where localized.

*# *Leucopogon pilifer* - Thready beard-heath (Bogong High Plains) - a rare thready heath, endemic to this area and in the headwaters of Buchan and Tambo Rivers (including Nunniong Tablelands).

* *Lycopodium scariosum* - Spreading clubmoss (head of Middle Creek near Cope Hut) - very rare clubmoss, occurring in Victoria only here and at the Baw Baws.

* *Mitrasacme montana* - Mountain mitrewort (Bogong High Plains at head of Middle Creek near Cope Hut) - rare matplant, restricted in Victoria to this locality and the Baw Baws.

*# *Olearia frostii* - Bogong daisy-bush (Bogong High Plains) - endemic and scattered in region between Mount Bogong and the Twins.

* *Oreomyrrhis argentea* - Silver carraway (Bogong High Plains) - rare alpine carraway, extending only to Nunniong Plain and the Bennison Tablelands in Victoria.

Oreomyrrhis brevipes - Carraway (Mount Nelse) - rare alpine carraway, extending in very localized occurrences between Mount Skene and the Cobberas.

Oreomyrrhis pulvinifica - Cushion carraway (Mounts Bogong and Feathertop) - uncommon matted carraway of higher alps, with an extension at Wombargo Range.

* *Parantennaria uniceps* - (Bogong High Plains near Mount Cope) - only locality in Victoria for this rare species of the higher alps (including Mount Kosciusko in New South Wales).

* *Pelargonium helmsii* - Stork's-bill (Bogong High Plains) - only locality in Victoria, this rare species extending also to Mount Kosciusko, New South Wales.

Plantago glacialis - Plantain (Bogong High Plains) - this is the only known Victorian locality.

Plantago muelleri - Star plantain (Bogong High Plains) - uncommon rosette herb, in Victoria only here and on Mount Wellington.

Poa hiemata - (Mount Bogong to Mount Hotham) - uncommon grass of these higher alps.

Poa hothamensis - (Bogong High Plains and Mount Hotham) - uncommon grass of these higher alps, endemic to Victoria.

Poa saxicola - Rock poa (Bogong High Plains) - very localized grass occurring in Victoria only here, the Cobberas, Holmes Plain, and Mount Nunniong.

Prasophyllum flavum - Yellow leek-orchid (Bogong township) - uncommon leek-orchid, of scattered range in eastern highlands.

Pultenaea capitellata - Bush-pea (Spion Kopje and Wild Horse Creek) - uncommon bush-pea of eastern highlands, ascending to these alps.

*\# *Ranunculus eichlerianus* - Buttercup (Bogong High Plains) - type locality of this rare alpine buttercup, endemic to the study area.

Schizeilema fragoseum - Alpine pennywort (Mounts Bogong and Nelse, Middle Creek) - rare pennywort, occurring in Victoria only here and on the Cobberas.

Scirpus gunnii - Club-rush (Bogong High Plains) - rare mountain plant in Victoria, known only from the Bogongs and at Mount Kaye in East Gippsland.

Scleranthus singuliflorus - Knawel (Bogong High Plains) - uncommon and disjunct alpine grass.

Stipa nivicola - Snow spear-grass (Bogong High Plains) - uncommon and disjunct alpine grass.

* *Taraxacum aristum* - Austral dandelion (Bogong High Plains) - the only indigenous dandelion in Australia and of restricted range (known with certainty in Victoria only from the Bogongs and Brisbane Ranges).

Tetrarrhena sp. aff. *acuminata* - Rice-grass (near Mount Bogong) - an as-yet-uninvestigated grass of very disjunct range in Victorian Alps, the Grampians, and near coastal areas of East Gippsland.

Trachymene anisocarpa - Parsnip trachymene (Mount Fainter) - typically coastal herb, very scattered and disjunct in alps.

Uncinia flaccida - Mountain hook-sedge (Bogong High Plains) - one of very few localities in Victoria for this rare alpine sedge.

11. Cobungra

* *Bertya mitchellii* - Mitchell bertya (near Angler's Rest) - a glabrous mutant, and very isolated occurrence of a shrub otherwise restricted to the Mallee.

* *Botrychium lunaria* - Moonwort (Cobungra) - one of the several recorded Victorian localities for this very rare and seldom-observed fern.

* *Brachycome tenuiscapa* - Daisy (Cobungra) - very rare in Victoria, where otherwise known only from Pretty Valley on the Bogong High Plains, with an old dubious record for Ballarat.

* *Carex capillacea* - Sedge (Cobungra) - a rare alpine sedge favouring bogs on the high plains.

* *Carex raleighii* - Sedge (Cobungra) - known in Victoria only from this, the type area, Native Creek Plain, and on the Delegate River flats near Bendoc, but rare in each.

* *Eucalyptus neglecta* - Omeo gum (upper Livingstone Creek) - the type locality for this rare and very localized tree, which is endemic to eastern Victoria.

*\# ***Prasophyllum morganii*** - Mignonette leek-orchid (Cobungra) - the type locality of this extremely rare orchid, which is known only by three collections made in this area, the last in 1933.

* *Turritis glabra* - Tower mustard (Cobungra) - rare and very localized herb, known in Victoria otherwise only at sources of the Mitchell and Suggan Buggan Rivers.

12. Haldhead

Prostanthera walteri - Monkey mint-bush (headwaters of Haunted Stream) - one of several Victorian localities for this very scattered sub-alpine mint-bush.

* *Sticherus flabellatus* - Shiny fan-fern (Pheasant Creek, upper reaches) - otherwise known in Victoria only from far-east Gippsland (near Genoa, Wroxham, Tamboon Inlet, Mallacoota), where extremely localised.

* *Turritis glabra* - Tower mustard (Mitchell River sources) - see note for Cobungra block.

13. Benambra

* *Centaurea australis* - Austral cornflower (Lake Omeo) - extremely rare in Victoria, where last noted in the 1850s and probably now extinct.

Pterostylis laxa - Greenhood (Mount Little Tambo) - most westerly record of a localized montane orchid, known otherwise in Victoria from the Wulgulmerang and Suggan Buggan areas, Monument Ridge, and Mount Delegate in the East Gippsland study area.

* *Senecio georgianus* - Groundsel (Lake Omeo) - rare and very localized in Victoria, where known otherwise only from the Macalister River.

Sparganium antipodum - Floating bur-reed (Omeo and Benambra) - localized and uncommon bur-reed of eastern Victorian highlands.

14. Dartmouth

* *Acacia dallachiana* - Catkin wattle - rare occurrence of this endemic Victorian wattle.

* *Acacia dawsonii* - Poverty wattle (Mitta Mitta) - only known occurrence in Victoria, where very rare.

* *Calochilus grandiflorus* - Beard-orchid (Mitta Mitta) - extremely rare in Victoria, where known elsewhere only near Mount Beauty.

15. Pinnibar

* *Acacia dallachiana* - Catkin wattle - rare occurrence of this endemic Victorian wattle.

Ranunculus pachycarpus - Thick-fruit buttercup (near Mount Pinnibar Hut) - unusual montane occurrence of a lowland buttercup.

16. Buckwong

Botrychium australe - Austral moonwort (Bulley Creek, west of Cobberas; Cowombat Flat; Limestone Creek) - rare fern now restricted in Victoria to a few grassy places in the eastern highlands.

Brachycome obovata - Daisy (Cobberas) - rare alpine daisy restricted in Victoria to the Cobberas, Bogongs, and Box Saw--Lake Mountain region.

Carex capillacea - Sedge (Cobberas) - rare sedge favouring bogs on the High Plains.

Correa lawrenciana var. *rosea* - Mountain correa (Cobberas - small-leaved and red-flowered population restricted in Victoria to a few far-eastern mountains (including Mount Tambo).

Deyeuxia carinata - Bent-grass (Cobberas) - rare and localized alpine grass, otherwise known in Victoria only from Bogongs and Mount Buffalo.

* *Eucalyptus neglecta* - Omeo gum (upper Buckwong Creek, Dead Horse Creek) - very localized eucalypt, endemic to the eastern Victorian highlands.

* *Hydrocotyle* sp. aff. *sibthorpioides* - Pennywort (Buenba) - a most unusual aquatic species, otherwise known in Victoria only from the sources of the Little, Buchan, and Tambo Rivers.

Lepidosperma lineare - Little sword-sedge (Native Cat Track) - rare sedge in Victorian Alps.

Oreobolus oxycarpus - Tuft-rush (Cobberas) - small matted rush of alpine bogs, but locally frequent.

Oreomyrrhis brevipes - Carraway (Cobberas) - rare alpine carraway, otherwise known in Victoria only from Mounts Nelse and Skene.

Pilularia novae-hollandiae - Austral pillwort (Cowombat Flat) - most isolated and easterly record in Victoria for this occasional and scattered fern-like plant of damp flats.

Poa saxicola - Rock poa (Cobberas) - very localized high-mountain grass, known otherwise in Victoria only from Bogong High Plains, Holmes Plain, and Mount Wunnlong.

Schizeilema fragoseum - Alpine pennywort (Cobberas at "Ass's Ears") - rare pennywort, occurring otherwise in Victoria only on the Bogong High Plains.

Scleranthus singuliflorus - Knawel (Cobberas) - type locality for this uncommon plant of higher alps (Bogongs; Kosciusko Plateau, N.S.W.; and perhaps Mount Buller).

Spiranthes sinensis - Austral ladies' tresses (Murray River near junction with Buckwong River) - uncommon orchid in highlands of eastern Victoria, this being the most isolated occurrence.

17. Suggan Buggan

* *Anthocercis albicans* - Hoary ray-flower (Mount Stradbroke, Rocky Knob near Bridle Creek) - extremely rare shrub in Victoria, where known only from here and the Snowy River gorge area.

Astrotricha crassifolia - Thick-leaf star-hair (Ballantyne Hills near Suggan Buggan) - rare shrub restricted in Victoria to the upper Buchan River and Snowy River gorge area.

* *Bertya cunninghamii* - Sticky bertya (Snowy River near McKillop's Bridge) - rare shrub, occurring in Victoria only along the upper Snowy River and in the gorge tract of Mitchell River.

Botrychium australe - Austral moonwort (Rocky Plain, Rams Horn, Ingeegoodbee River) - rare fern now restricted in Victoria to a few grassy places in the eastern highlands.

* *Botrychium lunaria* - Moonwort (between Blue Hill and Rams Horn, near Native Dog Creek) - one of four recorded Vict-

orian localities for this very rare and seldom-seen fern.

Brachycome obovata - Daisy (Cobberas) - rare alpine daisy restricted in Victoria to the Cobberas, Bogongs, and Baw Baw--Lake Mountain region.

Carex capillacea - Sedge (Cobberas and the Playground) - rare alpine sedge.

* *Cassia nemophila* - Desert cassia (Suggan Buggan) - rare and very isolated occurrence of a shrub typifying Mallee habitats, on sand.

* *Correa lawrenciana* var. *rosea* - Mountain correa (Cobberas) - small-leaved and red-flowered population restricted in Victoria to a few locations in far-eastern highlands.

* *Corybas hispidus* - Helmet-orchid (Mount Hamilton, Suggan Buggan, and Ingeegoodbee River) - localized orchid, restricted in Victoria to north-eastern Gippsland (upper Snowy River watershed).

Deyeuxia carinata - Bent-grass (Cobberas) - rare and localized alpine grass, otherwise known in Victoria only from Bogongs and Mount Buffalo.

* *Deyeuxia* sp., undescribed, aff. *angustifolia* - Bent-grass (Ballantyne Hills near Suggan Buggan) - very localized grass, unknown elsewhere in Victoria.

* *Dipodium hamiltonianum* - Hyacinth orchid (near Mount Wheeler, above Snowy River) - extremely rare orchid in Victoria, known also in New South Wales and Queensland.

* *Drabastrum alpestre* - Mountain cress (Suggan Buggan) - extremely rare plant, unknown elsewhere in Victoria.

Eucalyptus glaucescens - Tingaringy gum (Stradbroke Chasm and Mount Wheeler) - mountain mallee of very disjunct and localized occurrence in eastern highlands of Victoria (between Mounts Erica and Tingaringy, inclusive).

* *Glossogyne tenuifolia* - Glossogyne (Suggan Buggan) - extremely localized herb, unknown elsewhere in Victoria.

* *Goodenia grandiflora* var. *macmillanii* - Pinnate goodenia (near Mount Wheeler, above Snowy River) - rare, disjunct, and very localized herb, known elsewhere in Victoria only from the nearby Deddick River and along the Macalister River below Licola.

* *Helichrysum adnatum* - Everlasting (Suggan Buggan) - very rare and localized shrub, known elsewhere in Victoria only at Marble Creek (Tributary of Tambo River near Bindi).

*# *Hibbertia spathulata* - Guinea-flower (Suggan Buggan) - apparently endemic in Victoria, where known elsewhere only from the Snowy River gorge tract, east from Butchers Ridge.

Lepidosperma lineare - Little sword-sedge (Rocky Plain) - rare sedge in Victorian Alps.

Leucopogon juniperinus - Long-flower beard-heath (MacFarland Flat track at Moscow Creek) - isolated record of an uncommon heath in eastern highlands.

Logania albiflora - Narrow-leaf logania (Mount Stradbroke and near Snowy River) - uncommon shrub of disjunct occurrence in highlands.

Myoporum floribundum - Slender myoporum (Suggan Buggan River near Pine Hill) - elegant and rare tall shrub, restricted in Victoria to rocky banks of streams between Suggan Buggan and Ambeyne crossing of Deddick River.

Oreobolus oxycarpus - Tuft-rush (Cobberas) - small matted rush of alpine bogs, but locally frequent.

Oreomyrrhis brevipes - Carraway (Cobberas) - rare alpine carraway, otherwise known in Victoria only from Mounts Nelse and Skene.

Poa clivicola - Poa (Native Dog Creek) - uncommon subalpine grass; restricted in Victoria to far north-eastern highlands on and beyond the Nunniong Tablelands.

Poa saxicola - Rock poa (Cobberas at "Ass's Ears") - very localized high-mountain grass, known otherwise in Victoria only at Bogong High Plains, Mount Nunniong, and Holmes Plain.

Pomaderris eriocephala - Pomaderris (Suggan Buggan and Snowy Rivers) - uncommon shrub of eastern highlands, chiefly along valleys of Tambo, upper Snowy, and Deddick Rivers.

Pomaderris pauciflora - Pomaderris (Suggan Buggan) - restricted to eastern Victoria and southern New South Wales.

* *Prasophyllum rogersii* - Marsh leek-orchid (upper reaches of Native Dog Creek) - very rare orchid with extremely disjunct range in Victoria (otherwise at Forlorn Hope Plain, Mallacoota, and near Portland.

* *Psilotum nudum* - Skeleton fork-fern (Ballantyne Hills near Suggan Buggan) - extremely localized and rare Victorian fern, elsewhere in State only at Mounts Zero and Arapiles in the southern Wimmera.

*# *Pterostylis aestiva* - Greenhood (Mount Hamilton and Suggan Buggan Range) - orchid ranging only between upper Tambo and upper Snowy Rivers, but locally frequent in favourable seasons.

* *Pterostylis coccinea* - Greenhood (Mount Hamilton area) - uncommon mountain orchid, restricted in Victoria to this and the Milky Creek area, where occasionally rather frequent.

Pterostylis fischii - Summer greenhood (Mount Hamilton) - rare orchid of montane eastern Victoria and southern New South Wales.

Pterostylis laxa - Greenhood (Mount Stradbroke, Mount Hamilton) - localized montane orchid, known otherwise in Victoria only from a few scattered locations.

Pterostylis mutica - Midget greenhood (Suggan Buggan area) - very isolated montane occurence of this orchid.

Pterostylis sp., aff. *alpina* - related to alpine greenhood (Rocky Plain area) - a localized montane orchid with a remarkable blue labellum, still in need of investigation.

* *Pultenaea subspicata* - Bush-pea (Wulgulmerang--Mount Hamilton area) - rare bush-pea, restricted in Victoria to this localized montane habitat.

Samolus valerandii - Brookweed (Snowy River at Suggan Buggan) - an uncommon brookweed confined in Victoria to a few parts of eastern Gippsland, usually in shady places near water.

Schizeilema fragoseum - Alpine pennywort (Cobberas at "Ass's Ears") - rare pennywort, otherwise in Victoria only on the Bogong High Plains.

Scleranthus singuliflorus - Knawel (Cobberas) - type locality for this uncommon plant of higher alps (Bogongs, Kosciusko Plateau, and perhaps at Mount Buller).

* *Sorghum leiocladum* - Wild sorghum (Suggan Buggan) - rare grass, now confined in Victoria to the Suggan Buggan--Ingeegoodbee area adjoining the New South Wales border.

Stenopetalum lineare - Narrow thread-petal (Suggan Buggan) - very isolated montane occurrence of a herb typifying the drier sandy regions of north-western Victoria.

Swainsona oroboides - Variable swainson-pea (Suggan Buggan and Mount Wheeler) - isolated montane occurrence of a pea typifying the drier parts of north-western and western Victoria.

* *Thelymitra cyanea* - Rare veined sun-orchid (Rocky Plains) - rare and localized orchid, known elsewhere in Victoria only from upper Delegate River and Maramingo Creek near Genoa.

* *Thesium australe* - Austral toad-flax (Rocky Plain and Mount Hamilton) - very rare and localized parasite, now reduced in Victoria to a few mountain habitats near the Wombargo Range and at Gillingal.

Trachymene anisocarpa - Parsnip trachymene (Suggan Buggan) - a typically coastal species with scattered range in the alps and sub-alps.

* *Turritis glabra* - Tower mustard (source of Suggan Buggan River) - rare and very localized herb, known otherwise in Victoria only from Cobungra and the sources of Mitchell River.

Zieria cytisoides - Downy zieria (Suggan Buggan) - uncommon shrub of east Gippsland, scattered between upper Snowy River watershed and Gabo Island.

18. Reedy

* *Acacia lucasii* - Wattle (Brumby Point) - extremely localized wattle, unknown elsewhere in Victoria, the nearest occurrence being in Tinderry Mountains, N.S.W.

Astrotricha crassifolia - Thick-leaf star-hair (Buchan River near Reedy Track) - rare shrub restricted in Victoria to the upper Buchan and Snowy River watersheds.

Bossiaea bracteosa - Mountain leafless bossiaea (Reedy River) - localized, leafless mountain pea.

Botrychium lunaria - Moonwort (Forlorn Hope Plain) - one of several recorded Victorian localities for this very rare and seldom-seen fern.

Carex capillacea - Sedge (Forlorn Hope Plain) - rare alpine sedge.

Correa lawrenciana var. *rosea* - Mountain correa (Reedy River, Mount Tambo, and Tambo River) - small-leaved and red-flowered population restricted in Victoria to a few locations in far eastern highlands.

Cystopteris filix-fragilis - Brittle bladder-fern (Upper Buchan River and Forlorn Hope Creek Falls) - very rare fern known only from a few montane habitats in eastern Victoria, otherwise almost cosmopolitan.

* *Dampiera* sp. undescribed - Dampiera (western scarps of upper Buchan River towards Brumby Point) - very localized plant, unknown elsewhere in Victoria but found also at Kydra Peak in the Kybean Mountains of New South Wales.

Eucalyptus kybeanensis - Ash-mallee (Brumby Point) - alpine mallee of very disjunct occurrence on eastern summits in Victoria, but here locally frequent.

Eucalyptus perriniana - Spinning gum (Nunniong Tablelands, Brumby Point Track) - uncommon tree of scattered range in eastern Victorian highlands.

* *Glossostigma* sp. uninvestigated - Mountain mud-mat (Native Cat Flat and Forlorn Hope Plain) - unknown elsewhere in Victoria, but recorded from mountain pools and bogs in the Australian Capital Territory.

* *Grevillea* sp. undescribed - Grevillea (Reedy and Buchan Rivers, Nunniong Tablelands) - apparently confined to these areas.

Helichrysum rogersianum - Everlasting (Little Reedy River near Brumby Point) - endemic in Victoria, where of very disjunct occurrence in three separate districts, this being the most easterly.

* *Hydrocotyle* sp. aff. *sibthorpioides* - Pennywort (Forlorn Hope Plain) - a most unusual aquatic species, otherwise known in Victoria only from sources of the Tambo and Little Rivers and from Buenba (north-east of Benambra).

* *Isoetes humilior* - Rock quillwort (Forlorn Hope Plain) - uncommon and localized quillwort, usually in rock pools or in depressions.

Lepidosperma lineare - Little sword-sedge (Native Cat track) - rare sedge in Victorian Alps.

*# *Leucopogon pilifer* - Thready beard-heath (Forlorn Hope Plain and Native Dog Creek) - a rare thready heath, endemic to eastern Victoria in boggy places around heads of the Buchan and Tambo Rivers and on Bogong High Plains.

*# *Monotoca rotundifolia* - Trailing monotoca (Brumby Point and escarpment north of Never Never Creek) - an extremely localized and procumbent heath, endemic to these two localities.

Oreobolus oxycarpus - Tuft-rush (Forlorn Hope Plain) - small matted rush of alpine bogs, but locally frequent.

Poa clivicola - Poa (Forlorn Hope Plain) - uncommon sub-alpine grass, restricted in Victoria to far north-eastern highlands, on and beyond the Nunniong Tablelands.

* *Poa petrophila* - Poa (Brumby Point and Horse Flat, Nunniong Tablelands) - uncommon alpine grass, known elsewhere in Victoria only at Mount Clear.

Pomaderris pauciflora - Pomaderris (Brumby Point) - restricted to eastern Victoria and southern New South Wales.

* *Prasophyllum rogersii* - Marsh leek-orchid (Forlorn Hope Plain) - very rare orchid with extremely disjunct range in Victoria (otherwise at Native Dog Creek, Mallacoota, and near Portland.

Pterostylis laxa - Greenhood (Mount Little Tambo) - localized montane orchid.

Tetrarrhena sp., aff. *acuminata* - Rice-grass (northern slope of Brumby Point) - an as-yet-uninvestigated grass of very disjunct range in Victorian Alps, the Grampians, and coastal areas of East Gippsland.

Thelymitra retecta - Sun-orchid (Brumby Point) - uncommon orchid of very disjunct occurrence in Victoria.

Trachymene anisocarpa - Parsnip trachymene (Nunniong Tablelands) - a typically coastal biennial with scattered disjunct range in the alps and sub-alps.

19. Nunniong

Asterotricha crassifolia - Thick-leaf star-hair (Buchan River near Reedy Track) - rare shrub restricted in Victoria to the upper Buchan and Snowy River watersheds.

Botrychium australe - Austral moonwort (Bentleys Plain) - rare fern now restricted in Victoria to a few grassy places in the eastern highlands.

Carex capillacea - Sedge (Nunniong Plain, Blue Shirt Creek) - rare alpine sedge.

Correa lawrenciana var. *rosea* - Mountain correa (Mount Tambo, Mellick Munjie Creek) - small-leaved and red-flowered population restricted in Victoria to a few locations in the eastern highlands.

* *Dampiera* sp., undescribed - Dampiera (western scarps of upper Buchan River) - very localized plant unknown elsewhere in Victoria but found also at Kydra Peak in the Kybean Mountains of New South Wales.

* *Deyeuxia microseta* - Bent-grass (north of Mount Nunniong, upper Frying Pan Creek) - localized grass of mountain forests, known otherwise in Victoria only from Combienbar.

* *Deyeuxia parviseta* - Bent-grass (upper reaches of Blue Shirt and Diggers Hole Creek) - known otherwise in Victoria only from Mounts Buller and Wellington.

* *Eriostemon* sp., uninvestigated - Wax flower (Mount Stewart) - apparently a local shrub of uncertain affinity.

Eucalyptus perriniana - Spinning gum (near Diggers' Holes and Mount Nunniong) - uncommon tree of scattered range in eastern Victorian highlands.

* *Grevillea* sp., undescribed - Grevillea (upper Buchan River near Reedy Track) - apparently confined to north-eastern Nunniong Tablelands.

* *Helichrysum adnatum* - Everlasting (Martle Creek near Bindi) - very rare and localized shrub, known elsewhere in Victoria only at Suggan Buggan.

* *Hydrocotyle* sp., aff. *sibthorpioides* - Pennywort (Nunniong Plain) - a most unusual aquatic species, otherwise known in Victoria only from sources of Goodwin Creek, Forlorn Hope Plain, and Buenba (north-east of Benambra).

Lepidosperma lineare - Little sword-sedge (near Mount Nunniong) - a rare sedge in Victorian Alps.

*# *Leucopogon pilifer* - Thready beard-heath (Nunniong Tablelands at heads of Timbarra River and Blue Shirt Creek) - rare thready heath, endemic to eastern Victoria in boggy places around heads of the Buchan and Tambo Rivers and on the Bogong High Plains.

Oreobolus oxycarpus - Tuft-rush (Nunniong Plain) - small tuft-rush of alpine bogs, but locally frequent.

* _Oreomyrrhis argentea_ - Silver carraway (Nunniong Plain) - rare rosetted carraway, known elsewhere in Victoria only from the Bogong High Plains and Bennison Tablelands.

* _Pimelea dichotoma_ - Diosma rice-flower (Marble Creek near Bindi) - extremely disjunct occurrence (unique in eastern Victoria) of a Mallee shrub.

Poa clivicola - Poa (Nunniong Plain) - uncommon sub-alpine grass, restricted in Victoria to far north-eastern highlands (between Nunniong Tablelands and Cobberas).

Poa saxicola - Rock poa (Mount Nunniong) - alpine grass of rare distribution.

*# _Pterostylis aestiva_ - Greenhood (near Ensay) - orchid ranging only between upper Tambo and upper Snowy Rivers, but locally frequent in favourable seasons.

Pterostylis fischii - Summer greenhood (Nunniong Tablelands) - rare orchid of montane eastern Victoria and southern New South Wales.

Sparganium antipodum - Floating bur-reed (Lake Hill, Nunniong Tablelands) - localized and uncommon bur-reed of Victorian eastern highlands.

Spiranthes sinensis - Austral ladies' tresses (Bentleys Plain) - uncommon orchid in highlands of eastern Victoria.

Thelymitra retecta - Sun-orchid (upper reaches of Diggers Hole Creek) - uncommon orchid of very disjunct occurrence in Victoria.

* _Thesium australe_ - Austral toad-flax (Gillingal) - very rare and localized parasite, now reduced in Victoria to a few mountain habitats at Gillingal, near the Wombargo Range, and Wulgulmerang area.

* _Wahlenbergia densifolia_ - Fairy bluebell (Nunniong Plain) - one of only two localities known in Victoria for this rare alpine bluebell, the other being Lankey Plain (on Dargo Tablelands).

20. Wulgulmerang

* _Acacia subtilinervis_ - Wattle (Snowy River gorge) - the only known occurrence in Victoria of this rare and localized wattle.

* _Anthocercis albicans_ - Hoary ray-flower (Snowy River gorge) - known in Victoria only from here, Mount Stradbroke, and Suggan Buggan.

Astrotricha crassifolia - Thick-leaf star-hair (Snowy River gorge area) - rare shrub, otherwise restricted in Victoria to the upper Buchan River and Ballantyne Hills near Suggan Buggan.

* _Bertya cunninghamii_ - Sticky bertya (Snowy River cliffs) - rare shrub occurring in Victoria only along the upper Snowy River and in the gorge tract of Mitchell River.

* _Boronia ledifolia_ - Showy boronia (Snowy River gorge) area) - one of only two localities known in Victoria for this rare and handsome shrub, the other being Timbarra River east from Mount Elizabeth.

Bossiaea bracteosa - Mountain leafless bossiaea (headwaters of Little River) - localised, leafless mountain pea.

*# _Brachycome petrophila_ - Rock daisy (gorges of Little River and Boundary Creek) - apparently endemic to eastern Victoria, known with certainty only from rhyodacite cliff faces here and along the Murrindal River near Buchan.

* _Brachycome riparia_ - Snowy River daisy (Snowy River gorge) - apparently endemic to the gorge tracts of the Snowy and Genoa Rivers.

* _Corybas hispidus_ - Helmet-orchid (the Bluff on Bonang--Gelantipy Road) - localized orchid known in Victoria only from the upper Snowy River watershed, especially in the vicinity of Suggan Buggan.

Cystopteris filix-fragilis - Brittle bladder-fern (Little River Falls) - very rare fern known only from a few montane to alpine habitats in eastern Victoria, otherwise almost cosmopolitan.

Dendrobium striolatum - Streaked rock orchid (Little River gorge, also Stradbroke Chasm) - an unusual penetration far into the mountains of this very localized, near-coastal rock orchid (here about 95 km from the sea).

*# _Dillwynia capitata_ - Slender parrot-pea (Mount Stradbroke) - one of only two localities known for this very rare endemic shrub, the other being near Mount Beauty.

* _Dillwynia prostrata_ - Matted parrot-pea (Bald Knob, and near Seldom Seen and Boundary Creeks) - the only known occurrence in Victoria of this matted mountain pea.

* _Dipodium hamiltonianum_ - Hyacinth orchid (near Mount Wheeler, above Snowy River) - extremely rare orchid in Victoria, known also in New South Wales and Queensland.

Dodonaea rhombifolia - Broad-leaf hop-bush - one of two occurrences in Victoria, the other being at Pine Mountain.

Eucalyptus glaucescens - Tingaringy gum (Stradbroke Chasm and Little River gorge look-out) - mountain mallee of very disjunct and localized occurrence in eastern highlands of Victoria (between Mounts Erica and Tingaringy).

Eucalyptus kybeanensis - Ash-mallee (Mount Seldom Seen) - alpine mallee of very disjunct occurrence on eastern summits in Victoria.

Galium binifolium - Bedstraw (east of Little River) - unusual mountain occurrence of an East Gippsland coastal bedstraw.

• *Goodenia grandiflora* var. *macmillanii* - Pinnate goodenia (near Mount Wheeler, above Snowy River) - rare, disjunct, and very localized herb, known elsewhere in Victoria only from the nearby Deddick River and along the Macalister River below Licola.

• *Grevillea* sp., undescribed - Grevillea (Mount Stradbroke) - apparently confined to this area.

•, *Hibbertia spathulata* - Guinea-flower (Snowy River east from Butchers Ridge) - apparently endemic to Victoria, where extending only to nearby Suggan Buggan.

Hydrocotyle sp., aff. *sibthorpioides* - Pennywort (head of Goodwin Creek) - a most unusual aquatic species, otherwise known in Victoria only from Nunniong and Forlorn Hope Plains and Suenba (north-east of Benambra).

Isoetes humilior - Rock quillwort (Little River Falls, Snowy River gorge) - uncommon and localized quillwort, usually in rock pools.

• *Leucopogon riparius* - River beard-heath (Snowy River gorge) - apparently endemic to the Snowy River gorge tract.

Logania albiflora - Narrow-leaf logania (near Snowy River) - uncommon shrub of disjunct occurrence in eastern highlands.

Myoporum floribundum - Slender myoporum (Snowy River) - elegant and rare tall shrub, restricted in Victoria to rocky banks of streams between Suggan Buggan and Ambyne Crossing (of Deddick River).

Olearia adenophora - Scented daisy-bush (east of Buchan River, north of junction with Reedy River) - very localized shrub, known in Victoria only at Pine Mountain, Ben Cruachan, and the Macalister River watershed.

Oreomyrrhis pulvinifica - Cushion carraway (Little River, Wulgulmerang) - uncommon matted carraway, usually of higher alps (Mounts Bogong and Feathertop), but extending to the Wombargo Range.

Phebalium glandulosum - Phebalium (Snowy River) - disjunct occurrence of a shrub typifying Mallee country in the western Wimmera.

• *Phebalium* sp., aff. *squameum* - Phebalium (Wulgulmerang Creek, near Little River) - very localized tall shrub, known otherwise in Victoria only from Mount Elizabeth.

Poa affinis - Poa (Wombargo Track) - uncommon subalpine grass, restricted in Victoria to north-eastern highlands between Nunniong Tablelands and Cobberas).

Pomaderris pauciflora - Pomaderris (north of Boundary Creek) - restricted to eastern Victoria and southern New South Wales.

Prostanthera walteri - Monkey mint-bush (Butchers Ridge) one of only a few Victorian localities for this very scattered sub-alpine mint-bush.

Pseudanthus divaricatissimus - Tangled pseudanthus (Snowy River gorge) - very disjunct occurrence of this uncommon wiry and tangled shrub of rocky habitats.

•, *Pterostylis aestiva* - Greenhood (Wulgulmerang district and Snowy River gorge) - orchid ranging only between upper Tambo and upper Snowy Rivers, but locally plentiful in a favourable season.

• *Pterostylis coccinea* - Greenhood (Mount Hamilton area; Milky Creek area) - uncommon mountain orchid, restricted in Victoria to these areas, where occasionally rather frequent.

Pterostylis fischii - Summer greenhood (Wulgulmerang district and Snowy River gorge) - rare orchid of eastern Victoria, chiefly of mountain regions.

Pterostylis laxa - Greenhood (Wulgulmerang district) - localized montane orchid, known otherwise in Victoria only from a few scattered localities between Mount Little Tambo and Mount Delegate.

Pterostylis nutans - Nodding greenhood (borders of Suggan Buggan valley, Bare Rock) - very isolated montane occurrences.

• *Pultenaea subspicata* - Bush-pea (Wulgulmerang--Mount Hamilton area) - a rare bush-pea, restricted in Victoria to this localized montane habitat.

Swainsona oroboides - Variable swainson-pea (Wulgulmerang) - isolated montane occurrence of a pea typifying the drier parts of north-western and northern Victoria.

Tetratheca subaphylla - Leafless pink-bells (New Guinea Gap) - localized leafless shrub, scattered through East Gippsland between Mount Elizabeth and the sources of Genoa River.

• *Thesium australe* - Austral toad-flax (upper reaches of Little River) - very rare and localized parasite, now reduced in Victoria to a few mountain habitats near the Wombargo Range and at Gillingal.

Trachymene anisocarpa - Parsnip trachymene (Mount Stradbroke) - a typically coastal biennial with scattered range in the alps and sub-alps.

Utricularia australis - Yellow bladderwort (upper Little River and east of Wulgulmerang--Gelantipy road in natural lake) - aquatic herb, widespread but scattered in lowland Victoria and rare in mountain areas.

Wahlenbergia gymnoclada - Naked bluebell (Wulgulmerang) - isolated montane occurrence of a bluebell typifying sandy heaths in lowland Victoria.

• *Westringia cremnophila* - Snowy River westringia (Snowy River gorge) - rare and extremely localized shrub of faces along the gorge tract of the Snowy River, where apparently endemic.

Westringia eremicola - Slender westringia (Little River gorge) - typically a Mallee shrub, but with a few disjunct occurrences in the farther eastern highlands of Victoria.

Westringia glabra - Violet westringia (W Tree Creek Falls, Snowy River gorge, and Boundary Creek) - riparian shrub of very disjunct range across Victoria between northern Grampians and Snowy River gorge.

Zieria cytisoides - Downy zieria (Snowy River gorge) - uncommon shrub of East Gippsland, scattered between upper Snowy River watershed and Gabo Island.

Appendix 3

FAUNA

Appendices 3A to 3F respectively list mammal, bird, reptile, amphibian, fish, and insect species recorded in the study area. These lists have been prepared by the National Museum of Victoria. The classification of mammals follows Ride (1970), and for birds follows Condon (1929, 1969, and 1975). The classification of reptiles and amphibians mainly follows Cogger (1975), and classification of fishes mainly follows Lake (1970).

In the lists horizontal lines are used to separate families. Native species are listed separately from introduced species. The habitat in which each species is most likely to be observed and also the descriptive block in which it has been recorded are indicated. Habitats are more fully described in Chapter 10 (Fauna), and in some block descriptions. Sumbols used in the list headings are explained below.

Habitat

WT	Wetland
RV	Riverine
OA	Alpine and sub-alpine open areas
SAW	Sub-alpine woodland
WOF	Wet open forest
DOF	Dry open forest
WD	Woodland
SC	Semi-cleared areas & forest margins
FL	Farmland

Blocks

1.	Skene	11.	Cobungra
2.	Buller	12.	Baldhead
3.	Cobbler	13.	Benambra
4.	Licola	14.	Dartmouth
5.	Barkly	15.	Pinnibar
6.	Bennison	16.	Buckwong
7.	Moroka	17.	Suggan Buggan
8.	Tea Tree	18.	Reedy
9.	Dargo	19.	Nunniong
10.	Bogong	20.	Wulgulmerang

APPENDIX 3A

FAUNA

A. MAMMAL LIST

Species		Habitat									Block																			
Scientific Name	Common Name	MT	RV	OA	SAW	WOF	DOF	MD	SC	PL	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Tachyglossus aculeatus	Echidna				x		x					x	x						x											
Ornithorynchus anatinus	Platypus	x										x	x	x	x		x			x										
Macropus giganteus	Eastern grey kangaroo		x	x	x	x	x	x	x			x	x	x	x	x			x	x	x	x	x	x	x	x	x		x	x
M. rufogriseus	Red-necked wallaby		x		x	x	x																x			x	x			x
Wallabia bicolor	Black wallaby		x		x	x	x					x	x	x	x		x			x	x	x	x	x	x	x	x		x	x
Petrogale penicillata	Brush-tailed rock wallaby						x																				x			x
Trichosurus vulpecula	Brush-tailed possum		x		x	x	x	x	x		x	x	x	x	x	x	x	x		x			x	x	x		x		x	x
T. caninus	Bobuck		x		x	x	x		x			x	x		x	x		x	x	x			x							x
Pseudocheirus peregrinus	Ring-tailed possum		x		x	x	x	x	x			x	x	x	x	x	x			x				x		x	x		x	x
Petaurus breviceps	Sugar glider		x		x	x	x					x	x	x		x			x	x				x			x	x		x
P. australis	Yellow-bellied glider		x		x	x	x	x					x							x	x						x			
Schoinobates volans	Greater glider		x		x	x	x					x	x	x	x	x	x		x	x			x	x	x				x	x
Acrobates pygmaeus	Feather-tailed glider		x		x	x	x	x				x			x	x				x				x			x			x
Cercartetus nanus	Eastern pigmy possum		x		x	x	x					x							x	x		x		x						x
Burramys parvus	Mountain pigmy possum			x	x															x										
Vombatus ursinus	Common wombat		x	x	x	x	x		x		x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x		x	
Perameles nasuta	Long-nosed bandicoot		x		x	x	x		x			x							x	x				x						
Dasyurus maculatus	Tiger cat					x																								x
Phascogale tapoatafa	Tuan					x						x																		x

Species		Habitat								
Scientific Name	Common Name	WT	RV	OA	SAW	WOF	DOF	KD	SC	FL
Antechinus stuartii	Brown antechinus		x	x	x	x	x	x	x	x
A. swainsonii	Swainson's antechinus		x	x	x	x	x		x	
Rattus fuscipes	Bush rat		x	x	x	x	x		x	
Hydromys chrysogaster	Water rat	x	x			x				
Mastacomys fuscus	Broad-toothed rat		x	x	x	x				
Pseudomys fumeus	Smoky mouse				x	x				
Nyctophilus timoriensis	Greater long-eared bat				x	x	x			
N. geoffroyi	Lesser long-eared bat			x		x	x			
Rhinolophus megaphyllus	Eastern horse-shoe bat							x		
Miniopterus schreibersii	Bent-winged bat							x		
Eptesicus pumilus	Little bat			x	x		x			
Chalinolobus gouldii	Gould's wattled bat		x	x	x	x	x			
C. morio	Chocolate bat		x			x	x			
Pipistrellus tasmaniensis	Tasmanian pipistrelle					x				
Tarida australis	White-striped bat					x				
Canis familiaris	Dingo		x	x	x	x	x	x	x	
Introduced species										
Oryctolagus cuniculus	Rabbit		x	x	x	x	x	x	x	x
Lepus europaeus	Hare			x						
Mus musculus	House mouse		x	x		x	x		x	x
Rattus rattus	Black rat		x			x	x	x	x	x
Vulpes vulpes	Fox		x	x	x	x	x		x	x
Felis catus	Cat				x	x	x		x	
Equus caballus	Brumby		x	x	x	x	x	x		
Cervus unicolor	Sambar deer		x			x				
Bos taurus	Cow						x			

Species		Block																			
Scientific Name	Common Name	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Antechinus stuartii	Brown antechinus	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x
A. swainsonii	Swainson's antechinus		x	x		x	x	x	x		x			x	x	x	x			x	x
Rattus fuscipes	Bush rat	x	x	x	x	x	x	x	x	x	x			x	x	x	x	x		x	x
Hydromys chrysogaster	Water rat		x	x											x						
Mastacomys fuscus	Broad-toothed rat		x							x	x				x		x				
Pseudomys fumeus	Smoky mouse								x										x		
Nyctophilus timoriensis	Greater long-eared bat		x								x										
N. geoffroyi	Lesser long-eared bat		x								x	x									x
Rhinolophus megaphyllus	Eastern horse-shoe bat																	x			
Miniopterus schreibersii	Bent-winged bat																	x			x
Eptesicus pumilus	Little bat		x								x										
Chalinolobus gouldii	Gould's wattled bat			x		x					x								x		
C. morio	Chocolate bat					x															
Pipistrellus tasmaniensis	Tasmanian pipistrelle														x						
Tarida australis	White-striped bat																				x
Canis familiaris	Dingo		x	x			x	x	x		x			x	x			'x	x		
Introduced species																					
Oryctolagus cuniculus	Rabbit	x	x	x	x	x	x	x	x	x		x	x	x	x	x		x	x	x	x
Lepus europaeus	Hare						x				x										
Mus musculus	House mouse		x				x				x				x						
Rattus rattus	Black rat				x									x	x			x			
Vulpes vulpes	Fox	x	x		x	x	x		x		x	x		x	x	x	x				
Felis catus	Cat		x	x											x						
Equus caballus	Brumby						x	x			x	x					x	x	x	x	
Cervus unicolor	Sambar deer	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x				x	
Bos taurus	Cow						x														

APPENDIX 3B

FAUNA

B. BIRD LIST

Species	Habitat									Block																			
	WL	RV	OA	SAW	WOP	DOP	WD	SC	PL	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Emu			x	x	x	x		x	x	x		x	x		x	x		x	x	x	x	x	x	x	x	x	x	x	
Little grebe	x										x		x	x					x	x		x							x
Hoary-headed grebe	x													x								x							x
Australian pelican	x																		x										x
Black cormorant	x										x		x						x	x		x	x	x		x			
Little black cormorant	x												x		x				x			x	x	x					x
Pied cormorant	x																		x										
Little pied cormorant	x												x	x	x				x			x	x	x	x				x
White-necked heron	x								x	x	x								x			x	x	x	x				x
White-faced heron	x								x		x		x	x			x	x	x	x		x	x	x		x		x	x
White egret	x																		x			x	x	x					
Nankeen night heron	x																		x				x						
White ibis	x								x		x		x						x	x		x	x	x					
Straw-necked ibis	x								x				x						x	x		x	x	x					x
Royal spoonbill	x																		x			x							
Yellow-billed spoonbill	x																		x	x		x	x	x					x
Grass whistling duck	x																					x							
Black swan	x																		x			x							x
Mountain duck	x														x				x			x							
Black duck	x										x		x	x	x				x	x		x	x	x		x		x	x
Grey teal	x										x		x		x				x	x		x	x	x				x	x
Chestnut teal	x																		x				x	x					
Blue-winged shoveler	x																		x			x							x
White-eyed duck	x																		x			x							x
Wood duck	x		x						x		x		x	x	x			x	x	x		x	x	x	x	x			x
Musk duck	x																		x			x							
Black-shouldered kite			x	x				x	x						x				x				x	x					
Fork-tailed kite																							x						
Whistling eagle	x			x		x		x	x				x		x				x	x		x	x	x				x	
Grey goshawk						x					x																		

Species	Habitat									Block																			
	WL	RV	OA	SAW	WOF	DOF	WD	SC	PL	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Australian goshawk		x		x	x	x		x	x	x	x		x	x	x	x	x	x	x	x		x	x	x	x	x		x	x
Collared sparrowhawk		x						x						x												x			x
Australian little eagle			x		x	x		x							x		x	x	x				x	x	x				
Wedge-tailed eagle			x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x				x
Spotted harrier	x								x										x										
Swamp harrier	x								x				x						x	x		x	x	x					
Black falcon	x					x			x								x												
Peregrine falcon		x	x	x	x	x		x	x		x		x		x				x	x	x	x	x	x	x	x			
Little falcon		x	x	x	x	x		x	x		x		x						x	x		x	x	x	x			x	x
Nankeen kestrel		x	x	x	x	x		x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x
Brown hawk		x	x	x	x	x		x	x		x		x	x	x		x	x	x	x	x	x	x	x	x			x	
Stubble quail			x					x	x						x				x	x		x	x	x					
Brown quail									x															x					
Painted quail				x		x		x		x			x	x					x	x			x						
Lewin water rail	x																		x										
Australian spotted crake	x																		x										
Spotless crake	x																						x						
Dusky moorhen	x												x						x			x	x					x	
Swamphen	x												x						x			x							
Coot	x														x				x	x		x							
Spur-winged plover	x		x	x				x	x		x		x	x	x	x	x	x	x	x		x	x	x	x	x		x	x
Black-fronted dotterel	x												x						x			x	x	x		x			
Southern stone curlew							x																					x	
Japanese snipe	x		x						x				x		x	x			x	x									
Silver gull	x		x																x			x							
Whiskered tern	x																					x							
Peaceful dove		x		x	x	x											x	x											x
Common bronzewing		x	x	x	x	x		x	x	x	x		x	x	x		x	x	x		x		x	x	x	x	x		
Brush bronzewing		x		x						x			x		x							x		x					
Wonga pigeon		x			x	x		x		x	x	x	x	x		x			x		x		x	x	x	x	x		
Yellow-tailed black cockatoo		x	x	x	x	x		x		x	x	x	x	x	x		x	x	x	x		x	x	x	x			x	x
Gang-gang cockatoo		x		x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x
Sulphur-crested cockatoo		x		x	x	x		x	x		x								x	x	x	x	x	x	x			x	x
Galah						x		x	x				x						x	x	x		x	x					x

Species	Habitat									Block																			
	WL	RV	OA	SAW	WOF	DGF	WD	SC	PL	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Rainbow lorikeet						x					x																		
Musk lorikeet					x					x																			
Purple-crowned lorikeet					x													x											
Little lorikeet					x	x					x		x			x													
King parrot		x			x	x	x			x	x	x	x	x	x	x		x	x	x		x	x	x		x			
Crimson rosella		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Eastern rosella		x				x		x	x		x								x	x	x	x	x	x					x
Red-rumped parrot								x	x		x								x										
Pallid cuckoo		x	x	x	x	x		x	x		x	x	x	x	x				x	x			x	x	x			x	
Brush cuckoo		x			x								x	x					x	x		x	x	x					
Fan-tailed cuckoo		x	x	x	x	x	x	x		x			x	x	x	x	x	x	x	x	x	x	x	x	x	x			
Horsfield bronze-cuckoo		x		x	x	x	x			x	x		x	x	x		x		x	x	x	x	x	x	x	x			
Golden bronze-cuckoo		x		x	x	x		x		x	x		x	x	x		x		x	x		x	x	x					
Powerful owl					x					x						x													
Boobook owl		x		x	x	x		x		x	x		x	x	x		x	x	x	x		x	x	x	x	x		x	
Barn owl								x			x								x										
Tawny frogmouth		x			x	x	x	x			x		x	x	x				x				x	x	x	x			
Owlet nightjar				x		x					x							x		x									
White-throated nightjar						x					x																		
Spine-tailed swift		A	e	r	i	a	l			x	x		x	x	x		x	x	x	x	x		x	x	x	x	x	x	
Fork-tailed swift		A	e	r	i	a	l			x	x								x										
Azure kingfisher	x	x											x																
Laughing kookaburra		x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Sacred kingfisher		x		x		x		x			x		x	x	x				x	x			x	x	x	x		x	
Rainbow bee-eater					x	x	x	x	x		x								x	x	x	x	x			x			
Dollar-bird		x				x		x											x				x	x				x	
Superb lyrebird		x		x	x	x				x	x	x	x	x	x	x	x	x	x			x	x	x	x	x			
Singing bushlark								x	x				x					x											
Welcome swallow	x	x	x		x	x		x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x		x		x	x
Tree-martin	x	x	x	x	x	x		x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x	x				
Fairy martin	x	x	x	x				x	x		x		x				x		x									x	x

Species	Habitat									Block																			
	WL	RV	OA	SAW	WOF	DOF	WD	SC	PL	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Australian pipit			x	x				x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x	x		x	x
Black-faced cuckoo-shrike		x		x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x
Little cuckoo-shrike						x							x						x										
Cicada-bird					x									x					x				x						
White-winged triller						x		x					x						x				x	x					
Australian ground-thrush		x		x	x					x	x		x	x				x	x				x	x					
Spotted quail-thrush	x			x	x					x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x		
Golden-headed fantail warbler	x												x						x			x	x	x					
Little grassbird	x								x										x	x		x	x	x					
Reed warbler	x										x		x						x			x	x	x				x	
Brown songlark						x		x	x										x	x		x							
Rufous songlark			x	x		x		x	x				x	x			x	x	x			x	x						
White-throated warbler					x	x													x				x	x					
Weebill		x			x	x	x	x					x	x									x	x		x		x	
Striated thornbill		x		x	x	x	x	x		x	x	x	x	x	x		x	x	x	x		x	x	x	x	x		x	
Little thornbill		x			x	x	x				x				x		x		x							x			
Brown thornbill		x	x	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	
Buff-rumped thornbill		x		x	x	x		x			x		x	x	x		x	x	x	x		x	x	x		x	x	x	x
Yellow-rumped thornbill				x	x	x		x	x		x		x	x					x		x	x	x			x			x
White-browed scrub-wren		x	x	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x
Large-billed scrub-wren		x			x								x										x						x
Heath wren		x			x									x															x
Speckled warbler								x													x								
Superb blue-wren		x		x	x	x		x		x	x	x	x	x	x		x	x	x	x		x		x	x	x	x	x	x
Southern emu-wren					x																								x
Pilot-bird		x			x					x	x	x	x	x					x			x	x		x				
Grey fantail		x	x	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Rufous fantail		x			x					x	x	x	x	x	x		x		x	x	x	x	x	x	x	x	x	x	
Willie wagtail		x				x	x	x	x		x		x	x				x	x	x	x	x	x	x		x		x	x
Leaden flycatcher		x		x	x	x		x			x		x	x					x			x	x	x	x				
Satin flycatcher		x		x	x	x	x	x			x	x	x	x	x	x		x	x	x		x	x	x	x	x	x		x
Restless flycatcher					x	x		x			x		x	x	x				x				x	x				x	
Jacky winter		x		x		x		x	x				x	x	x				x	x			x	x					
Scarlet robin		x		x	x	x	x	x			x		x	x			x	x	x	x			x	x	x	x	x	x	

Species	Habitat									Block																			
	WL	RV	OA	SAW	WOP	DOP	WD	SC	PL	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Red-capped robin					x					x																			
Flame robin		x	x	x	x	x		x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Pink robin					x						x		x		x				x									x	
Rose robin					x						x	x	x						x										
Hooded robin							x	x											x		x					x			
Southern yellow robin		x		x	x	x				x	x		x	x	x				x	x	x	x	x	x	x	x	x	x	x
Golden whistler		x		x	x	x		x			x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x
Rufous whistler		x		x	x	x	x	x			x	x	x	x	x			x	x	x	x	x	x	x	x	x		x	x
Olive whistler		x		x	x					x	x	x	x		x	x		x	x	x			x	x	x				
Grey shrike-thrush		x		x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Shrike-tit		x			x	x				x	x		x	x	x			x	x	x		x	x	x	x				
Eastern whipbird		x			x						x	x	x	x		x		x	x	x		x	x	x	x	x		x	
Orange-winged sittella		x		x	x	x	x	x			x		x	x			x		x	x		x	x	x		x			
Brown tree-creeper					x	x	x	x			x		x	x					x		x		x		x	x			x
White-throated tree-creeper		x		x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Red-browed tree-creeper		x			x	x					x		x	x					x			x	x	x	x			x	
Mistletoe bird		x			x	x	x	x			x		x	x					x		x		x	x		x			
Spotted pardalote		x		x	x	x	x	x		x	x	x	x	x	x	x	x		x	x		x	x	x	x	x	x		x
Yellow-tipped pardalote		x		x	x	x		x					x	x	x				x				x						
Eastern striated pardalote		x		x	x	x	x	x		x	x	x	x	x	x		x		x	x	x	x	x		x	x	x	x	x
Striated pardalote		x			x	x		x		x	x					x			x	x		x	x	x				x	
Grey-breasted silvereye		x	x	x	x	x	x	x		x	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x	
Lewin honeyeater					x					x																			
Fuscous honeyeater		x		x	x	x	x	x						x					x	x	x	x	x	x	x	x	x		x
Yellow-faced honeyeater		x	x	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
White-plumed honeyeater		x		x	x	x		x									x		x				x	x				x	
White-eared honeyeater		x	x	x	x	x		x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Yellow-tufted honeyeater		x			x	x	x				x		x	x		x	x		x							x		x	
Brown-headed honeyeater		x		x	x	x	x	x		x	x	x	x	x	x		x	x	x	x		x	x	x	x	x		x	
White-naped honeyeater		x	x	x	x	x		x		x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x		x	
Black-chinned honeyeater						x	x																			x			x
Little friar-bird		x			x	x		x					x	x									x	x					
Noisy friar-bird		x		x	x	x	x				x	x	x	x					x	x		x	x	x	x	x			
Crescent honeyeater		x	x	x	x	x				x	x	x		x	x			x	x	x			x			x	x		x

Species	Habitat									Block																			
	XL	RV	OA	SAW	WSF	DOF	WD	SC	FL	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
New Holland honeyeater		x		x	x	x				x			x	x			x								x			x	x
Regent honeyeater						x		x					x						x		x								
Eastern spinebill		x	x	x	x	x				x	x	x	x	x			x		x	x	x	x	x	x	x	x	x	x	x
Bell miner		x			x	x												x										x	
Noisy miner				x				x			x																		x
Red wattlebird		x	x	x	x	x		x		x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x	x
Diamond firetail		x				x	x	x	x				x	x							x	x	x	x		x		x	
Red-browed finch		x		x	x	x		x			x		x	x	x	x			x	x	x	x	x	x		x		x	
Olive-backed oriole		x		x	x	x		x	x		x	x	x	x	x				x	x		x	x	x	x	x			
Magpie lark		x						x	x		x		x	x					x	x	x	x	x	x		x		x	x
White-winged chough		x		x		x	x	x		x	x		x	x	x	x	x	x	x	x	x	x	x	x		x			x
Masked wood-swallow		x				x		x						x									x	x					
Dusky wood-swallow		x		x	x	x		x			x		x						x	x	x	x	x	x	x	x			x
Pied currawong		x	x	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x
Grey currawong		x	x	x	x	x		x		x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x		x	
Grey butcher-bird		x		x	x	x		x					x	x		x				x		x	x	x				x	x
Black-backed magpie		x	x	x		x		x	x		x	x	x						x	x		x	x	x					
White-backed magpie		x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x
Satin bower-bird		x			x	x					x		x	x		x			x	x		x	x	x	x				
Australian raven		x	x	x	x	x		x	x		x	x	x	x	x	x	x	x	x	x		x	x	x	x	x		x	x
Little raven			x	x	x	x		x	x		x	x	x	x	x	x		x	x	x	x	x	x	x	x	x		x	x
<u>Introduced species</u>																													
Skylark			x					x	x		x								x	x									
Blackbird		x						x	x				x	x					x		x		x	x		x		x	
Song thrush		x																					x						
Goldfinch							x	x	x		x		x	x				x	x	x	x		x			x		x	
Greenfinch								x					x																
Starling			x	x	x			x	x		x		x	x				x	x	x	x	x						x	x
House sparrow								x	x				x	x				x	x	x	x							x	
Tree sparrow					x			x	x										x									x	

APPENDIX 3c

FAUNA

C. REPTILE LIST

Species		Habitat									Block																			
Scientific Name	Common Name	WT	RV	OA	SAW	WOF	DOF	WD	SC	FL	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Amphibolurus diemensis	Mountain dragon		x		x	x	x		x								x	x	x				x	x	x	x	x			
A. muricatus	Tree dragon		x			x	x	x	x			x		x			x						x	x			x	x		x
Physignathus lesueurii howittii	Gippsland water dragon	x	x											x					x								x	x	x	x
Varanus varius	Tree goanna		x			x	x													x			x							x
Anotis maccoyi	McCoy's skink		x		x	x	x		x			x	x				x	x	x		x		x	x	x	x	x		x	x
Ctenotus robustus	Large striped skink						x	x	x															x						
C. taeniolatus	Copper-tailed skink						x	x															x	x			x	x		
Egernia cunninghami	Cunningham's skink						x	x				x									x		x	x			x	x		x
E. saxatilis intermedia	Rock skink						x	x															x	x			x			x
E. whitii	White's skink						x	x															x	x		x	x			
Hemiergis decresiensis	Three-toed skink					x	x																x	x						x
Leiolopisma coventryi	Coventry's skink		x		x	x			x							x	x	x	x						x	x	x			x
L. delicata	Delicate skink					x	x			x													x	x						
L. entrecasteauxii	Grass skink		x	x	x	x	x		x	x		x				x	x	x	x	x	x		x	x	x	x	x			x

Species		Habitat									Block																			
Scientific Name	Common Name	WL	RV	OA	SAW	WOF	DOF	WD	SC	FL	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
L. guichenoti	Garden skink		x		x	x	x	x	x	x		x		x					x	x	x		x	x	x	x	x			x
L. mustelina	Weasel skink					x	x		x											x			x	x		x				x
L. trilineata	Three-lined skink				x	x	x		x										x				x	x		x	x			
Pseudomoia spenceri	Spencer's skink		x		x	x			x							x	x	x	x		x		x		x	x	x			
Sphenomorphus kosciuskoi	Alpine water skink			x																						x				
S. tympanum(CT)	Water skink	x	x	x	x	x	x		x			x				x	x	x	x	x	x		x	x	x	x	x		x	x
S. tympanum(WT)	Water skink	x	x			x	x										x						x	x		x	x			x
Tiliqua casuarinae	She oak skink				x															x										
T. nigrolutea	Southern blue tongue				x	x	x		x			x						x	x		x		x	x		x	x	x		x
Typlops nigrescens	Blind snake						x					x												x						
Austrelaps superbus	Copperhead	x	x	x	x	x	x		x	x		x		x					x	x	x		x	x		x	x			x
Cryptophis nigrescens	Small-eyed snake						x	x															x	x			x			
Drysdalia coronoides	White-lipped snake			x	x	x	x		x							x				x			x	x		x	x			
Notechis scutatis	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
Pseudonaja textilis	Brown snake						x	x	x	x				x									x	x						x

Appendix 3D

FAUNA

D. AMPHIBIAN LIST

Species		Habitat									Block																			
Scientific name	Common name	WT	RV	OA	SAW	WOF	DOF	WD	SC	PL	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ranidella signifera	Common eastern froglet	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x
Geocrinia victoriana	Victorian froglet	x	x	x	x	x	x	x	x		x	x		x		x	x			x				x	x					x
Heleioporus australiacus	Giant burrowing frog	x				x	x															x								
Limnodynastes dumerilii	Eastern banjo frog	x	x			x	x	x	x	x		x	x				x		x	x	x	x	x	x		x	x		x	x
L. peronii	Brown-striped frog	x	x			x	x	x	x	x				x			x				x	x	x	x					x	x
L. tasmaniensis	Spotted grass frog	x						x	x	x				x					x		x		x	x						x
Pseudophryne bibronii	Brown toadlet	x					x	x	x	x		x								x										
P. dendyi	Southern toadlet	x	x	x	x	x								x			x		x	x	x		x	x	x	x	x		x	x
Litoria raniformis	Green and golden bell frog	x						x	x	x		x							x	x										
L. ewingii (complex)	Brown tree frog	x	x	x		x	x	x	x	x	x	x		x	x	x	x		x	x		x	x	x	x		x		x	x
L. lesueurii	Lequeur's frog	x	x			x	x	x	x		x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x			x
L. maculata	-	x				x	x																	x						
L. peronii	Peron's tree frog	x	x					x	x	x												x							x	
L. phyllochroa	Leaf green tree frog	x	x			x	x	x	x		x			x	x			x	x			x	x	x		x			x	
L. verreauxii (complex)	Verreaux's tree frog	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x		x	x		x	x

APPENDIX 3E

FAUNA

E (1). FISH LIST

Species		Block																			
Scientific name	Common name	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Mordacia mordax	Short-headed lamprey																	x			
Anguilla australis	Short-finned eel																	x			
A. reinhardti	Long-finned eel																	x			
Retropinna victoriae	Victorian smelt																	x			
**Galaxias bongbong*	Inland mountain trout										x										
G. coxii	Cox's mountain trout				x		x				x	x									
G. olidus	Ornate mountain trout						x			x	x			x			x				
**G. findlayi*	Kosciusko mountain trout						x			x				x			x	x			
Prototroctes maraena	Australian grayling																			x	
Macquaria australasica	Macquarie perch														x						
Maccullochella macquariensis	Trout cod														x						
M. peeli	Murray cod														x						
Gadopsis marmoratus	River blackfish													x	x			x			
Pseudaphritis urvillii	Congolli																	x			
N.B. * = probably *Galaxias olidus*																					
Introduced species																					
Salmo trutta	Brown trout			x			x	x			x			x	x	x	x	x			x
S. gairdneri	Rainbow trout										x			x	x	x	x	x			
Carassius sp.	Carp														x	x					
Perca fluviatilis	English perch (Redfin)														x	x					

APPENDIX 3E

FAUNA

E(ii). FISH - Biological characteristics

Scientific Name	Common Name	Occurrence: Middle reaches	Occurrence: Headwaters	Status: Introduced	Status: Game fish	Status: Forage fish	Food: Insects Arthropods	Food: Other fish	Food: Algae	Food: Plankton	Food: Detritus	Spawning: Optimum Water Temperatures (C)	Spawning: Season or Months	Preferred Habitats
Mordacia mordax	Short-headed lamprey	x	x			x	x						Spring	
Anguilla australis	Short-finned eel	x	x			x	x	x	x	x	x			
A. reinhardti	Long-finned eel	x				x	x	x	x	x	x			
Retropinna victoriae	Victorian smelt	x				x			x	x		15°	Spring	
**Galaxias bongbong*	Inland mountain trout		x			x	x						Spring	Cool waters
G. coxii	Cox's mountain trout	x	x			x	x						Spring	Cool waters
G. olidus	Ornate mountain trout		x			x	x							Cool waters
**G. findlayi*	Kosciusko mountain trout		x			x	x							Cool mountain streams
Prototroctes maraena	Australian grayling	x	x		x								March	
Macquaria australasica	Macquarie perch	x			x		x	x				16.5°	Sep. - Feb.	Pools & back-waters
Maccullochella macquariensis	Trout cod	x			x			x				20°	Sep. - Feb.	
M. peeli	Murray cod	x			x			x				20°	Sep. - Feb.	Deep holes with snags
Gadopsis marmoratus	River blackfish	x	x		x		x	x					Spring - early summer	Snags and undercut banks
Pseudaphritis urvillii	Congolli	x				x	x	x	x		x			
N.B. * = probably *Galaxias olidus*														
Introduced species														
Salmo trutta	Brown trout	x	x	x	x		x	x				8° - 15°	June	Cool waters
S. gairdneri	Rainbow trout	x	x	x	x		x	x				8° - 10°	August	Cool waters
Carassius sp.	Carp	x		x			x		x	x	x	15°	Spring-summer	Slow waters
Perca fluviatilis	English perch (Redfin)	x		x	x		x	x				11°	Early spring	Slow waters

APPENDIX 3F

INSECTS COLLECTED IN SURVEY - SUMMER 1973/1974

Order	Family	HABITAT TYPE				
		Riverine Forest (RV)	Alpine Open Area (OA)	Sub-Alpine Woodland (SAW)	Wet Open Forest (WOF)	Dry Open Forest (DOF)
		Number of sites sampled				
		3	3	2	7	11
EPHEMEROPTERA	N.A.	3			4	1
ODONATA	Lestidae	3			3	1
	Megapodagrionidae				1	
	Aeshnidae	3			3	1
	Synthemidae				1	
	Libellulidae	1				
BLATTODEA	Blattidae		1		1	
	Blaberidae		1			1
ISOPTERA	Kalotermitidae		1			
DERMAPTERA	Labiduridae				1	1
	Forficulidae					1
PLECOPTERA	Gripopterygidae		1			
ORTHOPTERA	Tettigonidae			2		
	Gryllidae	1			2	5
	Pyrgomorphidae	1		1	2	2
	Acrididae	3	2	2	7	11
HEMIPTERA	Eurybrachyidae				1	1
	Fulgoridae	1			1	
	Flatidae				1	1
	Nogodinidae				1	
	Machaerotidae		1		1	
	Cicadidae	1				1
	Cicadellidae	3	2	2	7	11
	Eurymelidae	2	1	1	4	6
	Membracidae		1	1	2	
	Psyllidae	3	2	2	3	9
	Miridae	1	1	1	2	6
	Reduviidae	1		1	2	5
	Coreidae				2	1
	Alydidae	2		1	4	2
	Berytidae					1
	Scutelleridae					1
	Cydnidae		1			
	Acanthosomatidae				1	1
	Pentatomidae	3	1	2	4	9
	Gerridae					1
	Ochteridae					1
	Notonectidae					1
	Nepidae					1
THYSANOPTERA	Phlaeothripidae		1		1	1
MEGALOPTERA	Corydalidae		1			1

Order	Family	HABITAT TYPE				
		Riverine Forest (RV)	Alpine Open Area (OA)	Sub-Alpine Woodland (SAW)	Wet Open Forest (WOF)	Dry Open Forest (DOF)
		Number of sites sampled				
		3	3	2	7	11
NEUROPTERA	Osmylidae	1	1	1	1	2
	Mantispidae					1
	Hermerobiidae	1	1	1	2	4
	Chrysopidae		1	1	2	3
COLEOPTERA	Carabidae	3	2	1	4	5
	Dytiscidae	1				1
	Hydrophilidae		1		1	
	Staphylinidae					1
	Lucanidae	1	1			
	Passalidae				1	
	Scarabaedae	2	1	2	5	9
	Buprestidae	1	1		1	1
	Rhipiceridae				1	1
	Elateridae	2		2	2	2
	Cantharidae		1	1		2
	Lycidae	1	2		2	3
	Melyridae		1		1	1
	Dermestidae	1				
	Cleridae	1			1	2
	Phalacridae	1		1		
	Coccinellidae	1	1		4	4
	Colydiidae	1				1
	Tenebrionidae	3	1		1	5
	Lagriidae			1		2
	Mordellidae			1		1
	Oedemeridae					1
	Anthicidae		1			
	Cerambycidae	1		1		3
	Chrysomelidae	3	2	2	7	11
	Anthribidae					1
	Belidae			1	3	
	Attelabidae	1	1			
	Brenthidae		1			
	Curculionidae	2	1	2	5	9
MECOPTERA	Bittacidae		1			1
DIPTERA	Tipulidae	2	1	1	4	3
	Culicidae	3	1	2	4	5
	Chironomidae	3	1		4	2
	Ceratopogonidae	3	3		5	3
	Bibionidae		1	1	2	2
	Sciaridae	1	1		1	1
	Mycetophilidae	1		2	1	3
	Rhagionidae		1	1	3	1
	Tabanidae	2	2	2	4	8
	Stratiomyidae	1	1	2	4	7
	Therevidae			1		1
	Asilidae	2	3	2	5	11

Order	Family	HABITAT TYPE				
		Riverine Forest (RV)	Alpine Open Area (OA)	Sub-Alpine Woodland (SAW)	Wet Open Forest (WOF)	Dry Open Forest (DOF)
		Number of sites sampled				
		3	3	2	7	11
DIPTERA (continued)						
	Bombyliidae					2
	Empididae		1	2	1	
	Dolichopodidae		1	1		2
	Syrphidae	1	2	2	4	5
	Platystomatidae	1	2	2	6	7
	Pyrgotidae	1	1	1	5	7
	Tephritidae	1	2	2	4	1
	Sciomyzidae	2	2	2	6	7
	Lauxaniidae	1	1		3	2
	Heleomyzidae	2			3	4
	Drosophilidae			1	1	1
	Anthomyiidae	3	2	1	4	7
	Muscidae	3	2	2	7	11
	Calliphoridae		1			4
	Tachinidae	3	2	2	6	10
TRICHOPTERA	N.A.	3			2	1
HYMENOPTERA	Pergidae	1	1	1	2	6
	Ichneumonidae	3	2	1	5	11
	Braconidae		1		1	3
	Chrysididae					1
	Scoliidae					1
	Tiphiidae	1		2	1	4
	Vespidae				1	1
	Eumenidae				1	2
	Sphecidae	1	1	1	3	7
	Halictidae		1	1		
	Formicidae	3	3	1	7	11
	NOTE: NUMBERS INDICATE NO. OF SITES AT WHICH INSECTS WERE COLLECTED					

Appendix 4

Noxious Weeds

The following table shows the species of noxious weeds recorded in the study area. Each one's distribution is indicated by the number of Parishes in each block in which it has been recorded. The total number of Parishes used in compiling weed-occurrence records in the block heads each column. A few Parishes have not been surveyed for presence of noxious weeds.

WEED SPECIES		BLOCK																			
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
(Number of Parishes in block for which records exist)		2	6	6	7	3	3	8	3	12	14	7	9	12	15	9	4	5	2	13	11
Common name	Scientific name																				
Amsinckia	*Amsinckia* spp.																	3			2
Bathurst burr	*Xanthium spinosum*				4	2					1	1	3	1	4					4	
Blackberry	*Rubus fruticosus* agg.	2	6	6	4	2	3	8	3	14	11	7	9	12	15	9	4	5	1	12	11
Boxthorn	*Lycium ferocissimum*				1			1		1		3	2	3						3	
Cape broom	*Genista monspessulana*	2		1							4	2		1	7					1	
English broom	*Cytisus scoparius*	2									2	5		6	2					1	
Fennel	*Foeniculum vulgare*				1													2		1	2
Furze	*Ulex europaeus*		7											1							
Great mullein	*Verbascum thapsus*												2	1				2		2	1
Hawthorn	*Crataegus monogyna*) *C. laevigata*)			3	2	1				1	4	4	1	4	3					1	
Hemlock	*Conium maculatum*		4	1	2					1	2	2	2	3	5	1		2		1	4
Horehound	*Marrubium vulgare*				4	2				1	2	5	3	3	1					4	
Italian or cut-leaf blackberry	*Rubus laciniatus*	1												1	2	1				1	4
Ox-eye daisy	*Chrysanthemum leucanthemum*		2	1		1				1											
Paterson's curse	*Echium plantagineum*				2						2	2	1	2							
Ragwort	*Senecio jacobaea*				3																
St. Johns wort	*Hypericum perforatum*	1	4	5	2	2	1	8	1	7	11	6	1	7	10						
Sand mustard or sand rocket	*Diplotaxis tenuifolia*												1								
Skeleton-weed	*Chondrilla juncea*		1	1	1	1		1	1		6	6	3	5	6	1				5	
Stinkwort	*Inula graveolens*				1								3		1	1		2		3	
Sweet briar	*Rosa rubiginosa*	1	4	5	5	2	1	2	1	1	9	7	4	10	10	1		5		11	11
Thistle, perennial or Californian	*Cirsium arvense*				1							1									
Thistle, saffron	*Carthamus lanatus*		3	1	1	1					2	1	2	2	2	1				3	
Thistle, Saint Barnaby's	*Centaurea solstitialis*											2	1	1							
Thistle, scotch	*Onopordum acanthium*											4	1	3							
Thistle, slender	*Carduus tenuiflorus*		4	4	5	2		2	1	2	6	6	4	10	3	1				5	
Thistle, spear	*Cirsium vulgare*		4	2	4	2		2	1	1	7	7	4	10	6					7	4
Thistle, spotted or variegated	*Silybum marianum*	1	4	2	4	2		1	1	2	6	6	3	4	4	1				5	
Thistle, star	*Centaurea calcitrapa*														4						
Thorn apple	*Datura stramonium*			2							3				4						
Tobacco	*Nicotiana tabacum*										3										
Tree of heaven	*Ailanthus altissima*							1			1		1								2
Tutsan	*Hypericum androsaemum*		3	3							1										1

APPENDIX 5

STREAM GAUGING DATA

Gauging station	Recording period	Drainage area (km²)	Annual discharge (megalitres)			Mean annual discharge/ drainage area (Ml/km²)	Salinity (milligrams/litre)		
			Maximum	Minimum	Mean		Maximum	Minimum	Mean
Avon R. at Valencia Ck Bridge	May '19 to Dec '33 Jan '37 to Apr '49 26 water years	862	334,310	23,090	112,620	131	No data available		
Buchan R. at Buchan*	Oct '59 to Apr '73 12 water years	850	362,690	46,560	157,260	186	225 @ 2.5 Ml/d	15 @ 152 Ml/d	68
Dargo R. at Dargo*	Jun '53 to Apr '73 19 water years	596	295,170	55,140	174,120	292	67 @ 301 Ml/d	20 @ 484 Ml/d	33
Delatite R. at Tonga Bridge*	May '47 to Apr '73 26 water years	367	302,800	34,010	135,510	368	69 @ 24 Ml/d	27 @ 296 Ml/d	46
Goulburn R. at Dohertys*	May '54 to Apr '73 18 water years	694	796,780	90,690	403,640	582	55 @ 183 Ml/d	19 @ 3227 Ml/d	32
Howqua R. at Ben Bullen*	Apr '66 to Apr '73 7 water years	370	314,230	61,930	195,000	527	47 @ 690 Ml/d	22 @ 318 Ml/d	28
Jamieson R. at Gerrans Bridge*	May '54 to Apr '73 19 water years	368	494,980	70,810	247,760	673	66 @ 1375 Ml/d	16 @ 409 Ml/d	37
Kiewa R. at Mongans Bridge*	May '55 to Apr '73 18 water years	552	954,910	156,160	512,210	928	52 @ 279 Ml/d	10 @ 3922 Ml/d	34
Kiewa R. (West Branch) at Snake Valley	Jan '26 to Apr '70 44 water years	88	237,490	45,330	119,160	1354	No date available		
Macalister R. at Licola Bridge*	Aug '52 to Apr '73 20 water years	1233	818,480	128,900	465,730	378	135 @ 12 Ml/d	16 @ 1855 Ml/d	47
Mitta Mitta R. at Colemans*	Mar '31 to Apr '73 41 water years	3634	2,026,260	205,740	924,260	254	39 @ 472 Ml/d	16 @ 2642 Ml/d	26
Mitta Mitta R. below Gibbo Junct.	Jan '31 to Apr '70 39 water years	2849	1,535,940	185,000	724,050	254	No data available		
Mitta Mitta R. at Hinnomunjie*	Jul '25 to Apr '73 46 water years	1463	922,080	131,760	471,587	322	No data available		

APPENDIX 5 (contd.)

Gauging Station	Recording period	Drainage area (km²)	Annual discharge (megalitres)			Mean annual discharge/ drainage area (Ml/km²)	Salinity (milligrams/litre)		
			Maximum	Minimum	Mean		Maximum	Minimum	Mean
Morass Creek at Uplands*	Nov '29 to Apr '73 43 water years	466	125,200	5,440	36,650	79	No data available		
Murray R. below Tin Mine Creek	Jun '55 to Oct '63 7 water years	466	276,300	91,540	158,000	339	No data available		
Nariel Creek at Upper Nariel*	May '54 to Apr '73 19 water years	262	302,670	29,900	134,480	513	36 # 1199 Ml/d	17 # 785 Ml/d	25
Ovens R.at Bright	Jan '25 to Dec '33 May '44 to date 36 water years	495	656,710	45,760	232,420	470	57 # 5473 Ml/d	20 # 232 Ml/d	29
Pretty Valley Creek at Junction	May '38 to Apr '59 21 water years	74	236,460	51,720	114,340	1545	No data available		
Rocky Valley Creek at Junction	Apr '38 to Apr '59 21 water years	69	199,580	52,180	112,370	1629	No data available		
Snowy R.near Buchan*	Jun '32 to Apr '73 37 water years	11,836	4,647,490	176,110	1,683,270	142	No data available		
Snowy Creek below Granite Flat*	Nov '32 to Apr '73 40 water years	407	471,000	43,850	192,830	474	57 # 691 Ml/d	17 # 585 Ml/d	24
Tambo R.at Swifts Creek*	May '65 to Apr '73 8 water years	943	207,130	20,710	67,450	72	290 # 3 Ml/d	20 # 286 Ml/d	132
Wonnangatta R. at Waterford*	May '22 to Dec '33 Jan '66 to Apr '73 18 water years	2,046	1,147,880	129,960	694,600	339	42 # 34 Ml/d	21 # 230 Ml/d	31

<u>Note</u>: The unit used for average annual discharge per unit area (Ml/km²) is equivalent to the depth of runoff in millimetres.

* Currently operational stations

APPENDIX 6

METRIC CONVERSION FACTORS

QUANTITY	METRIC UNIT	IMPERIAL UNIT	METRIC TO IMPERIAL	IMPERIAL TO METRIC
Length	millimetre (mm) centimetre (cm) metre (m) kilometre (km)	inch (in) foot (ft) mile	1 mm = 0.0394 inch 1 cm = 0.3937 inch 1 m = 3.281 feet 1 km = 0.6214 mile	1 inch = 25.4 mm 1 inch = 2.54 cm 1 foot = 0.305 ÷ (30.5 cm) 1 mile = 1.61 km
Area	hectare (ha) square kilometre (sq km)(= 100 ha)	acre (ac) square mile (sq mile)	1 ha = 2.47 acre 1 sq km = 0.3861 sq mile (247 ac)	1 acre = 0.405 ha 1 sq mile = 2.592 sq km
Mass	kilogram (kg) tonne (t) (= 10,000 kg)	pound (lb) ton	1 kg = 2.20 lb 1 t = 0.984 ton	1 lb = 0.454 kg 1 ton = 1.02 t
Volume	cubic metre (m^3) megalitre (Ml) (= 1,000,000 litres)	cubic foot (ft^3) super foot (timber) acre feet (ac ft)	1 m^3 = 35.31 ft^3 = 423.7 super feet true = 392.6 super feet (Hoppus log volume) 1 Ml = 0.8098 ac ft	1 ft^3 = 0.0283 m^3 1 super foot true = 0.00283 m^3 1 super foot HLV = 0.003 m^3 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) milligrams per litre (mg/l) litres per second (l/s)	bushels/acre parts per million (ppm) gallons per hour (gph)	1 t/ha = 14.9 bushels/ac (wheat) = 17.9 bushels/ac (barley) = 22.2 bushels/ac (oats) 1 mg/l = 1.000 ppm 1 l/s = 791.7 gph	1 bushel/ac = 0.067 t/ha = 0.056 t/ha = 0.045 t/ha 1 ppm = 1.000 mg/l 1 gph = 0.00126 l/s