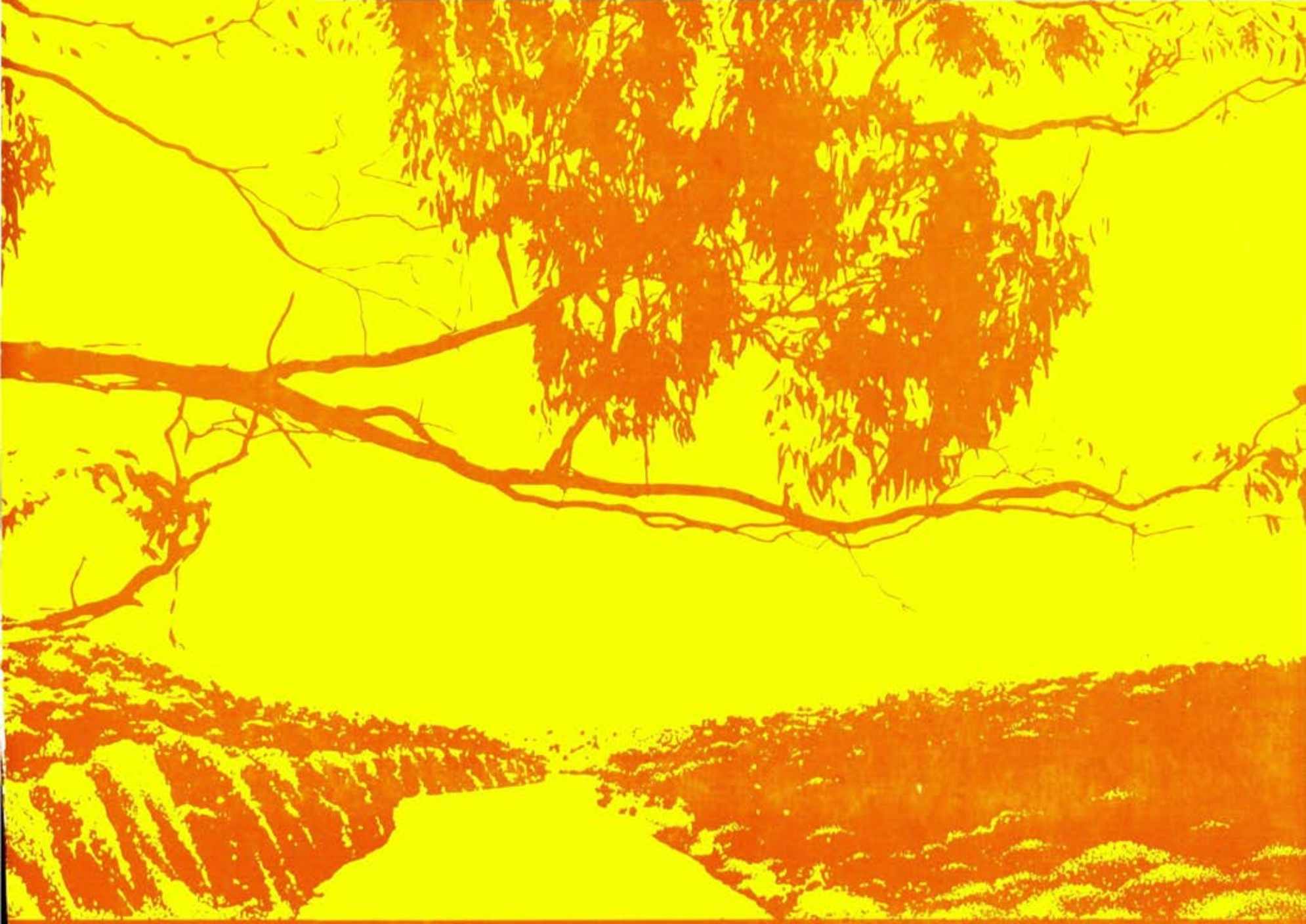

Land Conservation Council Victoria

North-Eastern Study Area, District 1.

Price $2.00

REPORT

on the

NORTH EASTERN AREA

(district 1)

Land Conservation Council, Victoria
Melbourne: December 1972

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CONTENTS

FOREWORD

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

This report sets out to describe and assess the natural resources of the public land in the North Eastern Area, District 1 and provides a factual basis on which members of the community may base their submissions to the Council. It ensures that all those persons and bodies who have an interest in the future use of public land in this area can obtain and study the basic information, which the Council will itself study, and so make informed and constructive suggestions to the Council for its consideration.

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

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

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

S.G.McL. DIMMICK
Chairman

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

LAND CONSERVATION ACT 1970

EXTRACT

Public Land

Section 2.

(1) "Public land" means -

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

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

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

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

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

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

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

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

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

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

Functions of the Council

Section 5.

(1) The Council shall -

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Investigations, Notices and Reports

Section 9.

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

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

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

(a) publish a report of the investigation;

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

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

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

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

Section 10.

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

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

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

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

and shall consider any 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.

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

Copy of every Recommendation and of Proposals to be Tabled in Parliament

Section 11.

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

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

ACKNOWLEDGEMENTS

Many Government departments, organizations, and individuals assisted the Council's staff to compile this report by supplying information and photographs, checking drafts, and contributing discussion and advice.

The generous assistance given by the Soil Conservation Authority is gratefully acknowledged. A publication of the Authority, "A Study of the Land in the Victorian Catchment of Lake Hume" by Mr. R.K. Rowe was a major source of information for this report.

The Forests Commission gave much assistance in the field work and supplied the information for the chapters on hardwoods and softwoods. The vegetation map was compiled from maps drawn up by the Commission's staff.

The State Rivers and Water Supply Commission contributed the water and water utilization chapters. The Mines Department provided information on geology, economic minerals and groundwater supplies, and the Department of Agriculture provided information on agricultural pursuits and capabilities.

The Department of Crown Lands and Survey prepared maps showing public land boundaries for the Council's use and assisted the Council with the drawing of maps in this report.

The National Museum, Fisheries and Wildlife Department and the National Parks Service contributed information on fauna.

The following departments also assisted with the compilation of the report - the National Herbarium, the State Electricity Commission, the Central Planning Authority, the Education Department of Victoria (special services), the Keith Turnbull Research Station (Department of Crown Lands and Survey), and the Commonwealth Bureau of Meteorology.

The assistance given by the following persons and organizations is gratefully acknowledged: Mr. E.P. Backen, Mr. A. Beaseley (National Parks Association), Mrs. M. Maxwell (Royal Historical Society), Mr. P.A. Rawlinson (Latrobe University), Mr. J.H. Willis, the Wodonga Field Naturalists Club, North-Eastern Apiarists' Association and the Mammal Survey Group.

Photographs

The Council is indebted to the following people who made their photographs available for the report: Mr. R.K. Rowe, Mr. P.T.C. Morrison, Mr. R.H. Billing, Mr. A.A. Martin, Mr. W. Roy Wheeler, Miss J. M. Dixon, Mrs. Crosbie Morrison, Mr. A. Howard, Mr. A.J. Coventry, Mr. L.B. Williams, Mr. A.L. West, Mr. T. Gordon, Mr. G. Thompson and Mr. J. A. Owen. Aerial photographs are reproduced with the permission of the Department of National Development.

PART I INTRODUCTION

AIMS AND METHODS

This report sets out to present all available information relevant to making decisions on the future use of public land in the study district. It describes the nature of the environmental features together with the character and distribution of the plant communities and animals in the area. It also examines the forms of land use that will make demands on public land, and attempts to assess their impact. It does not contain land use recommendations for public land, but rather provides 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 reconnaissances of mammals, reptiles, and amphibians. However, our knowledge of the environment, and of the interactions between land management practices and the environment, is still far from complete. Thus, when contemplating land use changes that involve substantial alterations to natural environments, we must make conservative initial land use decisions until we know more about them.

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

The four parts

Part I sets out the aims of the study and defines and briefly describes the study district. Following an outline of conservation principles, it gives a history of the region, including a brief account of the Aboriginal inhabitants and subsequent development of the district by the early settlers. A locality plan of the district is attached.

Part II describes the nature of the main features of the environment for the whole study district. Maps included show physiography, geology, and topography and rainfall. Another map

in a pocket at the back of this report delineates plant communities. Mammal, bird, and reptile habitats are described in terms of these communities. Finally, this part considers the features of the land together, describes them in tabular form, and maps twelve units (termed land systems) in which distinctive environmental patterns occur.

Part III deals with the main forms of land use that are likely to make demands on public land. After describing the hazards that occur in the region, such as erosion and fire, it discusses any deterioration in the condition of public lands that may occur as a result of changes of land use. Then, for each form of land use, this part considers the present level of activity in the district, the likely future demand, and the capability of public land to produce the products associated with the particular land use. The capability of privately owned land is also assessed in some cases. Finally, it deals with the relations between the various types of land use. Maps showing recreation resources, minerals, and the present forms of primary production are attached.

In Part IV the public land is divided into 13 blocks for ease of description and consideration. A map showing these blocks is attached. Part IV then describes the nature of the public land in each block and assesses its potential for the various forms of land use and associated hazards and conflicts. These descriptions and assessments are set in a consistent format of headings and sub-headings so that the reader can readily find specific information for any block and compare it with others.

A map of public land, in the pocket at the back of the report, may be useful in preparing submissions.

Appendix I contains tables of climatic data.

Appendix II, prepared by J.H. Willis, provides lists of vascular plants compiled for five localities in the study district during brief visits.

Appendix III lists the birds and mammals of the study district and shows broad habitat type and abundance for each species.

It also lists reptiles recorded for the district, and indicates the habitat type and biological characteristics for each species.

Also included is a list of the probable and recorded amphibian species of the district and a list of fishes.

CONSERVATION PRINCIPLES

Conservation is concerned with Man's relation to his environment. It is often said to be the wise, rational, 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 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 recognizes that a community needs land for recreational, scientific, and aesthetic purposes as well as for the production of food, timber, and minerals, or for urban and industrial use.

The Use of Resources

Two broad classes of natural resource may be distinguished:

Non-renewable resources

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

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

Renewable resources

The quantity of a renewable resource such as timber or wheat may increase or decrease with time. Animal and plant communities and landscape fall within this class. The balance of resource use is likely to change with time, and the definition of resources will change as technology changes.

Relations Between Resource Uses

Many uses of a resource are compatible. They may be supplementary and add to each other, or complementary in that one use benefits from the other, but they may also be competitive when an increase in one leads to a decrease in the other. For example, the relation between timber production and picnics within a forest may be complementary in the sense that picnickers gain access along tracks and

use open spaces created during timber operations. It may become competitive if logging makes the forest an unsuitable picnic area, and at other times picnickers may present a considerable fire risk. In general, decisions on land use will involve selecting major land uses for a particular area, and determining other uses compatible with these and the intensity of use above which they become incompatible.

The Principles of Land Use

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

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

Conclusion

Outstanding natural features should be preserved.

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

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

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

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

Review and reassessment of land becomes necessary as society and technology change.

THE STUDY DISTRICT

The district covered by this report consists of land in the Shires of Upper Murray and Towong.

It is bounded on the north and east by the New South Wales-Victoria border, from Bunroy on the Murray River to Mitta Junction at Lake Hume. The boundary then runs along the inundated course of the Mitta Mitta River to the railway bridge across Lake Hume. From here it follows the Murray Valley Highway east to Bullioh, continues along Tallangatta and Bucheen Creeks to Cravensville, and thence eastwards to Bunroy (see the locality plan facing page 6).

The total area within the district is 318,000 hectares (786,000 ac), of which approximately 153,500 ha (379,300 ac) is public land, mainly in several large consolidated areas. Little private property remains uncleared.

The district forms part of the Lake Hume Catchment and has been proclaimed as such under the Soil Conservation and Land Utilization Act of 1958. The Murray River is part of New South Wales. (Its headwaters were formerly termed the Indi River.) Major streams flowing into the Murray or directly into Lake Hume include Thowgla, Corryong, Cudgewa, Koetong, and Tallangatta Creeks.

The quite varied topography ranges from uplands to steep hills, valleys and open plains. Igneous rocks predominate in the north, sedimentary and metamorphic rocks in the south. The climate varies, from hot dry summers and cool winters at the lower elevations - on the plains and in the broad valleys - to mild summers and cool to cold winters at the higher elevations, such as the plateaux at Shelley, Mount Cudgewa, and Mount Burrowa.

Average annual rainfall varies from less than 760 mm (30 in.) along the Murray Valley and near Corryong to more than 1,270 mm (50 in.) east of Cravensville.

Vegetation on public land ranges from tall forests of alpine ash on friable brownish gradational soils at the highest elevations to low, scrubby stands of red cypress pine on undifferentiated sandy or stony loams on the driest northerly slopes. The vegetation over most of the district, however, mainly comprises broad- or narrow-leafed peppermint forest with grass to bracken fern as an understorey,

Lake Hume - Mitta Mitta arm

The township of Corryong

or red stringybark: long-leaf box forest with a grassy to scrubby understorey.

The predominant soils associated with these main vegetation types are friable reddish gradational soils and weakly bleached massive gradational soils.

Population

The main towns within the district are Corryong and Tallangatta. The Albury-Wodonga urban centre is 40 kilometres (25 miles) by road from Tallangatta and 129 km (80 miles) from Corryong.

The study district includes practically all the populated area of Upper Murray Shire and most of the populated area of Towong Shire. The Mitta Mitta Valley, with the townships of Eskdale and Mitta Mitta, lies within Towong Shire, but outside the study district.

Both Shires and their main urban centres showed a decline in population between 1966 and 1971. The population declined further in Upper Murray Shire (20%) than in Towong Shire (8½%). By contrast, that of the Albury-Wodonga urban centre increased from 32,000 to 38,000 in this same period - a rise of 19% for the 5 years. (See Table 1, on page 8.)

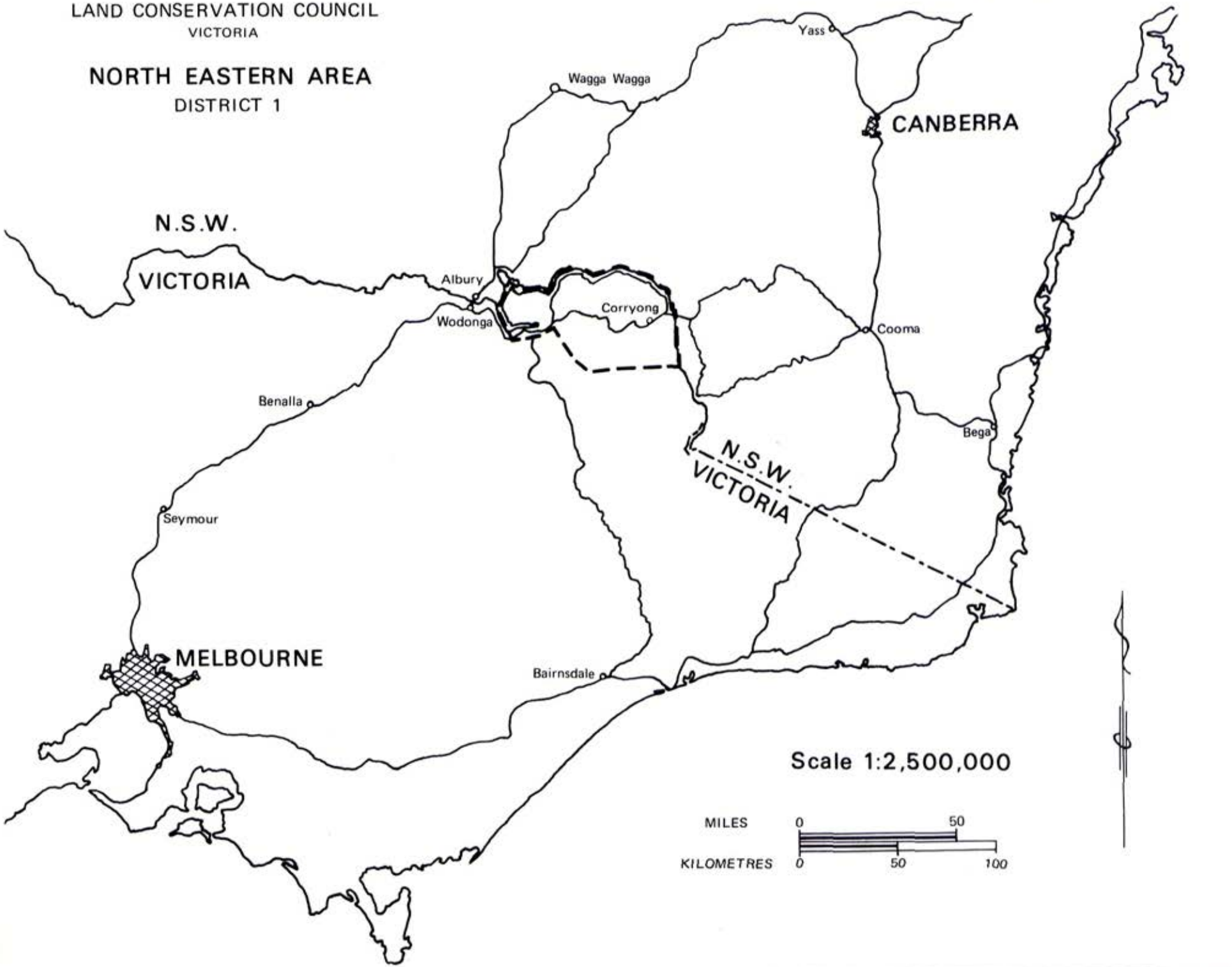
Towns

Corryong, the largest town, has a population of 1,380. It caters well for

LOCALITY

LAND CONSERVATION COUNCIL
VICTORIA

NORTH EASTERN AREA
DISTRICT 1



visitors, with good accommodation and two high-standard restaurants.

Corryong lies on a plain surrounded by mountainous topography. Processing industries comprise a butter factory, sawmill, pole-treatment plant, and engineering factory. It is also a stock marketing centre.

Tallangatta, with a population of 920, is situated near the Mitta Mitta arm of Lake Hume. It was shifted here from its previous site on Tallangatta Creek, now inundated, and was officially opened in 1956. Modern town planning on a hilly site and the mixture of old and new buildings make it attractive. Processing industries include a butter factory and sawmill.

The twin cities of Albury and Wodonga are just 13 km (8 miles) to the west of the study area. Situated astride the Murray River on the Hume Highway, this composite has grown rapidly and at present has a population of 38,000. Its strategic position makes it the economic centre of the whole Upper Murray Region.

Albury is a wool-selling centre and Wodonga an important cattle market. Processing industries are well represented by a number of newly established manufacturing plants. Good road and rail facilities serve to encourage decentralized secondary industries, and service industries are also well established.

Tallangatta - a modern town beside Lake Hume

Access

The Alpine Way from Canberra, via Cooma and Khancoban, connects with the Murray Valley Highway near Corryong. The Omeo Highway, which joins with the Murray Valley Highway 8 kilometres (5 miles) east of Tallangatta, provides a link between the north-east and east Gippsland. The main access from the west, from the Hume Highway at Albury-Wodonga, is along the Murray Valley Highway to Tallangatta.

A branch line (5 ft 3 in. gauge) from Wodonga to Cudgewa provides a rail link with the main Sydney-Melbourne rail system.

A regular air service operates out of Albury, and there are airport facilities at Corryong.

Internal access between population centres is good, with high standard and intensity of roading. Most roads run along the river valleys, the main exception being the Murray Valley Highway over Granya Gap and the Tallangatta-Koetong road to Corryong.

Power

Two single-circuit 330KV transmission lines from Dederang Terminal Station to the Murray Switching Station of the Snowy Mountains Hydro-electric Scheme pass through the district on a 91-m (300-ft) easement. This follows a route roughly defined by a line connecting Tallangatta Valley, Lake Findlay, Beetomba, Cudgewa, Corryong, and Towong Gap.

Table 1

POPULATION STATISTICS 1947-1971

	1947	1954	1961	1966	1971
Towong					
Urban (Tallangatta)	853	742	1,003	1,000	923
Rural	3,095	3,643	3,204	3,079	2,808
TOTAL	3,948	4,385	4,207	4,079	3,731
Upper Murray Shire					
Urban (Corryong)	808	891	1,129	1,665	1,393
Rural	1,567	1,630	1,809	1,672	1,274
TOTAL	2,375	2,521	2,938	3,337	2,657
Urban * (Albury-Wodonga)	N.A.	N.A.	28,796	32,032	37,916

* Not in the study district

HISTORY

Before European settlement, Victoria was the home of several thousand Aborigines. Their populations mainly congregated around river and lake environs where game and fish abounded, traversing or frequenting the arid plains and heavily timbered ranges for short periods only in certain seasons.

Probably only a few - no more than several hundred - Aborigines lived in the study district before the settlers came in the nineteenth century. The Jaimathang tribe inhabited the head-waters of the Mitta Mitta and Tambo Rivers, some of the sources of the Ovens River, and the Murray River valley to "Tom Groggin Run" south of this district. To the north-east of the Jaimathang tribe, the Wulgai tribe held territory in the upper Murray River valley. The Ginning-Matong, sub-tribe of the Pangeran tribe (whose territory extended to Mansfield and Wangaratta), used the Tallangatta Creek valley as their hunting grounds.

Within 30 years of the arrival of the first settlers, the tribes had been broken up and dispersed through disease, drink, and the loss of hunting grounds. By 1863, 45 Aboringines centred at Tangamballanga were the sole remnants of the once proud tribes.

Although never very numerous, the Aborigines did have an effect on their environment through the use of fires, which they used in connection with their hunting activities.

Present-day evidence of the Aborigines' presence within the district includes paintings on two rock shelters, one on

Aboriginal rock shelter at Mount Porcupine

the Conic Range north of Darbyshire and the other at Mount Porcupine near "Thologolong". There are also a few "canoe" trees near Bullioh and Talgarno, and evidence of Aboriginal culture along the Corryong Creek south of Colac Colac.

Discovery and early settlement

The first Europeans to sight the area, members of the Hume and Hovell expedition, crossed the Murray a short distance upstream from its confluence with the Mitta Mitta River in November 1824. They described the country either side of the river downstream from here as being a perpetual succession of lagoons interspersed by thickly wooded swamps and bogs. The undergrowth was luxuriant and included various vines, ferns, Kurrajong, flax, and peppermint plant *(Mentha* sp.*)*. Fish and ducks abounded and brolgas were also common. The appearance of the country away from the river was described as not too heavily timbered, with very little undergrowth. The general aspect was park-like, the ground being covered by kangaroo grass.

Reports of this journey and Major Mitchell's expedition in 1836 promoted a steady settlement of the eastern Riverina, which extended to the fertile, grassy flats of the Murray and its larger tributaries. Towards the end of that year, or early in 1837, runs were taken up along the Murray at Talgarno, Bungil, and Thologolong. When Strzelecki trekked through the Corryong Valley in 1840, the bulk of the area was under some form of occupation, with runs being established in the Murray River valley to Biggara and up the Corryong, Cudgewa, and Tallangatta Creek valleys. These runs were grazed by cattle mainly, but also by sheep.

The early settlers were known as squatters, for they occupied (not owned) tracts of land for which they paid an annual rent to the Government. In 1844, a new set of land regulations limited the area of a run to 25 square miles, guaranteed possession for 8 years, and allowed purchase of 320 acres. More important events affecting settlement were the Waste Lands Occupation Act of 1846 and the Order-in-Council of 1847.

Although ineffective, the Duffy Land Act of 1862 heralded the end of the squatting era. This Act and subsequent amendments provided for selection of land with security of tenure, for which Grant's Act of 1865 and Casey's Act of 1869 gave the impetus. The first selectors to take up land in the Corryong and Cudgewa valleys did so in 1867. This pattern continued over the district (with the larger runs being sub-divided on a more orderly basis and the forest being cleared) until the early part of this century, when the land ownership became fairly stable. It has remained so to the present day.

The early settlers cleared the land using axe and saw, horse or bullock

team, and fire. They often cleared steep slopes by these means, fenced the area, and set stock to graze on the native grasses. However, the native pastures were not adapted to heavy, continuous grazing by hard-hooved animals and became degraded. Thus the prevalent condition was one of over-grazing, and so erosion began. The introduction and spread of the rabbit, which breeds rapidly and grazes closely, also contributed to erosion.

Early mining

The tin rush to Koetong initiated mining activities, but was short-lived and the mining population soon dwindled away.

Gold-bearing lodes were discovered at Bethanga in 1875 but the gold proved difficult to extract from the ore. The subsequent gold rushes at Thowgla in 1881 and Mount Elliott in 1894 brought many miners to the district; Upper Thowgla boasted more than 500 people in 1881. As the gold became less profitable to win, many ex-miners settled down to agricultural pursuits, establishing farms wherever the land was suitable.

Transport and communications

Bush tracks provided the initial means of access, and bullock drays and horses the principal modes of transport. A fortnightly mail service between Melbourne and Sydney via Albury was established in 1838. The rail link from

Early tin mining in alluvial deposits

Melbourne to Wodonga, completed in 1873, was extended to Tallangatta by 1891. In 1914, the Tallangatta-Cudgewa rail link over the Koetong Plateau was begun and 1921 saw its completion.

Roads have been considerably improved and the main road from Tallangatta to Corryong and across the border into New South Wales is of a high standard.

View of Corryong in the early 1900s

Land Use

Agriculture

Initial land settlement was chiefly for cattle-grazing, but in later years sheep were extensively introduced. Agricultural activities, such as the cultivation of oats, pumpkins, millet, and maize for the supplementary feeding of dairy stock, increased as the district became more closely settled.

Forestry

Hardwood saw-milling has not played a major role in the development of the district. Timber requirements of the early settlers were met from the immediate forest areas. Historical accounts indicate that private saw-milling in the Granya area catered for local rural demand and retail trade in Albury-Wodonga during the early 1920s. Mixed-species hardwoods were cut on private property and public land and converted to sawn timber at two mills nearby. With the dwindling of supplies, one mill ceased operation in 1958/59: the other also ceased but was relocated at Corryong in 1965.

Logging in the Corryong area commenced in that year. At present, the main log supplies for the two mills situated at Corryong and Cudgewa come from alpine ash forests located to the south of the study district.

Since 1880, several attempts to utilize land around Shelley for agriculture have met with little success. Early in 1961, the Forests Commission of Victoria completed a survey that indicated considerable areas of land suited to radiata pine culture. Following a land determination by the now-defunct Land Utilization Advisory Council, some of

the public land was made available for a plantation scheme. In addition, some private property was purchased and used for plantation purposes. Work began in March, 1961, with headquarters at Shelley, 43 km (27 miles) east of Tallangatta. The first trees were planted in 1962 and total plantings to date cover about 5,300 ha (13,000 ac).

Development

Tallangatta and Corryong are the main population centres in the district. The town of Corryong began its existence with the opening of a store and hotel in 1875, and in 1879 building blocks in the township were surveyed and sold. The township of Tallangatta was shifted further west from its old site on Tallangatta Creek because of enlargement of Lake Hume and was officially opened in 1956.

Most of the early industries were established to meet local needs and were associated with the manufacture of foodstuffs from the products of the district.

Lake Hume

The dam built to control and utilize the waters of the Upper Murray catchment had its initial stage, capable of impounding 1¼ million acre-feet, completed in 1936. A wall to increase the capacity to a total of 2½ million acre-feet was commenced in 1951 and completed in 1961.

View of Lake Hume from Bethanga Gap

Lake Hume supplies water for irrigation areas in Victoria, New South Wales, and South Australia. It also provides an important storage for urban water supplies for many towns and cities, including Adelaide. Some electric power is generated at this site.

References

Andrews, A. "The First Settlement in the Upper Murray, 1835-1845." (Ford: Sydney 1920.)

Bailliere, F.F. "Victorian Gazetteer and Road Guide." (Bailliere:Melbourne 1865.)

Billis, R.V., and Kenyon, A.S. "Pastoral Pioneers of Port Phillip District." (Macmillian and Co.: Melbourne 1932.)

Howitt, A.W. "The Native Tribes of South-east Australia." (Macmillian and Co.: Melbourne 1904.)

Massola, A. "The Aborigines of South-eastern Australia as They Were." (Heinemann: Melbourne 1971.)

Miller, R.R. "The Upper Murray - A Centenary Survey." (Spectator: Melbourne 1934.)

Mitchell, J.R. Petrographs in the Koetong Creek valley. *The Victorian Naturalist*, 1954, 70, 219.

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

Smyth, R. "Aborigines of Victoria." (Government Printer: Melbourne 1878.)

Tindale, N.B. Results of the Harvard - Adelaide Universities anthropological expedition, 1938-1939: distribution of Australian Aboriginal tribes: a field survey. *Transactions of the Royal Society of South Australia*, 1940, 64, 140-231.

Tugby, D.G. Conic range shelter: a preliminary account of rock paintings in north-east Victoria. *Mankind*, 1953, 4, 446-50.

West, A.L. Painted Aboriginal rock shelter on Mount Porcupine, north-eastern Victoria, Australia. *Memoirs of the National Museum, Victoria* 1970, 31, 25-30.

PART II NATURE OF THE LAND

PHYSIOGRAPHY

The entire district falls within the major unit of the eastern highlands, which have basic structure comprising uplifted and dissected remains of ancient erosion surfaces, now evident as dissected plateaux or broad ridge-tops. Dissection has resulted in a complex physiographic pattern. The map facing page 16 (indicating slopes of more than 20°) shows its main elements, which may be described as follows.

Uplands and massifs

The Koetong uplands comprise an extensive surface that stretches north from Mount Cudgewa almost to the Murray River at Thologolong and east from Jarvis Creek to the head of Beetomba Creek.

The degree of dissection varies from weak to moderate and gives rise to plateaux, broad ridges, and basins of low relief at elevations generally ranging from 600 to more than 920 m (2,000-3,000 ft). Some basins dip below 600 m and some peaks, such as Mount Lawson (1,020 m) and Mount Granya (870 m), rise above the surrounding topography. The highest plateau is at Mount Cudgewa.

The surface is drained by streams flowing either into Tallangatta and Cudgewa Creeks or directly to the Murray, the major one being Koetong Creek.

A view of the Koetong uplands - Mount Lawson in centre background

Mittamatite massif and surrounding plain

Three well defined massifs exist to the north-east of the uplands. The highest of these, the Mount Burrowa massif, has been well dissected by steep-graded streams trending north-east and south-west. The summits are broad ridges and small plateaux, which lie at levels of 1,070 m to 1,200 m (3,500-4,000 ft).

The Pine Mountain massif, rising between Tintaldra and Walwa, presents a moderately dissected surface. Streams generally have steep gradients and exhibit rectangular drainage patterns. Small perched basins are a feature of the massif, which reaches elevations of more than 920 m (3,000 ft).

The township of Corryong is overshadowed by the Mittamatite massif, which extends from north of Corryong eastwards towards Tintaldra. The summit is reached in the south-west section, at an elevation of 1,018 m (3,340 ft).

The massif is weakly dissected and the streams drop steeply down the scarp faces, with the exception of Horse Creek, which flows at a moderate grade north-eastwards into the Murray.

Foothills and valleys

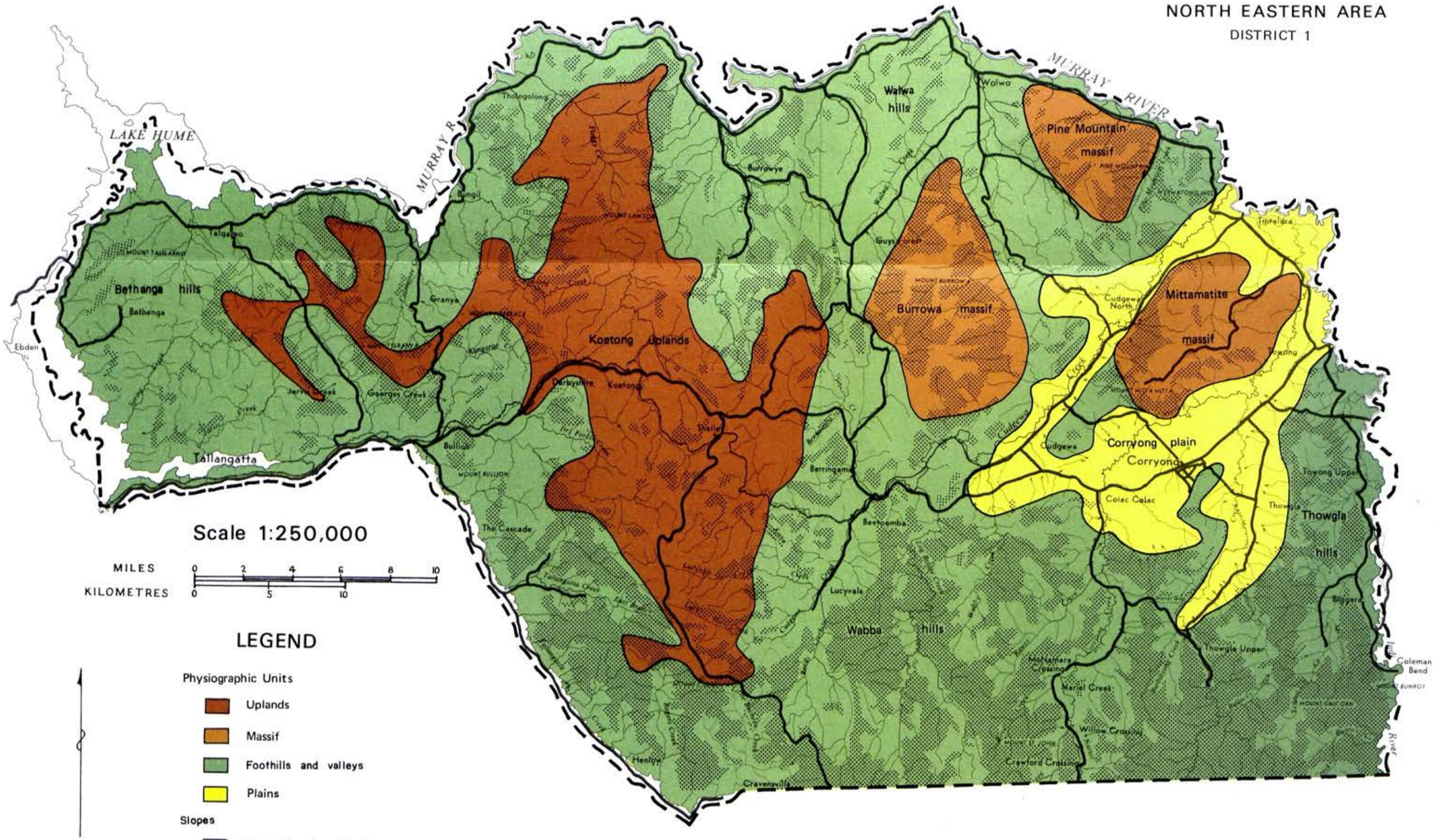
The approaches to the uplands and to the alpine region to the south of this district comprise large areas of mountainous terrain interspersed with gently undulating, rolling, or hilly topography at lower elevations. Rolling to hilly topography is found around Bethanga, whereas the catchments of Lucyvale, Cudgewa, Reedy, Wabba, Burrowye, and Walwa Creeks have gently undulating to rolling topography.

Landscapes in the south are mainly hilly - for example in the Log Bridge Creek and the upper Thowgla Creek watersheds. Elevations range from 1,040 m (3,600 ft) on the ridges in the far south to 200 m (660 ft) on the valley floors in the north-west. Some valleys - such as those of the Murray River up to Biggara, Tallangatta Creek up to Cravensville, and Corryong, Cudgewa, and Thowgla Creeks - have broad alluvial flats.

PHYSIOGRAPHY

LAND CONSERVATION COUNCIL
VICTORIA

NORTH EASTERN AREA
DISTRICT 1



Plains

Extensive plains occur between Corryong, Cudgewa, and Thowgla Creeks, where much of the landscape consists of upper terraces, gently sloping alluvial fans, and relatively small areas of lower terraces and flats all at 260-350 m (850-1,150 ft) elevation. The surface around Corryong is known as the Corryong plain.

GEOLOGY

The district formed part of a great belt of mainly marine sediments deposited in the Tasman Geosyncline, a wide trough that occupied the eastern part of Australia throughout Palaeozoic time.

Ordovician and Silurian

In Ordovician times, when the area was submerged beneath the sea, great thicknesses of muds, silts, and sands were deposited. Subsequent major folding and faulting of these sediments was accompanied by regional metamorphism.

Following this deformation, wide belts of sedimentary strata were metamorphosed to a variety of schists and gneisses by a process of injection and assimilation at high temperature, with some resultant mineralization.

During Silurian times, acid volcanics flowed into a narrow trough in the Mitta Mitta River-Mount Benambra area, which was formed by down-faulting along major faults in the crust.

Devonian

During the early part of the Devonian period, granitic magma intruded and metamorphosed the older rocks. Later uplift and prolonged erosion exposed some of these grey granites at the land surface.

Volcanic activity resumed during the Devonian period and a roughly circular fissure developed. Accompanying crustal subsidence resulted in an inflow of acid volcanics to a thickness of more than 600 metres (2,000 ft), which now forms most of the Burrowa massif.

Plugs of quartz feldspar porphyry and feldspar porphyry intruded Ordovician sediments at Mounts Morgan and Unicorn. At about this time red granites and associated sets of parallel dykes (dyke swarms) were intruded into the older grey granites.

Devonian to Tertiary

There is a long gap in the geological record for the remainder of the Palaeozoic Era. No marine deposits younger than Ordovician age occur, and intermittent uplift and erosion have probably been the main trend since then.

Tertiary

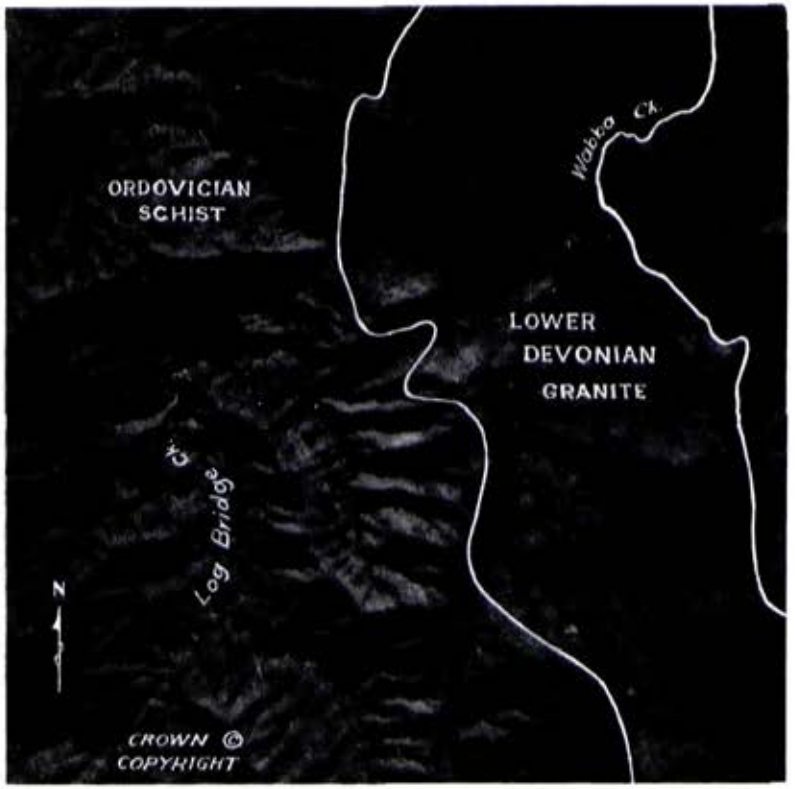
By the beginning of the Tertiary period, the surface of the district had been worn down to an undulating lowland. Uplift and mild dissection of this surface resulted in a topography of moderate relief with broad river valleys containing deposits of river gravels towards the close of the Tertiary.

A series of uplifts culminating in the Kosciusko Uplift then took place along an axis running through Mounts Kosciusko and Hotham. This resulted in tilting to the north-west, and major faulting parallel to the main axis of uplift.

Rejuvenation of the streams and dissection of this surface gave rise to topography similar to that of the present day, where the main features are the extensive uplands of the Koetong-Shelley and Bungil areas and a series of ridge tops at 750-900 metres in the south-east of the district.

Quaternary

By the Pleistocene epoch the present major landscape features had been formed. Subsequent events resulted mainly in a slight lowering of elevated surfaces and the building up and dissection of alluvial deposits. Since the last major geological movements, the lower reaches of the streams have deposited gravels, which finer materials have covered in turn.



Aerial photo shows topographic patterns developed on two different rock types

Stratigraphy

The oldest rocks in the district - fine-textured sedimentary rocks of Ordovician age - are situated in the south of the district and extend eastwards from Tallangatta Creek almost to the Murray River at Biggara. The beds mainly comprise greywackes (a type of sandstone), shales, or slates, interbedded with minor sandstones and carbonaceous

Granite tors at Mount Lawson

slates. Fairly intense folding on north-south axes has produced steeply dipping beds. The folding is more intense where shales predominate and more open where the sandstones are massive.

Gneissic rocks formed by metamorphism of the Ordovician sediments outcrop around Bethanga and Mount Granya. In these coarse-grained rocks, bands rich in granular minerals predominate. In other areas the sediments were altered by the action of granitic intrusions to form phyllites, spotted schists, andalusite, and micaceous schists, depending on the degree of alteration. These fine- to medium-grained rocks contain a large proportion of mica minerals

Silurian rocks outcrop south-east of Cravensville. These are mainly coarse-textured rhyodacites at the northern extremity of the Mitta Mitta volcanic belt.

Rocks of Devonian age are coarse-textured, mainly acid igneous rocks. Lower Devonian grey granites around Koetong and Corryong form part of a more extensive body that extends into New South Wales. Granite, granodiorite, and intermediate types occur, and variable textures are a feature of this rock mass.

Middle Devonian rocks are limited in extent and occur as isolated outcrops of coarse-grained quartz porphyry and quartz feldspar porphyry near Bullioh, surrounding the Mount Burrowa massif and at Mounts Unicorn and Morgan.

The dyke swarms concentrated about Pine Mountain and Mount Mitta Mitta are thought to be of Upper Devonian age. They vary in composition from acidic to basic (that is, they include granite, porphyry, porphyrite, and dolerite) and also in texture. The fine-grained granite dykes contain tin, sometimes in payable quantities. The porphyry and porphyritic dykes erode less rapidly than many of the surrounding rocks, and form small hills and prominent ridges in the vicinity of Corryong, as well as "walls" across the hills between Walwa and Tintaldra.

The bulk of the Mittamatite and Pine

Table 2

STRATIGRAPHY

Quaternary	Recent	Alluvial flats and swamp deposits
	Pleistocene	Plains, high-level river terraces, and colluvial-alluvial fans
Tertiary		Terrace gravels
		Erosion to peneplain *
	Upper	Acid volcanics (Jemba Rhyolite), red granite
Devonian	Middle to Upper	*Diastrophism* * Intrusive plugs and dykes
	Lower	Koetong and Corryong grey granites
Silurian		Acid volcanics (Mitta Mitta volcanics)
		Diastrophism (alteration of sediments) *
Ordovician		Greywacke, shales, slates, sandstones, carbonaceous slates

* Unconformities

Mountain massifs are coarse-textured, pale, reddish granites of Upper Devonian age, which weather to produce the most coarse-textured and chemically deficient soils in the district.

A mass of rhyolite comprising almost the whole of the Mount Burrowa massif is also regarded as being of Upper Devonian age. This rock type is coarse-textured, with larger crystals set in a micro-crystalline ground mass, and resembles granite in composition. A conglomerate outcrop north-west of Talgarno is probably of Upper Devonian age.

The only Tertiary materials are isolated deposits of rounded gravels near Granya, Koetong, and Lucyvale. Some of these contained alluvial tin or gold.

Quaternary deposits include Pleistocene sands, silts, clays, and gravels - on the plains, upper terraces, and colluvial-alluvial fans - and Recent silts, sands and gravels - on stream flats and in swamps.

References

Anon. "Resources Survey. Preliminary Report, Upper Murray Region." (Central Planning Authority: Melbourne 1949.)

Hills, E.S. Cauldron subsidences, granitic rocks and crystal fracturing in

Outcrops of red granite at Pine Mountain

Jemba rhyolite crags on the Burrowa massif

South-east Australia. *Sonderdruck aus der Geologischen Rundschau*, 1959, 47, 543-61.

Leggo, M.C., and Beavis, F.C. North-east Victoria. In "Regional Guide to Victorian Geology." Ed. J. McAndrew and M.A.H. Marsden (Melbourne University Press: Melbourne 1967.)

Singleton, O.P. Geology and mineralization of Victoria. In "Geology of Australian Ore Deposits." 2nd Ed. 440-4. (Eighth Commonwealth Mining and Metallurgical Congress: Melbourne 1965.)

Talent, J.A. Notes on Middle Palaeozoic stratigraphy and diastrophism is eastern Victoria. *Mining and Geological Journal* 1959, 6 (3), 57-8.

Talent, J.A. The stratigraphy and diastrophic evolution of central and eastern Victoria in Middle Palaeozoic times. *Proceedings of the Royal Society of Victoria*, 1965, 79, 179-95.

Tattam, C.M. The metamorphic rocks of north-east Victoria. *Bulletin of the Geological Survey of Victoria*, 1929, 52.

Williams, N. Palaeozoic geology of the Bethanga Goldfield area, north-eastern Victoria. B.Sc. (Hons.) Thesis, Australian National University 1969.

WATER

It is difficult to quote figures for water yield in this district because of the lack of data and because the major streams have some, or most, of their effective catchment outside the study area. Cudgewa Creek, which rises in the southern part, is the only major stream that lies (with its tributaries) almost completely within the district.

Surface Water Resources

Most of the water that contributes to stream flow comes in the cooler months, because of the combination of a rainfall peak and small evapotranspiration losses in winter. The main source of water is rain, although some precipitation on country above about 920 m (3,000 ft) falls as snow. The rate at which water reaches stream channels is influenced by the intensity and duration of the storm. Gentle rains tend to result in a slow and prolonged yield, whereas heavy rains reach streams rapidly, largely by overland flow. Run-off rate is also influenced by vegetation types, with greater and more rapid yields coming from cleared areas compared with those from forested land. These factors in turn affect the duration and magnitude of peak stream flows.

The most efficient catchments comprise land above 1,070 m (3,500 ft), but as such land makes up less than 2% of the district it yields only a small total amount of water. Land below 1,070 m contributes little to stream flow during the summer months, except for occasional flash run-off following heavy storms. Even in autumn the rains must saturate the dry soils before water becomes available for stream flow.

It is necessary to retain or improve the hydrological characteristics (water quality, run-off rate, and water yield) of the catchment areas, particularly steeper sections and the elevated sections with a high water yield, so as to retard run-off and minimize soil loss.

Major streams

The study district contains the following major streams:

* Murray River - upstream of Lake Hume to Bunroy
* Corryong and Nariel Creeks - Crawford's Crossing to Murray River
* Thowgla Creek - lower half

* Cudgewa Creek - (and tributaries)

* Tallangatta Creek - (eastern catchment only); Dry Forest Creek

* Walwa, Burrowye, Koetong, Flaggy, and Cottontree Creeks - total (Murray tributaries)

Gauging stations

Seven gauging stations have been established in this district, and Table 3 sets out the records for five of these, and for one on Nariel Creek upstream of the district boundary.

Water quality

The quality of surface water is generally satisfactory for domestic purposes. The Corryong town supply is of excellent quality, but the Cudgewa and Walwa supplies are less acceptable because of their bacteriological content. Cudgewa also has a plumatella problem. This is a coral-like organism, which feeds on small organisms including algae and which can block water meters and impart unpleasant tastes to the water supply. It is likely that conditions are more favourable to plumatella where the water source includes run-off from farmland.

Streams with mainly forested catchments appear to have much lower salinity levels than those with catchments comprising agricultural land (see chapter 22). However, in all cases salinity is relatively low, falling in the range of 20-50 p.p.m. total dissolved solids.

The Murray River upstream from Biggara.

Existing storage

Lake Hume, with its 2,500,000 acre-feet capacity, regulates an average annual flow of 3,300,000 acre-feet, which is now augmented by a net Snowy Scheme increment of 480,000 acre-feet. This storage is operated by the River Murray Commission so that allocations as agreed

Table 3

STREAM GAUGINGS

Station	Operation	Maximum annual discharge (acre-feet)[1]	Minimum annual discharge (acre-feet)	Mean annual discharge (acre-feet)	Quality (T.D.S. in p.p.m.)
Murray River - Jinjellic	1890-1971	4,978,000	549,000	1,920,000[2]	28
Tallangatta Creek - Bullioh	1936-1971	287,300	7,700	74,800	45
Little Koetong Creek-Burrowye	1936-1943	10,290	370	3,380	N.A.
Burrowye Creek-Burrowye	1936-1943	47,500	2,040	15,900	N.A.
Cudgewa Creek - Berringama	1953-1971	218,960	16,970	59,580	30
Nariel Creek - Upper Nariel	1954-1971	245,380	24,240	180,000	24

1. For conversion, 1 acre-foot = 1233.48 cubic metres.

2. The Regional Committee Report estimates that Victorian catchments contribute 700,000 acre-feet.

may be made to South Australia, New South Wales, and Victoria in all but years of extreme drought. Present usage is for irrigation and domestic supplies.

Possible storages

Two sites on the River Murray (at Jingellic and Murray Gates) have been examined for potential storages: so also have sites outside the district on the Mitta Mitta River at Dartmouth and Gibbo Junction. Dartmouth was the preferred site and a dam is being constructed on the Mitta Mitta River approximately 4 miles downstream of its junction with the Dart River.

A number of sites on Nariel, Cudgewa, and Walwa Creeks could be used to construct small storages to supply nearby towns.

Groundwater

This district lies beyond the eastern margin of the Murray Basin in the highlands, where groundwater supplies are generally small. The basement rocks throughout the area consist of Middle to Upper Ordovician geosynclinal sediments (which are intruded and metamorphosed in places by granite intrusions) and Devonian igneous rocks. Quaternary alluvial sediments occupy the valley floors.

Only small amounts - less than 75 litres per sec. (1,000 gallons per hour) have been obtained from the few bores sunk into the basement rocks. Groundwater is mainly restricted to the uppermost 30 metres (100 ft) in the weathered rock, but would occur at greater depth in the granite in open master joints. Its quality is excellent, with total dissolved solids amounting to less than 100 p.p.m. in most instances.

Within the alluvium occupying the valley of the Upper Murray River and the lower reaches of its tributaries lie important aquifers composed of sand and gravel. These occur at depths ranging from near the surface down to 60 m (200 ft), and yield as much as 2,270 litres per sec (30,000 gallons per hour). Salinity is mostly less than 250 p.p.m.

Groundwater recharge

A proportion of the precipitation in the district infiltrates the alluvial deposits and forms part of the recharge of the underground water of the Murray Basin. At present there does not appear to be any threat to the quality of the recharge water, as a result of the generally low levels of fertilizer and pesticide applications. Any such potential threats should be considered when contemplating change in the land use.

References

Bibra, e.e., and Riggs, H.C.W. "Victorian River Gaugings to 1969." (State Rivers and Water Supply Commission: Melbourne 1971.)

Anon. "Resources Survey: Preliminary Report, Upper Murray Region." (Central Planning Authority: Melbourne 1949.)

CLIMATE

The district is one of the higher-rainfall areas of the State. It lies at the eastern end of the Upper North-east District (as defined by the Bureau of Meteorology), which, with an average annual rainfall of 769 mm (30.27 in.), ranks fifth-highest among the 15 Victorian Districts. The variability of annual rainfall from the average is also important, particularly in some agricultural areas. One measure of it, the coefficient of variation, indicates that this meteorological District has a relatively high variation from year to year, being exceeded only by the Northern and Mallee North Districts.

The climate within the study district varies widely, due mainly to the effect of topography. With increase in elevation, rainfall generally increases and temperatures decrease. Topography also has a great influence on other aspects of climate, such as wind characteristics and the amount of solar radiation received.

Precipitation

Precipitation mainly takes the form of rain. However, light snowfalls occur fairly regularly in winter above about 760 m (2,500 ft), as, for example, at Shelley and Mount Cudgewa. Hail and dew do not contribute significantly to annual totals.

Rainfall varies from slightly less than 760 mm (30 in.) along the Murray Valley and near Corryong to more than 1,270 mm (50 in.) east of Cravensville. The rainfall and topography map accompanying this report shows the isohyets. These have been taken from Rowe's 1967 study, and are based on data from rainfall stations and a study of the topography and patterns of native vegetation. In broad terms, they indicate high rainfall on the higher country and a rain shadow centred about Corryong. Standard-period figures for representative stations may be found in Appendix I Table A, and Figure 1 presents them in graphical form.

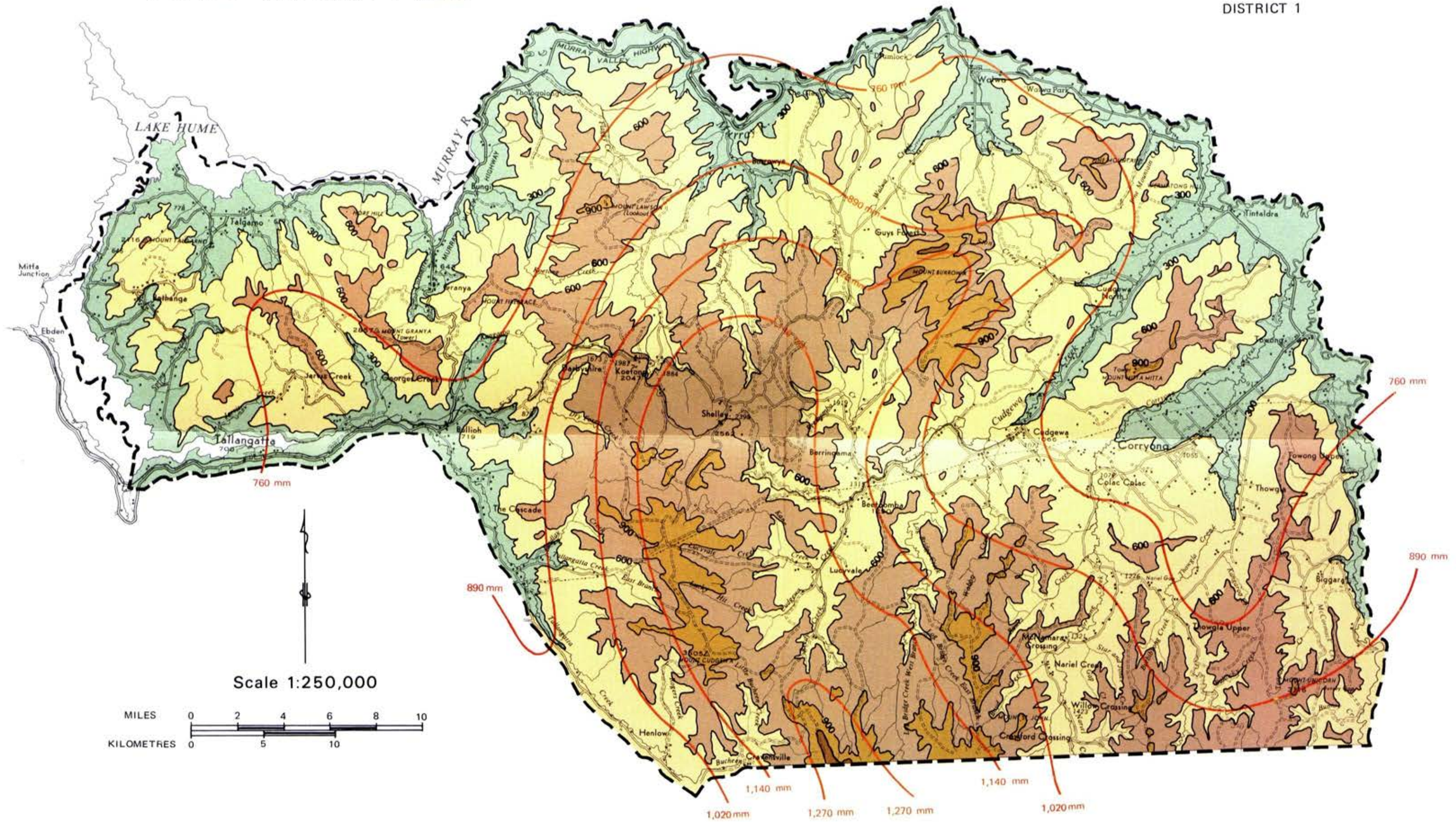
Distribution throughout the year

A few rainfall stations have been selected to represent conditions over certain parts of the catchment. Koetong represents the plateau environment. Unfortunately, no complete records exist

TOPOGRAPHY AND RAINFALL

LAND CONSERVATION COUNCIL
VICTORIA

NORTH EASTERN AREA
DISTRICT 1



Scale 1:250,000

MILES 0 2 4 6 8 10

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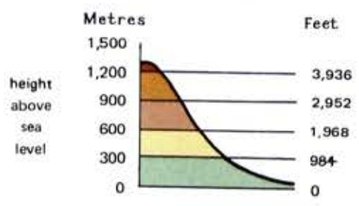
LEGEND

TOPOGRAPHY



AVERAGE ANNUAL RAINFALL

Isohyet —630 mm—

Millimetre	Inch (nearest)
1270	50
1140	45
1020	40
890	35
760	30
630	25

Rainfall isohyets from "A Study of the Land in the Victorian Catchment of Lake Hume", by R. K. Rowe, S.C.A.

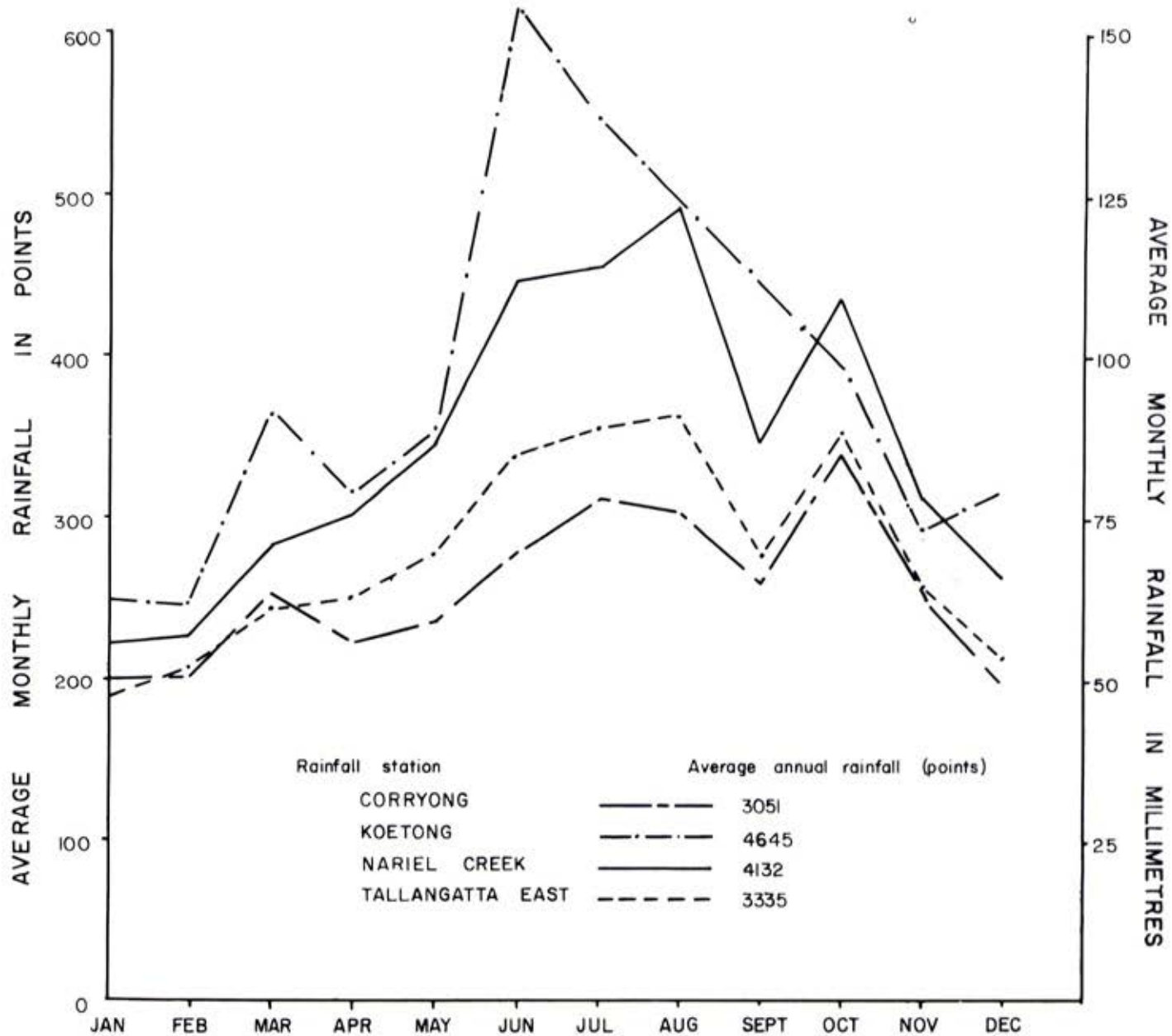


Figure. 1. AVERAGE MONTHLY RAINFALL

for the standard period from 1931 to 1960, so records for an earlier period encompassing 29 years have been used. These indicate a definite winter peak in the rainfall. (Available records for the standard period indicate a similar, although not so marked, peak in winter.) The driest months are January and February.

Burrowye and Nariel Creek are representative of narrow upper-valley tracts that come under the influence of the high topography close by. The monthly rainfall is low from December to February, with January showing the lowest values.

Summer dryness is more pronounced at Burrowye, with 46 mm (1.80 in.) in January compared with 56 mm (2.21 in.) at Nariel Creek. Winter rainfalls (June, July, August) exceed 114 mm (4½ in.) per month. Rainfall drops by about 32 mm (1¼ in.) late in August and September, and subsequently rises about 25 mm (1 in.) in October before dropping again in November and December.

Tallangatta East and Corryong are fairly typical of the valleys of the north-west and north-east respectively. January is the driest month for each. Monthly rainfalls of more than 76 mm (3 in.) are recorded for June, July, August, and October for Corryong. September figures drop to about 71 mm (2.8 in.) for Tallangatta East and 66 mm (2.6 in.) for Corryong.

Rainfall intensity and thunderstorms

The intensity of a storm - i.e., the rate at which rain falls - and the time of year in which it occurs are important for a number of reasons. For example, high storm intensities in summer, when ground cover may be sparse, can lead to serious erosion.

No direct measures of storm intensities for the district are available. However, Figure 2 presents calculated values of average rain per wet day for each month, and a table of the data is attached as part of Appendix I (Table B).

At all the stations graphed, the highest rainfall intensities occur during summer and autumn. The bulk of summer and autumn rain occurs as localized thunderstorms: the air can carry large volumes of water vapour at that time, and conditions for precipitation are not so common as in winter. Air streams in winter are cool and moist and come mainly from the south-west and north-west. They are more general in coverage and produce less intense rain.

Some indication of the occurrence of high-intensity rainfall is given by the incidence of thunder days - calendar days on which thunder is heard at least once. Wodonga has an average of 21 such days per year, of which 16 occur between October and March, with the highest frequency in December. (Thunderstorms may or may not be accompanied by rain.)

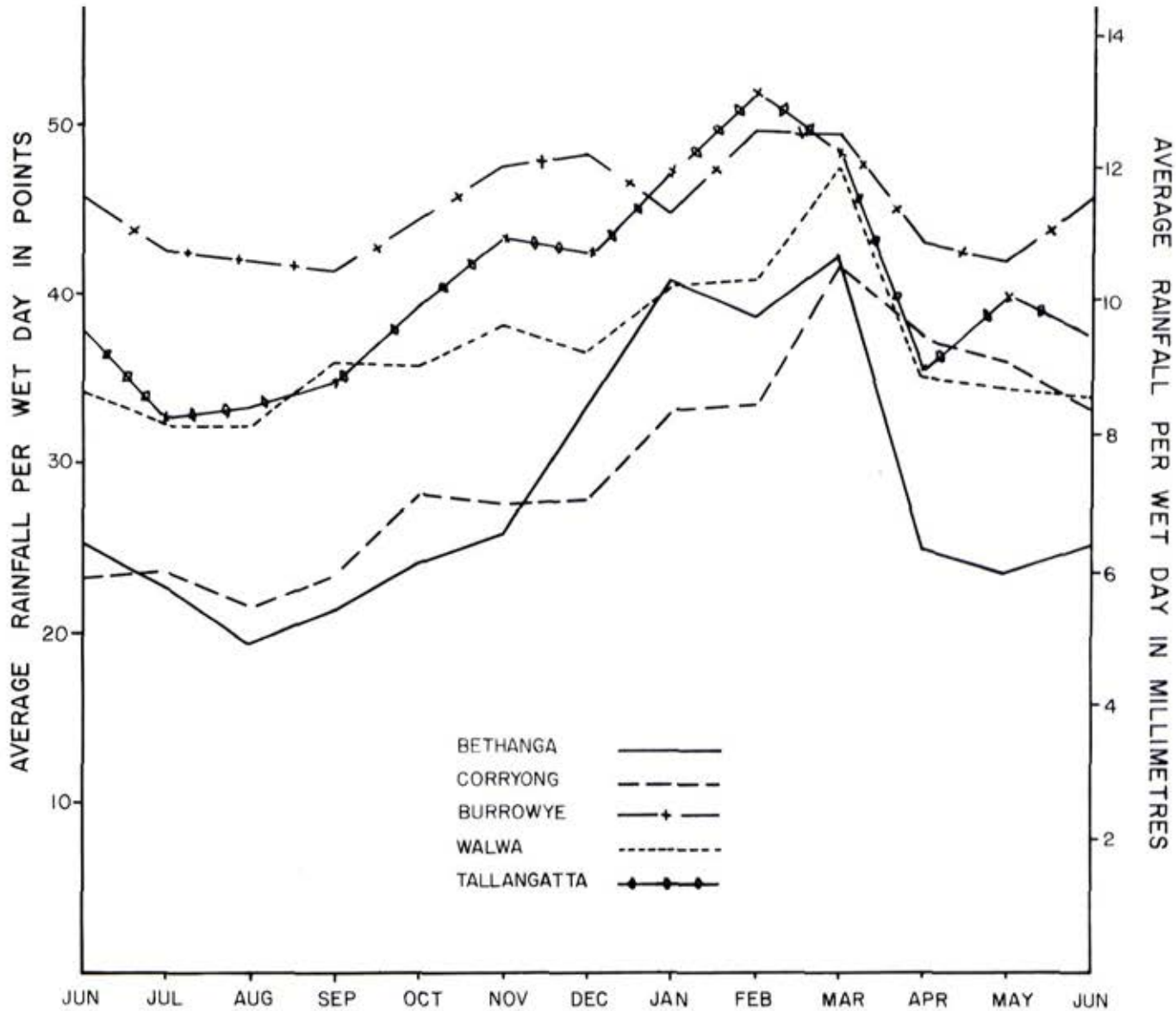


Figure 2. AVERAGE RAINFALL PER WET DAY

Thunderstorms may take the form of hailstorms or high-intensity rainstorms. Lightning accompanies them, and in some cases starts fires. The average annual number of thunder days in the district - 30-40 - indicates the frequency of thunderstorms. This figure is fairly common for much of the eastern highlands. Higher frequencies occur south of the study district and between Mansfield and Heyfield. Hailstorms affect small areas in the summer months, and showers of small hail are not uncommon during cold outbreaks in winter and spring.

Temperature

No temperature-recording stations lie within the district. However, Figure 3 presents the data for Albury and Hume Reservoir on the New South Wales side of the dam wall. These show that July is the coldest month of the year and January and February are the hottest.

In an attempt to obtain indications of temperatures over the Lake Hume catchment of Victoria, Rowe drew a series of graphs correlating average monthly temperature with elevation of the location. These have been used to plot values for four elevations, corresponding to Corryong at 305 m (1,000 ft), Koetong at 610 m (2,000 ft), "Avondale" on the Koetong uplands at 920 m (3,000 ft), and Mount Burrowa at 1,220 m (4,000 ft), as shown in Figure 4. In this Figure lines have been drawn at 10°C (50°F), below which plant growth is severely restricted, and 5.6°C (42°F), below which it is prevented entirely. This has importance for growing seasons, as discussed later in this chapter.

Average maximum and minimum temperatures

The average maximum daily temperature in January at Hume Reservoir is the highest for the year at 30.6°C (87°F). Albury reaches an average maximum temperature of 32.4°C (90.4°F) in February.

Walwa receives summer maximum temperatures of about 30°C (in the high 80s°F). Areas below 305 m (1,000 ft) altitude may experience very hot days, i.e., more than 32°C (90°F).

Around Corryong and in the upper section of the main river valleys, monthly maxima would approximate 27°C (80°F) in the warmest months and 10°C (50°F) in the coldest month (July).

At elevations of 920 mm (3,000 ft) or more, normal January maximum temperatures are approximately 24°C (75°F) in areas where local topography does not superimpose any other influences. Local effects of topography include that of aspect - northern aspects being warmer than southern.

Minimum temperatures can vary greatly from locality to locality because of the influence of topographic features, such as valleys and depressions, on night temperatures.

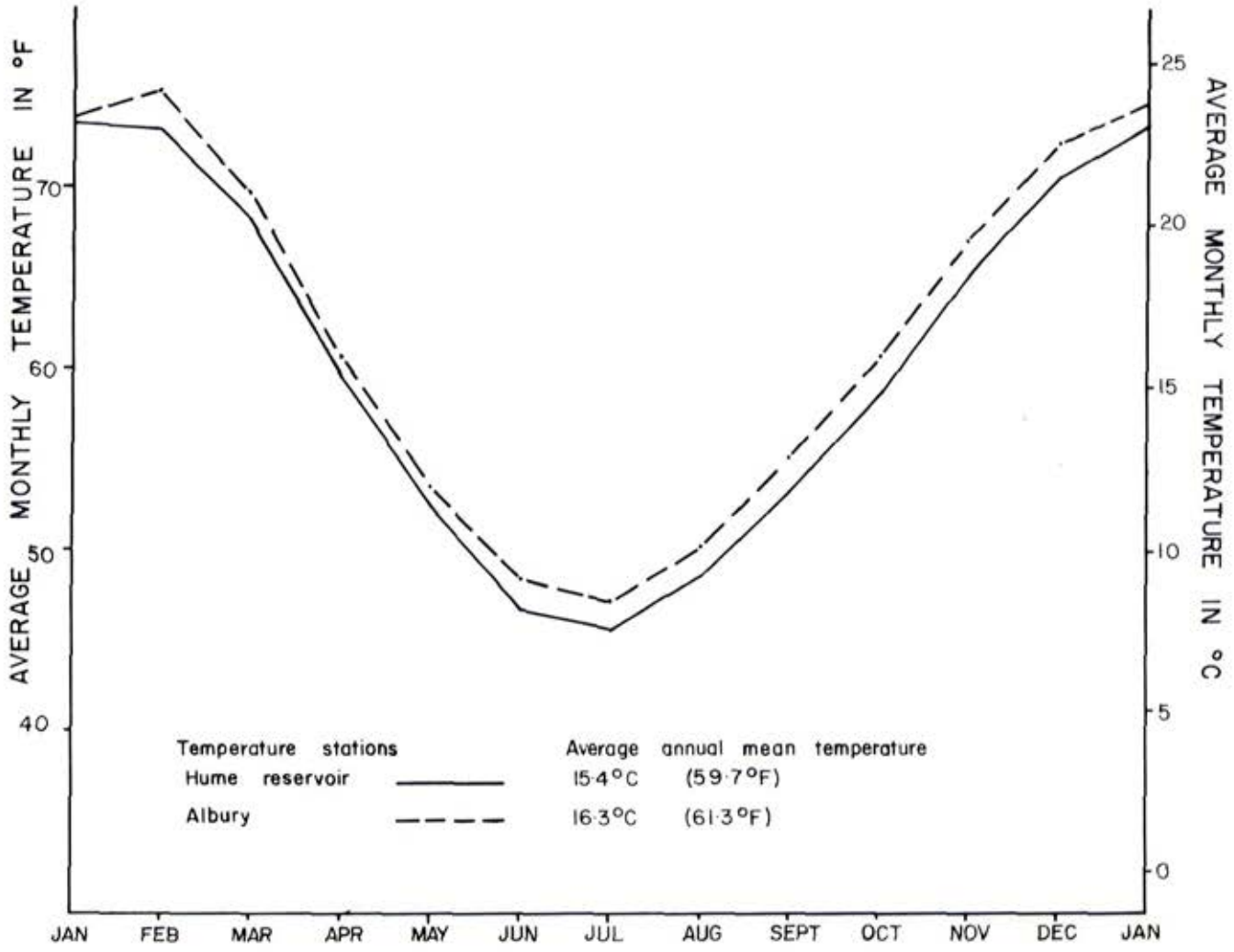


Figure 3. AVERAGE MONTHLY TEMPERATURE

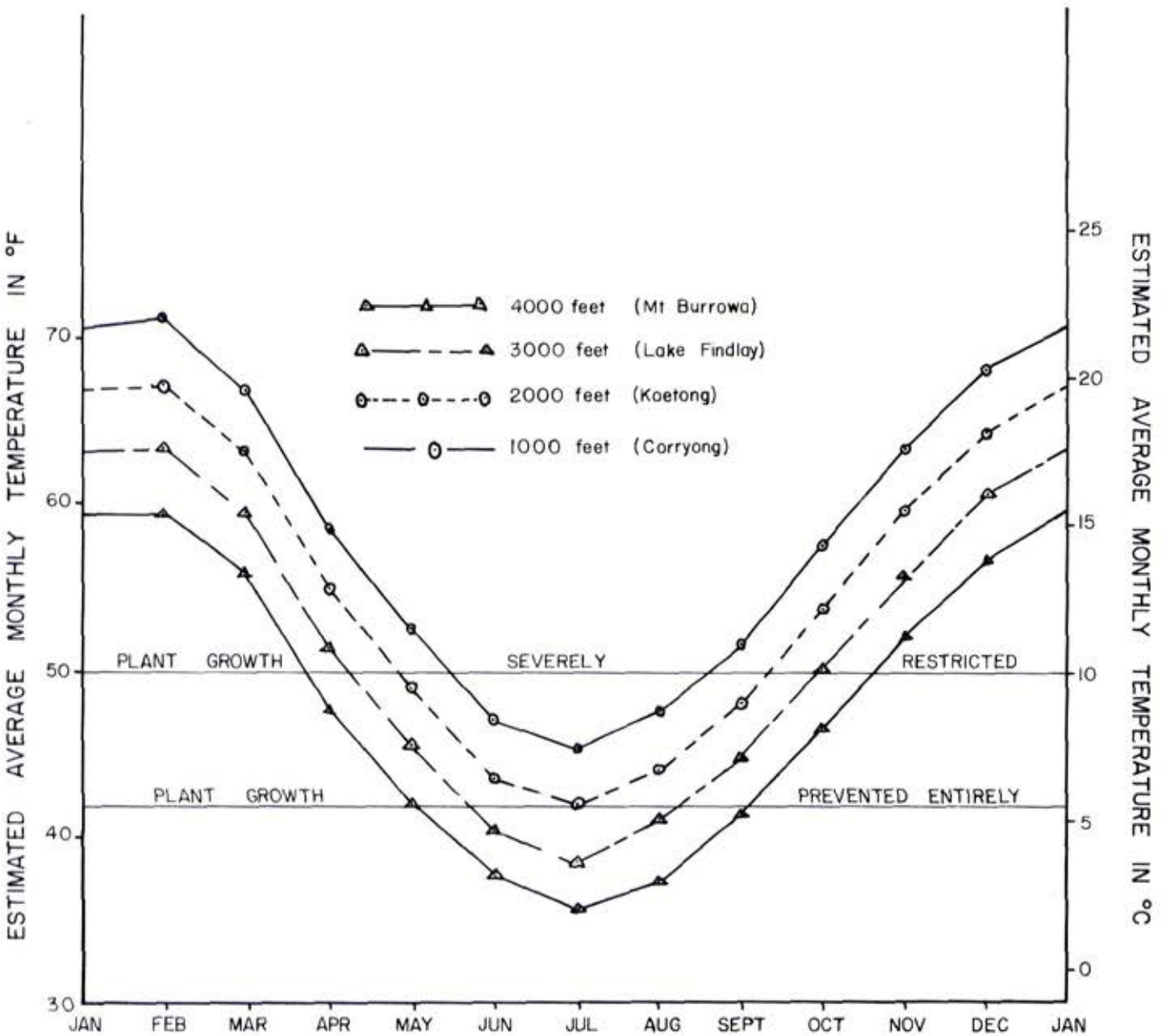


Figure 4. ESTIMATED TEMPERATURE AND ALTITUDE

Table 4

AVERAGE 9 a.m. RELATIVE HUMIDITIES
FOR ALBURY

(%)

No. of years of record	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Year
33	47	52	58	68	81	87	87	81	69	60	52	47	66

At Hume Reservoir, the average minimum monthly temperatures are 3.4°C (38.1°F) for July and 15.6°C (60°F) for January. The corresponding temperatures for July and February at Albury are 3.4°C (38.2°F) and 15.7°C (60.2°F).

Average minimum July temperatures are between 2.2°C (36°F) and 3.9°C (39°F) in the Murray River Valley as far east as Walwa and in most other areas situated at less than 305 m (1,000 ft). Areas above 920 m (3,000 ft) normally have July minima near freezing point (0°C or 32°F).

Minimum temperatures during the hottest months normally range from 13.3°C (56°F) to 15.6°C (60°F) in the sections of the district at low elevation. Normal summer minima at the higher elevations are about 11°C (in the low 50s°F).

Wind

The predominant wind stream flows from the north-west or north-east. However, many northerlies and southerlies occur, particularly during the summer months. Easterly winds are less frequent. Wind varies from season to season, between day and night, and from place to place. The latter two variations are particularly noticeable in the hilly country of this district - the katabatic breeze brings cold air down the valleys at night, and prevailing winds are deflected up narrow valleys.

Humidity

The incidence of high humidity is important to the wine and fruit industries, tobacco-growers, and wheat-farmers. Table 4 lists local values.

Frost

On the basis of the 1930-39 data for Hume Reservoir and Albury (as shown in Table 5), the open northern valleys have a frost-free period from about mid September to about the end of April. Severe frosts (temperatures below 0°C or 32°F) occur on the average between May and August, but at around 610 m (2,000 ft) may extend to mid September. At elevations greater than about 610 m, frosts have occurred during most months of the year.

Evaporation

No information on evaporation is available for any station within the district, but records for Hume Reservoir are presented in Appendix I Table C.

Climate and Plant Growth

Effective rainfall

A widely accepted measure of the availability of moisture to plants as affected by rainfall and evaporation is

Table 5

OCCURRENCE OF FROST

Station	First 2.2°C (36°F)			First 0°C (32°F)			Last 0°C (32°F)			Last 2.2°C (36°F)			Average frost-free period
	1	2	3	1	2	3	1	2	3	1	2	3	Days
Albury	May 17	11	Apr 15	Jne 15	12	Apr 30	Aug 1	15	Oct 23	Sep 9	14	Nov 10	249
Lake Hume	May 13	15	Jan 3	Jne 28	15	May 25	Jly 29	12	Sep 26	Sep 13	12	Nov 3	241

1. Average date of first or last frost (1930-1939)
2. Mean deviation from average date
3. Average date of first or last frost from 1908 or earliest date

effective rainfall. This is the amount of rain necessary to start or maintain plant growth. It has been calculated for each month for three stations in the district, together with the probability of receiving rainfall equal to or exceeding the effective amount, based on long-term records (see Table 6).

These stations give a good indication of conditions in the valleys, where most of the land is used for agriculture. In

Table 6

PERCENTAGE FREQUENCY OF OCCURRENCE OF EFFECTIVE RAINFALL

Month	Tallangatta East	Walwa	Corryong	Mitta Mitta
January	38	41	41	52
February	48	48	48	50
March	54	59	60	70
April	73	74	73	76
May	90	91	89	90
June	99	100	99	100
July	99	100	100	99
August	95	95	95	95
September	93	92	93	99
October	88	82	85	90
November	60	60	55	68
December	54	54	55	65

the open northern valleys, effective rainfall can be expected in 4 years out of 10 in January and 5 years out of 10 in February. The chances of receiving it increase in successive months, until it is virtually assured in June, July, and August. Chances decrease in spring, and by December effective rain can be expected in 5-6 years out of 10.

Mitta Mitta, which lies outside the district, indicates conditions in the upper-valley country, where the chances of receiving effective rain are generally better throughout the year.

Growing season

The availability of soil moisture and the effect of low temperatures are the two most important factors influencing the length of the growing season in this district. One commonly used method of estimating the length of the growing season is to total the number of consecutive months with frequencies of occurrence of effective rainfall equal to or exceeding 50%.

On this basis, the broad northern valleys (Tallangatta East, Corryong) have a growing season of 10 months, from March to December inclusive. The growing season indicated for the upper-valley situations is 12 months.

However, other factors - such as soil-moisture storage and low temperatures - also affect the growing season. In addition, the growing season can only be discussed in terms of the type of plant being considered and its management. For example, clean cultivation of vineyards conserves soil moisture. Again, plants with large root systems (such as trees) or deeply-rooted ones (such as lucerne) have an advantage over shallow-rooting plants with small root systems.

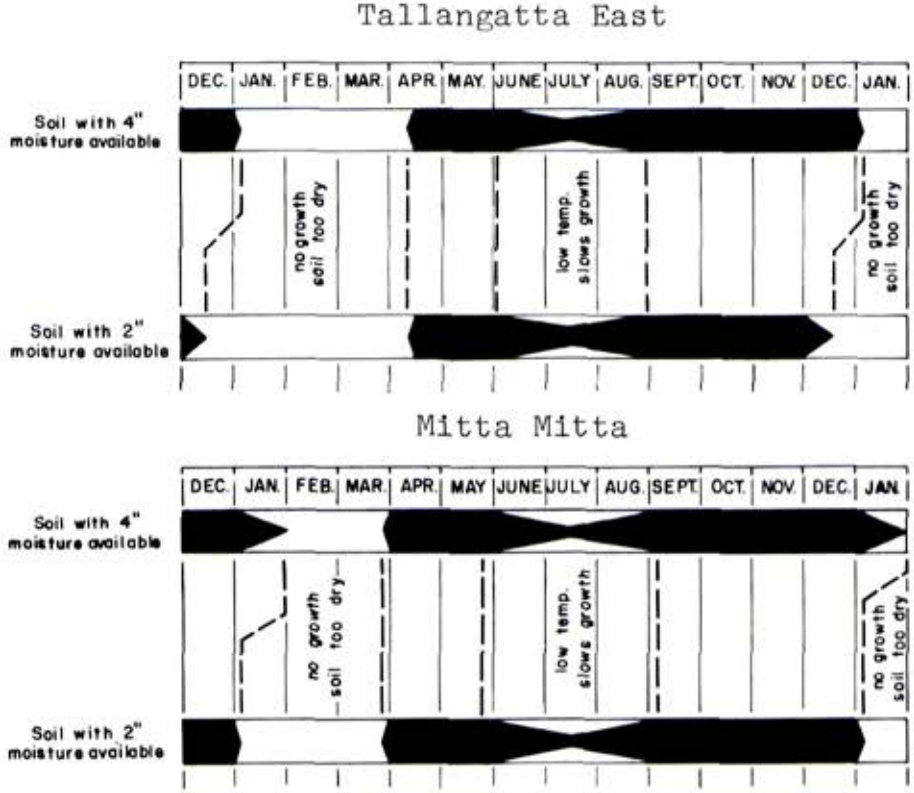
Rowe has calculated patterns of growth for permanent pastures, based on average monthly temperatures, the average monthly additions (precipitation) and losses (estimated evapotranspiration) to soil moisture, and the moisture-storage capacities of the typical soils in the area. Figure 5 presents growth patterns for Tallangatta East and Mitta Mitta.

The pattern expected at Tallangatta East is a period of checked growth during the drier months, growth commencing possibly early in April and continuing steadily to the end of May, slow growth during June, July, and August, and vigorous growth commencing in early September and continuing until soil moisture limits it. This will probably occur in early December in soils with only 2 in. of moisture storage, or in early January with 4 in. of soil moisture storage.

At Mitta Mitta growth is expected to commence in early April after a period of checked growth in the drier months. Growth continues at a steady rate until slowed by low temperatures in late May. Slow growth during June and July

Figure 5

Patterns of growth at Tallangatta East and Mitta Mitta as influenced by temperature, rainfall, evapotranspiration, and soil moisture storage.



Snowfall at Shelley

quickens in August; vigorous growth commences in September and continues until soil moisture becomes limiting - again in December if soil moisture storage is only 2 in., or in January if 4 in. of available moisture is stored in the soil. (Table 8, on page 47, gives moisture-storage estimates for various soils.)

Drought Frequency

The frequency of droughts may be estimated on the basis of effective rainfall: a drought is considered to have occurred over the period when monthly rainfalls did not reach the respective effective amounts. Calculations for Corryong and Mitta Mitta can be summarized as follows.

The frequency of winter drought is extremely low for the two stations, and indeed over the whole district.

During the summer, Corryong will probably have droughts in December in 32% of years, during January in 37% of years, and in February in 21%. Corresponding figures for Mitta Mitta are 24%, 35%, and 19% respectively. Chances of a 2-month, 3-month, or 4-month drought beginning in January are 21%, 11%, and 5% respectively at Corryong, and 22%, 9%, and 2% respectively at Mitta Mitta.

References

Anon. "Resources Survey: Preliminary Report, Upper Murray Region." (Central Planning Authority: Melbourne 1949.)

Anon. "Tank Evaporation Maps." Commonwealth Bureau of Meteorology: Melbourne 1967.)

Anon. "Average Annual Thunder Day Map of Australia." Commonwealth Bureau of Meteorology: Melbourne 1967.)

Anon. Climate. In "Victorian Year Book 1972." (Government Printer: Melbourne 1972.)

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

SOILS

Soils are bodies of unconsolidated mineral or organic material at the earth's surface, formed as the result of the interaction of climate, parent materials, living organisms (which include both plants and animals), and topography over varying periods of time. They are a basic resource that cannot be replaced. The uses to which they may be profitably and wisely put depend to a large extent on their characteristics.

Soil classification

Almost all classifications of the soil are intrinsic. That is, soils are recognized by features that distinguish one soil from another, rather than by features preselected according to their relevance to a particular form of land use. At the same time, many characteristics used to differentiate soils are known by experience to be relevant to a wide range of uses. This is a fortunate circumstance where the suitability of land for alternative uses is being considered.

Rowe has described and classified the soils cf this study district and his book provides the data on which this chapter has been based.

A new classification of the soils in the district has been devised, as set out in Table 7. This further groups the soil groups of Rowe according to Northcote's principal profile forms, which divide soils into three classes on the basis of the texture pattern of the profile: uniform, gradational, and duplex. Uniform soils may exhibit some texture changes down the profile, but these fall within the span of one texture group. For example, a loam may change to a sandy clay 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 clay loam or sandy clay. Duplex soils, on the other hand, change sharply to a clayey subsoil. Northcote's classification has not been carried further than this primary distinction because of its complexity and because the soils have not been described in a way that would permit this.

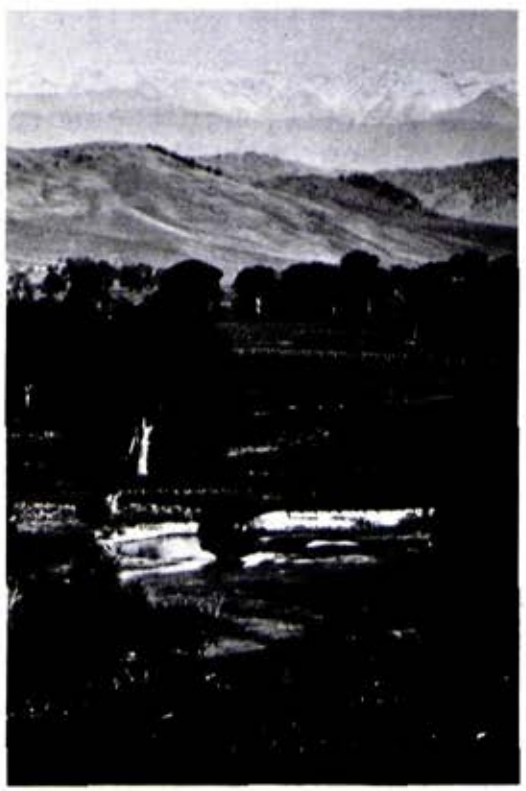
Within each class, the soils correspond to the groups used by Rowe, with the exception of the friable brownish gradational soils, which incorporate two groups. Descriptive names, using features that can readily be observed in

the field, have been used. The following section summarizes the distribution patterns and characteristic features of the soils of the district.

Uniform-textured Soils

Dark, structured, non-calcareous clays (prairie soils)

These are associated with stream flats and are of limited extent. Typically they are dark clay loams to light clays with strongly developed structure at the surface, becoming paler and less well structured with increasing depth. There is no free lime. Gravel is often present at about one metre depth.



The most common soils of the stream flats are alluvial brownish loams

Undifferentiated stony loams (lithosols)

Stony loams are common on steep slopes and exposed ridge-tops but are limited in extent. Stones dominate this soil, and little fine material is present.

Undifferentiated sandy loams (regosols)

Sandy loams are associated with relatively youthful alluvial land forms and stream deposits, and are limited in extent. They are predominantly pale sandy soils with organic material darkening the surface.

Alluvial brownish loams (alluvial brown earths)

The most common soils on stream flats are alluvial brownish loams. Typically, these brown loams have a well-developed surface structure. Their colour pales and structure declines with increasing depth. They are usually well drained, with gravel at about one metre depth.

Greyish loams with gleyed subsoils (meadow soils)

These are poorly drained soils of stream flats, where they occur relatively

Table 7

SOIL GROUPINGS FOR NORTH-EAST DISTRICT 1

Principal profile form (Northcote)	Descriptive name	Groupings (after Rowe)
Uniform texture	Dark, structured, non-calcareous clays Undifferentiated stony loams Undifferentiated sandy loams Alluvial brownish loams Greyish loams with gleyed subsoil	Prairie soils Lithosols Regosols Alluvial brown earths Meadow soils
Gradational texture	Friable brownish gradational soils Friable reddish gradational soils Weakly bleached, massive gradational soils Bleached gradational soils with gleyed subsoil	Acid brown earths Cryptopodsols Amphipodsols Leptopodsols Gley podsolic soils
Duplex texture	Reddish duplex soils	Red podsolic soils

commonly. They are usually grey to greyish-brown loams with moderately well-structured surface. The colour pales and structure declines with increasing depth. The subsoils are typically gleyed, and iron oxide staining of root channels may be common throughout.

Gradational-textured Soils

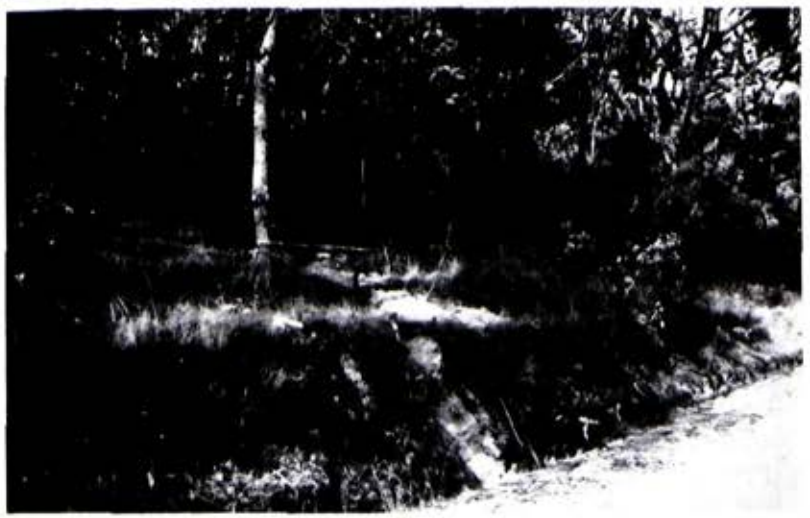
Friable brownish gradational soils (acid brown earths and cryptopodsols)

Friable brownish gradational soils are dominant on the mountainous slopes where rainfall exceeds about 890 mm (35 in.). They are usually relatively deep, but more stony, shallower, and lighter-coloured soils occur in the drier localities. The black to dark-brown loamy surface, with strongly developed fine structure, gradually changes to yellowish brown or yellowish red clay loams to light clays in the subsoil, where structure is less well developed. They are friable and porous throughout, and often stony. Depth varies, but usually more than one metre covers abundant rock.

Friable reddish gradational soils (amphipodsols)

Friable reddish gradational soils are the characteristic soils of the plateaux and broad ridge-tops. They are also common on other areas of low relief in the higher-rainfall areas. The surface soil, typically a dark brown loam with well-developed fine structure, changes gradually at shallow depth to reddish brown or red clay loam, and to light clay in the more compacted subsoil where structure is less well developed. A weakly bleached subsurface horizon may be present. The soil is friable throughout but only moderately porous in the subsoil. It may be stony and is usually more than one metre deep.

Friable reddish gradational soils are the dominant soils of this plateau land surface at Koetong



Profile of weakly bleached massive gradational soil

A reddish duplex soil near Corryong

Weakly bleached massive gradational soils (leptopodsols)

These soils are common in the lower mountain slopes and hills in the drier areas. They are also associated with coarse-textured parent materials in low situations. Usually, a brown loamy surface with moderate to weak structure covers a paler loamy horizon with no clear structure, which gradually changes at depths of about 30-40 cm (12-16 in.) to a more strongly coloured, massive clay loam subsoil. Subsoil colours vary from reddish brown in well-drained soils to yellowish or pale brown in poorly drained soils. Fine pores may be common in the subsoil.

Bleached gradational soils with gleyed subsoil (gley podsolic soils)

These gradational soils, associated with stream flats on low terraces, are of limited extent. A greyish brown loamy surface with weak structure over-lies a pale loamy horizon with no clear structure, gradually changing to a gleyed, yellowish grey, light clay subsoil.

Duplex Soils

Reddish duplex soils (red podsolic soils)

Reddish duplex soils predominate on areas of low relief where rainfall is less than about 890 mm (35 in.) and are

the typical soils of the valleys. They usually exhibit a brownish loamy surface with weak structure over a pale loamy horizon, which changes at about 25-30 cm (10-12 in.) to reddish-brown clay with well-developed structure. The surface soil sets hard when dry. The subsoil, although friable when moist, is compact and has relatively low porosity.

Chemical and Physical Properties

Particle size

Soil particles are denoted- according to size - as gravel, coarse sand, fine sand, silt, and clay. The texture estimated in the field reflects the percentages of the sand, silt, and clay fractions. Gravel is removed from the sample before testing, to leave the fine earth remainder.

In the soils of this district, the coarse sand fraction generally constitutes less than 20% of the fine earth. However, sandy uniform soils and weakly bleached massive gradational soils may contain up to 50% coarse sand. Fine sand may constitute up to 50% of soils, although 25-35% is more common. The silt fraction varies. It is usually below 25%, but may be higher in the more strongly weathered soils, such as the gradational soils from higher elevations.

The clay fraction is of particular interest because of the physical and chemical properties it imparts to the soil.

The friable brownish gradational soils and uniform loams generally contain less than 30% clay. The reddish gradational soils of the plateaux vary in clay content from less than 20% in the surface horizon to 40% in the lower portion of the subsoil. In weakly bleached massive gradational soils, clay generally constitutes less than 15% of the topsoil and increases only slightly with depth. Reddish duplex soils range from less than 20% in the topsoil to 40% or more clay in the subsoil, with a relatively sharp increase between the two. The clay fraction is uniformly low in undifferentiated sandy loams.

Available water

The amount of water that can be stored in the soil in a form available to plants is important in prolonging plant growth beyond the point where water losses due to evapotranspiration exceed water gains from precipitation.

Rowe has estimated the available water capacities for typical profiles of various soils, as shown in Table 8.

The friable brownish gradational soils have relatively high available water capacities. The alluvial brownish loams have fairly high capacities also, increasing from 16% of soil volume at the surface to 20% at 60 cm (2 ft). The

Table 8

ESTIMATES OF STORAGE CAPACITIES OF AVAILABLE WATER FOR TYPICAL PROFILES AND VARIOUS DEPTHS OF ROOTING

	Depth of rooting (ft)				
	2	3	4	5	6
	Storage capacity (in.)				
Friable brownish gradational soil	5	8	11	14	17
Weakly bleached massive gradational soil	4	6	7	9	-
Friable reddish gradational soil	3	5	7	9	-
Reddish duplex soil	3	5	6	-	-
Undifferentiated sandy loam	4	5	7	-	-
Alluvial brownish loam	5	5	9	-	-

Conversion: 1 in. = 25.40 mm
1 ft = 30.48 cm

remaining surface soils can hold about 20% of soil volume. However, differences are apparent in the subsoils. There, friable reddish gradational soils have a higher available water capacity than reddish duplex soils, despite similar textures, holding 14-17% compared with 10-11%. Weakly bleached massive gradational soils also have relatively low capacities (9-14%) in the subsoil. Undifferentiated stony loams have uniformly low available water capacities through the profile.

Permeability

This is the ability of a soil to absorb water. Friable brownish gradational soils readily absorb water and allow substantial subsurface percolation to streams. Friable reddish gradational soils are also permeable, but are more prone to compaction (with consequent loss of permeability). Reddish duplex soils have moderate surface permeability, but because of lower permeability in the subsoil may become saturated during prolonged wet weather. Weakly bleached massive gradational soils have low permeability.

Aeration

Poor aeration of soils may cause low yields of many crops, because death or poor vigour of roots may result from lack of oxygen or excessive carbon dioxide. Aeration is indicated by air capacities. Baver quotes capacity figures of the order of 10-20% for optimum growth of several crops.

Generally, the surface horizons of the soils in this area for which data are available have about 15% or higher air capacity. However, subsoils range from about 14-18% in the friable brownish gradational soils, through about 8-11% in the weakly bleached massive gradational soils, to as low as 4-7% in the clays of the friable reddish gradational soils and reddish duplex soils.

The low air capacity percentages of the latter two soils probably restrict root penetration of less tolerant plants, such as potatoes, into these horizons, thus limiting the ability of the roots to obtain supplies of nutrients and moisture.

Flood rain storage

The ability of soils to absorb run-off is an important property in relation to flood mitigation. Generally, the deep friable brownish gradational soils of the mountains have high capacities to hold flood rain temporarily. The friable reddish and weakly bleached massive gradational soils of the plateaux have moderate capacity, with the former soils having better effect. Reddish duplex soils of the valleys and the less steep foothills are limited in their ability to absorb run-off.

Reaction (pH)

District soils that have been sampled were acid throughout the profile. The friable reddish and brownish gradational soils have surface pH reactions of about 5.0-5.5 (strongly to moderately acid) and show no significant trend down the profile. Weakly bleached massive gradational soils and greyish and brownish loams have surface reactions of about 5.5 (moderately acid), which usually increase gradually to about 6.0-6.5 (slightly acid) lower in the profile. A similar trend also occurs in reddish duplex soils.

Available phosphorus

The soils of this district are low in available phosphorus.

Available nitrogen

Although difficult to measure directly, available nitrogen is indicated by the ratio of organic carbon to nitrogen in the soil (C:N ratio). A ratio of less than 12 seems to be desirable for the satisfactory growth of most crops and pastures.

Soils under native forest vegetation, including friable brownish and reddish gradational soils, have C:N ratios of about 20 or higher, whereas comparable figures for reddish duplex and weakly bleached massive gradational soils under native pasture are generally well below 20.

Although a low C:N ratio in the soil may be important for introduced plant

species, the native flora generally appear to be adapted to a lower level of available nitrogen.

Exchangeable cations

The cation exchange capacity (C.E.C.) of a soil is a measure of its ability to hold nutrients in available form for plants. It bears a close relation to organic matter in the soil and the clay fraction.

Most soils have higher capacities at the surface, the main exceptions being the reddish duplex soils and the weakly bleached massive gradational soils. These show a low C.E.C. at the surface with increases in the subsoil, but the effect is greater in the reddish duplex soil. The friable reddish gradational soils and alluvial brownish loams have only moderate C.E.C. at the surface and it decreases with depth. The undifferentiated sandy loams have fairly low C.E.C. throughout the profile, while the friable brownish gradational soils have high C.E.C. at the surface, which decreases markedly down the profile.

Other plant nutrients (exchangeable cations)

Exchangeable calcium and magnesium show similar trends in most profiles, with calcium as the more abundant cation. The friable brownish gradational soils contain less of both these cations than soils from the drier areas. Despite a high concentration at the surface, amounts elsewhere are low and decrease markedly down the profile. The friable reddish gradational soils show a similar but less marked trend for exchangeable calcium, but the concentration of exchangeable magnesium tends to remain constant throughout the profile. The reddish duplex soils and weakly bleached massive gradational soils both show an increase in these cations in the subsoil.

Figures for exchangeable potassium indicate a reasonably adequate status for all the surface soils sampled. Levels are maintained (or increase with depth) in all soils, with the exception of the friable brownish gradational soils.

References

Baver, L.D. "Soil Physics." (John Wiley and Sons: New York 1940.)

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

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

VEGETATION

In temperate and tropical climates, vegetation dominates our impression of natural land - it is everywhere, displaying infinite variation as species, form, density, and height change across the landscape. It constitutes a major part of what we regard as scenery, naturalness, or wilderness, and profoundly influences the value or character of an area of land.

Plants provide for many of Man's needs - and protect other values, such as soil stability, grazing, hunting, various forms of wildlife, water yield, and water quality. The role vegetation plays in recreation is becoming more important as urban populations grow.

This chapter is divided into two parts. The first deals with the importance of vegetation in conservation and with general principles of its ecology, description, and classification. The second describes the vegetation of the study district and should be studied in conjunction with the vegetation map provided in a pocket at the back of this report.

With a few exceptions the descriptions refer to vegetation on public lands, as very little native vegetation remains on private land in the study district.

General Principles

The food chain

Photosynthesis is the process by which green plants convert water, carbon dioxide, and certain simple minerals into organic compounds, releasing oxygen to the atmosphere. The energy necessary for the process comes from sunlight.

With the minor exception of some specialized bacteria, all the activities of all living organisms are based on the consumption of the products of photosynthesis; this occurs because of the flow of energy through the so-called food chain. For example, insects that feed on plants provide the food of the brown phascogale; in turn, this creature is preyed on by hawks or owls. The food from which all these animals draw their energy for growth, movement, and reproduction ultimately depends upon the material and energy formed and stored by plants.

Thus plants are primary producers in the truest sense of the word.

Study of vegetation

The importance of vegetation to land use and conservation can be summarized under three broad headings.

Firstly, plants are a group of organisms of intrinsic interest and beauty. The study of plants is a prerequisite for agriculture and forestry, and in the field of pure science has contributed to our knowledge of genetics, evolution, biochemistry, pharmacology, and ecology. The need to preserve as many as possible of the species and communities of the biosphere is set out in chapter 14. Vegetation merits special attention because of its unique position as the first link in the food chain.

Secondly, vegetation is important for the conservation of animals, birds, and insects, as all these organisms depend directly or indirectly on plants for their food, and often for shelter, nesting places, and protection. Most animal habitats can be described in terms of vegetation and, in the absence of detailed knowledge of the distribution of many animals, preservation of as many types of vegetation as possible should result in the preservation of the full complement of animals. The habitats of the birds and animals of the study area are described in chapter 11.

Thirdly, since the physical factors of a site - soils, climate, and topography - largely determine the natural vegetation on the site, the nature of the physical environment can be judged from the type of vegetation present. Assessing site factors in this way has the advantage that, while the factors that are usually of interest, (such as some soil characteristics or microclimate) are hard to measure directly, vegetation can be readily mapped in the field and from aerial photographs. Field evidence and, if possible, experimental evidence should be available to show that the species or group of species does in fact accurately indicate a specific site condition. Within the study district, the relations between native vegetation and the land's potential for growing pasture or pine plantations have been assessed and are used later in this report to classify land for these purposes.

Growth and development

Three factors are responsible for the great diversity of the form and composition of natural vegetation:

* the differing tolerances of plants to environmental factors
* the great differences that occur in the factors - temperature, light, soil fertility, and moisture - that make up the environment
* the availability of species (and their dispersal efficiency in the particular area under study

The plants present on any site are those whose requirements are met by the site. If the features of the site change rapidly, a correspondingly rapid change in the plant communities present will occur.

Plant succession

While the nature of the habitat basically determines the type of plant community, the community in turn determines many of the characteristics of its habitat. As plants colonize a previously bare area, they alter the original conditions of the site and impose new ones, and the modification of the environment in turn allows other, different species to become established. This process is called succession. For example, the first plants to colonize the bare rocks of steep slopes are lichens followed by mosses. These build up soil material and act as a reservoir of moisture, making conditions suitable for herbs and grasses. With further build up of soil, small perennial shrubs such as fringe-myrtle replace the annual plants and in time trees, for example red cypress pine, will form a low open forest on the site.

In the early stages of succession the vegetation changes rapidly, but as the community develops the rate of change slows, till a stage is reached where the vegetation is in equilibrium with the environment, and changes only as climate or soils change. Attainment of this stable phase may take several hundred years, and under conditions where the vegetation is periodically disturbed by fire - as is the case throughout most of Victoria - the final stage, or climax, is never reached.

However, secondary or deflected succession still takes place and vegetation develops and changes rapidly after fire. A community that is not the true climax but is maintained by Man's activities, such as grazing or frequent burning, is called disclimax.

In some cases, communities that appear to be stable since they are not undergoing directional change may be undergoing cyclic change - the vegetation passes through a number of phases that represent fluctuations about an average condition.

For scientific reasons, conservation of stages in succession is as important as conservation of climax communities.

Competition and dominance

These two processes play a major part in shaping the development of communities. Competition is the interaction between two species that have similar requirements, usually for space, light, moisture, and nutrients. It may result in a balance being struck between individuals, or the partial or complete displacement of one. Other interactions that may occur are parasitism and

symbiosis. Succession occurs when changes in the environment enable one species to gain a competitive advantage over an established species and so displace it.

The nature and function of a community is not determined equally by all the plants present. Some plants exert a controlling influence by virtue of their size or numbers, and these plants are known as dominants. Over much of the north-east, trees are dominant and condition the habitats of all associated species. Dominance may be regarded as a result of competition - for example, for a time eucalypt seedlings must compete with scrub species, but if they can overcome this competition, they can grow and eventually dominate these rivals. Dominants exert their influence by creating shade, changing the microclimate, and creating water stress.

Influence on vegetation

The activities of Man have caused major changes to the environment and these have had many direct and indirect effects on the natural vegetation. Activities that have had major effects are land clearing and cultivation, grazing, logging, mineral extraction, introduction of weeds and rabbits, construction of roads and tracks, burning, and applications of fertilizers and pesticides. The effects of these activities include initiation of new plant successions, loss of plant species, changes in wild animal and bird populations, and changes to the water table. All these factors act to change the natural ecosystems rather than destroy them. Natural communities react to imposed changes in a manner that, in the long term, tends to minimize change and bring about a return to stability.

Fire

Fire is mentioned above as a Man-induced factor that has resulted in change to the natural vegetation. This is an over-simplication; the existence of so many fire-resistant species shows that fire has been an important part of the Australian environment for thousands of years, originating from lightning strikes and, more recently, from the activities of Aborigines.

The relation between fire and vegetation is quite complex. The frequency of fire, its intensity, and the season of the year in which it occurs are important. The type of vegetation is also important, particularly the presence of physiological and morphological adaptations to fires such as epicormic buds, lignotubers, and thick bark. The minimum age to flowering and seed-set and the sensitivity of seeds to fire are also important. Eucalypts are well adapted to escape the deleterious effects of fire, and frequent burning probably helps them competitively. Vegetation influenced by repeated fires

never reaches a mature or stable stage of succession.

Fire is a most important tool in the management of vegetation, and we already have techniques for controlling the intensity and rate of spread of low-intensity fires. The most important requirements now are a fuller understanding of the effects of fire on the different parts of the environment and clearly stated aims for the management of vegetation.

Management

Since neither the composition nor the form of vegetation is ever static, preservation must consist of managing change. It is essential to establish clear aims in the management of vegetation and to determine how much and what kind of change can be tolerated.

Aims will vary according to the specific land use required and the nature of the vegetation. For areas of near-climax forest managed as wilderness, one aim would be to keep fire to an absolute minimum. However, maintenance of most forest and heath communities in Australia demands prevention of destructive wild fires and this may best be accomplished by controlled fuel-reduction burning.

The presence of plant or animal species sensitive to frequent fire may demand modification of burning practices in certain areas. Some communities in successional stages after fire are particularly rich in species, and these cannot be conserved by the complete exclusion of fire. Similarly, the conservation of a mosaic of communities created by grazing may require the retention of grazing. In some cases, rapidly expanding populations of native or introduced animals may have to be controlled.

Management is impossible without clear aims, and aims must be carefully examined to ensure that they are compatible. Preservation of a favoured dominant species, or of a particular stage of succession, may not be compatible with the preservation of some animal and bird populations.

Development of management techniques involves an understanding of the processes of succession and population dynamics, and manipulation of these processes to achieve aims. Continuous study should help this understanding.

Description and classification

The description and classification of vegetation require first a knowledge of the species present, or floristic composition, and the structure. However, the ecologist is rarely satisfied with this approach and usually endeavours to measure and escribe as many as possible of the features of the environment of each vegetation type recognized.

Structure

The structure of a plant community is defined in terms of three components:

* the vertical arrangement of the species into strata
* the horizontal arrangment of plants, or spacing
* the abundance of each species

The stratification or layering of a stand of vegetation is readily seen. For example, vegetation on certain sites in the Lucyvale block consists of a layer of tussock grass and herbs at ground level, a layer of bracken at 1 m (3 ft), an open small-tree layer of scattered blackwood at 8 m (25 ft), and a layer of tree canopies (narrow-leaf peppermint and blue gum) at about 30 m (100 ft).

The horizontal arrangment of a stand of vegetation refers to the position or distribution of plants in each layer. The distribution of individuals in a community is seldom random. Rather, individuals of a species are often grouped, and it is necessary to describe the size and pattern of the groups.

The abundance of a species can be described in several ways. These include subjective assessment using terms like common and rare, counts of the number of individuals within an area, and measurement of crown cover, which is the proportion of the ground that a vertical projection of the crowns of the plants under consideration occupies.

Floristics

When describing a large area of vegetation, a list of the species present may be helpful. However, floristic information means more if the species are grouped into units of those that usually occur together. The continuously varying nature of vegetation makes the description and delineation of discrete associations of species difficult.

Ecologists have made many attempts to define homogeneous floristic units, and now little doubt remains that such units can be defined within certain limits.

In 1952, Beadle and Costin published the method of classification now most common in Australia. Its major floristic unit, the association, they defined as a "climax community in which the dominant stratum has a qualitatively uniform floristic composition, and which exhibits a uniform structure as a whole". The dominant stratum is "that which, because of its physiognomy and relative continuity, dominates the rest of the community in the sense that it conditions the habitats of the other strata".

Floristically similar associations of similar structure may be grouped into

alliances. Associations may be sub-divided on the basis of variation in the most important subordinate stratum, to form sub-associations.

This method of classification has been criticized on the ground that the groupings are determined subjectively, and that it places too much importance on the dominant species.

An alterantive method aims at defining homogeneous species units by collecting data from carefully set-out plots or quadrats, and processing these data statistically in a computer. This method delineates groupings of species that are truly associated, which form extremely useful units for defining habitats and as indicators of site conditions.

However, the method has the disadvantage that data collection is a painstaking and slow process, and the key species in any grouping may be a small plant that would be very difficult to map. These techniques are impracticable for mapping and describing the vegetation of the study district.

North-eastern Area District 1

The district was originally covered by a continuous cover of tree canopies, except for some woodlands and small grassy plains in the broad river valleys.

Since early settlement, the woodlands have been cleared or thinned out and pastures of introduced plants such as clovers and grasses established. The other major vegetation change has been the clearing of peppermint forests on the Koetong uplands for pine plantations in recent years. While the vegetation on most of the public land can be called natural, the effect of Man is apparent here also, if not so obvious. He has introduced weeds, practiced logging and grazing on some areas, and altered the natural pattern of fires.

Mapping and classification

The vegetation of the study district was first grouped into a number of structural units, as set out in Table 9. These have been modified from a classification developed by Specht for use in the International Biological Programme. The modifications involve redefinition and subdivision of the height classes to better suit the vegetation of the study district and in addition to fit in with existing data for other areas. Table 9 groups the structural forms according to projective foliage cover, which is defined as the percentage of area covered by foliage, measured by a vertical point quadrat technique. It is not the same as crown cover. A tree is defined as a woody plant more than 5 m tall, usually with a single stem. A shrub is a woody plant less than 8 m tall, frequently with many stems arising at or near the base.

Table 9

STRUCTURAL FORMS (NORTH-EASTERN AREA DISTRICT 1)

Life form and height of tallest stratum	Projective foliage cover of tallest stratum			
	Dense (70-100%)	Mid-dense (30-70%)	Sparse (10-30%)	Very sparse (<10%)
Trees >49 m (>130 ft)		Open forest IV		
Trees 28-40 m (90-130 ft)		Open forest III		
Trees 15-28 m (50-90 ft)		Open forest II	Woodland II	
Trees 5-15 m (16-50 ft)		Open forest I	Woodland I	
Shrubs 2-8 m (6-27 ft)	Closed scrub	Open scrub		
Shrubs 0-2 m (0-6 ft)	Closed heath	Open heath		
Herbs (including moss, ferns, lichens)		Mossland	Open mossland	

Within this structural framework, the vegetation has been grouped according to commonly occurring combinations of tree species. These have been chosen subjectively and have been termed vegetation units to distinguish them from the groups determined by ordination methods. They are not based on a detailed study of species relations, but are readily recognizable in the field and each unit reflects the operation of a certain set of environmental factors.

Table 10 sets out these vegetation units, which also form the units for the map at the back of this report. The description and detailed mapping were undertaken because of the importance of vegetation in planning for conservation.

Table 11 demonstrates the relations of the units to other schemes. The map was drawn from information supplied by the Forests Commission, together with some aerial photo interpretation and field checking. The mapping units represent mature vegetation communities: stands of alpine ash have been mapped as open forest IV, even though some of these have not yet reached full mature height and form. However, symbols indicate whether stands are of regrowth or mature size, in this case.

The map makes no distinction between mountain gum *(Eucalyptus dalrympleana)* and candlebark gum *(E. rubida)* as they are very similar both botanically and in their appearance in the field. Nor does it distinguish between the two forms of forest red gum, or more correctly Blakley's red gum *(E. blakleyi)*. One form grows on the terraces and in drainage lines at low elevations, and the other, a stunted form sometimes referred to as hill gum, occupies some steep dry slopes where soils are shallow.

Description of the Vegetation Units

Candlebark gum: snow gum, open forest I

This vegetation unit has an overstorey of candlebark gum *(E. rubida)* and snow gum *(E. pauciflora)* usually less than 15 m high. An associated tree species, broad-leaf peppermint *(E. dives)*, comes into the community on dry rocky sites. The understorey layers comprise low shrubs - including hop bitter-pea *(Daviesia latifolia)*, handsome flat-pea *(Platylobium formosum)*, leafy bossiaea *(Bossiaea foliosa)*, and golden oxylobium *(Oxylobium ellipticum)* - and a grassy layer of snow grass *(Poa australis)*.

The unit is restricted to ridge tops at the high elevations in the district, 1,160-1,200 m (3,800-4,000 ft), at Mount Burrowa and east of Cravensville.

Alpine ash, open forest IV

The dominant species of this unit is alpine ash *(E. delegatensis)*. Its seeds require low winter temperatures to break their dormancy, which restricts it to areas that receive light winter snows -

Table 10

VEGETATION UNITS

Typical structural form(s) (at maturity)	Major tree species (common name of unit)	Associated tree species	Major understorey species
Open forest I	Candlebark gum: snow gum	Broad-leaf peppermint	Snow grass; hop bitter-pea, handsome flat-pea, leafy bossiaea, golden oxylobium
Open forest IV	Alpine ash	Candlebark gum blue gum	Snow grass; hop bitter-pea; common ground fern; silver wattle
Open forest III	Narrow-leaf peppermint	Candlebark gum manna gum blue gum brittle gum broad-leaf peppermint red stringybark	Tussock grass; bracken fern, hop bitter-pea; common cassinia, silver wattle, blackwood; blanket-leaf, musk daisy-bush, hazel pomaderris
Open forest II	Broad-leaf peppermint	Candlebark gum red stringybark long-leaf box blue gum narrow-leaf peppermint but-but (apple box)	Tussock grass; bracken fern, hop bitter-pea, handsome flat-pea
Open forest II	Red stringybark: long-leaf box	Candlebark gum broad-leaf peppermint red box but-but (apple box)	Tussock, kangaroo, and wallaby grasses; handsome flat-pea, golden guinea-flowers, purple coral-pea; grasstree; silver wattle
Open forest I	Red stringybark: long-leaf box	Forest red gum broad-leaf peppermint but-but (apple box) red cypress pine candlebark gum	Tussock grass; grasstree, common fringe-myrtle, dagger wattle, woolly wattle
Open forest I, closed to open heath, open mossland	Red cypress pine complex	Forest red gum long-leaf box kurrajong red box	Lichens and mosses, common fringe-myrtle, wedge-leaf hop-bush, dagger wattle, woolly wattle, drooping sheoak
Open forest II, Woodland II	Forest red gum	White box long-leaf box but-but (apple box) yellow box red box	Wallaby grass, kangaroo grass
Open forest II Woodland II	River red gum	-	Common reed
Open forest II	Swamp gum	Black sallee	Tussock grass, sword sedge, tea-tree
Softwood forest Grassland and/or scrub			

Table 11

Vegetation units	Vegetation communities (after Rowe)	Major vegetation alliance (Frankenberg)
1. Candlebark: snow gum Open forest I	Wet sclerophyll forest *E. pauciflora - E. rubida*	17
2. Alpine ash Open forest IV	Wet sclerophyll forest *E. delegatensis*	5
3. Narrow-leaf peppermint Open forest III	Wet sclerophyll forest *E. radiata - E. rubida - E. dives*	16
4. Broad-leaf peppermint Open forest II	Wet (dry) sclerophyll forest *E. radiata - E. rubida - E. dives*	14
5a. Red stringybark: long-leaf box Open forest II 5b. Red stringybark: long-leaf box Open forest I	Dry sclerophyll forest *E. macrorhyncha*	14
6. Red cypress pine Open forest I Closed to open heath Open mossland	Dry scrub *E. tereticornis - Calytrix tetragona*	14
7. Forest red gum Open forest II Woodland II	Savannah woodland *E. tereticornis - E. albens - E. goniocalyx*	21
8. River red gum Open forest II Woodland II	Savannah woodland *E. camaldulensis*	21
9. Swamp gum Open forest II	Tall woodland *E. camphora - E. stellulata*	15

at elevations of about 1,070-1,200 m (3,500-4,000 ft) in this district. Precipitation here exceeds 1,020 mm (40 in.) per annum, and soils remain moist throughout the year. Summers are mild and winters are cold. Soils are deeply weathered and freely drained.

Tree species associated with alpine ash include candlebark gum and blue gum *(E. st. johnii)*, usually with an understorey of one or more layers. Snow grass usually forms a layer close to the ground and may be continuous or scattered. A low shrub layer 1/3-1 m (1-3 ft) high - comprising hop bitter-pea, common ground fern *(Culcita dubia)*, and/or Derwent speedwell *(Veronica derwenti)* - may be present; and taller shrubs 2-6 m 6-20 ft) high - including such species as buffalo wattle *(Acacia kettlewelliae)*, and forest lomatia *(Lomatia fraseri)* - grow on the more sheltered sites.

This vegetation unit is confined to sheltered aspects high on the Burrowa massif and to a broad ridge east of Cravensville. Wildfires have resulted in a pattern of regrowth stands among the mature ones, as fire readily kills this species but by the same token produces conditions that favour its regeneration.

Narrow-leaf peppermint, open forest III

Such forest covers quite a large proportion of the forested landscape. The major species, narrow-leaf peppermint

Narrow-leaf peppermint open forest III near Koetong. Understorey of silver wattle, bracken fern and grasses

(E. radiata), requires moderately high soil-moisture status throughout the year. It sometimes forms stands in drier situations but the trees have poor crowns and apparently do not grow vigorously. The species occurs in areas receiving rainfall of more than 1,020 mm (40 in.) per annum on deep, well-drained soils, or in locally moist sites such as

Broad-leaf peppermint open forest II with a dense tussock grass understorey

southern aspects in lower-rainfall areas. Its elevation ranges from about 300 m (1,000 ft) to about 1,070 m (3,500 ft). On cool moist sites it is frequently mixed with blue gum or manna gum *(E. viminalis)*, and on drier sites with broad-leaf peppermint, brittle gum *(E. mannifera)*, and red stringybark *(E. macrorhyncha)*.

The tree canopy is generally between 28 and 40 m high. Undergrowth varies from a moist gully type of tall (3-9 m or 10-30 ft) broad-leaved shrubs - which may include blanket-leaf *(Bedfordia salicina)*, hazel pomaderris *(Pomaderris aspera)*, austral mulberry *(Hedycarya angustifolia)*, and musk daisy-bush *(Olearia argophylla)* - to a ground layer of ferns, including fishbone water-fern *(Blechnum nudum)*. The typical understorey of the Koetong plateau is either a grassy forest floor of tussock grass *(Poa australis)* or a layer of bracken fern *(Pteridium esculentum)* above a discontinuous grassy sward. Scattered individuals of blackwood *(Acacia melanoxylon)* or silver wattle *(A. dealbata)* are a feature of the plateau country. Low shrubby layers that may also be present may include hop bitter-pea and handsome flat-pea.

Basins at lower elevations and in sheltered sites sometimes contain a layer of common cassinia *(Cassinia aculeata)* at a height of 1-3 m (3-9 ft), usually associated with bracken fern. Kangaroo grass *(Themeda australis)* may replace tussock grass to a large extent at the lower elevations.

As well as covering the bulk of the Koetong uplands south of Koetong, this unit occurs on moister sites (with southern aspects or in moist gullies) over most of the district.

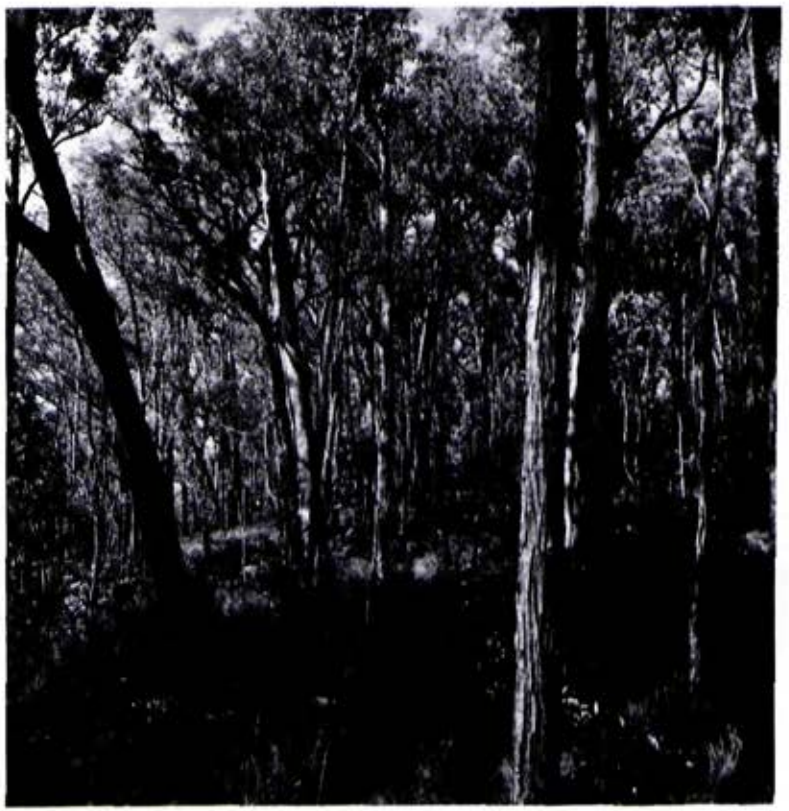
Broad-leaf peppermint, open forest II

Broad-leaf peppermint *(E. dives)* has a greater ecological range than its near relative, narrow-leaf peppermint. It grows on shallower, well-drained soils within the narrow-leaf peppermint range and also on southern aspects with shallow soils in the warmer areas that receive less than 890 mm (35 in.) of

rainfall per annum. It does occur in pure stands, but candlebark gum is usually associated with it, particularly on the moister sites. Blue gum is associated with broad-leaf peppermint in the moist sheltered gullies. On dry ridges and slopes in the south of the district, long-leaf box *(E. goniocalyx)* is often an associate and in the north red stringybark comes in as an additional associate.

The tree canopy is generally about 15-28 m (50-90 ft) high. Understorey vegetation consists mainly of either a dense grass sward or grasses mixed with a low shrub layer. The grass is generally tussock grass and the low shrubs include handsome flat-pea. In some areas bracken fern forms an understorey layer.

This unit is distributed over most of the region, mainly on dry ridges and northern slopes but sometimes on southern aspects in the north of the district.



Red stringybark: long-leaf box open forest II with a low scrubby understorey

Red stringybark: long-leaf box, open forest II

The canopy of this unit is generally from 15 to 28 m (50-90 ft) above the ground, the main species being red stringybark *(E. macrorhyncha)* and long-leaf box *(E. goniocalyx)*. Red stringybark occurs widely in the district as a result of its wide ecological range. It grows on freely drained soils under annual rainfalls varying from 630 mm to 1,020 mm (25-40 in.). The species may occur in high-rainfall areas if soil moisture-holding capacity is low, but low temperatures probably help to restrict it to below about 760 m (2,500 ft) elevation. It is closely associated with long-leaf box, which occurs generally on soils subject to excessive winter wetness and summer dryness where annual rainfalls are up to about 1,020 mm (40 in.). Long-leaf box is generally

Red cypress pines in association with red box near Flaggy Creek

limited to elevations below about 610 m (2,000 ft). Its range overlaps those of forest red gum, red cypress pine, red stringybark, and broad-leaf peppermint. Other species that occur frequently in mixtures with the major ones are broad-leaf peppermint and candlebark gum. Less frequent associates are red box *(E. polyanthemos)* and but but *(E. bridgesiana)*.

The understorey may consist of a sward of tussock grass with scattered wattle or perhaps litter, or a layer of heathy shrubs, including grey bush-pea *(Pultenaea cunninghami)*, daphne heath *(Brachyloma daphnoides)*, urn heath *(Melichrus urceolatus)*, box-leaf wattle *(Acacia buxifolia)*, small-leaf parrot-pea *(Dillwynia retorta* var. *phylicoides)* and dusty miller *(Spyridium parvi-folium)*. Elsewhere, handsome flat-pea and purple coral-pea *(Hardenbergia violacea)* may be scattered among a sward of tussock grass.

The unit mainly occurs on dry sites in the Granya, Bethanga, and Lawson blocks where the soils are deep and also in drier, less steep country in the Wabba, Bunroy, and Elliot blocks.

Red stringybark: long-leaf box, open forest I

Although the same major tree species are generally present, the height of the canopy is less than 15 m (50 ft), and the associated tree and understorey species indicate a drier environment than that of the previous unit. A stunted form of forest red gum *(E. blakleyi)* and red cypress pine *(Callitris endlicheri)* are examples of the tree species, and shrubs include grasstree *(Xanthorrhoea australis)*, dagger wattle *(Acacia siculi-formis)*, woolly wattle *(A. lanigera)*, and grevillea *(Grevillea ramosissima)*. Some sites may not have a shrub layer, only a scattering of tussock grass or

even litter alone covering the forest floor.

Red cypress pine, complex

This unit is really a grouping of different formations that are often intimately mixed together. The open forests less than 15 m (50 ft) in height grow on the deepest soils of the complex. Here the main tree species are usually red cypress pine *(Callitris endlicheri)* and forest red gum *(E. blakleyi)*. Associated trees include long-leaf box, red box, and occasional kurrajongs *(Brachychiton populneus)*. Underlying the open forest type may be only mineral soil covered by a litter layer, or perhaps scattered tall shrubs such as drooping sheoak *(Casuarina stricta)* and a low layer that includes crimson grevillea *(Grevillea polybractea)*, nodding blue lily *(Stypandra glauca)*, and guinea flower *(Hibbertia* sp.*)*.

Closed to open heath is composed mainly of common fringe-myrtle *(Calytrix tetragona)*. Other species in this formation are dagger wattle, woolly wattle, and rock fern *(Cheilanthes tenuifolia)*. The heath may cover large continuous areas or may surround isolated rocky outcrops. On the outcrops themselves, open mossland of lichens and mosses occurs. The main distribution of this complex is to the north of Mount Lawson, on steep rocky escarpments near the Murray River, and also on the Pine Mountain and Burrowa massifs to the east.

A woodland of forest red gum and white box near Lake Hume

Forest red gum, open forest II and woodland II

This vegetation unit has been mainly cleared for agriculture. It now exists on public land in a few drainage lines and on hillocks in the Granya and Lawson blocks. Forest red gum *(E. blakleyi)* occurs typically on hillocks or terraces where a perched water table may be

expected during winter and where soils dry out during summer. It does not occur at elevations above about 600 m (2,000 ft). The species prefers an annual rainfall of about 760 mm (30 in.), hot summers, and cool winters. Forest red gum is associated with white box *(E. albens)*, long-leaf box *(E. goniocalyx)*, but but *(E. bridgesiana)*, yellow box *(E. melliodora)*, and red box *(E. polyanthemos)*. Usually, a grassy understorey comprises wallaby grass *(Danthonia* sp.*)* and kangaroo grass *(Themeda australis)*. Some areas with shallow soils support rock fern and low shrubs such as box-leaf wattle *(Acacia buxifolia)*, nodding blue lily, and wedge-leaf hop-bush *(Dodonaea cuneata)*.

River red gum, open forest II and woodland II

The river red gum *(E. camaldulensis)* occurs in pure stands confined to stream flats from about 180 to 305 m (600-1,000 ft) elevation, which are periodically waterlogged and have a moderately high water table throughout the year. Low temperatures appear to be critical in limiting its distribution. Major native understorey species (chiefly grasses) have been mainly replaced by introduced species. The common reed *(Phragmites communis)* grows in swamps and surrounding billabongs. The tree crowns are 15-28 m (50-90 ft) high, and may be almost touching or spaced wide apart in woodland formation. Very little public land carries river red gum stands.

Swamp gum open forest near Lake Findlay

Swamp gum, open forest II

At elevations higher than about 300 m (1,000 ft), the stream flats carry swamp gum or broad-leaf sallee *(E. camphora)*. Black sallee *(E. stellulata)* occurs usually with or near swamp gum, but on better-drained sites; low temperatures and a moderate rainfall seem to be correlated with its presence. Understoreys in the poorly drained sites

vary from a moss bed *(Sphagnum* sp.) coral heath *(Epacris microcarpa)* at the higher elevations to reeds *(Phragmites communis)* at the lower elevations. Small trees such as mountain tea-tree *(Leptospermum grandifolium)* and blackwood may be present, and also low ferns such as alpine water fern *(Blechnum penna-marina)* and fishbone water-fern *(Blechnum nudum)*.

Softwood forest

Plantations of radiata pine *(Pinus radiata)* have been established in the Koetong - Shelley area, mainly on sites formerly occupied by narrow-leaf peppermint open forest III.

Grassland or scrub areas on public land have been previously cleared and in some cases have reverted to scrub.

Endangered Species

In a table of native Victorian plants in danger of extinction, Willis listed the following as occurring in the study district. An asterisk indicates those endemic to Victoria.

1. * *Chiloglottis pescottiana* - known only from Cravensville, and presumed to be extinct because of clearing for farmland.

2. * *Acacia phasmoides* - an extremely localized wattle, found only at Pine Mountain.

3. * *Brasenia scheberi* - an extremely localized species found at the Goulburn Weir and along the Murray River from Lake Moodamere to Biggara (in the study district).

4. *Digitaria diffusa* - localized plant found only at Walwa on the Upper Murray River.

5. *Dodonaea rhombifolia* - the Victorian distribution of this species appears very restricted and localized in the far north-east and in East Gippsland; it has been recorded at Pine Mountain and Upper Murray River.

6. *Grevillea jephcottii* - a localized plant found on Pine Mountain and Mount Burrowa.

7. *Cyperus flavidus* - confined in Victoria to marshy places of the north-east, where it is rare and localized.

8. *Grevillea ramosissima* - a restricted and localized plant found on granite ranges near Walwa, at Pine Mountain, and Mount Mittamatite.

9. *Lemna polyrhiza* - a very rare and localized species in Victoria, known only from lagoons at Towong and Biggara, also at Heyfield.

10. *Pterostylis hamata* - a very rare and localized species found in north-eastern Victoria at Walwa and in the Benalla, Beechworth, and Springhurst districts.

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The Kurrajong - in Victoria - an uncommon tree of the east and north-east

In addition, Willis has designated the following rare to uncommon species as being of significance for conservation. This list notes their general distribution in Victoria and indicates where they were recorded in this district. The common plants of the district are also important for conservation and these are mentioned in Part IV of this report.

1. *Brachychiton populneus* (kurrajong) - in Victoria this tree is confined to the far east, including the Snowy River Valley, and the north-east, particularly on hills bordering the Upper Murray River near Granya and Walwa.

2. *Brachycome ptychocarpa* - Victorian distribution appears very restricted and localized on granite mountains of the north-east and East Gippsland; found at Pine Mountain.

3. *Dampiera purpurea* - Victorian distribution appears restricted and localized in the north-east and East Gippsland; recorded at Pine Mountain.

4. *Dodonaea boroniifolia* (hairy hop-bush) - although scattered widely through the State, this uncommon plant has a localized distribution; recorded at Pine Mountain.

5. *Echinopogon cheelii* (long-flower hedgehog-grass) - an uncommon species restricted in Victoria to steep montane forest of the far north-eastern highlands; recorded near Guy's forest.

6. *Eucalyptus chapmaniana* (bogong gum) - an uncommon tree distributed between Mount Buffalo and Khancoban in New South Wales at altitudes between 2,000 and 4,000 ft; recorded at Pine Mountain.

7. *Grevillea polybractea* (crimson grevillea) - found on rocky hills along Upper Murray, from "Thologolong" to Biggara, and also at Granya Gap; confined to the far north-east of Victoria with a very limited distribution.

8. *Haeckeria ozothamnoides* - uncommon in Victoria with a widely spread but

localized distribution; recorded at Pine Mountain and Walwa.

9. *Leptospermum micromyrtus* - uncommon in Victoria with a localized distribution, restricted to the north-east and East Gippsland; recorded along the Upper Murray River and at Pine Mountain.

10. *Mirbelia oxyloboides* (mountain mirbelia) - found in the higher ranges from the Strathbogies to Bendoc and also into New South Wales; recorded at Cravensville and Shelley.

11. *Olearia adenophora* - very uncommon if not rare in Victoria; known so far from only two widely separated areas - to the north of Heyfield and at Pine Mountain.

12. *Patersonia sericea* (silky purple-flag) - an uncommon plant of eastern Victoria found on rocky terrain in coastal to sub-alpine tracts; recorded at Pine Mountain.

13. **Phebalium* sp. nov. - as yet known only from Pine Mountain, where it appears to be endemic.

14. *Pomaderris velutina* - apparently an uncommon riparian plant of fairly widespread distribution in East Gippsland and the north-east; recorded at Biggara and Burrowye.

15. *Pimelea treyvaudii* - confined in Victoria to the far north-east, where it is apparently uncommon, with very restricted distribution; recorded at Shelley, Cudgewa North, Granya Gap, and Cravensville.

16. *Pultenaea cunninghamii* (grey bush-pea) - a shrub occupying a belt of the north-eastern highlands between Glenrowan, Whitfield, and Mount Granya, also in New South Wales and Queensland; recorded in the Granya block.

17. *Pultenaea platyphylla* - apparently uncommon in Victoria, with a wide but very localized distribution, mostly in the north-east; recorded at Pine Mountain.

18. *Pultenaea vrolandii* - an uncommon plant of very limited and localized distribution in the north-east; recorded at Pine Mountain and Mittamatite.

19. *Pultenaea polifolia* - apparently uncommon in Victoria, and confined to the north-east and East Gippsland, with a very localized distribution; recorded at Granya Gap and Mount Granya.

20. *Tetratheca glandulosa*, var. *orbifolia* - uncommon, and known so far from only a few widely spread localized areas; recorded at Pine Mountain.

21. *Viola caleyana* - uncommon in Victoria, and apparently confined to the far north-east and East Gippsland, with scattered and localized distribution; recorded at Biggara and Towong.

22. *Spiranthes sinensis* - a widespread but localized plant in Victoria; recorded at Towong and Guy's Forest.

References

Beadle, N.C.W., and Costin A.B. Ecological classification and nomenclature - *Proceedings of the Linnean Society, N.S.W.*, 1952, 77, 61-82.

Cochrane, G.R., Fuhrer, B.A., Rotherham, E.R., and Willis, J.H. (eds.) "Flowers and Plants of Victoria." (Reed: Melbourne 1968.)

Daubenmire, R. "Plant Communities - a Textbook of Plant Synecology." (Harper and Rowe: New York 1968.)

Frankenberg, Judith. The species of native Victorian vascular plants in danger of extinction. In "Nature Conservation in Victoria, - a Survey." Ed. J.S. Turner. (Victorian National Parks Association: Melbourne 1971.)

Gailbraith, J. "Wildflowers of Victoria." (Longmans: Melbourne 1967.)

Kershaw, A. "Quantitative and Dynamic Ecology." (Elsevier Publishing Company: New York 1964.)

Odum, P. "Fundamentals of Ecology." 3rd ed. (W.B. Saunders: Philadelphia 1971.)

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

Specht, R.L. Vegetation. In "The Australian Environment." Ed. G.W. Leeper. (CSIRO and MUP: Melbourne 1970.)

Willis, J.H. "A Handbook to Plants in Victoria." Vol. 1. (Melbourne University Press: Melbourne 1962.)

FAUNA

Each species of animal is adapted to a certain environmental range and only within the habitat that provides the particular conditions it requires can the species survive. It follows that the preservation of suitable habitat is fundamental to conserving wildlife.

This chapter falls into four sections. The first considers birds and mammals, the second reptiles and amphibians, the third fish, and the fourth arthropods.

Birds and Mammals

Habitat

The most essential requirement the habitat provides for the bird or mammal is food. The type of food available in the habitat depends on the plants growing there, for even though the bird or mammal may not feed directly on plants it will feed on animals that have previously fed on plants. The term animal includes invertebrates, amphibians, and reptiles as well as warm-blooded animals.

The habitat must also provide suitable cover for concealment from predators and shelter from the weather. For most birds and mammals, plants also provide these requirements. Plants thus occupy a very basic role in nature as producers and because of this the classification of vegetation is a very convenient way of describing different habitats.

Each vegetation type is the home of a different community of birds and/or mammals. Some species are restricted to one vegetation type, as it is the only one that can fulfil their particular requirements for food and shelter. For example the eastern water rat is only found in the wetlands and the pipit in grassland. Other more versatile species live in several vegetation types; the white-eared honeyeater and the echidna, for instance, are found in open forest, woodland, and heath.

Although many different species of birds and mammals can usually be seen in any particular vegetation type, they do not all eat the same food or build nests in the same sites. Each species occupies a separate niche within the vegetation type, where it has relatively little competition from other species for food and other needs. For example, in the

The eastern water rat inhabits wetlands

wetter open forest the striated thornbill and yellow-faced honeyeater feed in the crowns of the trees, the white-throated tree-creeper on the trunks of the trees, the satin flycatcher and the grey fantail in the air between the trees and the ground, the brown thornbill in the crowns of the undergrowth, and the white-browed scrub wren in the low ground cover.

Similarly the various mammals that are present utilize different parts of the forest environment to provide their specific niches.

Birds and mammals play a very significant regulatory role in maintaining a balance in their particular habitats. For example, many birds are insectivorous and may keep insect populations in balance. The pied currawong, for instance, is an important predator of the leaf-eating phasmatid.

Behaviour

Preservation of habitat, although the dominant factor, is not the only aspect that must be considered in the conservation of birds and mammals. Various aspects of animal behaviour are also important.

Studies of Australian birds and mammals indicate that the breeding season for many of them is greatly affected by such factors in the habitat as rainfall, temperatures, and day length. Local variations in climate may cause the peak breeding season of a particular species to vary from place to place, and from year to year in a particular place.

The response to environmental stimuli varies between species. For example the southern yellow robin starts breeding in August, the crimson rosella in October, and the brown phascogale in July.

Sometimes breeding fails to occur even when to human eyes conditions seem ideal; some factor vital for the species is missing. The yellow-tailed black cockatoo will not breed unless trees are available with suitable nest hollows, even though food and other requirements are adequate. Such factors influence

not only breeding but also the distribution of a particular species. The reproductive capacity of a species is important when considering its ability to colonize or recolonize areas of suitable habitat.

Territories

Many birds and mammals require a particular area in which they can establish themselves, which will provide their needs. This territory, as it is called, is defined as an area defended against intruders. A pair, family, or clan of animals will occupy a territory and defend it against any intruder of the same species or a closely competitive species that crosses its boundary. The territories of different species may overlap when the animals are not in close competition for food and cover.

The territory meets some or all of the requirements of the occupants, depending on the species. Some species require territories that will provide them with food, water, shelter, and nesting sites throughout the year. Other species require territories only during the breeding season. Breeding is often timed so that the period of greatest nutritional demand by the off-spring coincides with a flush of food.

The territorial requirements are quite specific and may vary substantially between closely related species. Two species that are very similar in

The brown phascogale

appearance but have quite different territorial requirements are the Australian raven and the little raven.

A pair of Australian ravens occupies a large territory of about 120 hectares (300 acres) throughout the year. The area must include some tall timber in which the bird can find nesting sites at least 12 metres above the ground. The birds forage, roost, and breed in their territory, and each year the young are forced to leave the territory to join nomadic flocks before ultimately taking up their own territories.

The little raven does not require a clearly defined territory at all. These birds defend the immediate area around

their nests against intruders; they forage widely and merge into loose flocks. Both the parents and young birds leave the breeding area in autumn and travel extensively. This species rarely nests above 9 metres.

It is known that female brown phascogales live in permanent territories whereas males are partly nomadic, particularly in the mating season, when they may traverse large distances between the territories of several females.

Movement

Birds and mammals may move from place to place to find the environment they require. Their movements may be regular migrations, nomadic wanderings, or dispersion from over-populated areas.

Intercontinental migration is practised by a few species of birds in the study district, such as the Japanese snipe. This species breeds at very high latitudes in the northern hemisphere and migrates to the southern hemisphere for its non-breeding season in the southern summer.

Latitudinal migration involves many birds in the study area, the pallid cuckoo, rufous songlark, and satin flycatcher among them. These species breed in southern parts of Australia during summer and move north - sometimes as far as the New Guinean and Indonesian islands - during the winter months.

Altitudinal migration is shown by a few species. The flame robin breeds at places of high elevation such as the Burrowa massif and moves to low-lying areas such as the Murray River valley during the winter.

Nomadic wanderings are characteristic of some mammals and many bird species, notably the lorikeets and some honeyeaters. These species have a restricted diet and must follow their food supply. More versatile species or those with a reliable food source can reside permanently in the one locality, but even these species exhibit some movement, known as dispersion.

Under normal circumstances any particular area of land can support only a fixed number of animals of any one kind. The surplus number produced each year must move on to a new area or die. The main requirements of these young animals are food and shelter, and they can occupy ecological niches that are unsuitable for breeding pairs.

Passage of Time

Time brings changes to any area. These changes are obvious in places where bare ground becomes available to plants for colonization, for instance abandoned farm land or a severely burnt forest. Closely following the succession of plants on an area comes a succession of bird and mammal species.

Less obvious changes are continually occurring. Evidence accumulated from many parts of south-eastern Australia shows that quite marked changes in the climate of the region have occurred during the past 20,000 years, and these have led to changes in the vegetation and its animal populations. The sequence appears to have comprised comparatively wet conditions during the last glacial periods, followed by a warm arid period reaching its peak about 5,000 years ago.

Conservation

Birds and mammals not only have a very high value to the community for aesthetic and sentimental reasons, they also play a significant regulatory role in the natural environment. Their habitat requirements are concerned mainly with the structure and species composition of vegetation. Any management practice or natural ecological process that affects a plant community also affects the birds and mammals inhabiting that community. Thus clearing, logging, fire, and the passing of time all affect bird and mammal populations. These practices can destroy or degrade habitat for some species, but by the same token increase habitat or improve it for others.

Similarly any regeneration process that perpetuates a particular plant community tends to perpetuate the bird and mammal community dependent on it.

Changes to the present use of land will result in changes to the bird and mammal population. The desirability of land use changes can be judged only if their impact on birds and mammals is known, and can be assessed in terms of an aim.

At the present time the aim of conserving as many species as possible is widely accepted. However, formulation of more specific aims must await further research.

In the study district, we know the distribution of the major plant communities and something of their ecology. We know a great deal about the general distribution of birds, and something about their more obvious migration habits, but not nearly enough about their exact habitat requirements, movements, and population densities. Little is known of the mammal species present in the district, or of their distribution and abundance, while cataloguing and classification of species is still in progress for some members of the fauna and flora.

An immediate aim is to recognize, classify, and conserve the widest possible diversity of species. It would include the most common ones, as these are likely to play a significant role in the ecology of the area and are important in the long-term planning for conservation of species. Single-purpose reserves can readily be justified in certain cases, for example where rare or endangered

species occur, and these reserves must be actively managed if they are to serve their purpose.

In many areas, conservation of birds and mammals need not conflict with other forms of land use. In fact much of the present bird population in the north-east depends on a mosaic of agricultural land and small uncleared areas such as along stream banks and roadsides for its habitat requirements. Conservation of wildlife can be a by-product of good management of not only public land but also private land.

Birds and Mammals of North-East Area District 1

Bird lists for the district were compiled from records of reliable observers, so the presence of species is fairly well established.

Little is known of the occurrence of the less obvious mammals of the district. However, some field work carried out in the Koetong area (under Joan M. Dixon of the National Museum of Victoria) has contributed to knowledge of the distribution of some of the mammals and added to the scanty existing official records.

This district forms part of the watershed of the Upper Murray River. The billabongs and flats along the river itself provide habitat for a number of mammals and water birds. To the south of the river lie the foothills, valleys, and plateaux of the Eastern Highlands. To the north-west, foothills descend to the plains of north-central Victoria and southern New South Wales.

In terms of distribution, the birds and mammals, apart from wide-ranging species, fall into three main groups. One occurs along the Murray River valley and adjacent rivers in New South Wales (not always exclusively); another is centred about the forests of the Eastern Highlands. The third group, of which only a few species have been recorded in the district, is centred about the dry, open plains.

Examples of birds found along the Murray River include rare species - the white-

The dusky phascogale - a common mountain forest species

Straw-necked ibis nesting

breasted sea eagle, brolga, and little egret - and common ones - mountain duck, black duck, and black swan.

Birds and mammals of the mountain forests include uncommon to rare species such as the tiger cat, king parrot, satin bower-bird, and wonga pigeon, and more common ones such as the common wombat, black-tailed wallaby, long-nosed bandicoot, greater glider, dusky phascogale, and crimson rosella. Species of the dry, open plains include the red-capped robin and crested pigeon.

Significant Species

A lack of knowledge makes it difficult to discuss the significance of birds and mammals. A species may be significant in the sense that it plays a notable role in the ecology of the area (little is known of this for most species, however), or because the district plays an important part in its conservation. This may be because the species in Victoria is rare, uncommon, restricted in habitat, at the edge of its range, or common in the district in relation to some other areas in Victoria.

Most of the birds and mammals mentioned below are rare in Victoria, uncommon, or common in localized areas only. However, conservation is also concerned with the widespread common species in any area. These are recorded in Appendix III and are also mentioned in the block descriptions.

Water birds

The construction of Lake Hume has reduced the value of this area for water birds, not enhanced it. However, Lake Hume and the Murray River (with its associated swamps and billabongs) are still of significance to water birds in general. Ibis, nankeen night herons, cormorants, little egrets, and other birds nest in dead trees in the lake and in vegetation bordering the lake and river.

The district is relatively unimportant for duck management, although several species, such as the chestnut teal and mountain duck, breed in the area.

Other birds associated with the river system

The brolga *(Grus rubicundus)* is distributed throughout Australia. In Victoria it is comparatively rare, occurring mainly on the plains and in swampy localities in western and northern areas. Although some brolgas are nomadic, other are localized, as at a locality near Corryong where a few pairs appear to be permanent residents, nesting and wintering in wet, swampy sites. They live on insects and small animals such as frogs, reptiles, and rodents. Their conservation depends on protection from shooting, the maintenance of swamps (which in this instance are on private property), and the avoidance of insecticide usage.

The white-breasted sea eagle *(Haliaeetus leucogaster)* occurs over most of coastal Australia. The Murray River valley, inland lakes and reservoirs, and the Gippsland coast are the main Victorian haunts of this rather rare species. Its normal food in inland areas includes small mammals, eels, and tortoises. It has been observed to breed in the district, and may build its nest in a tall tree overlooking the water, or on a cliff edge.

The azure kingfisher *(Alcyone azurea)*, another rather rare species, lives along rivers, streams, and lake margins, mainly in northern and eastern Victoria. It is found throughout most of Australia and its range extends to islands to the north. Its food consists of small fish, frogs, crustaceans, and insects. The nest is a hole dug in the river bank, and nesting has been recorded at Tintaldra for this district.

Summer visitors

Most of the under-mentioned birds migrate along water courses, where the vegetation of stream frontages provides shelter and food. They migrate from eastern Australia into Victoria along the Eastern Highlands or its inland margins, and the Murray River and other major streams provide important migration routes.

The little friar-bird *(Philemon citreogularis)* frequents well-watered open-forest and woodland areas of northern and eastern Australia. In Victoria it is found mainly along the Murray River, including parts of the study district.

The noisy friar-bird *(P. corniculatus)* occurs in open forest and woodland areas of eastern Australia from Cape York to eastern Victoria. It is rather rare in the southern parts of its range, where it occurs as a nomadic species in the Gippsland Lakes region and along the Murray River upstream from Kerang, being regularly recorded in the study district. It often builds its nest on a branch overhanging water. It is relatively common in red stringybark:

long-leaf box open forest at such localities as the Bunroy, Mittamatite, and Burrowa blocks.

The white-throated warbler *(Gerygone olivacea)* is found in woodland and open forest areas of northern and eastern Australia. It is a summer migrant to Victoria, where it is regarded as being rather uncommon. Its strongholds in this State appear to be in east Gippsland and in the north-east, including the study district, where it is a common bird of the red stringybark: long-leaf box open forests.

The dollar bird *(Eurystomus orientalis)* is a common but localized migrant to Victoria, where it lives mainly in open forests, particularly along the Murray River valley in northern and north-eastern districts. Nesting takes place in a hole in a tree. It has been recorded at various localities in the study district.

The cicada bird *(Edoliisoma tenuirostre)*, a rare summer migrant, is here confined mainly to heavily timbered ridges in eastern and north-eastern Victoria. A report by the Victorian Ornithological Research Group in 1962 listed it among 18 rare species. It ranges from islands north of Australia to coastal northern Australia and down the eastern States to Victoria. The visitors breed here, in nests built on branches from 9 to 20 m (30-70 ft) above the ground. They feed on insects and caterpillars, which they gather from the foliage of the trees.

The painted honeyeater *(Grantiella picta)*, another rare visitor to this State, is distributed from Darwin across to Queensland and down to northern Victoria. This honeyeater is most unusual in that it lives largely on the berries of mistletoes. The visitors breed in Victoria in nests built in drooping foliage at heights of 1-6 m (3-19 ft) from the ground. They have been recorded in red stringybark: long-leaf box open forest around the Mittamatite massif.

The little friar-bird - found mainly along the Murray River valley

Other significant bird species

The red-capped robin *(Petroica goodenovi)* is found throughout the inland areas of the southern half of Australia. In Victoria it is often associated with cypress pine areas. It occurs in the study area at the extreme south-eastern limit of its normal range.

The lewin honeyeater *(Meliphaga lewinii)* is a bird of the wetter forest areas, often frequenting heavily timbered creeks in mountainous country. It is found along the Great Dividing Range from Atherton to eastern Victoria, where it is occasionally recorded as far west as the Dandenongs. Although comparatively rare in Victoria, it has been recorded from parts of the study district including areas around Koetong.

The male satin bower-bird in the bower

The red-browed tree creeper *(Climacteris affinis)* is a rather rare species, which in Victoria is confined mainly to the wet open forests and adjacent areas in eastern and central Victoria. It has been recorded for various parts of the study district including the Cravensville area.

The satin bower-bird *(Ptilonorhynchus violaceus)*, an uncommon species of eastern Australia, is mainly confined to mountain forests. In autumn and winter the birds gather into small flocks, when they sometimes raid orchards, but in the summer breeding season they disperse as isolated pairs. Each builds its nest on a tree branch or in a clump of mistletoe.

The wonga pigeon *(Leucosarcia melanoleuca)* is an uncommon species, which in Victoria is confined to the timbered forests of eastern and north-eastern parts. Its range extends to eastern Queensland. It has been recorded in the Mount Cudgewa and Bunroy blocks.

The brush cuckoo *(Cacomantis variolosus)* is a rather rare summer migrant found in this district. Its range extends from the Moluccan Islands through Timor and New Guinea to Australia. The common foster parents for the young birds are such species as robins and flycatchers.

The grey goshawk *(Accipiter novae-hollandiae)* is rare in Victoria. It is distributed across northern and south-eastern Australia, into South Australia, and also in Tasmania. It frequents forested areas, where it preys on small birds, often ambushing them from thick cover. It has been recorded from the Bethanga, Granya, and Lawson blocks.

Mammals

The tiger cat *(Dasyurops maculatus)* is widespread but localized in Victoria. It occurs in coastal districts and mountainous areas of eastern Australia, although it is uncommon over most of this range, and also in Tasmania. The tiger cat lives mainly in dense forest or low scrubby areas, where it shelters in hollow logs or rock piles. It has been recorded for Talgarno-Granya areas.

The long-nosed bandicoot *(Perameles nasuta)* occurs mainly in open forests in mainland eastern Australia, where it is fairly common. Apparently dense populations of this species occupy some moist gullies near Koetong, and would lend themselves to scientific study because of their numbers. It feeds mainly on insects and insect larvae, and nests under ground litter and debris.

The greater glider *(Schoinobates volans)* has a distribution along the east coast from Mackay in Queensland to Daylesford in Victoria, as it prefers open forest in mountainous areas. It nests in hollow branches of trees and feeds mainly on leaves and shoots of eucalypts. This type of habitat is being cleared for pine plantations around Koetong. Like all possums, it is subject to effects of felling, especially of stags. It is not generally found in immature forest.

The platypus *(Ornithorhynchus anatinus)* has been recorded for many river systems in Victoria and may be more numerous than is commonly believed. Its main haunts appear to be in the slower-moving streams, although it has been found in rapid mountain streams. Its diet comprises aquatic insect larvae, tadpoles, crustaceans, worms, and other small aquatic animals. It digs its burrow into the stream or lake bank, usually with an entrance 1-2 m above water level. Little is known of its ecology, but drastic changes in stream-bank vegetation and stream-bed characteristics may result in a reduction in numbers and distribution. It has been recorded in the Upper Murray river system.

The eastern grey kangaroo *(Macropus giganteus)*, a common, widespread animal in Victoria, occurs commonly in the study area, being recorded for almost all blocks. It usually inhabits grassy open forests and forest margins. Being a large animal, it is vulnerable to shooters. It may become a pest when it reaches large numbers around farm lands and in young pine plantations.

The black-tailed wallaby *(Wallabia*

Adult and young long-nosed bandicoots

bicolor) dwells in forest country with scrubby understories. The scrub may consist of bracken-fern gullies in an otherwise grassy forest. It is a common species throughout eastern Victoria, including the study district.

The wombat *(Vombatus ursinus)* occurs commonly in the district, being found mainly in wet and dry open forest areas. Although rare in western Victoria, it is relatively common throughout the eastern part of the State.

Conservation

The greatest change in land use on public land is the clearing of native vegetation for pine plantations in the Shelley-Koetong area. With this in mind, Joan M. Dixon carried out a brief survey of the area in November 1971 and January 1972.

The main habitats she investigated were gullies, hillsides, and plateaux. The common species of the plateaux and hillsides were the eastern grey kangaroo, wombat, and greater glider. The sugar glider and feathertail glider occurred here also. In the gullies, the black-tailed wallaby, wombat, and long-nosed bandicoot were common. The brown phascogale, dusky phascogale, and bush rat were also present in this habitat type.

It appears that the establishment of pine plantations will not threaten the fauna of the gullies if strips about

The common wombat - a common forest inhabitant of the district

40-100 m (2-5 chains) wide are left on either side of the permanent streams. The gullies in the Koetong area are slightly damp, and rely on water from the slow-running creeks. These hydrological characteristics could be altered by blockages in the creek-beds due to road design or filling. The long-term effects of radiata pine on the hydrology of the area are not known. Viable areas of plateaux, hillsides, and ridges should also be preserved for the fauna of these habitats to remain in the area.

Reptiles and Amphibians

Because the absence of any published data for this district, two reconnaissances of reptiles and amphibians were carried out, one under P.A. Rawlinson and the other by A.J. Coventry of the National Museum. The shortness of the time available made it impossible to carry out a detailed study of both reptiles and amphibians, so most attention was directed towards the reptiles. However, it was possible to draw some general conclusions about the amphibians.

Zoogeographic regions

Australia has been divided into four zoogeographic sub-regions based on animal distributions. Each of these sub-regions 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 (20-in.) rainfall isohyet. The Bassian sub-region 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 where elevations are generally less than 310 m (1,000 ft), average rainfalls are less than 760 mm (30 in.) per annum, and the vegetation canopy is not dense, for example woodland, open woodland, or grassland.

The cool temperate zone includes the Eastern Highlands below 1,220 m (4,000 ft) where surface temperatures are low and rainfalls are more than 760 mm (30 in.) per annum. The vegetation includes open to closed forest.

The cold temperate zone consists of alpine and subalpine areas above 1,200 m (4,000 ft) where temperatures are very low, precipitation (much of which falls as snow) is high, and vegetation varies from closed to open forest to herbfield.

The Study District

North-east District 1 lies well inside the 510-mm (20-in.) rainfall isohyet and therefore is included in the Bassian sub-region, although no major physiographic barriers separate this area from the Eyrean sub-region. The warm temperate zone predominates, although the cool temperate zone is represented in the more densely wooded areas and at the higher altitudes - above about 1,070 m (3,500 ft).

Reptiles

Appendix III summarizes the zoogeographic distribution of the reptile fauna. Of the 25 species recorded, 14 are exclusive to the Bassian in Victoria, 7 are transitional from the Bassian to the Eyrean, and 4 are tran-

sitional from the Eyrean to the Bassian. The large number of exclusively Bassian species, and the absence of any exclusively Eyrean species, shows that the reptile fauna is Bassian in nature and proves the area to be Bassian.

As mentioned above, this area includes warm and cool temperate Bassian zones. Nineteen of the 25 reptile species occur in the warm temperate zone and 13 occur in the cool temperate, thus the former zone has the greater diversity. The list in Appendix III also shows the distribution of these species in the major Victorian zoogeographic sub-regions.

Habitats

The major habitats of the district have been divided into eight categories, and Appendix III lists the occurrence of the 25 reptile species in these habitats. From this it is possible to grade the major habitats in order of diversity of reptile species, and therefore in order of importance to reptiles. Open forest (wet) carries the most diverse reptile fauna (13 species), followed by open forest (dry) (11 species), semi-cleared areas and forest margins (9 species), woodlands (dry hillocks) (8 species), grassland (7 species), heath (6 species), woodland (river flats) (5 species), and finally wetland (4 species).

The major reasons for this gradient is that reptiles must depend on the habitat

The garden skink (Leiolopisma guichenoti) - *an exclusively Bassian reptile*

to provide suitable microenvironments for activity and for shelter when inactive.

Amphibians

The Appendix also lists the probable amphibian species found in the district. Although the information is not as detailed as that for reptiles, it is possible to state that the relative diversity of species in the eight major habitats would be almost the reverse of that for reptiles. About 16 species of amphibians occur in the area, and the greatest diversity would be in the wetlands and river flat woodlands (approximately 14 species in each), and the

The tree frog (Hyla ewingi) *lives exclusively in forest habitats*

least diversity would be in the wet open forest (approximately 10 species). Thus the diversity gradient for amphibians would not be as great as that for reptiles. The major reasons for this gradient are the requirements for free water for breeding and to prevent desiccation.

Conservation

The biggest threat to reptiles and amphibians is habitat destruction. For reptiles, destruction of wet and dry open forest would result in a substantial reduction of the species diversity of the area, as these vegetation forms provide the only suitable microenvironments for activity and shelter for many species. Thus some substantial tracts of these forest forms need to be preserved to protect the reptile fauna. On the other hand only a few of the amphibians (such as the tree frog *(Hyla ewingi)* and the froglet *(Crinia victoriana)* live in forest habitats exclusively, and clearing of forest habitats would not necessarily result in a significant reduction in species diversity. However, if unbroken blocks of pine plantations replaced the forests this generalization would not hold, as these plantations, when mature, are unsuitable for amphibians (and reptiles). This situation can be avoided by leaving areas of native vegetation in plantations.

The type of extensive logging practice followed in mixed-species forests results in an increase in most amphibian and reptile populations. It favours amphibians because of the construction of fire dams and the small pondage sites left by disturbance of the soil along tracks and at log landings. The amount of logging refuse and the subsequent new growth that springs up not only encourage an increase in insect populations, which are a source of food for many amphibians and reptiles, but also afford shelter for some species.

Another factor of major importance to reptiles and amphibians is that all are primary or secondary carnivores and all ultimately depend on insects for food. Thus any development in this area that

involves the use of insecticides will pose a threat to the reptiles and amphibians.

Only two species (one amphibian and one reptile) appear to be restricted to north-eastern Victoria. The bullfrog *(Dimnodynastes interioris)* has been recorded at a roadside near Bethanga, while the coppertail skink *(Ctenotus taeniolatum)* occurs in some heaths and rocky areas around the Burrowa massif.

The latter also occurs in two or three isolated populations, the most westerly of which is at Tatong, in the North-east Area, District 2. Both species are fairly common and extensively distributed in south-eastern New South Wales, so it does not appear that there are any endangered species in the region. It is of interest to note that Bougainville's skink *(Lerista bougainvilli)* reaches the north-easterly limit of its range near Mount Firebrace.

One area, the Burrowa massif, which reaches to more than 1,200 m (4,000 ft), deserves special mention. At least 10 of the 25 reptile species occur on this massif and probably about 8 of the amphibians also occur in the area. The presence of the skink *(Anotis maccoyi)*, the grass skink *(Leiolopisma entrecasteauxi)*, the skink *(L. weekesae)*, and the black rock-skink *(Egernia saxatilis)* shows that the mountain-top fauna is an outlier of the cool temperate fauna of the Eastern Highlands.

The black rock-skink (Egernia saxatilis) *is found on the Burrowa massif*

Fish

Little is known of non-game fish in the district. Among game fish, the introduced brown trout, rainbow trout, and red-fin predominate. Carp also abound in Lake Hume and the Murray River. These introduced species have replaced the native fish to a considerable degree.

Murray cod are present in low numbers in Lake Hume, the Murray River, and Cudgewa and Corryong Creeks. However, the genus *Maccullochella* is now known to comprise two species of fish (Berra and Weatherley, 1972): the Murray cod, *Maccullochella peeli*, and the trout cod, *M. Macquariensis*. The limited data available indicate that the trout cod

The Macquarie perch (left) and river blackfish are both seriously threatened species

has a very restricted distribution, and application has been made to I.U.C.N. to have it placed on the world list of endangered species. However, it appears to favour cool waters at higher altitudes, and further investigation of the study district may show that the fish there are trout cod rather than Murray cod as formerly believed.

Macquarie perch are found in Lake Hume and the Murray River, and river blackfish are present in low numbers in the Murray River. Lake (1971) lists both of these as seriously threatened species. Macquarie perch are becoming far fewer, and the river blackfish, although widely distributed in Victoria's river systems, has low population numbers. Generally the numbers of native species and their distribution in this district have been greatly reduced.

The greatest threat to fish species is probably stream pollution. Apart from obvious forms caused by some industrial and sewerage effluents, pollution can be caused by the misuse of pesticides on adjoining land. Construction of large dams, with consequent reduction of water temperatures and flooding, is considered to have adversely affected some native fish, such as the Macquarie perch and Murray cod, in the Murray River system. Poor agricultural practices, such as cattle grazing and watering at the river bank, and timber-harvesting practices on adjoining land, can lead to stream-bank erosion, siltation of the stream-bed, and increased turbidity, thus reducing the quality of the habitat for fish. Silting of stream-beds through unwise land use and the removal of snags from streams have probably been the major factors affecting the river blackfish.

Arthropods

The arthropods include such groups as arachnids (spiders, scorpions, mites, ticks, etc.), crustaceans, insects, and myriapods (centipedes, millipedes, etc.).

These groups all play a significant part in the ecology of most temperate environments. Insects are particularly important from the economic point of view. Some can damage and destroy crops, harm or kill domestic animals, or transmit diseases of plants and animals (including Man). Beneficial aspects include use of the honey-bee for honey production, control of noxious weeds and vermin, and pollination of plants by bees and nectar-seeking blowflies, beetles, and moths. Insects are related to other members of the biological community in a number of ways.

Plants, for instance, provide food for a wide range of insects. Some insects are leaf-eaters, such as the Australian sawflies *(Pergidae)*, the spur-legged phasmatid *(Didymuria violescens)*, and the locust *(Chortoicetes terminifera)*.

Others suck plant sap (aphids, scale insects, lerps, bugs, leaf-hoppers, and thrips), form galls, or attack the bark and wood of living or dead trees. This latter group includes jewel beetles, longicorns, weevils, ambrosia beetles, termites, and the larvae of various wood moths.

The action of insects in assisting the decomposion of dead wood, plant debris, fungi, animal cadavers, and faeces contributes a great deal to the cycling of nutrients.

Insects form an important part of the diet of a considerable number of terrestrial and fresh-water vertebrates. The Australian fauna includes a number of exclusively or largely insectivorous species, such as the echidna, the long-nosed bandicoot, dusky and brown phascogales, and most species of bats. Many fish feed on aquatic insects, including caddis-flies, dragon-flies, and stoneflies. Many invertebrates are also insectivorous. Spiders for example subsist mainly on insects, and many other arachnids and myriapods prey largely upon them.

Arthropods of the Study District

It is difficult to fully evaluate the arthropod fauna of the district because we know little about it. Collection and description of the fauna is continuing, however. Apart from insects that play a significant role in the ecology of the district, some species have scientific interest. For example, a species of caddis fly *(Ulmerochorema luxaturum)* that is new to science was recently collected in Nariel Creek near Nariel. Its distribution is not known, but is likely to be restricted to the locality.

Two dragon-fly species in the district provide the southern-most records for otherwise northern species. One species of cicada *(Diemeniana neboissi)* is known to occur only in the Biggara locality.

Investigations to evaluate the stonefly fauna are under way at present, but it will be some time before these can produce results. Nevertheless, it is interesting to note that the area just north of the district contains entirely different stonefly fauna from that of the alpine country to the south of the district.

Crustaceans of the district include the Murray cray *(Eustacus armatus)*, which is found in most river systems, and the common yabbie *(Cherax destructor)* and white yabbie *(Cherax albidus)*, which are found in static water such as in billabongs and dams.

Conservation

One important aspect is the conservation of aquatic insects. These form part of an irreplaceable food chain required by fresh-water fishes, and some of them are very sensitive to chemical and other changes taking place in the water. For example, ashes washed into streams following wildfires decrease acidity to a level that kills certain insect groups in sections of the streams, and recolonization of these sections would take years. Disturbance to stream-bank vegetation can result in siltation of the stream-bed, and vegetation removal results in an increase in water temperature. Both effects are detrimental to these insects.

Other vertebrates, such as amphibians and many mammals, depend to a large extent on insects as a food source.

References

Berra, T.M., and Weatherly, A.H. A systematic study of the Australian freshwater serranid fish genus *Maccullochella*. *Copeia*, 1972, 53-64.

C.S.I.R.O. "The Insects of Australia." (Melbourne University Press: Melbourne 1970.)

Dixon, Joan M. "Report on the Mammals, Reptiles, and Amphibians of the North Strathbogie Ranges, Blue Range, and Koetong Plateau areas of Victoria." Report for the Land Conservation Council. (National Museum of Victoria: Melbourne 1972.)

Frankenberg, Judith. "Nature Conservation in Victoria - a Survey." Ed. J.S. Turner. (Victorian National Parks Association: Melbourne 1971.)

Hill, R. "Australian Birds." (Nelson: Melbourne 1968.)

Lake, J.S. "Freshwater Fishes and Rivers of Australia." (Nelson: Melbourne 1971.)

Littlejohn, M.J., and Rawlinson, P.A., Amphibians and reptiles of Victoria. In "Victorian Year Book" No. 85, 1971.

Mammal Survey Group. "A Survey of the Native Mammals of Victoria." Report to Land Conservation Council. (1972).

Marlow, B. "Marsupials of Australia." (Jacaranda Press: Melbourne 1968.)

Ride, W.D.L. "A Guide to the Native Mammals of Australia. (Oxford University Press: Melbourne 1970.)

Wheeler, R. "A Handlist of the Birds of Victoria." (Melbourne University Press: Melbourne 1967.)

LAND SYSTEMS

Differences between land systems, and their consequent suitability for various uses, exist because of differences in topography, soil parent materials, climate, soils, and the organisms (both plants and animals) that occur on them. However, it is not enough to consider any one of these factors on its own in regard to land use; it is their combined effect that controls the uses to which the land may be put.

The previous sections have described separately the environmental factors that characterize the land. This section brings these together to facilitate the understanding of different types of land.

The fundamental unit of land in the sense described above may be regarded as an area in which the environmental factors do not vary beyond limits that significantly influence any of the likely forms of use. To this extent they are subjective. Such a unit may be a section of a ridge-top. Because these units may be, and frequently are, small in area (say, 5-20 hectares or 10-50 acres), it is practical to define combinations of units for management purposes and as an aid to mapping. The larger unit, such as shallow basin of the order of one to several hundred hectares (hundreds of acres), comprises an area where the fundamental units show a predictable pattern - for example ridge-top site to basin-floor site.

As an aid to mapping and general description, these larger units may be further grouped, as has been done for this report, which uses mapping units termed LAND SYSTEMS and SUB-SYSTEMS.

Rowe originally described these in 1967. Eight land systems have been recognized within the district, four of which have been subdivided to form eight sub-systems. These are presented in the Land Systems map, and Table 12 lists the environmental factors associated with each.

Chapter 13 (Hazards) and Part IV of this report (Block descriptions) further consider the effects of the interaction of the environmental factors in regard to land use. It should be pointed out, however, that the relations between the factors may be very much more complex than is at present known, and to a certain extent the present understanding is strongly influenced by experience.

Reference

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

PART III LAND USE

Table 12

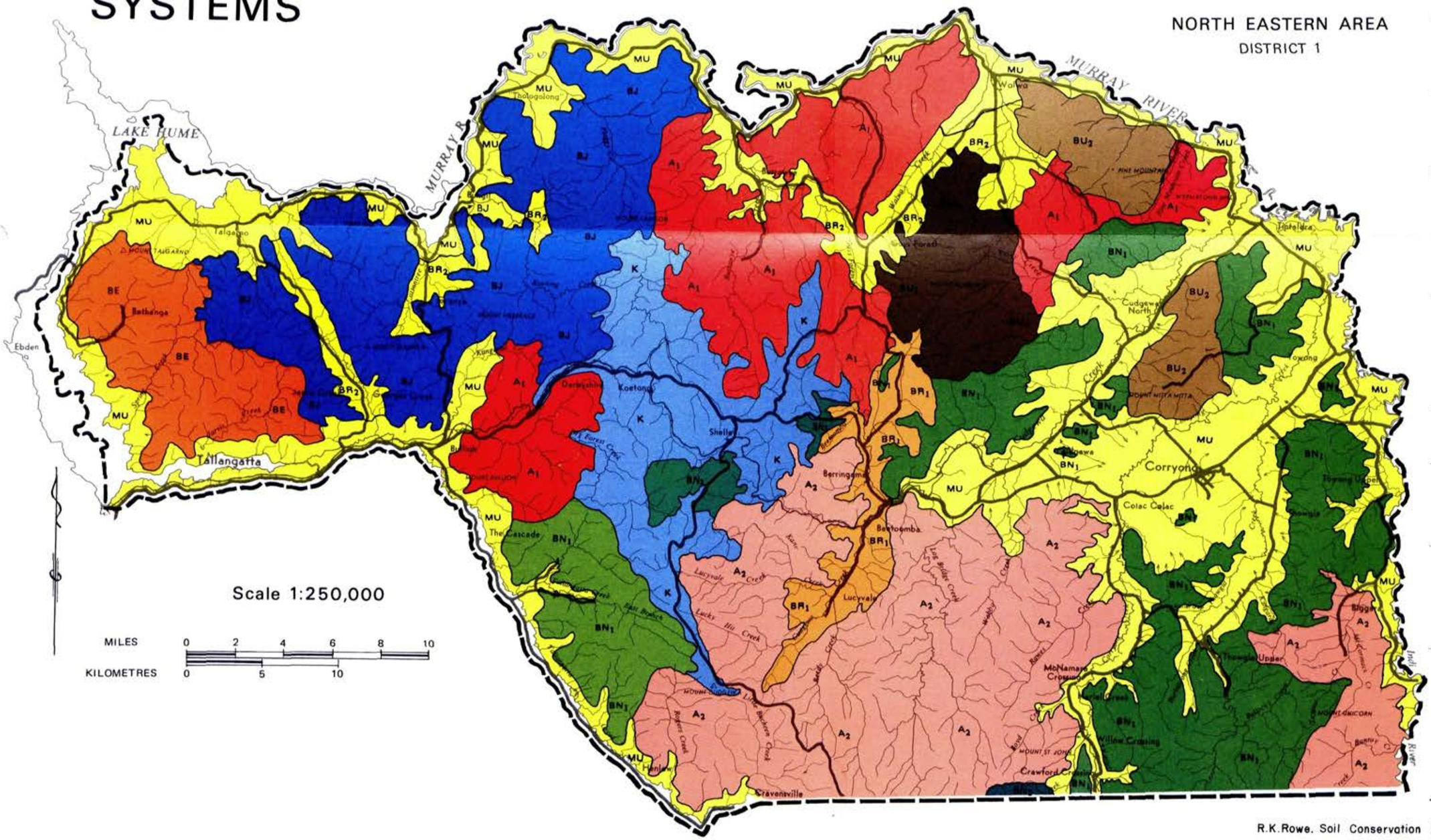
LAND SYSTEMS

Land System	Sub-system		Landscape	Annual Rainfall	Geology	Soils	Native vegetation	Erosion hazard	Percentage remaining public land
BUNJIL		BJ	Steep to very steep montane slopes with dissected plateaux at about 610-920 m (2,000-3,000 ft) elevation	760-1,020 mm (30-40 in.)	Grey granite to gneiss; some schist	Weakly bleached, massive gradational soils on steep slopes and friable reddish gradational soils on plateaux	Red stringybark:long-leaf box open forest I and II; broad-leaf peppermint open forest II; some narrow-leaf peppermint open forest III; red cypress pine open forest I, closed to open heath, open mossland; forest red gum open forest I and II	Moderate erosion hazard on the steep slopes; lower hazard on the plateaux	95
KOETONG		K	Dissected plateau at about 610-915 m (2,000-3,000 ft) elevation	1,020-1,140 mm (40-45 in.); occasional winter snow	Grey granite	Friable reddish gradational soils dominant, with weakly bleached, massive gradational soils on steeper slopes and in drainage lines	Narrow-leaf peppermint open forest III and broad-leaf peppermint open forest II; some swamp gum open forest II	Low sheet erosion hazard generally; roads and newly cultivated land may produce excessive run-off and cause turbidity in adjacent streams; slumping of road batters	75
BENAMBRA	Magorra	BN_1	Steep to very steep montane slopes up to about 915 m (3,000 ft) elevation	760-1,020 mm (30-40 in.)	Grey granite; schist; sandstone, mudstone, shale	Weakly bleached, massive gradational soils grading into friable brownish gradational soils on moister sites; some friable reddish gradational soils	Red stringybark:long-leaf box open forest I and II; some broad-leaf peppermint open forest II and narrow-leaf peppermint open forest III	High sheet erosion hazard if the ground cover is destroyed; high run-off could lead to gully erosion on adjacent less-steep country	90
	Thowgla	BN_2	Steep to very steep montane slopes up to about 1,220 m (4,000 ft) elevation	1,020-1,270 mm (40-50 in.)	Various	Friable brownish gradational soils; some friable reddish gradational soils	Narrow-leaf peppermint open forest III; some broad-leaf peppermint open forest II	Moderate sheet erosion hazard; roads and logging areas can produce high run-off and turbidity in streams	95
ADJIE	Towong	A_1	Steep to very steep montane slopes up to 1,000 m (3,300 ft), with rolling to steep hillocks at about 460 m (1,500 ft) elevation	760-890 mm (30-35 in.)	Grey granite; some schists	Weakly bleached, massive gradational soils on steeper slopes and reddish duplex soils on less-steep country	Red stringybark:long-leaf box open forest I and II; broad-leaf peppermint open forest II; some narrow-leaf peppermint open forest III	Moderate sheet and gully erosion hazards	40
	Dart	A_2	As for Towong sub-system, but with slightly higher elevations	1,020-1,140 mm (40-50 in.)	Fine sandstone, mudstone and shale; grey granite	As for Towong sub-system	Broad-leaf peppermint open forest II and narrow-leaf peppermint open forest III; some red stringybark:long-leaf box open forest I and II	Slightly less hazardous than the Towong sub-system	98
BETHANGA		BE	Steep hillocks up to 305 m (1,000 ft) elevation, and steep to very steep montane slopes up to 760 m (2,500 ft) elevation	630-760 mm (25-30 in.)	Gneiss to gneissic granite	Mainly weakly bleached, massive gradational soils; reddish duplex soils on less-steep slopes	Red stringybark:long-leaf box open forest I and II; some broad-leaf peppermint open forest II and narrow-leaf peppermint open forest III	Sheet and gully erosion hazards moderate to high; slumping in wet years	1
MURRAY		MU	Alluvial flats at about 245 m to 305 m (800-1,000 ft), with gently sloping dissected fans and terraces some 3 m to 9 m higher, flanked by rolling to steep hillocks up to 460 m (1,500 ft) elevation	710-1,020 mm or more (28-40+ in.)	Variable	Weakly bleached, massive gradational soils on steeper slopes; reddish duplex soils on fans and higher terraces; alluvial brownish loams; some bleached gradational soils with gleyed sub-soil, undifferentiated sandy loams	Forest red gum woodland II and open forest II; red stringybark:long-leaf box open forest II; river red gum woodland II and open forest II	Moderate sheet and gully erosion hazard on the hillocks and terraces, particularly in drier areas	< 1
BERRINGAMA	Lucyvale	BR_1	Rolling to steep hillocks at about 460 m (1,500 ft) elevation with undulating to rolling dissected fans and terraces at about 245 m (800 ft) in equal proportions	About 1,200 mm (40 in.); cooler and moister than Wagra sub-system	Variable	Weakly bleached, massive gradational soils on hillocks with some friable brownish gradational soils in locally moister sites and reddish duplex soils on the terraces and fans	Broad-leaf peppermint open forest II and narrow-leaf peppermint open forest III; some red stringybark:long-leaf box open forest II and swamp gum open forest II	Moderate sheet erosion hazard on the hillocks; lower sheet and gully erosion hazard on the terraces and fans; stream-bank erosion	12
	Wagra	BR_2		760-890 mm (30-35 in.)			Red stringybark:long-leaf box open forest II and forest red gum woodland II; some river red gum woodland II and open forest II		5
BURROWA	Jemba	BU_1	Steep to very steep montane slopes with small plateaux at elevations above 1,070 m (3,500 ft)	About 890-1,020 mm or more (35-40+ in.)	Rhyolite	Weakly bleached, massive gradational soils dominant on steep slopes and some undifferentiated stony loams on steepest slopes; friable reddish and brownish gradational soils on plateaux and in locally moister sites	Broad-leaf peppermint open forest II; narrow-leaf peppermint open forest III; red stringybark:long-leaf box open forest I and II; some candlebark gum:snow gum open forest I; alpine ash open forest IV, red cypress pine open forest I, and closed to open heath	Moderate to high sheet erosion hazard	99
	Mittamatite	BU_2	Steep to very steep montane slopes with small plateaux at 760 m to 915 m (2,500-3,000 ft)	About 760-890 mm (30-35 in.)	Red granite	Weakly bleached massive gradational soils dominant on steep slopes and in drainage lines on plateaux; friable reddish gradational soils on plateaux	Red stringybark:long-leaf box open forest I and II; red cypress pine open forest I, closed to open heath and open mossland; some broad-leaf peppermint open forest I and II, narrow-leaf peppermint open forest III	Moderate to high sheet erosion hazard	80

LAND SYSTEMS

LAND CONSERVATION COUNCIL
VICTORIA

NORTH EASTERN AREA
DISTRICT 1



LEGEND

Land System	Sub-System	
BUNJIL		BJ
KOETONG		K
BENAMBRA	Magorra	BN_1
	Thowgla	BN_2
ADJIE	Towong	A_1
	Dart	A_2
BETHANGA		BE
MURRAY		MU
BERRINGAMA	Lucyvale	BR_1
	Wagra	BR_2
BURROWA		
	Mittamatite	BU_2

R.K.Rowe. Soil Conservation Authority, Victoria.

LAND USE HAZARDS

A hazard in relation to the use of land may be defined as anything that threatens to reduce the land's ability to produce the chosen products at a sustained level, and may also threaten the productivity of adjacent land.

Some arise from accidents or as an indirect consequence of a seemingly beneficial course of action, but some result from deliberate action, taken without consideration of the known consequences.

Because of the interdependence of the environmental factors, a change in one usually produces changes in others until a new stable relation is attained. The readjusted condition may be more or less productive. Of the factors considered in Part II, only soil, vegetation, and fauna are readily changeable. However, small changes in topography - such as gully erosion or construction of roads and dams - can also be readily made and these in turn can affect the hydrological condition of the land.

It is possible to indicate a number of basic causes of deterioration in land productivity. These may act through the soil, the vegetation, the fauna, or the hydrological condition of the land.

Hazards affecting soil

Soil is a basic resource. It cannot be replaced, and many of its attributes are subject to damage, which may not be easily remedied.

Fertility may fall

The most obvious cause of loss of fertility is sheet erosion, which removes the surface soil - where plant nutrients have become concentrated, either by biological activity or by fertilizer application. However, loss of nutrients may also occur if the natural recycling process is disturbed in such a way that the rate of release of nutrients from organic or mineral combinations increases to exceed the rate of uptake by plants. This may result from frequent burning or excessive cultivation. Nutrient capital may also be removed in the produce of the land, and this occurs under intensive cropping.

Soil moisture status may deteriorate

Again, the most obvious cause is soil erosion, where it reduces the depth of the soil or, as in gully erosion,

causes excessively free drainage. Increased subsurface drainage may also be expected from above side-cut roads in steep country. Breakdown of surface structure and compaction of the surface - such as may result from stock trampling or excessive vehicular trafficking - can prevent the infiltration of water and reduce the moisture available to plants. In this case, surface run-off and erosion are also likely.

Excessive wetness results from a change from deep-rooted vegetation to plants that do not effectively utilize the available soil moisture. It may occur in any area, but is more likely in higher-rainfall areas. Excessive wetness may simply reduce the area's accessibility or productivity, but it may also lead to erosion of drainage lines and is the principal cause of mass movement erosion.

The use of chemicals can cause soil deterioration. Widespread and excessive use of insecticides to control pasture pests could destroy beneficial soil fauna. This could result in the locking up of nutrients in plant remains (which these animals normally decompose), leading to a drop in soil fertility.

Excessive applications of fertilizers can also have some detrimental effects. For example, heavy applications of lime can induce manganese deficiency in some soils.

Hazards affecting vegetation

Direct destruction of native vegetation results from fire. Next to the deliberate clearing of native vegetation by Man, fire is the most destructive agent and may so damage a plant community that its character is completely changed. However, most native plants are resilient to fire damage and will recover in time. The effects of fire on nutrient availability and on soil physical condition could also cause changes in vegetation, but little is known of the nature and duration of such changes.

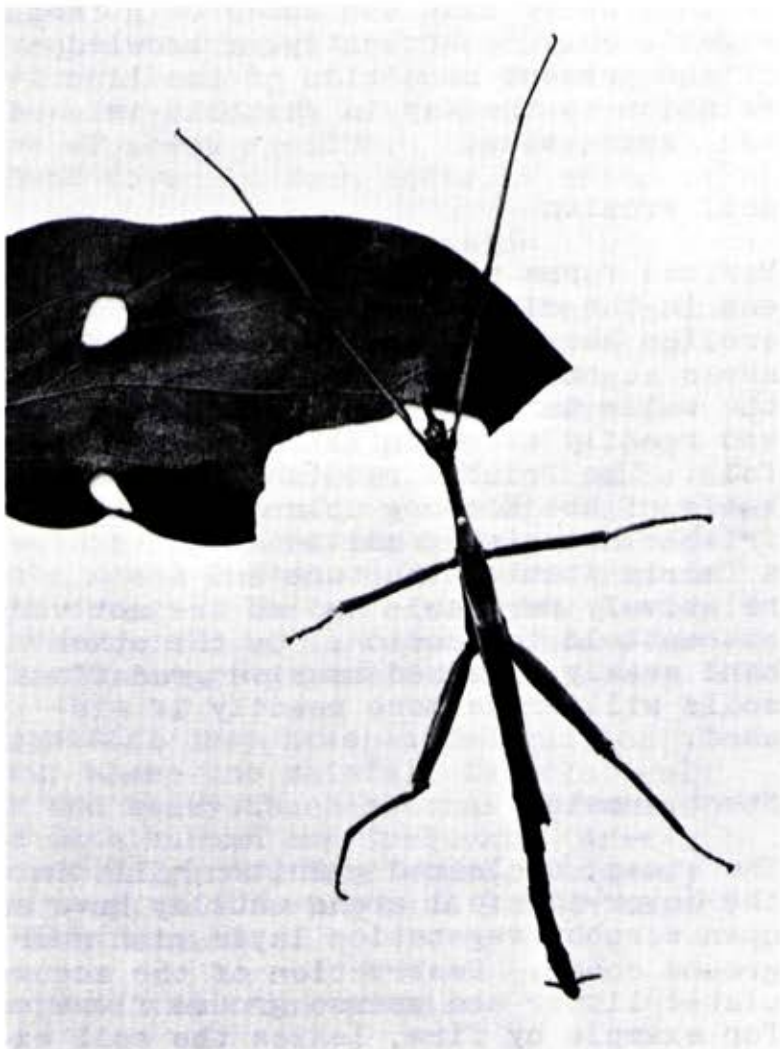
Undesirable plants may become successful competitors with the desired vegetation (natural or cultivated) and may reduce its value or even cause its elimination.

Animal pests may utilize the vegetation. The rabbit - the best-known example of such an animal pest - has had drastic effects on both natural and cultivated vegetation. Unregulated grazing animals in general may provide a similar hazard.

Insects may also be a hazard. For example, leaf-eating insects attack eucalypt forests or cultivated vegetation. Wood-boring insects as well as leaf-eaters can reduce productivity in timber-producing forests.

Disease constitutes another hazard. Pathogens such as fungi may be the primary agents in causing vegetation deterioration. However, some diseases

are secondary, being induced by soil deficiencies or toxicities.



The spur-legged phasmatid (Didymuria violescens) - *a leaf-eating insect*

Hazards affecting natural fauna

Because of their dependence upon habitat, which provides food and shelter, fauna are subject to a range of hazards similar to those listed above for vegetation. The deliberate or accidental alteration or total destruction of habitat thus constitutes a major hazard.

Fire can be a most destructive agent and the recovery of animal populations may be slow, particularly if the fire covers large areas and/or the animals have low reproductive capacities.

Competition for habitat and food from animal pests is a major hazard. The rabbit and domestic animals rank foremost in this regard. Moreover, the larger introduced carnivores prey on small native animals, and Man himself has often threatened the survival of individual species through predation.

Deliberate or indiscriminate use of poisons (including pesticides and weedicides, which may become concentrated in animal tissues *via* the food chain) pose hazards to all animal life, and are frequently difficult to trace to their source.

Hazards affecting the water resources

Changes in the quality, quantity, or flow regime of streams are closely associated with changes in vegetation or soils. In particular, all three stream

characteristics can be altered by manipulating vegetative cover in the catchments. Depleted ground cover may result in rapid surface run-off, which leads to sediment-laden flash floods. Total yield may be increased, but both quality and regime suffer. The change from deep-rooting to shallow-rooting vegetation can increase water yield, as can the destruction of vegetative communities that draw upon the water table, particularly in summer, but associated undesirable changes in soil stability may occur.

Flooding of permanent streams may be accentuated by changes in vegetation on the catchments, and a decline in base flows is usually accompanied by an increase in flood peaks.

Contamination of surface water by discharge of pollutants is a hazard usually associated with settlement, particularly where industrial development occurs. Contamination of groundwater may also occur. As the alluvial deposits are located in an intake region for both shallow local aquifers and the deeper aquifers of the Murray basin, care should be taken to minimize infiltration of potential pollutants such as pesticides.

Present Condition of the Land

A complete understanding of the interrelations between the environmental variables would enable us to predict changes that would cause a decline in productivity. However, at present (to a large extent) knowledge of the existence of hazards to land use comes only from experience. Consequently, a knowledge of the present condition of the land in relation to the way in which it is used has great value.

Soil erosion

Various forms of soil erosion are apparent in the district. The lowest soil erosion hazard exists in the flatter areas at the higher elevations, where the soils tend to be deep and friable and readily allow infiltration of rainfall. The friable reddish gradational soils of the Koetong uplands and the friable brownish gradational soils have a fairly stable structure and are relatively permeable and so are not very susceptible to erosion. On the other hand weakly bleached massive gradational soils will erode more readily if misused.

Sheet erosion

The steep, uncleared granitic hills in the lower-rainfall areas usually have an open scrubby vegetation layer with poor ground cover. Destruction of the accumulated litter and sparse ground flora, for example by fire, leaves the soil exposed to summer and autumn storms, which usually produce high-intensity rain, and results in accelerated sheet erosion. Rabbit grazing plays an important role

in initiating or continuing erosion. Severe sheet erosion occurs on forest land at Pine Mountain, Mount Burrowa, and Flaggy Creek and is in the incipient stages on steep slopes along the Murray River, at Bethanga and Berringama. Any further clearing of slopes in these and other low-rainfall areas increases the risk of sheet erosion. Preservation of ground cover in such areas is essential.

Stream-bank and gully erosion

Stream-bank erosion has resulted in the loss of substantial areas of good agricultural land on some farms along Corryong and Thowgla Creeks. Stream-bank erosion is also prevalent along Walwa and Sandy Creeks. Maintenance of stream-side vegetation and of vegetative cover of the hillsides in upper catchments would prevent or at least reduce this damage. The effect of the latter measure would be to reduce surface run-off and damaging peak flows.

Occasional deep, steep-sided gullies occur where the rainfall is relatively low and heavy thunderstorms in summer and late autumn are frequent. Areas around Talgarno, Berringama, Cudgewa, Corryong, and Towong have a high hazard in this regard.

Roadside and track erosion

This erosion includes rilling and slumping of road batters and gullying of the road surface. Careful design can minimize or prevent this form of erosion, but some soils are more susceptible than others.

Mass movement of soil

Slumping on cleared land occurs on the steeper hill slopes, particularly on southerly aspects and in years of above-average rainfall. It is evident to a small degree at Berringama and George's Creek.

Fire

Fire has been a part of the environment for thousands of years. Although the incidence of fire prior to settlement is unknown, it is almost certain that during the early years of settlement and until recently the frequency and severity of fires, and the area burnt annually, have been greater than previously. Cattlemen used fires to remove coarse dry grass from the runs on public land and encourage new palatable growth. Fire was apparently used only as an aid to clearing on the freehold land.

Fire incidence for most parts of the district is not high. The absence of prolonged summer drought, heavy scrub growth, and the occurrence of large areas of stringybark species over all but the dry northernmost section assist in this regard. Fuel densities are normally low (3-5 tons per acre) because of the predominantly grassy understorey. A slow fuel build-up of forest litter

indicates a period of 5-10 years after fire before the fire hazard becomes high again. The most hazardous areas are the dry scrubby red stringybark forests around Pine Mountain, north of Mount Burrowa, and in the Lawson, Granya, and Bethanga blocks.

Fire incidence seems to be greater in the Granya area than elsewhere. Thunderstorms are a feature of the area and lightning strikes start a high proportion of fires. Fires initiated by Man are few, but, because most settlement is mainly to the north of the forested area, such fires are likely to spread into forest under the influence of northerly winds in summer.

Wherever conditions are suitable, the responsible fire authority burns large areas of public land to reduce fuel quantity and so lessen the likelihood of high-intensity fires in summer. High-intensity fires - burning under conditions of high temperature, low humidity, strong winds, and dry fuel - can destroy or damage hardwood and softwood timber stands and wildlife habitats, and can invade farmlands and residential areas. Fires of this nature present a hazard to all forms of land use. However, where they affect relatively small natural areas they may be regarded as having scientific or educational value with regard to the study of succession of plant and animal communities.

Major fires ravaged the district in 1952, burning 163,000 acres, or 25% of the forested area. These fires originated at Holbrook in New South Wales, and quickly crossed the Murray River onto forested northerly slopes.

Adequate fire protection of forest areas relies on ready detection, good access, efficient communication, fuel-reduction burning, strategic water storage, sufficient equipment, and an adequate work force of trained personnel. These measures are designed to cover all forested land, but are concentrated around rural or urban areas where forest fires pose a threat and around valuable resources such as a park or pine plantation.

For example, primary protection measures for the plantation area at Shelley aim at maintaining a low fuel density in a belt of the surrounding native forest about 1.5 km (1 mile) wide.

Secondary protection relies on roads through the major forest blocks to the north and west of the plantation area to provide access and create burning units that can be fuel-reduced when conditions are favourable. Fire protection of forest areas is assisted when the boundary between forest and farmland is short. Cleared land that extends into forest in narrow strips (such as along creek valleys) increases this perimeter.

Fuel-reduction or controlled burning is widely practised in Australia, and the

technique is recognized as a necessary part of any programme aimed at minimizing the risk of destructive wildfires. However, nobody knows that long-term effects regular low-intensity fires at intervals of 5-7 years would have on plant and animal communities, and on soils and hydrology. In the long term, regular firing could remove much of the diversity of environment and produce unwanted soil and hydrological properties.

In the short term, adverse effects can be minimized at the operational level by leaving a mosaic of unburnt forest within areas to be burnt. However, more research is needed to determine the long-term effects.

Flooding

The larger portions of most of the streams in the study district are moderately graded to steep mountain streams, with little or no flood-plain adjacent to the main course. Consequently high flows are generally well contained within the banks and cause little or no damage. The Murray River and downstream sections of its main tributaries (Thowgla, Corryong, and Cudgewa Creeks, etc.) are not so steeply graded, and flows in these streams exceed bank-full conditions at something approaching annual frequency.

However - because of the short duration of these peak flows - submersion causes little damage to pasture, and existing bank-protection works (including willow planting by farmers) limit erosion damage to minor proportions.

Biological Hazards

Diseases and pests have a minor impact on agriculture, timber production, and natural plant communities. The effect on animal communities is more difficult to assess.

Wild dogs and vermin

Up to the present, no reliable estimate has been made of the effects of wild dogs, foxes, and feral cats on native animal populations. However, Coman has recorded the diets of these animals. The diet of dingoes and feral dogs in eastern Victoria mainly comprised native mammals (45% by volume). The black-tailed wallaby, common wombat, eastern grey kangaroo, brush-tail possum, greater glider, and echidna are ranked here in order of decreasing importance in the diet (by volume). Introduced animals such as rabbits, sheep, cattle, rats, and mice provided a relatively minor food source. Birds and reptiles were of secondary importance in the diet.

Records for the study district indicate that 50% of the diet there comprised wombats, echidnas, and black-tailed wallabies. Low-volume figures were recorded for smaller mammals and birds. The numbers of such animals eaten would of course be relatively higher than those of the larger species.

Wild dogs are confined mainly to the wilder, southern parts of the district. Foxes are common and feral cats less so. Both are opportunist predators and scavengers, and the level of predation on any one prey type will depend to a large

Table 13

POTENTIAL HABITATS FOR NOXIOUS WEEDS ON PUBLIC LAND IN THE STUDY DISTRICT

	Disturbed sites within natural areas, such as recreation sites, roadsides, and grazing areas	River frontages	Partly cleared land, pine plantations, abandoned farmland
Blackberry	*	*	*
St. John's wort	*		*
Boxthorn	*		*
Hawthorn	*		
Sweet briar	*		
Apple of Sodom	*		*
Hemlock	*		*
Horehound	*		*
Bathurst burr	*		*
Paterson's curse	*		*
Skeleton-weed	*		*
Stinkwort	*		*
Tree of heaven	*		*

extent on its relative availability.

Thus, removal of rabbits would increase dependence on other sources, including native mammals. The diets of 31 foxes sampled from the study district indicate that they took their food from farmlands and disturbed habitats. Rabbits contributed 50% of the diet (by volume); insects accounted for 19%, and birds formed a relatively small part.

The diet of foxes in undisturbed areas would be mainly based on native fauna. Information from Victoria generally indicates that feral cats from un-developed bush areas rely heavily on small native mammals.

The introduced rabbit has been blamed for the near extinction of some native animals due to the destruction of their habitat. It presents a serious hazard in any environment because of its effects on soil and vegetation. It has been present in plague proportions in previous years, and its population can build up quickly under suitable conditions.

Man

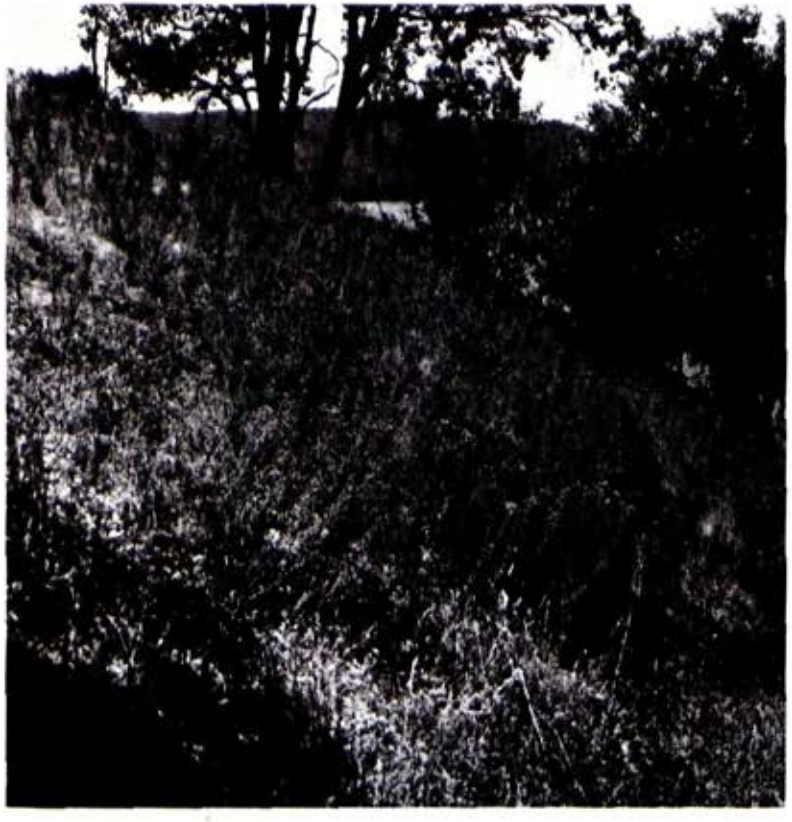
The shooting of large birds such as emus and hawks and large animals such as the eastern grey kangaroo have reduced the populations of these species, but Man's hunting and trapping activities are limited and have minor influence as far as other species are concerned.

Weeds

A survey carried out in 1970 showed that 30 species of noxious weeds occurred in the study district. Of these, 13 are likely to pose problems on public land and the most important are discussed below. Many species could pose problems on areas developed for farming. The control of weeds and also vermin is made more difficult where farmland extends into forested land in narrow strips such as along narrow creek valleys. Table 13 lists the main habitats where these weeds occur.

Blackberry *(Rubus fruticosus)* grows mainly in areas where the annual rainfall exceeds 760 mm (30 in.), and so occurs widely in the study district.

Blackberry bushes invading unimproved grazing land near Biggara



St. John's wort invading a partly cleared hillside

It resembles other alien weeds in that it rarely invades virgin country, but rapidly becomes established along creek banks and on sites that have been disturbed. Provided the rainfall is adequate, blackberry thrives on roadsides, railway easements, fence lines, creeks, channel-banks, neglected areas in townships, logged areas, and old mining districts. The dense, prickly thickets are commonly 1-3 m (3-9 ft) high and impenetrable to Man and his domestic animals. This growth presents an ideal harbour for rabbits, a fire hazard in summer, and a seed supply for the potential invasion of farms with unsound management.

Blackberry has the potential to become an important problem in areas reserved for the preservation of natural vegetation and for most forms of outdoor recreation. It is a major problem on many river and creek frontages in partly developed areas and neglected areas of public land.

St. John's wort *(Hypericum perforatum)* is one of the major weeds in the north-east of the State, where it occupies thousands of acres of timbered country, roadsides, and poorly managed pastures. This perennial weed can establish in timbered country and spread rapidly, to the exclusion of the native understorey vegetation. Control measures include introduction of insects that feed on the plant.

In the north-east, St. John's wort readily establishes in areas where Man has made some alteration to the environment.

Paterson's curse *(Echium lycopsis)* occurs throughout the State. It grows in the district and has proved difficult to eradicate by conventional methods on steep, dissected slopes. Aerial spray-

ing may be more effective. The weed does not pose any major threat to biological communities on public land in the district.

Several woody noxious weeds - such as African boxthorn *(Lycium ferocissimum)*, hawthorn *(Crataegus* spp.*)*, sweet briar *(Rosa rubiginosa)*, and apple of Sodom *(Solanum sodomeum)* - are established in the study area and have the potential to restrict the use of recreation areas by limiting access to streams, paths, etc. They all have prickles or spines that make them objectionable in recreation areas, and they provide harbour for vermin animals such as rabbits. All these species develop readily in partly cleared situations.

Other noxious weeds recorded in the area that may affect the utilization of public lands include hemlock *(Conium maculatum)*, which has an offensive smell and is poisonous, and horehound *(Marrubium vulgare)*, which can occupy sparsely vegetated areas and change the habitat for native animals.

Annual weeds such as cape-weed *(Arctotheca calendula)* and a variety of thistles, besides being useless as pasture species, may also contribute to erosion, for as the summer approaches the weeds die off, leaving the soil with poor protection.

The noxious weeds in the district can be dealt with by spraying with herbicides, by mechanical methods such as slashing or cultivation, or by biological means.

These practices have relevance to future land use and management. They may upset a stable and balanced situation and result in problems not directly associated with, and perhaps more serious than, the original weed (or vermin) problem. For example, soil erosion may follow weed removal, or herbicides may persist in soils and run off into streams and so may damage other desirable plants.

When measures to control weeds are being formulated, these associated problems should be considered and weighed against the benefits of control.

Insects

No serious insect pests infest the district. However, the introduced Sirex wood wasp *(Sirex noctilio)* poses a potentially dangerous threat to the local pine plantations. It is known at present in the north-east, but its effects can be minimized by appropriate plantation management practices. In drought years the hazard of attack from Sirex populations increases.

One of the bark beetles *(Hylastes ater)* is a pest of pine plantations in the district. The gum-leaf skeletonizer *(Eraba lugens)* eats foliage in its larval stage and has the effect of reducing nectar flows, which is of concern to bee-keepers.

The spur-legged phasmatid *(Didymuria violescens)*, a leaf-eating insect that can damage and even kill eucalypts, has occurred in plague proportions in the Koetong-Shelley area in the south of the study district. Plagues probably build up as part of a natural cycle, but control by aerial spraying has been attempted because of the damage caused to vegetation.

Fungi

The needle-cast fungus *(Sclerophoma pityophylla)* has affected radiata pine at Shelley, but this fungus does not appear to be a serious threat under Victorian conditions. *Diplodia pinea* also attacks radiata pine, but is of no great concern except perhaps under drought conditions, when the resistance of the tree is lowered.

The root fungus *Phytopthora cinnamomi* poses a potential threat to both radiata pine and native plants. Affected trees suffer gradual dieback and loss of foliage, and eventually die. The hazard would be greater where drainage is poor, and at the lower elevations, where soil temperatures are relatively high.

Chemical Hazards

The widespread use of insecticides to control pasture pests could destroy beneficial soil fauna and lead to a drop in soil fertility. Insecticides present a hazard to colonies of bees and also to insectivorous amphibians and mammals. However, only limited use of pesticides occurs in this district.

References

Coman, B.J. Helminth parasites of the dingo and feral dog in Victoria with some notes on the diet of the host. *Australian Veterinary Journal*, 1972, 48, 456-61.

Coman, B.J., and Brunner, H. Food habits of the feral cat in Victoria. *Journal of Wildlife Management*, 1972, 36 (3).

Douglas, G.W. A review of myxomatosis in Victoria - 1950-1965. *Journal of the Victorian Department of Agriculture*, 1965, 63, 557-62, 568.

NATURAL AREAS

In Australia, in less than 150 years of extensive settlement, we have established a viable and prosperous nation, but in the process we have greatly changed the whole environment. It is now difficult to find any large tract of country in its virgin state

Fortunately the worst excesses of land exploitation, such as uncontrolled logging, overgrazing, and frequent burning, are now over. Nevertheless, a rapidly growing demand has developed here, as elsewhere, for land still carrying natural vegetation and wildlife to be set aside in special reserves in which all further development is kept to a minimum.

The Need for Natural Areas

Such natural areas are required for many reasons and the list below is not exhaustive.

Recreational

Many forms of outdoor recreation, including those related to enjoying and understanding natural environments and those requiring solitude, need natural reserves. These give people an opportunity to renew contact with the natural world where their ancestors once struggled for existence.

Tourism is one of the world's major industries, and natural areas that give a country its individual character are an important factor in attracting tourists. Visitors may put heavy pressure on an area, and if it is to remain "natural' we must restrict access.

Aesthetic

The preservation of the beauty and regional diversity of the natural landscape should supplement our proper concern for the preservation and display of Man's own finest creations - art, music, buildings, and writing. Thus we must preserve characteristic Australian scenery and wildlife within an economic system that necessarily encourages the import and spread of exotic plants and animals, often in monocultures.

Scientific

We need to preserve undisturbed samples of natural ecosystems, which provide basic data of value in understanding and improving the man-made systems used for

A relatively undisturbed area near Log Bridge Creek

productive purposes. For example, solutions to problems of soil erosion or salting may be found through a comparison of the natural situation with the artificial farmland Man has developed.

We must also preserve species and varieties (a "gene pool") that one day may have profound value to Man, either directly or through his domesticated plants and animals. We must conserve a bank of parental material for improving our agricultural and forest species and for medicinal purposes. Some Queensland rain-forest trees are sources of useful drugs. Penicillium was a nuisance mould on bread until its antibiotic effects were discovered.

Educational

We need outdoor laboratories for education in the bilogical sciences and an abundant and renewable supply of species and individuals. A large natural area gives opportunities not only for enjoying natural scenery, but for every variety of study, from simple natural history observation to the most sophisticated non-destructive experiments.

Viability of Natural Areas

Many factors influence the viability of a natural area. In general, viable populations of plant species could be maintained on a smaller area than populations of large mammals. Natural areas must be large enough to absorb the impact of any proposed uses. Those set aside primarily to provide opportunities for solitude and primitive surroundings must be very large. In Canada it has been suggested that such an area should require 2 full days to cross on foot. This would usually involve about 50,000 hectares (124,000 ac). But 40 ha (100 ac) or less may be sufficient to preserve a particular small plant species.

Truly natural areas will need a buffer zone to reduce the impact of Man's activities in the surrounding countryside. The buffer zone could be affected by weed invasion, vermin, or fertilizer and pesticide applications. As well as hazards caused by Man's use of surrounding land (or the area itself), there are natural hazards such as fire, flood, and disease. The larger the area, the more likely it is to survive these. Protection may also be achieved by setting aside several separate examples of a particular land type. Communities that exist in more variable climatic zones usually require larger areas, or more examples set aside, to ensure survival.

"Natural" areas should be "managed". Although seemingly a contradiction in terms, this is often necessary as nature is dynamic. Management may take the form of controlling fire, culling animal populations, practising silviculture, strictly controlling the number and activities of visitors, fencing to exclude introduced animals, or eradicating introduced species. The degree of management possible or necessary depends upon objective interpretation of the environment, the techniques available, and the cost of implementing them. Careful management may enable small areas to remain viable.

Choosing Areas

In addition to the considerations of viability outlined above, many other factors influence the selection of natural areas. These include the great diversity of interests among the people, and the possibilities of a number of compatible uses of a single area.

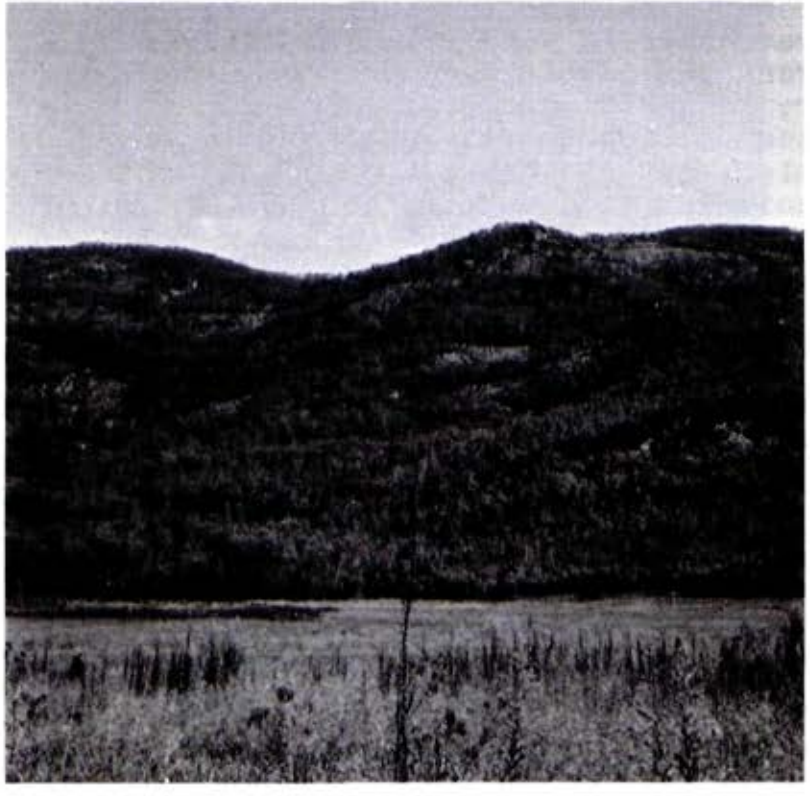
The biological content and diversity of the area must be considered. There is a need to conserve large communities of common species rather than just concentrating upon the preservation of varieties in very small non-viable reserves. This does not mean that the remnants of previously more important communities should be ignored. The migratory and nomadic existence of some animals requires corridors of habitat, linking, for example, breeding and feeding grounds.

It is desirable to select an area with natural boundaries, such as a watershed. This type is usually the easiest to manage and maintain. Scenic or landscape values should also be assessed. In practice, it is likely that a balanced system will include a few fairly large areas (more than 20,000 ha) in which the major communities are represented, supplemented by a greater number of smaller, more intensively managed areas.

The Study District

Although large parts of the study district still remain in a relatively natural condition, certain types of land that are well suited to agriculture have

been almost totally cleared. Remnants of the natural vegetation that once covered these areas remain in scattered pockets and along some river flats. If a sample of each type of land is to be preserved in its natural state, any viable remnants, such as public land in the Murray, Berringama, and Bethanga land systems, need to be reserved.



Pine Mountain - a natural area with high scientific and recreational values

At present, 20% of the Koetong land system is being used for agriculture or softwood production. The current rate of pine plantation extension is of the order of 400 ha (1,000 ac) each year. Reservation of typical areas of this land system for scientific and educational purposes would be desirable.

The Jemba sub-system and parts of the Bungil land system have very diverse vegetation communities and are high in recreational as well as scientific value.

The Mittamatite sub-system at Pine Mountain has a rich and varied flora (see Appendix II). It too has high scientific and recreation values.

The Wabba Hills section of the Dart sub-system offers opportunities for cross-country driving, hiking, and solitude.

References

Dasmann, R.F. "Environmental Conservation." (Wiley: New York 1968.)

Frankenberg, Judith. "Nature Conservation in Victoria: a Survey." Ed. J.S. Turner. (Victorian National Parks Association: Melbourne 1971.)

Main, A.R. Problems in nature conservation. *Gazette of the University of Western Australia*, 18, 38-41.

RECREATION

Recreation involves activity, undertaken without compulsion, for the pleasure of the individual. Obviously it takes a multitude of forms, and individual preferences vary.

This chapter concerns recreation on public land, which can involve such activities as skiing, hiking, picnicking, or simply sight-seeing. Some of these may require large tracts of land, but uses such as timber production, cattle-grazing, or mining can occur together with recreational activities, provided certain restrictions are imposed.

Factors Affecting Demand

The increasing demand for land for recreation can be attributed to a number of factors, some of which are listed below.

Population

The size of the population as well as its density in particular areas will determine the demand for land for recreation. Victoria's population has doubled in the past 35 years and is now about 3,500,000. An overwhelming proportion is concentrated in the metropolitan area.

Income

In general, the bulk of the population has more money to spend after paying essential expenses. Many spend some of this money on recreational activities.

Leisure time

As working conditions improve, individual periods of leisure such as weekends, annual holidays, and retirement years are lengthening.

Transport and communications

Improvements in transport increase the mobility of populations, making areas more accessible and increasing the effective length of individual periods of leisure. More efficient communications disseminate information and ideas more freely, and increase people's knowledge about places of interest and things to do.

Location of cities and towns

The geographic locations of cities and

towns in relation to available natural features of recreational interest, such as beaches and snow-fields, influence the types of activities pursued.

Life style

Life style cannot really be considered in isolation from the factors outlined above. However, additional factors such as education, age, and fashion can influence the degree of participation in outdoor recreation.

Evidence indicating the increasing demand for outdoor recreation in recent years can be obtained from the few Victorian figures available. These indicate that, while the population has been increasing at 2% per year (doubling every 35 years), the number of people using developed areas of national parks and other outdoor recreation areas, the number of car and motor-boat registrations, and similar indices are all increasing at 10%-15% every year (doubling in less than 7 years). More than 725,000 people visited Victorian national parks in 1971/72, compared with about 350,000 visits in 1966/67.

Although it may be clear that the demand for outdoor recreation is increasing, the nature of this increase is difficult to predict. It has been suggested that by the end of this century the Australian population will total 22 million, a 3- or 4-day working week will be common, *per capita* income will have trebled in real terms, and the 3 million cars will have increased to 10 million - which will be used nearly twice as often as today.

Activities that are popular now may not be so in the future, and completely new types are certain to emerge. All that can be done is to plan for an increased demand for outdoor recreation and keep the plan as flexible as possible to cope with the changes in its nature.

Choosing land for outdoor recreation

As previously mentioned, outdoor recreation is often compatible with other forms of land use. However, sometimes areas must be set aside specifically for recreation.

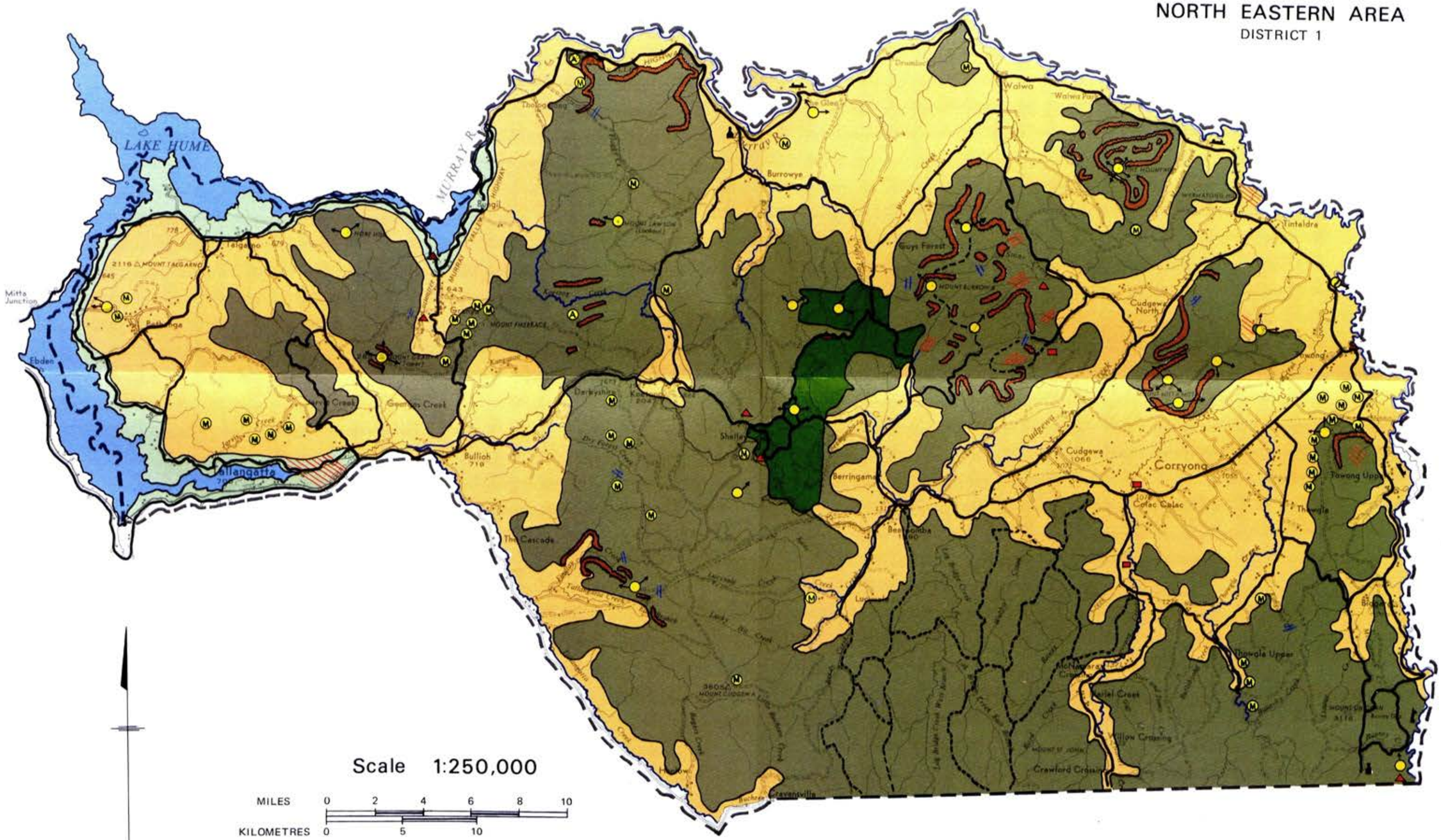
The area and nature of the land chosen will depend upon the type of recreation to be pursued. At one extreme, small areas that retain little of the natural environment are used for such activities as tennis, golf, and picnicking. Major usage occurs after work and at weekends, and they are invariably located close to the population that uses them.

At the other extreme, areas of hundreds of thousands of acres provide for such activities as hiking, sight-seeing, camping, fishing, and nature study, mainly during vacations. Development is usually limited to a small part of the area, the rest being undisturbed. These areas are located where outstanding

RECREATION

LAND CONSERVATION COUNCIL
VICTORIA

NORTH EASTERN AREA
DISTRICT 1



LEGEND

Environments
- Lakeside environment
- Rural environment
- Native Forest environment
- Softwood Forest environment

Features
- Rock outcrop or rocky scarp
- Waterfall
- Open water
- Fishing stream
- Canoe Stream
- Outstanding wildflower area
- Outstanding wildlife area
- Scenic lookout

Historical
- Historic building or site
- Early mining site
- Aboriginal relics

Routes
- Major tourist route
- Hiking route

Facilities
- Picnic area
- Campground

natural features occur, often far from the population using them.

Obviously a complete range exists between these extremes. American statistics indicate that the greatest increase in demand will be for the intermediate areas that are outside large urban centres but within about 2 hours' driving time of them.

Area of land required

In many respects, an area's carrying capacity for outdoor recreation can be assessed in physical terms in the same way as a farmer determines the optimum stocking rate for his farm. A particular site can accommodate a certain number of cars and people, and above this level damage to the vegetation and soil will occur, leading to deterioration of the land.

Moreover, a psychological element must also be considered; overcrowding detracts from people's enjoyment of the area, although the land may not suffer physical damage.

The analogy with the determination of stocking rates on a farm over-simplifies the case to some extent, because attractive and accessible parts of a recreational area tend to be heavily used while large parts are little used. An added complication is that people use these areas intensively for brief periods and not at all for longer periods. This results from the interaction of available leisure and weather conditions with the distance of the recreational area from the population.

Recreation in the Upper Murray Region

Travel industry appraisal

In 1972, the Australian National Travel Association published a report appraising the case for travel development of the Upper Murray region. This region centred around Albury-Wodonga and included the population centres of Urana, Holbrook, Tumbarumba, and Khancoban in New South Wales, and Yarrawonga, Wangaratta, Bright, Myrtleford, Beechworth, Tallangatta, and Corryong in Victoria. Albury-Wodonga lies on the major route between the cities of Sydney and Melbourne, 589 km (366 miles) from Sydney and 307 km (191 miles) from Melbourne. This centre is growing rapidly and its growth would be boosted even further in the event of an effective decentralization plan.

The Association's report viewed recreation in terms of the whole region as a major travel destination and, in any future development, the district around Corryong and Tallangatta should be seen as a part only of the broader region.

Apart from its strategic position, the region appeals to the visitor because of its proliferation of scenic routes and the various attractions of its towns.

A picnic site on tourist route near Cudgewa Creek

Visitor survey

During 1970/71, 211,000 visitors came to the region and a further 2 million passed through it, giving some indication of its potential.

During a period of 5 weeks in April-May, 1971, a visitor survey was conducted and a base sample of 415 valid interviews was analysed. Subject to the limitations of the survey, the following statements can be made.

Age

The majority of visitors were between 35 and 65, but a significant number were under 25. The survey gathered statistics for a number of age groups, and it was noted that Tallangatta-Corryong had a relatively large proportion of visitors in the 25-34 age group - 29.7% compared with 17.6% for the region.

Income

The middle-income ($3,00-$6,000) group comprised the largest proportion of the sample. This was 49.6% for the region, but Tallangatta-Corryong had a larger proportion in this group than the region as a whole.

State or country of residence

Throughout the region as a whole, most States were represented. Victoria contributed 60% of visitors, New South Wales 18%, and South Australia 7.6%. The United States of America contributed 4.6%.

Purpose of visit and lengeth of stay

The main purpose of the visit was for holidays (see Table 14). Tallangatta-Corryong had the highest proportion (11.8%) visiting friends and relatives.

Table 14

PURPOSE OF VISIT TO REGION

Purpose	%
Holiday	71.3
Business	8.0
Business and holiday	4.8
Working holiday	4.1
Educational	2.2
Visiting friends or relatives	7.5
Other purposes	2.1

The calculated average length of stay in the region was 6.3 days. However, there was a large proportion of short visits; 41% stayed between one and three nights.

Tallangatta-Corryong had the lowest average length of stay, at 4.5 days.

Repeat visits

Over and above those who might be expected to make a number of visits to friends or relatives, the survey showed a good spread of visitors returning; 42% made three or more visits (see Table 15).

Tallangatta-Corryong showed an above-average percentage (20.6) in the 3-5 visits category, which may indicate that the area has attractions to draw people back again.

Table 15

REPEAT VISITS

Number of visits since 1960	%
1	38.1
2	19.5
3-5	19.5
6-8	8.7
9-11	4.1
12 or more	9.6
Not stated	0.5

Recreation resources in the study district

Recreation resources have been presented in the accompanying recreation map and are discussed below.

Environments

The district has a number of environments, each of which has a different appeal to the visitor and which together give variety to the landscape. The lakeside environment around Lake Hume is an important drawcard. Other major environments are native forest and rural. The rural environment is mainly confined to the plains, lower valleys, and foothills. The softwood forest at Shelley has provision for a tourist circuit and picnic area.

Bellbridge - a developing holiday centre at Lake Hume near Albury

Recreation features

Outdoor recreation activities are concentrated around Lake Hume and in the Corryong area. They include boating, swimming and sun-bathing, picnicking, water-skiing, duck-shooting, canoeing, fishing, hiking, camping, nature walking, and driving for pleasure and sight-seeing. Table 16 list these activities and their requirements for land.

Lake Hume, the Burrowa massif (or Cudgewa Bluff as it is popularly known), and fishing streams around Corryong receive the most use. The Murray Valley Highway and roads around Bethanga and Corryong are used for sight-seeing and driving for pleasure. This traffic is enhanced by the fact that the main roads are also used by travellers *en route* to the snow-fields of Koscuisko National Park.

Recreation usage in the district, however, is relatively low. The district contains a number of recreation features

Fishing in the Murray River at Bunroy

and these have been depicted on the map facing page 110. There is quite a diversity of environments with many outstanding features, some of which are listed below.

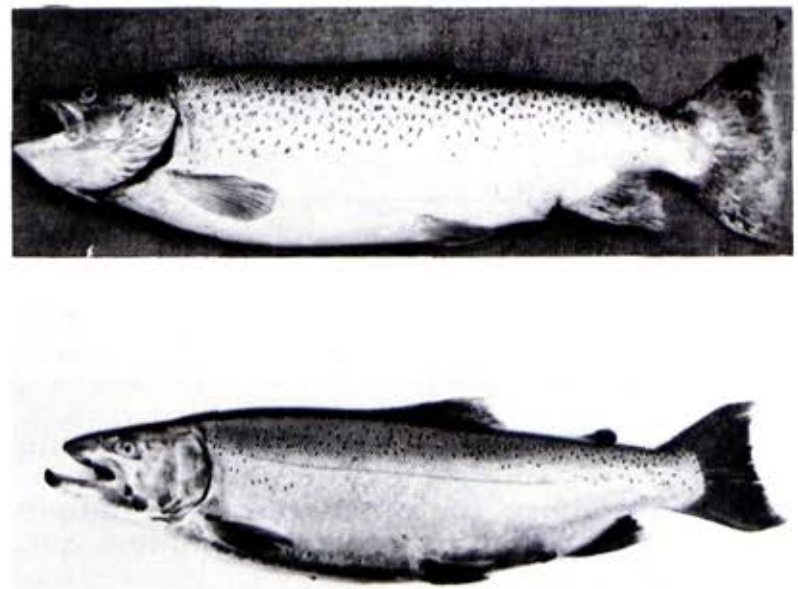
Scenic viewpoints are located at Mount Granya, Mount Lawson, Mount Elliot, Mount Burrowa, Lawrence Lookout, and Mount Mittamatite.

Lake Hume offers opportunities for all kinds of water sports.

The Burrowa massif (Cudgewa Bluff) area has wide ecological diversity, precipitous rock faces, waterfalls, wildflowers, and many scenic views of the district and the Snowy Mountains. Picnic sites and walking tracks are provided.

The Pine Mountain massif (which is connected to the Cudgewa Bluff by a low ridge of public land) has an attractive mosaic of steep rocky outcrops and low scrubby forests and heaths. The flora contains many interesting plant species, some of which are showy, for example the grevilleas and wattles. The highest peaks afford excellent views of the Upper Murray environs.

The Flaggy Creek basin and Mount Lawson area has large stands of red cypress pine, rocky cliffs and scarps, a spectacular gorge and waterfalls, and remains of tin-mining operations, all set in a forest environment.



Brown trout (top) and rainbow trout are abundant in many streams

Aboriginal rock shelters exist near Flaggy Creek and near Koetong Creek.

A large unbroken tract of steep mountainous country comprising the Wabba block, which is traversed only by 4-wheel-drive tracks, offers opportunities for cross-country driving, hiking, and camping.

Summary

Examination of social and economic factors and present trends indicates that the general level of recreation activity will increase greatly in the

Table 16

MAIN TYPES OF OUTDOOR RECREATION IN THE NORTH-EAST AND THEIR LAND REQUIREMENTS

Types of recreation	Land requirements
Passive outdoor pursuits	
Driving for pleasure	General protection of diversity in the landscape
Sight-seeing	Preservation of historic points, scenic lookouts, and outstanding natural features
Picnicking	Provision of suitable facilities in open-space surroundings readily accessible from urban centres
Nature walks	Preservation of natural areas, provision of walking tracks and interpretative services, and exclusion of vehicles
Walking for pleasure	General protection of diversity in the landscape, and provision of access to areas of public land, including stream frontages and shoreline; exclusion of vehicles from some areas
Recreation on developed sites	
Organized outdoor sport	Some areas of public land may be required for golf courses, football grounds, and airfields close to urban centres
Caravanning	Provision of facilities in pleasant surroundings

Table 16 (contd.)

Types of recreation	Land requirements
Open-country recreation	
Hiking	Preservation of extensive areas of open space, particularly areas with diverse landscape and outstanding natural features; exclusion of vehicles from some areas
Camping	Provision of suitable facilities in areas of open space close to water and outstanding natural areas
Hunting	Preservation of habitat for game species
Cross-country driving	Provision of open-space areas that can withstand this type of recreation, some distance from areas being used for other forms of recreation
Horse-riding	Provision of open space with paths
Water-based recreation	
Swimming or sun-bathing	Provision of access and suitable facilities at safe beaches and other swimming areas, particularly those close to urban areas
Boating	Provision of access and suitable facilities along stream frontages and shorelines
Fishing	Provision of access to stream frontages and shorelines; protection of stream banks and aquatic habitats

Waterfall in the Flaggy Creek gorge

future. Decisions to reserve adequate land resources for recreation should be made now.

The most popular localities are around Lake Hume and the natural areas around Corryong. Most of the people using the area come from Victoria and New South Wales; some of them reside in the rapidly growing urban centre of Albury-Wodonga. This factor, together with the district's proximity to major snowfields in Victoria and New South Wales, suggests that the relatively low level of recreation activity of this naturally well-endowed area may show sharp increases in the future.

Areas that are little used at present may experience very high, even destructive, pressures in the future.

References

Australian National Travel Association. "A course for travel development in the Upper Murray Region." February 1972.

Boden, R.W. The role of ecology in the provision of rural recreation. *Proceedings of the Ecological Society of Australia,* 1969, 4, 8-16.

Burton, T.L. (ed.) "Recreation Research and Planning." (George Allen and Unwin: London 1970.)

Clawson, M. The crisis in outdoor recreation. *American Forests,* 1959, 65, 22-31.

Clawson, M., and Knetsch, J.L. "Economics of Outdoor Recreation." (Johns Hopkins Press: Baltimore 1966.)

McMichael, D.F. Society's demand for open-air recreation wilderness and scientific reference areas. *Proceedings of the 6th Conference of the Institute of Foresters of Australia, Thredbo* 1971.

Mercer, D. Urban recreational hinterlands: a review and example. *The Professional Geographer*, 1970, 22, 74-8.

Outdoor Recreation Resources Review Commission. "Outdoor Recreation for America." (U.S. Government Printing Office: Washington 1962.)

Webb, L.J., Whitelock, D., and Brereton, J.LeG. (eds.) "The Last of Lands." (Jacaranda Press: Melbourne 1969.)

AGRICULTURE

Agriculture supports a very high proportion of the people of the study district. The towns of the district are largely service and retail centres for the surrounding countryside. About 40% of the total area of the district has been cleared and carries pastures. A further 20% is scrub and timbered country, which is also grazed lightly. Unfortunately, the boundaries of the study district do not coincide with published statistical units; however, statistics for the Shires of Upper Murray and Towong are presented as an indication of trends in the agriculture of the region. Virtually all of the agricultural land of the Upper Murray Shire lies within the study district, but only about half of the Towong agricultural land is included.

Present Use of Agricultural Land

Present agricultural use is displayed on the primary production map that faces this page.

Beef cattle production is the dominant industry throughout the district. Dairying and sheep for meat production are the other main industries, but their importance is declining. Little cropping takes place, apart from oats and fodder crops sown for grazing.

Small areas of fodder crops, perennial pasture, and vegetables are irrigated from streams (see Chapter 21, Water Utilization), and several small apple orchards grow in the district. Table 17 and Figure 6 show the land use and livestock trends for the Shires of Upper Murray and Towong during the period 1960/61 to 1970/71.

Beef production

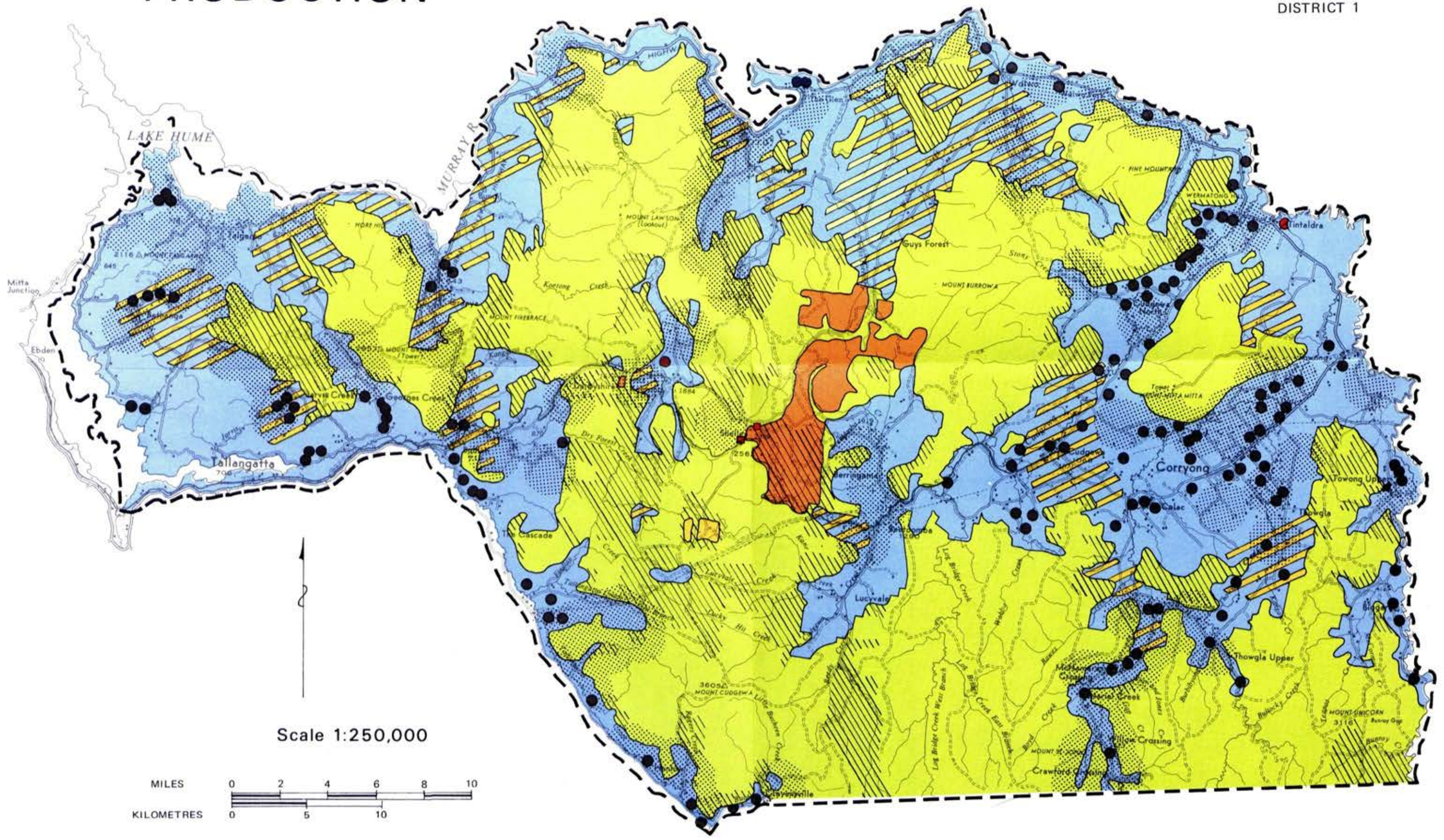
Although beef production is traditional in the area, it has been reinforced in recent years by a strong movement of dairy and sheep farmers into the industry. Almost all cattle-producers own some breeding cattle, but many have large fattening enterprises that buy store steers and fatten them on pasture. The Hereford is the dominant beef breed in the district, but the Murray Grey - which originated in the Thologolong area of the study district - is also very popular.

In addition to direct sales for slaughter, this district is likely to continue to supply breeding cattle and stores

PRIMARY PRODUCTION

LAND CONSERVATION COUNCIL
VICTORIA

NORTH EASTERN AREA
DISTRICT 1



LEGEND

- Cattle
- Sheep for meat
- Sheep for wool
- Dairy farm
- Grass seed production
- Dominantly potatoes
- Orchards—deciduous
- Forest grazing
- Honey production
- Softwood production
- Protection forest and/or Hardwood production—extensive

Note: Width of coloured band denotes degree of land use dominance, e.g. Cattle, primary use; Sheep for meat, secondary.

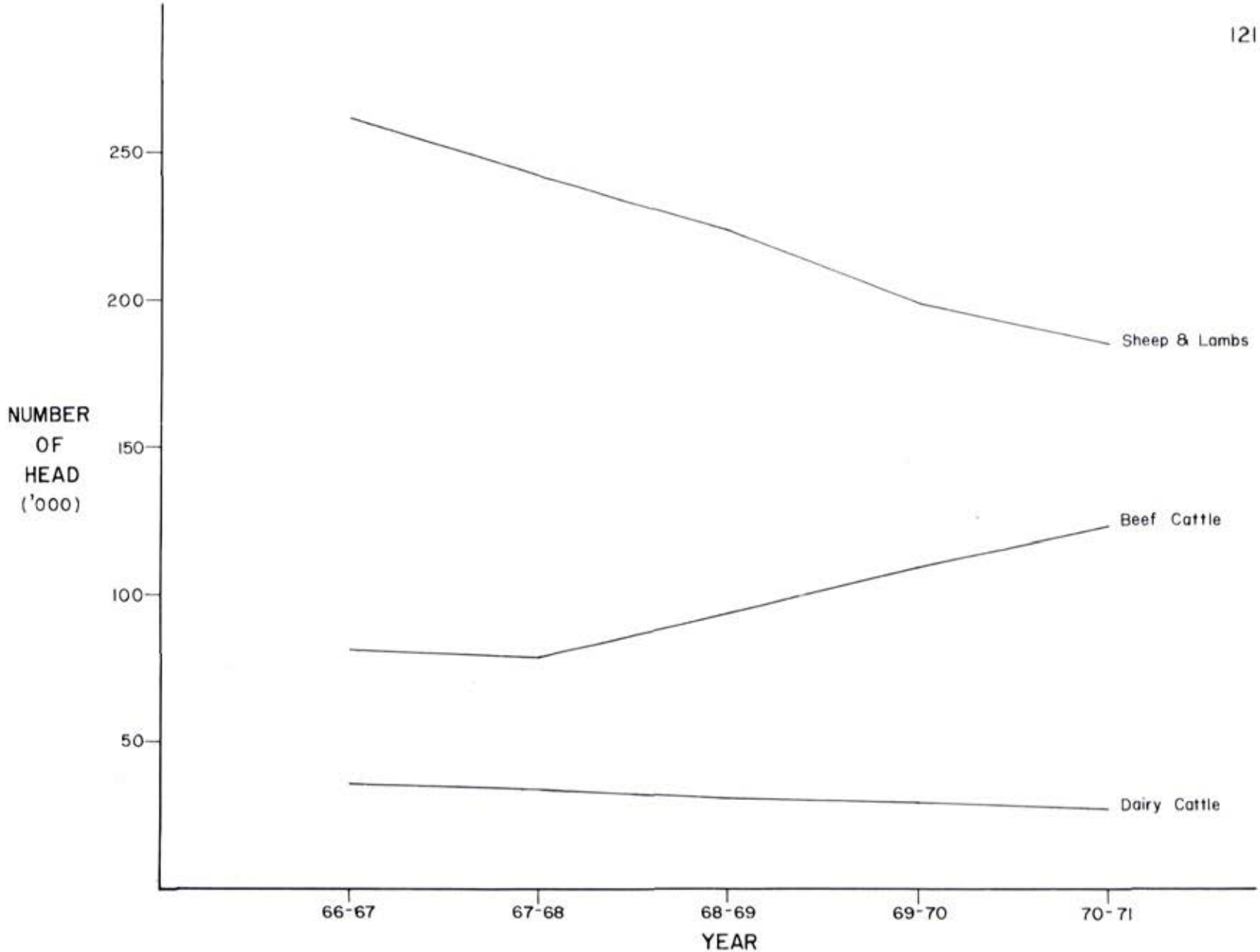


Figure 6. TRENDS IN LIVESTOCK POPULATIONS

Table 17

LAND USE 1960/61 and 1970/71

Shire	Upper Murray		Towong[1]	
	1960/61	1970/71	1960/61	1970/71
No. of holdings	288	289	491	500
Area occupied (acres)[2]				
Total	304,965	317,177	424,092	393,277
Crop	887	1,708	2,776	2,881
Native pasture	102,237	164,269	270,510	128,059
Sown pasture	68,817	131,227	75,783	229,378
Balance	132,696	19,688	74,843	31,397

1 The district contains only about half of the agricultural land of the Shire of Towong, but nearly all of the Upper Murray farms

2 Conversion: 1 acre = 0.4047 hectares

for fattening in other parts of Victoria and New South Wales.

Dairying

The district contains about 150 dairy farms, largely concentrated along the Tallangatta, Cudgewa, and Corryong Creek valleys. They average about 200 acres, but some larger properties run dairy cattle with beef cattle or sheep. In the Cudgewa-Corryong area most farms supply cream to the local butter factory, but in the Tallangatta area the majority of farms are supplying whole milk and the trend is in that direction. The farms supplying cream usually run pigs to use their skim milk. There is

also a tendency to use beef bulls on dairy cows, to produce cross-bred calves for beef production. The main calving period on dairy farms is autumn to early winter.

Sheep

About 60 farms concentrate on fat lamb production and only three on wool production. Most of these properties also run beef cattle and some would carry dairy cattle. They practise autumn-winter lambing and generally sell mid-season lamb. The most common breeds used for fat lamb production are Dorset Horn rams on a first-cross ewe. Although some parts of the district are well suited to sheep production, economic factors have encouraged the trend towards beef.

A sheep farm near Bethanga

Beef cattle grazing in the Georges Creek valley

Development Potential of Alienated Lands

In the past decade, the grazing capacity of the district has increased very substantially. Since 1960/61, about 50,600 ha (125,000 ac) of additional pasture land has been cleared on farms; the area recorded as sown rather than native pasture has doubled in Upper Murray and trebled in the Shire of Towong. Livestock numbers in the two shires have increased by more than 25% in terms of dry-sheep equivalents in this same period.

Most of the pastures are established on the reddish duplex soils of the mature

Ringbarked area at Koetong ready for clearing and pasture establishment

river valleys and plains. These good agricultural soils have moderate surface permeability and good sub-surface drainage. They have moderate levels of exchangeable calcium, magnesium, and potassium, and fairly high total potassium levels. The surface soil is relatively acid, but probably not so acid as to require lime for clover establishment. Superphosphate applications can produce optimum results from improved pastures.

Alluvial brownish loams are the dominant soils of the stream flats. These are relatively well-drained despite their low topographic situation. Occasional winter or spring floods may make it difficult to prevent weeds from becoming established, and flood debris often hinders management. Generally these soils can carry high-productivity pastures, possibly of perennials, in most places. They may be too wet for sheep during the wetter months, but should be ideal for cattle-grazing throughout the year and for sheep in summer.

The sown pastures are largely based on subterranean clover and perennial ryegrass, but phalaris and cocksfoot are now being sown on many areas and white clover is used on the higher-rainfall and river-flat areas. Although some potential to sow more native pasture areas to improved species still exists, much of the remaining unsown area is too steep for ground machinery, and aerial topdressing is the only practicable means of pasture improvement. Native and sown pastures have received about 10,200 tonnes (10,000 tons) of superphosphate per year in recent years, or about 125 kg per ha (1 cwt per ac).

Stocking rates vary widely between farms, localities, and land systems, but the present aggregate stocking rate

is equivalent to about 2 dry sheep per acre of sown and native pasture. Winter cold is one of the major limits preventing an increase in this figure.

Seasonal adjustments in the livestock enterprises and increased transfers of feed to the winter period are the main methods by which the carrying capacity and stocking rate could be raised. Farms have considerable potential for increased conservation of spring and summer pasture production for use in the winter, and may also have scope for additional livestock enterprises that have lower winter feed needs. In 1970/71, only 3% of the sown pasture area in the Shires of Upper Murray and Towong was cut for hay. Greater use of fertilizers and the development of pasture species more suited to winter cold could also increase pasture production and enable more livestock to be carried.

Higher stock numbers may also be possible through future expansion of irrigation, both from existing streams flowing through the district and from catchment irrigation schemes along the valleys.

About 80,000 acres, or 20% of the private land, is covered with scrub and timber. This is mainly land with poorer-than-average capability for agriculture. In addition, many slopes with a southern aspect carry poor weed-infested pasture. Both of these situations allow some scope for agricultural improvement.

In summary, the private lands of the district have been subject to considerable agricultural development in the past 15 years. Opportunities exist for further improvement, but the effect of winter cold upon pasture growth must be recognized. Livestock enterprises with lower winter feed needs may prove a suitable basis for additional development.

Outlook for Livestock Products

The prosperity and future development of agriculture in the district will largely depend on the future market prospects for its main livestock products, particularly beef, as this industry is likely to increase its dominance over other agricultural pursuits in the district.

Haymaking under way on alluvial flats near Biggara

In addition to the apparent strong demand, a very favourable long-term outlook exists for beef cattle and beef, which this district is well placed to supply. For most other agricultural activities, the longer-term market outlook is not so favourable as to encourage expansion in this district.

Agricultural Capability of Public Land

Part IV of this report discusses the agricultural capability of specific areas of public land in the study district and the present use of such land. Considerable areas of forested public land are leased for grazing by sheep and cattle, but land used in this way does not have a high productive capacity. The largest areas leased are in the Bunroy block (1,600 ha), Mount Cudgewa block (3,000 ha), Wabba block (5,300 ha), and Lucyvale block (6,400 ha). In most leased areas average annual stocking rates would be less than one sheep to 6 ha (16 ac), and many leases are only used for parts of the year. However, stocking rates around Koetong may be as high as one sheep per acre. Sheep graze cleared public land at "Avondale", and about 500 sheep graze in the pine plantation at Shelley.

Beef cattle graze these pastures at Berringama; the hills in the background carry bracken fern and scrub

Physical and economic factors must be considered together in assessing the future capabilities of land for agriculture. The major physical factors that influence the assessment of agricultural potential in the district comprise topography, rainfall, temperature, location, soils, and existing vegetation.

Economic factors that need to be considered are land-clearing and development costs, possible levels of production or yields, accessibility of markets, and the price outlook for the various products.

This chapter can discuss capability in broad terms only, as most of the factors vary considerably throughout the district: Any assessment of the agri-

cultural capability of a specific area would involve detailed study of each of these factors as it applies to that area. This is done to some extent in the block descriptions.

In some areas in the district, such as at Koetong, horticultural crops or vegetables could be grown, but accessibility to markets in competition with much more favoured areas elsewhere would limit the development of these industries in the study district.

In general terms, the main potential agricultural use of public land in the district is for grazing of beef cattle and/or sheep. In this regard, the steep montane slopes of all land systems in the study area have low potential or are unsuited to agriculture. Cultivation with conventional machinery is not practicable on slopes in excess of about 12% (7 degrees) and so steeper areas could only be used for beef-grazing using native pastures.

Elevations above about 610-760 m (2,000-2,500 ft) experience low temperatures in winter, which severely limit pasture growth (see Figure 4, page 34).

Capability of the main soils

Friable reddish gradational soils are widespread on the Koetong uplands, but also occur on areas of low relief in the higher-rainfall areas. They are usually deep and permeable and have a relatively good physical condition. Phosphorus is well supplied in total amount, but available phosphorus is fairly low. Because the soils are relatively acid and appear to be moderately high in sesquioxides, any application of superphosphate to increase fertility may need to be heavy or frequent to overcome the tendency to phosphorus fixation.

Sheep grazing at "Avondale"

Pasture establishment potential on these soils varies. In some areas, subterranean clover can be established readily, but others need several years

of topdressing with superphosphate before the clover becomes established. Variability in clover establishment may be associated with cultivation methods. Phosphorus fixation may also affect clover establishment, but this would be ameliorated by the use of heavier applications of superphosphate, plus lime drilled in with seed. The nitrogen status of the soil is low, and so several years of clover dominace may be needed before perennial grasses will become established.

It is difficult to assess the potential carrying capacity of pasture established on these soils, as winter temperatures on the uplands would necessitate considerable hand-feeding or movement of livestock to warmer areas. However, once fully established (5-6 years after sowing), improved sown pastures could probably carry about 4-6 dry sheep per acre or their equivalent in other stock.

Weakly bleached massive gradational soils have a generally low agricultural capability. These soils of the hill slopes have poor structure and low permeability and are thus prone to erosion, particularly on the steeper sites. In addition, they have low effective moisture-storage capacities. Levels of exchangeable calcium, magnesium, and potassium appear to be generally satisfactory. They have relatively high total reserves of phosphorus and potassium and little free ferric oxide.

When the land is used for grazing, exposure of the bare soil should be avoided and maintenance of maximum ground cover is desirable on the slopes of more than about 25% (14 degrees).

The application of superphosphate in moderate amounts should raise the available phosphate content to a sufficient level for good pasture growth. However, the droughtiness of these soils means that pastures dry off earlier than on the reddish duplex soils of the lower country. Consequently, the hill slopes are not favoured for dairying or fattening unless farmed in conjunction with less droughty soils. The very steepness of the slopes alone creates problems in managing these soils for agricultural production.

References

Anon. "Rural Industries." (Commonwealth Bureau of Census and Statistics, Victorian Office: Melbourne 1960/61 to 1969/70.)

SOFTWOOD TIMBER

Pine plantations are a notable feature of the study district and comprise 5,290 hectares (13,000 acres) of *Pinus radiata* plantings situated on either side of the main Tallangatta-Corryong Road at Shelley.

Historical

Since 1880, several attempts to utilize land on the Koetong uplands for pastoral pursuits have met with little success, and some areas cleared by early settlers reverted to the Crown. These areas have in some parts returned naturally to a low-grade forest cover of native eucalypts.

During the late 1950s and early 1960s, the Victorian Forests Commission surveyed large tracts of relatively flat land, with rainfall and soils thought to be suitable for *Pinus radiata* growth, because of an expanded softwood planting programme in Victoria.

Early in 1961 the Commission completed an appreciation survey covering some 30,800 ha (76,000 ac) of country in the Koetong Shelley locality. The survey indicated that some 24,300 ha (60,000 ac) of public land and private property were suitable for *P. radiata* culture.

The whole of the prospective plantation lay within the catchment of Lake Hume.

In 1961 the Land Utilization Council determined that forestry was the best form of land use and, as a result, the Department of Crown Lands and Survey made available to the Forests Commission the majority of the area which is now under plantation.

Works commenced in March 1961, with site headquarters at Shelley, 27 miles from Tallangatta. First plantings took place in 1962, and plantings to date total 5,293 ha (13,078 ac) net. Privately owned land totalling 6,744 ha (16,664 ac) has been purchased for plantation purposes at a total cost of $229,000 (approximately $14 per acre).

Protection belts along permanent streams in the northern part of the plantation have been left for water supply purposes, to provide animal habitat and corridors, and to provide aesthetically desirable break-up within the plantation. Amenity plantings have been

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established along roadways and points of scenic interest.

Industry requirements

In general, the industry requires plantations in large compact blocks, close to centres of population and served by good transport facilities. Large plantations enable the owner to benefit from economies of scale in establishment, fire protection, roads, and maintenance costs. The flat terrain of the Koetong uplands is ideal for mechanical planting and harvesting. As log transport costs make up a high proportion of the cost of raw materials, the plantations must be located close to the milling centre.

Forests Commission pine plantation on the Koetong uplands at Shelley

The most efficient utilization of raw materials is achieved by a complex of integrated industries, which can handle small-size material from thinnings as well as logs and in which one industry can utilize the by-products of another. However, modern wood-processing plants such as sawmills and particle-board plants are capital-intensive installations, and an assured supply of raw material is a prerequisite to their construction.

In general, economies of scale are realized in plantations larger than 10,000 acres, and a plantation resource of the order of 40,000 acres is necessary to support an integrated complex of industries, the main components of which would be a large sawmill and a ground-wood pulp factory. Such industries need guaranteed supplies of volumes of timber. Continuity of supply has been guaranteed for establishment of such industries in the past in Victoria.

Outlook

It is difficult to make even short-term forecasts of demand for a commodity, and longer periods increase this difficulty enormously. However, for forest crops, current planting rates must be based on forecasts of the amount and nature of consumption in 30-40 years' time. In Australia, the current planning is based

on forecasts of demand for the year 2000.

The demand for softwoods

Australian native softwood resources are restricted to some rain-forest species in the tropics and Tasmania, and the slow-growing *Callitris* forests of the dry inland. These forests make up only 4.8 million acres of a total commercial forest area of 87 million acres. Moreover *Callitris*, the main genus, produces only small-size timber that is relatively dense and is not generally suitable for the variety of uses to which exotic softwood timber may be put.

Australia's forest products industries have expanded and become more sophisticated with the country's growth in population and affluence. Many of these industries prefer softwood as the raw material, due to its lightness, lack of defect, and pulping and chipping characteristics. Australian production of softwoods has remained at a low level, and so large volumes have been imported.

After the wool boom in the early 1950s, Australia entered a phase in which balance-of-payments difficulties were a prominent economic problem. Forest administrators began to express concern at the high volume of softwood imports and the future implications of a dependence upon imports. Jacobs stated this concern, and a plan for reducing such dependence, in the following way:

* Australia's import bill for timber and timber products is about $200 million per annum.

* This import bill is so high that it acts as a constraint on the development of the nation.

* Population and *per capita* consumption will increase, and so shortfall in timber supply will be greater in the future. As its basis for planning, the Commonwealth Government has used 1,100 million cubic ft of forest products as an estimate of Australian annual requirements by the year 2000 A.D.

* Australia has large areas of land suitable for growing conifer forests, which could produce substitutes for most of our present imports.

* In future it may not be possible to find adequate supplies of wood on world markets, as countries that export at present will be forced to direct their resources to satisfying domestic markets.

* The reliability of imports may be threatened by wars and internal economic controls.

Jacobs suggested that half of Australia's requirements in 2000 A.D. could be grown on 3 million acres of coniferous plantations and the remaining half on 25 million acres of native forest.

He also pointed out that any programme to implement such a plan should be reviewed periodically in the light of revised supply and demand estimates.

Parkes and others have criticized these arguments on several grounds, which include the following opinions:

* Undue emphasis has been placed on balance-of-payments difficulties, as Australia has recently accumulated large reserves of foreign exchange.

* Even if Australia faced an unfavourable trade balance, the substitution of locally grown timber for imported timber may not be the best means of improving the balance. If Australia is comparatively more efficient in other industries, it would be to the general advantage for new investment to be concentrated in those industries. Australia would then rely upon softwood imports from existing sources, including New Zealand, and perhaps encourage the development of timber industries in Papua-New Guinea, Indonesia, and Malaysia. Thus each country would produce and exchange the goods in which it has a comparative production advantage.

* Australia's imports of timber products are not high compared with those of other important trading nations such as the United Kingdom, West Germany, and South Africa.

* Some recent predictions of consumption and yield suggest that the current planting programmes will produce a surplus of timber within Australia after the year 2000.

However, the Commonwealth Government has accepted the need for greatly increased softwood plantings, subject to review every 5 years, and the arrangements for this are outlined below.

Commonwealth Act

In 1967, the Federal Government passed the Commonwealth-States Softwood Forestry Agreements Act to ratify an agreement between the Commonwealth and the States, meeting as the Australian Forestry Council. The agreement was renewed in 1972. The Act is designed to overcome the projected shortfall in the supply of softwood in Australia and provide Commonwealth financial assistance to help the States undertake expanded softwood planting programmes. The national target is 1,200,000 ha (3,000,000 ac) of plantations by the year 2000. The target for all the State Forest Services for the first 5-year period 1967-1971 was 103,900 ha (256,800 ac).

Victoria planted 20,200 ha (50,000 ac) during this period. The State financed the first 2,430 ha (6,000 ac) of planting in each year and the Commonwealth the balance with loan funds that are interest-free for the first 10 years.

The Victorian Forests Commission expects to plant 4,690 ha (11,580 ac) a year for the current 5-year period, which ends in 1976. Private companies will plant about 2,630 ha (6,500 ac) each year, bringing the total for the State to about 7,300 ha (18,000 ac) a year. Private companies are not assisted by the Commonwealth.

The study district.

The Forests Commission aims at providing a softwood resource that will support an economically viable industry in north-eastern Victoria. Achievement of this aim requires not only that the area be suited for pine growth, but also that the plantation complex be reasonably consolidated, to provide large volumes within economic range of suitable industrial sites.

The Forests Commission plans to establish at least 40,000 ac (net) of plantation in the Koetong-Shelley area, relying on conversion of timbered public lands and purchased farmland.

At the present rate of planting, the plantation has the potential to sustain a particle-board plant within 5 years and a sawlog industry by 1980. Minor utilization began in the plantation in 1970 to produce fencing materials - posts, strainers, and rails.

Based on an annual planting programme of 405 ha (1,000 ac) for the next 30 years,

Thinnings in the young pine plantation at Shelley yield small round posts

the projected potential would suggest that the plantation should yield an anticipated ultimate annual timber production of 125 million super feet, employing some 1,200 men in both the plantation and dependent industries - obviously an aid to decentralization and rural employment.

High timber yields and low extraction costs will help offset remoteness of markets for timber products. The area has potential local markets for softwood products and is within economic range of the southern Riverina and Canberra. Major road and rail links to Sydney and Melbourne will assist in tapping Australian and world markets.

Pine posts being loaded for transport to a post-preservation plant at Corryong

Capability

Requirements of radiata pine

Sites for commercial plantations of radiata pine require:

* a minimum annual rainfall of 30 in.
* an acid soil of at least moderate fertility
* soils with physical characteristics that allow vigorous root growth and with sufficient volume to support an adequate root system
* soils with good drainage but adequate soil-moisture storage characteristics

Rainfall

The map facing page 28 indicates that most of the district has a rainfall of 30 in. or more.

Soil fertility

Phosphorus, which is important in pine nutrition, is well supplied in total amount on the friable reddish gradational soils on which most pines are grown, but available phosphorus is fairly low. Responses to superphosphate treatment confirm this. Site quality reflects a range in soil fertility to some extent, and this may indicate deficiencies of one or more plant nutrients. Pines on low-quality sites have shown significant responses to boron applications.

Physical soil properties

The friable reddish gradational soils are strongly structured in the upper part of the topsoil but only moderately to weakly structured below this. They are generally well drained, except in some low topographic positions and in drainage lines.

Table 18

SITE QUALITY FOR RADIATA PINE

Site quality	Site Index height (ft) at age 20	Total yield over 30 years (cubic ft under bark to 4 in. ØSE per acre)*	Average annual yield+
I	102	13,660	455
II	96	12,170	406
III	90	10,660	355
IV	85	9,230	308
V	79	7,650	255
VI	71	5,440	181
VII	61	3,390	113

* ØSE - small-end diameter of the log

\+ Approximately half of this volume comprises sawlogs with a small-end diameter exceeding 8 in. (8 in. ØSE)

Measurements indicate that available water storage capacities of these soils are not high, as reflected by retarded early growth of pines, due partly to competition with grass for moisture. This effect in establishment can be minimized by management techniques.

Site quality

Although radiata pine grows quite rapidly in this region by world standards, wide variations in growth rate occur due to differing site factors. Plantations are assessed and placed into

site quality classes (SQ) at about 10 years, to form the basis for calculating growth rates and the quantities of the various classes of log material that will become available for industry. The sole criterion of site quality is the total volume of timber produced.

Seven qualities have been defined. Five (SQ1-SQV) cover healthy stands; SQVI means marginally healthy, and SQVII ranges from marginal to failed.

The site quality of a stand can be estimated from the height of the trees at the age of 20, called Site Index: a stand with a Site Index of 90 would fall into class SQIII. Table 18 sets out the productivities of the different classes.

It is not possible to classify a site accurately until a stand of trees has actually grown on it. However, the form and composition of native vegetation, and soil, climatic, and topographic factors, are useful indicators of suitability for radiata pine.

Table 19

RADIATA PINE SITE QUALITY AT SHELLEY

Top height range at age 9 years	Site Index (S.A. formula)	Site quality	Percentage of area
53' - 57'	110'	I+	4
48' - 52'	100'	I - II	34
43' - 47'	90'	III - IV	38
39' - 42'	80'	V	16
34' - 38'	70'	VI	9
			100

Table 19 summarizes a recent survey of 1962 plantings at Shelley.

The survey measured a total of 107 sample plants distributed systematically throughout the 1,015 acres of 1962 plantings. Examination of the results shows that 88% of the area is of site qualities I-V, with 72% being of site qualities I-IV (see table). A small area (4%) exhibits site-enhancement from localized burning of slash rather than inherent superiority of site.

Predicted volumes

Data from the sample plots have formed the basis for predictions of volumes on the 1,015 acres at age 20 years (1982) for various small-end-diameter limits of the logs. These volumes have been calculated at 5.1 million cubic feet overbark for a 4-in. ØSE log and 1.6 million cubic feet for an 8-in. ØSE log, giving yields of 5,000 cubic feet per acre and 1,600 cubic feet per acre respectively at age 20 years.

Table 20 divides the land in the study district into categories based on suitability for radiata pine. These form the basis for descriptions of pine potential in Part IV.

Other softwood species

On southerly slopes at the higher elevations, where rainfall is high (45-50+ in.) and temperatures are cool, Douglas fir *(Pseudotsuga menziesii)* is suitable as a softwood plantation species.

The expected yields would be of the order expected from radiata pine site qualities II and III.

References

Australia, Commonwealth. "Softwood Forestry Agreement Act 1967." (Commonwealth Government Printer: Canberra 1967.)

Jacobs, M.R. To what extent should Australian foresters plan for national demand? *Australian Timber Journal*, 1963, 29, 235-42.

Jacobs, M.R. Forecasts for the future. *Australian Timber Journal*, 1966, 32, 35-43.

Jacobs, M.R. The need for planning future Australian timber supplies. *Australian Timber Journal*, 1966, 32, 30-5.

Jacobs, M.R. Market prospects for Australia's forest products. *Proceedings of the ANZAAS 43rd Congress, Brisbane* 1971.

Parkes, E.D. International comparisons of trade in forest products and some implications for Australian forest policy *Australian Forestry*, 1971, 35, 167-81.

Table 20

RADIATA PINE SUITABILITY CLASSES *

Category	Native vegetation	Major soils	Indicated pine potential	Slopes
A. suitable	Narrow-leaf peppermint open forest III (90-130 ft); some broad-leaf peppermint open forest III	Deep (4-6 ft) friable reddish gradational soils and friable brownish gradational soils	Site qualities of II to III	Mainly 0-15 degree slopes; some 15-20 degree slopes (costs of establishment and harvesting are relatively low on 0-15 degree slopes)
B. suitable to marginal (some unsuitable)	Broad-leaf peppermint open forest II (50-90 ft)	Shallow (2-4 ft) friable reddish gradational soils and weakly bleached massive gradational soils	Site qualities of IV to VI; these could possibly be raised by special site preparation and/or fertilizer applications; some site qualities would be VII	Mainly 15 to above 20 degree slopes; some 0-15 degree slopes
C. marginal to unsuitable	Red stringybark:long-leaf box open forest II (50-90 ft)	Weakly bleached massive gradational soils and reddish duplex soils, subject to summer drought	Site qualities of VI to VII	Variable
D. unsuitable	Red stringybark:long leaf box open forest I (less than 50 ft)	Weakly bleached massive gradational soils and undifferentiated stony loams	Not suitable for pine establishment	Slopes mainly 15 to above 20 degrees
	Swamp gum open forest II (50-90 ft)	Weakly bleached massive gradational soils and undifferentiated sandy loams	Not suitable for pine establishment; excluded from clearing operations	

* Sites at the high altitudes (greater than 3,500 ft) - where temperatures are lower and areas where rainfall is less than 30 in. - have not been included in this table, as they would be considered unsuitable for pine plantations.

HARDWOOD TIMBER PRODUCTION

The hardwood forests of the district are mostly low-quality mixed-species stands.

The forest types encountered range from river red gum, occurring as open forest and woodland on alluvial flats, to isolated pockets of mature and regrowth alpine ash at higher elevations. The forest red gum open forest and woodlands of the plains and hillocks grade into the red stringybark:long-leaf box forests of the montane slopes on drier aspects, and broad-leaf peppermint forests on the moister aspects. On steep rocky northern slopes red stringybark is reduced to a scrubby form less than 15m (50 ft) high, and is associated with long-leaf box, forest red gum, and red cypress pine. A peppermint-gum type occurs on the plateaux and broad ridges, mainly narrow-leaf peppermint and candlebark gum, with occasional blue gum pockets on moister sites and broad-leaf peppermint and long-leaf box on exposed sites.

Further variation results from the occurrence of swamp gum and black sallee on stream flats at higher elevations and snow gum on exposed rocky ridges greater than 3,500 feet in elevation. The occurrence of kurrajong, as isolated trees on dry northern aspects, is also of interest.

The red gum open forests and woodlands on river and creek flats and undulating to steep foothill country have mostly been cleared for farming. Clearing has also extended into the red stringybark: long-leaf box type and broad-leaf peppermint type in many localities.

The forest areas most suited for management for hardwood timber production consist of isolated pockets of varying size scattered over the plateau region and on moist, southerly slopes. Manna gum, narrow-leaf peppermint, and blue gum are considered to be the species of most commercial importance. Past utilization has had to rely on removing such commercial pockets of timber from within large areas of low-quality native forest.

Sawlog supplies

The total production of sawlogs from the district has been about 60 million super feet, the average annual production over the last 20 years being 2 million super feet. Currently only 1 million super feet is being drawn from the area annually, as an operation preceding con-

version of sections of the plateau country to *Pinus radiata*. It is doubtful if such areas carry more than 1,000 super feet of sawlogs per acre.

However, a number of areas of public land carry mill logs and poles in stands of importance to the local dependent industry. Significant stands, which may average 2,000-3,000 super feet per acre and may range up to 10,000 super feet per acre, occur at Mount Lawson, north of Koetong Creek, north of Darbyshire Creek, and in the vicinity of Rodgers Creek, Lucky Hit Creek, and Reedy Creek.

At present 600-800 acres of native hardwood are harvested each year to provide sawlogs. It is estimated that supplies can be maintained for about 5 years.

No detailed resource information is available, but indications are that 5-6 million super feet of sawlog-quality species remain to be converted in the Tallangatta area. Supply is exhausted in the Corryong locality, only isolated pockets of commercial species remaining in inaccessible areas.

Little silvicultural treatment has been carried out in the area, but it may be practically and economically feasible in selected localities. In general, little seedling growth follows logging and burning.

Evidence of some timber stand treatment can be seen at Lake Findlay, where ring-barking for grazing interests has produced regrowth stands of small logs and poles.

The sawmilling industry (including the two mills located in the study area but drawing log supplies from outside) employs 20 men full-time and 5 men part-time throughout the year.

Pulpwood supplies

An area of 32,000 ha (80,000 ac) of narrow-leaf peppermint forest in the district could yield pulpwood material averaging 800-1,200 cubic feet per acre. This pulpwood material would be produced from mature trees, logging residue, and some regrowth. However, the amount of future annual yields is unknown.

Other wood products

Apart from sawlogs, the main timber products obtained from the hardwood forests are round timbers for poles and fencing materials, split posts, and firewood. These are mostly for local consumption.

The district has produced 1,858 poles during the last 10 years, mainly from blue gum and manna gum. The best pole areas average only a quarter to a half a pole per acre. Only 3,000 poles altogether have been removed from the study district. Those remaining are confined to isolated and inaccessible pockets of land.

A treatment plant for the pressure impregnation of native eucalypt round timbers is located at Corryong. Posts, rails, and shed poles cut from regrowth stands of blue gum, peppermint, and some stringybark (resulting from early ring-barking) are treated for the local market. Annual supply would not exceed 2,000 pieces.

A licence was issued in 1969 for the picking of 400 tons of *Eucalyptus macrorhyncha* leaf for intended rutin production, however the licence has not been acted on to date. Royalty was fixed at 50 cents per 100 lb green leaf weight.

Capability

Very little evidence of growth rates of the commercial species is available. Blue gum regrowth stands, which have had large cull trees removed, show growth rates of the order of 30 cubic feet per acre per annum (to 12 in. ØSE).

Experimental plots planted with various eucalypt species likely to have high growth rates have provided inconclusive results in relation to predictions of volume production.

It is noteworthy that southern blue gum *(E. globulus)* grown in South Gippsland under plantation conditions for pulp production (including clearing, site preparation, and fertilizer treatments) could possibly produce up to 250 cubic

An alpine ash regrowth stand by the Gibb range road

feet per acre per annum (to 4 in. ØSE) in a 10-year cycle.

Limited areas of the highly productive alpine ash stands grow in the district. These need relatively long rotations (60-80 years) to produce mill logs. Their average growth rates during this period would be of the order of 300 cubic feet per acre per annum (to 12 in. ØSE).

ECONOMIC MINERALS

Various minerals are mined in this district. However, the major products now being worked are tin and fluorite.

Tin

Apart from its main use (as a protective coating for copper, steel, and other stronger metals), tin is widely used in alloys with other metals.

The chief belt of tin mineralization in Victoria extends from Walwa, south to Mount Wills, and south-west to Eldorado near Beechworth.

The most important ore of tin is the mineral cassiterite. Because of its high specific gravity and resistant nature, cassiterite is readily concentrated in alluvial deposits. Primary or lode tin deposits are generally associated with granitic rocks high in silica and potash, with very little lime or magnesia. Commonly the lodes occur as pipes or veins of pegmatite, aplite, greisen, quartz, or quartz feldspar porphyry, either within the source granite or in the adjoining country rock.

In the past decade, rising world demand for tin has attracted small prospecting groups and public companies into this tin belt. But, despite much exploration activity in north-eastern Victoria, no major discoveries have resulted. Tin production at Koetong has been minor. At Walwa low-grade stanniferous aplite dykes are mined by open-cut methods.

Between 1960 and 1968, 230.5 tonnes (226 tons) of tin concentrate were produced in Victoria. During this period Koetong field produced 10.2 tonnes (10 tons) and Walwa field 115 tonnes (113 tons). In 1969 and 1970, a total of 12 tonnes (10.8 tons) of tin concentrate was mined at Walwa and production is continuing.

Koetong field

Practically all the tin from the Koetong tin-field has come from alluvial deposits along stream flats or Tertiary gravel deposits. Localities include streams adjacent to Koetong and Shelley, and near Dry Forest and Flaggy Creeks. Reserves of alluvial tin are likely to be limited, as the alluvial flats and terraces are narrow and have already been worked to a large extent. However, deeper alluvial material along larger streams around the edge of the granite has not been properly investigated.

Primary tin lodes at Koetong and south of Mount Lawson do not persist in depth. The lodes appear to be too small and few in number to promise any worth-while reserves of tin ore.

Mount Cudgewa field

Tin has been won from both lodes and alluvial deposits in the past, but no production has been recorded since 1919. The tin lodes are narrow (30 cm or less wide) and have not been traced for strike distances of more than 50 m. Reserves therefore are likely to be small. Woframite and tourmaline occur with the tin in this field.

Alluvial tin has been worked in small streams near Mount Cudgewa, including

Sluicing for alluvial tin on Flaggy Creek; now abandoned

Separating the tin ore at "The Bounce" tin mine, Walwa

the headwaters of Cudgewa Creek. Downstream on Cudgewa Creek alluvial deposits are low-grade.

Walwa field

The Walwa field has produced the most tin in this district over recent years. The cassiterite occurs in aplite, pegmatite, greisen, and granite dykes,

which are either relatively short (up to 100 m or 300 ft), approximately 1 m (3 ft) wide, and dipping steeply, or relatively large sub-horizontal dykes with an irregular outcrop. The sub-horizontal of dykes offer the greatest potential for large tonnages of ore available by open cutting.

Mount Alwa mine has proved reserves of 520,000 tonnes (510,000 tons), with an average grade of the order of 0.2% tin. However, the distribution of tin within the dykes is very erratic.

At the Bounce Mine, a sub-horizontal dyke 6 m (20 ft) thick extends over a proved area of 85 m by 60 m (280 ft by 200 ft). Insufficient work has been done on this ore body to obtain any grade estimates. Tantalite is associated with the cassiterite at this deposit, and is discussed later.

Recent alluvium and old terrace deposits nearby do not seem to have been prospected, although they are almost certainly tin-bearing.

Mount Alfred field

Mining of tin lodes between Burrowye and Mount Alfred was carried on during the early 1880s. However, no further reports of any operations in the locality exist and lack of information makes it impossible to assess either the possible grade or reserves for this field.

Fluorite

Fluorite is used in the basic open-hearth steel-making process, and in the manufacture of opaque glass, ceramics, and insecticides and pressure-pack propellants.

The only deposit being mined at present is at Pine Mountain. Here, fluorite occurs in a steeply dipping lode, averaging 1 m (3-4 ft) wide and extending about 120 m (400 ft). The ore is mined by underground methods and contains 60-90% fluorite. Zinc, silver, barium, and lead minerals are associated with it.

Fluorite also occurs at Sandy Creek in the Parish of Walwa. Here, the ore contains 43-67% fluorite.

Other Minerals

Gold

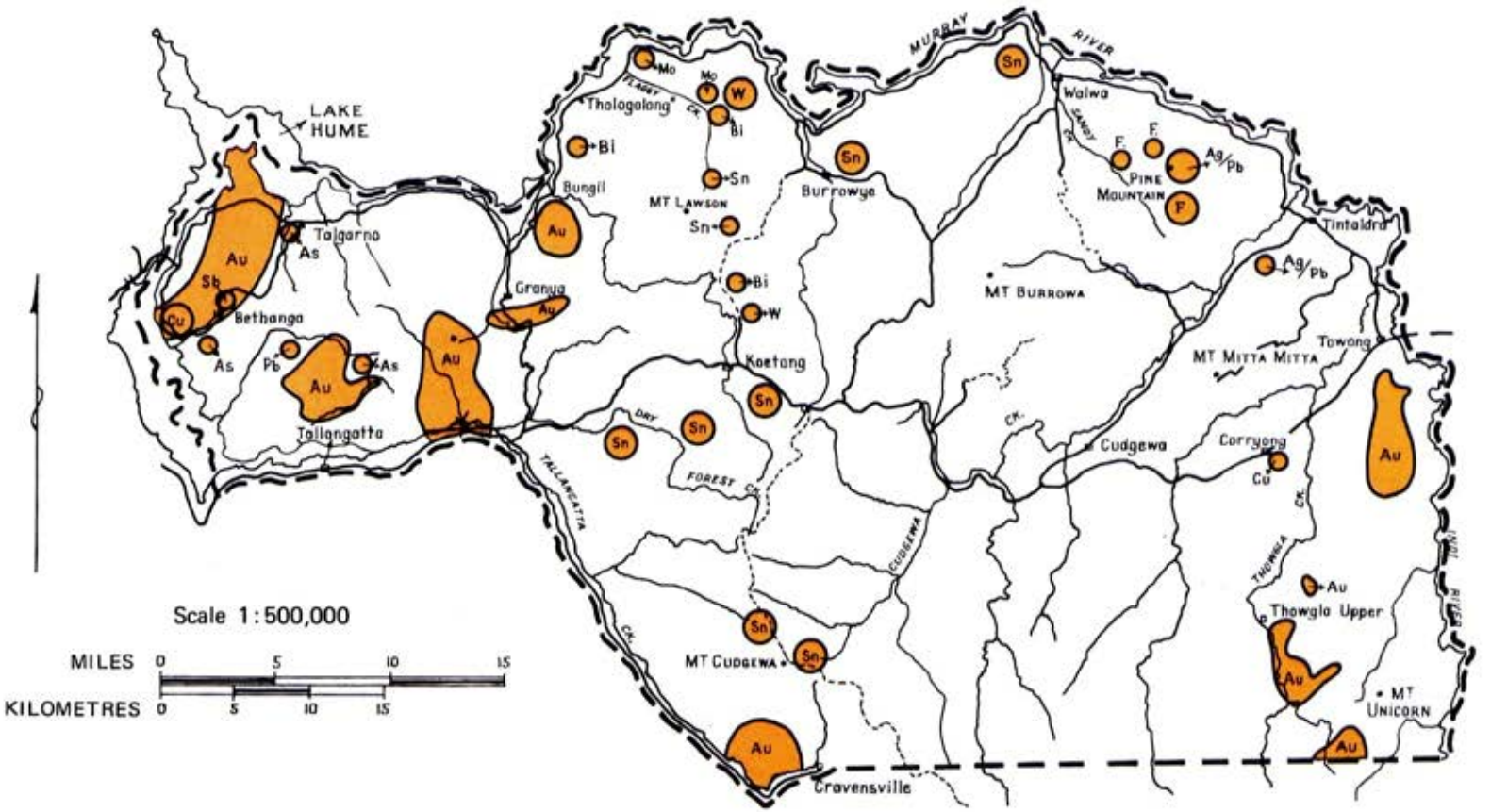
Although this district contains several gold-fields, no appreciable amounts of gold are being mined at present.

At Bethanga, gold occurs in steeply dipping veins within gneisses. It is associated with arsenic, iron and copper sulphides, and small quantities of lead and zinc sulphides. The thinness of the lodes and the difficulty of separating the gold by roasting or chemical methods have restricted economic development. Gold-bearing lodes at Jarvis Creek are also associated with arsenic and with

LAND CONSERVATION COUNCIL
VICTORIA

NORTH EASTERN AREA
DISTRICT 1

MINERALS



LEGEND

Outcrop area		As	Arsenic	Pb	Lead
Minor deposit		Bi	Bismuth	Mo	Molybdenum
Occurrence		Cu	Copper	Ag	Silver
		F	Fluorine	Sn	Tin
		Au	Gold	W	Tungsten

Adapted from "Mineral Deposits, VICTORIA, JULY, 1970", MINES DEPARTMENT, MELBOURNE

iron and lead sulphides. Very little alluvial gold has come from this field.

The Granya gold-field consists of numerous north-easterly trending lodes within granite and gneiss. The workings are mostly shallow and, in addition to gold, the reefs contain copper, arsenic, and iron sulphides.

Gold-fields at Mount Elliot and Upper Thowgla contain gold in reefs and in alluvium. Gold has also been worked at Bungil and Cravensville.

Molybdenum

Molybdenite has been recovered as a by-product of wolframite mining at Thologolong.

Antimony

Antimony occurs in small quantities near Bethanga.

Arsenic

Arsenical ores, chiefly arsenopyrite, form a considerable portion of the mineral content of lodes at Bethanga, and crude arsenic has been produced from here. Arsenic is also found in a narrow lode at Talgarno.

Copper

Copper, mainly in the form of sulphide ores, occurs in lodes at Bethanga and Granya. Indications of copper have been found near Corryong township, associated with dyke rocks in granite country rock.

Silver and lead

Silver and lead sulphide minerals have been recorded near Tintaldra. The lode mined for fluorite at Pine Mountain also contains silver and lead sulphides. Lead (as galena) has been mined near Bethanga, where it is a constituent of highly mineralized quartz lodes.

Tantalum and niobium

Tantalite has recently been reported in tin concentrates from Walwa. These contain up to 8% tantalum oxide and 4% niobium oxide, corresponding to an original grade of combined tantalum and niobium oxides in the rock of 0.02%.

Tungsten

The tungsten ores wolframite and scheelite both occur in the district. At Koetong, these ores are sometimes associated with tin. In 1911 it was reported that prospecting of the lodes had been unsuccessful because they did not persist in depth. Finds of tungsten have also been recorded near Thologolong.

Titanium

Ilmenite or black sand, a titanium mineral, has been found in alluvial deposits on Cudgewa Creek near Lucyvale.

Rutile, the main ore of titanium, was said to be common in the alluvium. Rutile and ilmenite are used in the manufacture of titanium-white for paint.

Barium

Barite occurs in small quantities in quartz-sulphide veins at Walwa and is associated with fluorite at Pine Mountain.

Bismuth

Bismuth is associated with wolframite and molybdenite in quartz reefs at Thologolong, where small amounts were obtained in a mixed concentrate as a by-product of wolframite mining. Occurrences have also been recorded at Flaggy Creek and south of Mount Lawson.

Gravel

Gravel for road-making is obtained from Tertiary and Pleistocene gravel deposits and alluvial terraces, and from Pleistocene to Recent alluvial fans. In some localities gravel has been removed from stream-beds. Demand for gravel is localized. Construction and maintenance of roads and the growth of Albury-Wodonga are the main factors influencing demand.

The main gravel pits occur:

* on public land to the west of Nariel Gap
* near Red Bank Creek between Walwa and Jingellic
* by the Murray Valley Highway north-west of Burrowye
* on public land on McCormack's Gap road near Thowgla
* south of Mount Mitta Mitta by the road from Corryong to Cudgewa North
* on public land near "Walwa Park"
* near Darbyshire
* in two pits located near Pheasant Creek

References

Anon. "Resources Survey. Preliminary Report, Upper Murray Region." (Central Planning Authority, Melbourne 1949.)

Anon. "Prospectors Guide." (Mines Department Victoria: Melbourne 1966.)

Bowen, K.G. Mount Alwa and the Bounce tin mines. *Mining and Geological Journal*, 1970, 6, 3-15.

Cochrane, G.W. Tin deposits of Victoria. *Mines Department of Victoria, Bulletin* No. 60, 1971.

Dunn, E.J. Corryong and Thowgla Creek. *Records of the Geological Survey of Victoria*, 1909, 3(1), 98-100.

Easton, J.G. Scheelite at Koetong. *Records of the Geological Survey of Victoria*, 1915, 4(4), 427-9.

Easton, J.G. The Mount Cudgewa tin sluicing mine. *Records of the Geological Survey of Victoria*, 1916, 4(3), 303-5.

Easton, J.G. Mount Alwa tin mine and Spicer's claim, Walwa. *Records of the Geological Survey of Victoria*, 1920, 4(4), 412-4.

Easton, J.G. Fluorspar at Sandy Creek, near Walwa. *Records of the Geological Survey of Victoria*, 1920, 4(4), 434-5.

Easton, J.G. Glengarry Mine, Tin Hut Reef, near Tallangatta. *Records of the Geological Survey of Victoria*, 1921, 4(4), 381-2.

Easton, J.G. Bounce tin mining company, Walwa. *Records of the Geological Survey of Victoria*, 1921, 4(4), 414-5.

Gregory, J.W. Mount Cudgewa tin field. *Bulletin of the Geological Survey of Victoria*, No. 22, 1907.

Leggo, M.D., and Beavis, F.C. Northeast Victoria. In "Regional Guide to Victorian Geology." Ed. J. McAndrew and M.A.H. Marsden. (University of Melbourne: Melbourne 1967.)

Singleton, O.P. Geology and mineralization of Victoria. *Eight Commonwealth Mining and Metallurgical Congress Melbourne*, 1965, 440-9.

APICULTURE

Apiculture is a small but important primary industry producing honey and beeswax.

The industry

Honey mainly provides a food for humans, but is also used as food for stock and in the preparation of meat, vinegar, some types of tobacco, and some pharmaceutical and cosmetic products. Beeswax is used in a wide variety of industries, the most important consumers being polish and cosmetic manufacturers. Pollen is being sought after as a protein health food.

Apiculture contributes to the welfare of some other primary industries; many fruit, vegetable, and seed crops of commercial importance depend almost completely upon the honey bee for pollination. Such crops include apples, cherries, plums, pears, pumpkins, clovers, cabbages, rape, sunflower, and lucerne.

Level of production

The Victorian production of honey during the last 5 years has averaged 3.3 million kg (7.3 million lb) per year. This represents just over 18% of the total Australian production of 18.1 million kg (39.9 million lb). A large proportion of Australian honey is exported to the United Kingdom, and in 1970/71 Victoria produced 4.45 million kg (9.8 million lb) of honey, of which 2.95 million kg (6.5 million lb) - 66% - was exported.

Beeswax is also exported, Japan and the United Kingdom being the main buyers. Of the 54,400 kg (120,000 lb) produced in Victoria in 1970/71, 45,800 kg (101,000 lb) or 83% was exported. This represents about one-third of the Australian exports.

The level of production can fluctuate considerably due to climatic conditions. For example, as a result of the 1967 drought, the 1968/69 production figure for honey was only 1.6 million kg (3.6 million lb) compared with the 1970/71 figure of 4.45 million kg (9.8 million lb).

Value

The number of apiarists registered in Victoria in 1970/71 was 1,278. Many of

these, however, have few hives and make an insignificant contribution to the industry. About 300 apiarists produce 90% of the State's honey and beeswax.

The net value of production (the value placed on recorded production at the wholesale price realized in Melbourne, less costs of materials used in the production process and less costs of marketing) during the past 5 years has averaged about $750,000 per year.

Outlook

World demand for honey has increased noticeably in recent times. One reason for this is that people in many countries now regard honey as a health food. It is a natural food that is very unlikely to be contaminated by insecticides. Supply has not been able to meet demand this past year, so present prices are high. Demand will probably increase in the future.

Industry Requirements

The honey bee

Australia contains a number of indigenous bee species. The honey bee used in apiculture, however, is the European species *Apis mellifera*. It is a social insect and lives in colonies or hives of up to 100,000 individuals.

Efficient production of honey requires that colonies of bees be kept healthy and at top strength, and that the colonies be relocated periodically so that they can readily harvest a continuous series of nectar flows.

Maintaining the colony

Bees collect nectar, water, pollen, and propolis from the field. They convert the nectar into honey, which is the major energy-producing food for the hive, and use water for drinking, for dilution of honey to make food for the bee larvae, and for cooling the hive. Pollen is the bee's sole source of protein. Propolis, a resinous exudation from certain plants, provides a general-purpose cement or putty about the hive.

In the natural state, bees collect and store sufficient nectar and pollen over the summer months to provide themselves with food for winter and for rearing young bees in spring. Thus, when a beekeeper manages bees for honey production he never harvests all the honey gathered by the colony, but leaves a large quantity (up to 180 lb a year). He must leave this for the prosperity of the colony. The beekeeper's crop is the surplus honey over and above the basic requirements of the hive. Adequate stores of pollen and honey must be available to the bees if they are to survive the winter and produce a full strength of young bees ready to commence harvesting the first nectar flows in the following season.

Importance of eucalypts

The principal supply of nectar in Victoria comes from eucalypts and a few other native trees and shrubs. The native ground flora, although important in other countries, is of relatively little importance as a source of nectar in most parts of Victoria. Introduced ground species such as cape weed and Paterson's curse contribute to honey yields, however.

The value of a particular eucalypt species to the apiarist depends on its flowering period and its yield of nectar and of pollen. Flowering periods vary, not only between species but also within species from district to district, due to local climatic effects. Flowering intensity varies from year to year, poor flowering being caused by low levels of food reserves within the tree, by adverse weather, or by insect attack or fire resulting in defoliation. As a general rule, however, the majority of important eucalypts flower heavily every second or third year. Some species are valued for their yield of either nectar or pollen, others for their yield of both.

Migratory beekeeping

Because of its dependence upon flowering eucalypts, beekeeping must be migratory. or nomadic. For maximum production of honey, hives are moved from district to district to coincide with peak nectar flows of various eucalypts over the summer months. Hives must be placed not only close to the nectar source, but also close to a reliable water source. An adequate source of pollen must be available too, especially in autumn when bees are storing food for winter.

The best localities for over-wintering hives are warm coastal districts or the so called desert areas of western Victoria and south-eastern South Australia. However, other localities in northern Victoria, such as the Warby ranges near Wangaratta, provide good wintering conditions.

Beekeeping in the district

This district is mainly used by apiarists who live in or close to it. Other users are migratory beekeepers, many of whom would come from the Wangaratta area to harvest red stringybark flows.

Pattern of use

Most colonies utilizing the area would be wintered in the locality and use the nectar and pollen from ground flora, white box, and broad-leaf peppermint to build up the strength of the hive for honey flows in the summer. Every second year, the forest red gum of the rocky hills starts flowering in late October (when the ground flora have nearly finished) and continues into November and early December. This

provides at least good breeding conditions for the bees and more than likely an extractable surplus of honey, depending on the quality of budding of the trees.

From early December, honey yields can be obtained from river red gum, blue gum, narrow-leaf peppermint, and candlebark gum. These species usually flower at about the same time. On alternate or

Table 21

IMPORTANT HONEY AND POLLEN-PRODUCING PLANTS OF THE DISTRICT

Species	Flowering period	Honey yield * (per hive per year)	Pollen yield
Red stringybark	Feb. - Mar.	Good: 30 lb	Good
River red gum	Dec. - Jan.	Good: 30-60 lb	Good
Cape weed	Oct.	Fair: 10-20 lb	Good
Blue gum	Dec.	Fair: 10-15 lb	Good
Forest red gum	Late Oct. - early Dec	Fair: 15 lb	Good
Long-leaf box	Mar. - Apr.	Poor: 5 lb	Good
Candlebark gum	Feb. - May	Poor: 5-10 lb	Good
White box	Nov.	Fair: 15 lb	Good
Narrow-leaf peppermint	Oct. - Nov.	Poor: 5 lb	Good
Broad-leaf peppermint	Oct. - Nov.	Poor: 5 lb	Good
Paterson's curse	Oct. - Nov.	Fair: 20 lb	Good
Red box	Sept. - Nov.	Poor: 10 lb	Poor

* 1 pound = 0.4536 kilogrammes

Beehives at a forest site

varying years, usually late in the summer, red stringybark flows usually provide good yields. These flows often bring a large number of migratory beekeepers into the area.

The bees breed prolifically during the flowering of all species (with the exception of red box) because of the abundance of pollen that is produced.

Important plants

Table 21 lists the plant species found in the study district and valued by apiarists, in order of magnitude of total honey yield. It also indicates flowering period and honey and pollen yields.

Value of the area to the industry

Figures collated from apiarists' records indicate that the district provides a livelihood for the equivalent of eight full-time apiarists and returns a total of $33,000 gross a year, based on an average whole sale price of 12 cents per lb. In any one of the last 10 years, up to 50 sites have utilized flora of forest areas, 20 sites utilized stream frontages, 12 sites utilized roadside reserves, and 24 sites utilized private property.

The district is not being used to its full capacity at present because of poor accessibility within it and also because it is relatively remote from the main centres of beekeeping in Victoria - Wangaratta and Bendigo-Maryborough. The types of nectar-producing flora growing in the district are also to be found closer to Wangaratta and still in sufficient quantity for most beekeepers in the Wangaratta region to work profitably.

At present, the heaviest usage of the district occurs in the western and northern sectors, where beekeepers from further west gain closest and easiest access. Only a few beekeepers live in and work the district. If the honey industry were to expand, however, it

could utilize the potential of the district more fully, particularly in the Lawson and Lucyvale blocks.

Land use considerations

Land clearing in the past has been mainly on the more valuable areas for honey production. Most of the red gums of the flats and plains have been removed, yet even today river red gum ranks second in importance only to red stringybark. The remaining mature trees on road, lake, and stream frontages and on private property are of vital importance to the apiarists of the area. The stringybark forests of the hillocks and mountain slopes have been cleared for agriculture in many instances, and recent clearing of this species on private property has occurred. The remaining red stringybark forests on public land provide the main source of honey, and thus have great importance.

The establishment of pine plantations has chiefly involved narrow-leaf peppermint and broad-leaf peppermint sites and these species are not important honey-producers in this district. However, protective burning in the red stringybark:long-leaf box forests to the north and west of the plantations may reduce the value of these forests to apiarists.

Large areas of public land are becoming increasingly important to apiarists as private property is progressively cleared and as insecticides, especially those applied by aerial spraying, are more widely used in agriculture.

Beekeeping is compatible with any form of land use that retains a cover of suitable flowering plants. Nectar and pollen crops can be repeatedly harvested from such areas without any detriment to other values.

References

Anon. The honey industry. In "Victorian Year Book." 1972, 353-4.

Commonwealth Bureau of Census and Statistics. "Apiculture - Season 70-71." Reference No. 35, 1971.

WATER UTILIZATION

The drought of 1968 was the most severe ever experienced in south-eastern Australia in recent times and, as a result, interest in water supply is greater than ever before.

Farmers' organizations and local groups are encouraging the construction of water conservation schemes wherever practicable and, among farmers who are not adjacent to streams, the construction of farm dams has never been more popular. This interest in water is in spite of, or possibly because of, less favourable world prices for farm products.

At the same time the water needs of rural towns are rapidly expanding, and certain areas have competing demands for available water resources.

Spray irrigation on dairy farm

Utilization in the Study District

Irrigation

Irrigation cannot be justified as easily in this district as in the drier areas of Victoria. This is emphasized by the fact that at present (1972) the district is one of the few areas in the State containing streams that are not considered "fully committed". In other words, farmers can obtain authority to irrigate from the natural flow of the stream.

Stream flows are reliable because of climate, catchment conditions, and the small irrigation commitment. The 1968 drought saw few restrictions on water

use of the drastic nature applied to other unregulated streams in the State.

Diverters in this district who irrigate receive authority either by permit or licence to irrigate a specific area. The quantity of water they use in any one irrigation season is arrived at arbitrarily - the formula varies with rainfall and the type of crop being irrigated.

Until all diversions of water are metered, it will not be possible to make any accurate assessment of water usage. Table 23 shows the present licence situation and indicates the purpose of irrigation. Only part of the licensed area would usually be watered in any one season.

Domestic supplies from towns

Corryong draws its supplies from a diversion weir and pumping station sited on Corryong Creek. Tallangatta derives its water from Lake Hume. Cudgewa pumps water from Cudgewa Creek to supply its needs, and Walwa pumps its supplies from the Murray River.

The quality of water supplied to Corryong township is excellent.

While the water supplied to Cudgewa is physically and chemically satisfactory, it has high bacterial counts, and the polyp plumatella has been responsible for some tainting of the supply and has blocked some water meters.

The Walwa water supply is physically and chemically satisfactory, but contains bacteria that indicate some pollution.

Tallangatta has good-quality water, but algae cause some seasonal problems with taste.

Table 22 summarizes reliable estimates and meter readings of water consumption for these towns.

Table 22

WATER CONSUMPTION

Town	Maximum daily consumption	Average daily consumption
	(gallons)	(gallons)
Corryong	337,000	76,500*
Cudgewa	55,000	12,500
Tallangatta	>200,000	165,000*
Walwa	59,000	13,500

* metered figure
conversion: 1 gallon = 4,546 litres

Corryong Creek provides water for Corryong township

Future Requirements

Because of the rainfall in this district, irrigation is not practised to any great extent.

The area irrigated has gradually increased, from 175 ha (432 ac) in 1967 to 264 ha (653 ac) at present (1972), but although this trend is expected to continue, it is not likely to increase spectacularly.

However, smaller storages for domestic and stock supplies will no doubt increase in numbers and size. These may supply either single farms or groups of farms.

Table 23

WATER USE

Source	Number of irrigation permits and licences
Beetoomba Creek**	1
Bethanga Creek	
Boundary Creek	1
Bucheen Creek	
Corryong Creek**	8
Cudgewa Creek**	10
Dry Forest Creek	1
Georges Creek	
Indi River**	1
Johnstones Creek	
Lake Hume	5
Murray River**	5
Pine Mountain Creek	
Stony Creek	
Tallangatta Creek**+	2
Thowgla Creek	1
Koetong Creek	1

Table 23 (contd.)

WATER USE

Number of other permits		Area of agricultural enterprise irrigated (acres)*				
Domestic permits	Industrial permits	Perennial pasture	Annual pasture and crops	Market gardens	Forestry nursery	Total
1		6				6
3						
					3	3
1						
7	1	176				176
5		153				153
4		3				3
4						
		50				50
1						
16		64		15		79
15	1	121	20			141
	1					
1						
17		16				16
1	1			½		½
		25				25
						652½

* Conversion 1 acre = .4047 hectares
** stream not fully committed
\+ eastern catchment only in district

LAND USE RELATIONS

The preceding chapters of this report have described the natural resources of the study area and discussed the potential uses of public land. This chapter examines the relations between these various uses.

Uses are said to be competitive when an increase in one leads to a decrease in another based on the same set of resources; they are supplementary when the increase in one does not lead to any change in another, and complementary when an increase in one benefits another.

Often a given set of uses can be complementary, supplementary, or competitive depending on the level of each. The most flexible uses are often those that are complementary or supplementary with many other uses over a wide range of levels.

Agriculture

The pattern of agriculture in the study district is one of mixed grazing at medium intensity in the river valleys and of extensive grazing elsewhere. At these levels, supplementary uses include apiculture, water production, and recreation activities such as driving for pleasure and picnicking. Agriculture also favours some aspects of nature conservation, as some animal species have benefited from the expansion of grassland habitat brought about by clearing. Species such as the stubble quail, brown hawk, black-backed magpie, and eastern grey kangaroo profited at the expense of others inhabiting the original vegetation.

At its present level, and in particular localities, agriculture is competitive with softwood timber production, many aspects of nature conservation, and recreation activities requiring timbered country or solitude. An increase in the area of land used for agriculture will make agriculture increasingly competitive with most other forms of land use.

Softwood timber production

Softwood timber production in plantations is an inflexible land use. It is competitive with agriculture, nature conservation, some types of recreation activity, and hardwood timber production to some extent. It is possible that it

is competitive with water production, as pine plantations may use more water than the native forests in their growth. Research is continuing on this topic.

Hardwood timber and protection forestry

Protection forestry and hardwood timber production on an extensive level constitute a major land use of public land in the study district. The present low level of production allows many complementary and supplementary uses, including grazing, apiculture, all but the strictest aspect of nature conservation, most forms of outdoor recreation, and water catchment protection.

Even at high levels, hardwood timber production is still only slightly competitive with most other uses, particularly as high levels are at present feasible on limited areas only. For example most native plants and animals will still be preserved (perhaps with altered abundance) and opportunities for many forms of outdoor recreation will still exist.

It is competitive with intensive agriculture and softwood timber production.

Mineral extraction

Although mining and extractive industries operating in the district at present have little impact on the environment generally, they are competitive with all other uses in their particular

Patterns of land use near Shelley

locality. Mining regulations ensure that water used in the tin-separation process at Walwa is recirculated and does not find its way into the river system. In the short term, the tin mines at Walwa and the fluorspar mine at Pine Mountain could be regarded as of interest to visitors, and in the long term they may be of historic appeal.

Moreover, they may also be complementary with the study of some aspects of natural history, since they provide opportunities for studying plant succession and geology.

Honey

As previously mentioned, honey production is a supplementary use with agriculture and also with extensive hardwood production and protection forestry. It is competitive with some agricultural usage, particularly intensive agriculture that removes all mature trees and uses pesticides to a large degree.

Water production

Water production is another major use of the public lands of this district. It is to some extent competitive with agriculture, and with softwood and hardwood timber production, depending upon the intensity of production and the management techniques employed.

The competition applies especially to the quality of water and the seasonal distribution of yield. Logging or clearing activities and overgrazing may increase stream turbidity and siltation of reservoirs. The salinity of streams in this district may be related to the proportion of their catchments cleared for agriculture:

	Mean salinity (p.p.m.)
Tallangatta Creek at Bullioh	45
Cudgewa Creek at Berringama	30
Nariel Creek at Upper Nariel	24

A large proportion of the Tallangatta Creek, a lesser proportion of the Cudgewa Creek, and virtually none of the Nariel Creek catchments have been cleared for agriculture above the point of sampling. No apparent geological explanation for this salinity variation exists. Water storages increase the opportunities for some forms of recreation, but the flooded area and the down-stream river environments are markedly changed.

Nature preservation

Areas set aside for strict nature preservation and for scientific purposes are competitive with all other uses except, perhaps, water production. Even where parts of these areas are devoted to education and recreation, only a low level of use for activities directly related to enjoying and understanding natural environments is compatible.

PART IV BLOCK DESCRIPTIONS

BLOCK DESCRIPTIONS

The following chapters enumerate for each block the general features, the nature of the land, the capabilities of the land for various uses, the likely hazards and conflicts involved with such uses, and the significance of the block. The notes in most cases refer only to public land, for example, in the case of each section devoted to land systems (section A6i), the percentages quoted refer to the relative amounts of the public land in the block that fall within a particular land system or subsystem.

The concepts of capability and significance, as used in this part of the report, require some explanation.

Capability

This term refers to the value of the land for the various uses to which it may be put. In the strict sense it refers to potential productivity, but as used here it also includes present production. For some forms of use, such as water production and nature conservation, the term refers to the inherent characteristics of the land; but for other others, such as beef cattle production or softwood production, the value of the land will depend both on the inherent nature of the land and on inputs that will raise productivity, such as fertilizer applications. Practical levels of inputs have been considered in assessing the capabilities for various uses.

In most cases, this report has dealt with assessment of capabilities in general terms, because the amount of information has varied from block to block and/or because the values are difficult to quantify.

Significance

The purpose of this section is to highlight the outstanding capabilities of each block.

1. BETHANGA

A. General

1. Location

This area, adjacent to Lake Hume, encompasses 2,674 hectares (6,610 ac) of public land in the County of Benambra - Parishes of Talgarno (part), Berringa, Tatonga, and Bullioh (part). The main area of public land comprises about 2,400 ha (6,000 ac) centred between Jarvis Creek and Georges Creek.

Boundaries: Lake Hume, Georges Creek-Talgarno Road, and Forest Creek.

2. Present tenure

Reserved forest: 2,160 ha (5,340 ac)
Unreserved Crown land: 490 ha (1,210 ac)
Reserves, including recreation reserve on Spring Creek: 24 ha (60 ac)
Public land around margins of Lake Hume
Various stream frontages and road reserves

3. General description

An area of alluvial flats, terraces, and rolling hillocks rises to steep hillocks, and montane slopes. The underlying rocks are predominantly coarse-grained gneisses in the west and schists in the east. The majority of the block is cleared and the main forested region comprises steep montane slopes culminating in the Jarvis Creek plateau. The characteristic native vegetation consists of open forests of red stringybark:long-leaf box on the northern aspects and broad-leaf peppermint open forest on some southern aspects and on the plateau.

4. Present use

The public land around Bethanga carries grazing stock. Gold-mining leases are current on some of this public land, but no actual operations are current. The whole of the forested land near Jarvis Creek is grazed by sheep. Beekeepers have 11 sites utilizing the vegetation on public land, with the main honey crop coming from red stringybark, white box, and and forest red gum.

The public land around Jarvis Creek serves a valuable function as a protective forest cover, particularly as it is so close to Lake Hume. The steep forested montane slopes also provide a scenic attraction, as they contrast with cleared land around the lake.

B. Nature of the Land

1. Climate

Average annual rainfall is between 660 mm and 813 mm (26 and 32 in.), a large proportion of which falls during the cooler months. Summer rainfall largely falls at high intensities, with consequent low infiltration and high run-off. Summers are relatively hot and dry at the lower elevations and warm on the plateau and higher country. Winters are cold. Cold air drainage causes a higher frost incidence in valley tracts.

2. Physiography and geology

The streams flow directly into Lake Hume with the exception of small watercourses that drain the south-eastern part of the plateau above Georges Creek. Valleys in the south and east are steep-sided, but those in the north, for example Johnstones Creek, are broad and relatively flat. The generally irregular dissection of the land underlain by gneissic rocks contrasts with the north-east south-west alignment of the Jarvis Creek plateau and its steep montane slopes underlain by schistose rocks. The plateau has been described as an extension of the Koetong uplands.

3. Soils

The plateau and locally moist areas carry dominantly friable reddish gradational soils. The major soils, however, are the weakly bleached massive gradational soils that mantle the steep hillocks and montane slopes. Undifferentiated stony loams are prevalent on the steepest slopes, particularly on northern aspects, whereas reddish duplex soils predominate on the flatter, lower-rainfall country in the valleys.

4. Vegetation

The influence of aspect on the native vegetation is readily observed on the main area of public land. The northern and north-eastern aspects carry red stringybark: long-leaf box open forests II (15-28 m or 50-90 ft) on the ridges and slopes, with minor pockets of narrow-leaf peppermint open forest in the drainage lines. The southern and south-western aspects predominantly carry broad-leaf peppermint open forest II to III (15-28+ m or 50-90+ ft) on the plateau and on the ridges and spurs, with some narrow-leaf peppermint open forest III in the drainage lines and moister aspects.

The narrow-leaf peppermint open forest understorey varies from layers of bracken fern at 1 m (3 ft) and silver wattle at 6 m (20 ft) to a grassy layer. Broad-leaf peppermint open forests generally have a grassy understorey. Red stringybark:long-leaf box open forests may be greater or less than 15 m (50 ft) in height and have scrubby understories, mainly composed of handsome flat-pea mixed with a sparse cover

White-breasted sea eagle

Red-capped robin

of grasses, or sparse understories with a litter layer and scattered grasstrees.

Most of the private land in the block has been cleared for agriculture, with the exception of about 970 ha (2,400 ac) on steep slopes north-west and south-east of the main public land area.

5. Fauna

Lake Hume, which provides water-bird habitat around its margins where slopes are relatively shallow, attracts many birds, including grebes, pelicans, cormorants, herons, bitterns, egrets, spoonbills, ibis, ducks, and swans. The white-breasted sea eagle nests in the area, and the red-capped robin and grey goshawk have been recorded near Bethanga. The larger mammals include wombats and eastern grey kangaroos. Amphibians include the bullfrog, *Limnodynastes interioris*.

6. Land systems

Bethanga land system 25%; and Bungil land system 75%.

C. Capabilities

1. Flora

No significant species have been listed for the block. The main area of public

land has medium capability for flora conservation, as it covers about 2,400 ha (6,000 ac), but the diversity of vegetation units is not high.

2. Fauna

The bullfrog, *Limnodynastes interioris*, has been recorded in Victoria only on a roadside reserve near Bethanga. Some of the public land around the margins of Lake Hume has a high capability for water-bird conservation. A number of species nest in the area, particularly around Tallangatta East.

The main area of public land has a moderate value for fauna conservation, as it is large enough to sustain resident populations of wildlife. Five significant species have been recorded for this particular area. The public land around Bethanga, however, consists of a number of small parcels of land that generally have low capability for conservation because of their small size and because they have been cleared of all but a few scattered trees.

3. Hardwood timber

The capability for mill log production is generally low. However, some broad-leaf peppermint stands in the Jarvis Creek plateau and narrow-leaf peppermint and blue gum stands on some southern aspects could produce mill logs. The area has a moderate capability for fencing timber and firewood production, mainly because of its close proximity to Albury-Wodonga.

4. Softwood timber

The Jarvis Creek plateau and slopes less than 20° carrying narrow-leaf peppermint open forest or broad-leaf peppermint open forest are suitable to marginal (site qualities IV to VI) for radiata pine growth. Other areas are marginal to unsuitable.

5. Agriculture

The plateau would be suitable for pasture establishment and grazing or horticulture. At lower elevations to the north-east of the plateau, moist basins with slopes less than 15° would be suitable for clearing and grazing.

The bullfrog (Limnodynastes interioris)

The presence of an apple orchard at Georges Creek indicates that adjacent areas are capable of this use. The less-steep slopes around Bethanga could support grazing if overstocking is avoided.

6. Honey

This block shows the highest honey production figures in the district, with a value estimated at $7,000 a year. Red stringybark is the main species used. There is no further potential for an expanded industry.

Broad-leaf peppermint forest on the Jarvis Creek plateau

7. Water

The public land is not a significant source of water for Lake Hume. The main streams that drain the block are Spring, Jarvis, Johnstones and Forest Creeks. The quality of the water in these streams is of great importance, however, as they flow directly into Lake Hume.

8. Minerals

The gold-copper lodes at Bethanga could become more important with an increase in metal prices. At present the thinness of the lodes and the difficulty of separation of the gold ores from associated minerals make mining uneconomic.

9. Recreation

Forested public land has moderate to high recreation values, as it provides a forest environment relatively close to Albury-Wodonga for activities such as driving for pleasure, picnicking, and walking for pleasure. The population of the Albury-Wodonga urban centre is likely to increase much more rapidly than at present if an effective decentralization plan eventuates. Lake Hume and its foreshores already have a high recreation usage. Bellbridge is a developing resort centre. Activities

include fishing, boating, and water-skiing, and the capability is high.

D. Hazards and Conflicts

Erosion on public land does not present many serious problems at present. However, sheet erosion on cleared steep northern aspects is moderate to severe in some parts, for example near Talgarno. Some stream-bank erosion, gully erosion, and slumping is evident. The erosion hazard is generally as high as any in the district and the block's proximity to Lake Hume makes any erosion all the more important. Damage or destruction of the protective ground cover (mainly accumulated leaf litter) on the montane slopes in particular would lead to severe sheet erosion. Repeated fires would result in a low level of litter accumulation. The erosion hazard is moderate on the plateau country, which has more permeable soils, gentle slopes, and generally better conditions for plant growth. Erosion around the shores of Lake Hume due to wave action when the Lake is near full-supply level could be compounded by high recreation usage.

The relatively large number of fires starting in this block attests to its high wildfire hazard during the summer months. These are due mainly to either lightning strikes or fires associated with residents and visitors.

Conflicts would arise between the use of the main forested block as a forest environment for recreation activities and use of the plateau and some slopes for pine plantations or agriculture.

E. Significance

The public land around Bethanga township has been greatly altered from its natural condition. It could have value for mining, or educational value with regard to mining. The values of the main public land block lie in its relatively natural condition and its close proximity to the rapidly expanding population centre of Albury-Wodonga, a centre that is likely to increase to an even greater rate in the future. It has prime significance for maintenance of water quality, fauna and flora conservation, and recreation.

2. GRANYA

A. General

1. Location

Lying west of Granya, this area of land includes 6,230 ha (15,370 ac) of public land in the County of Benambra - parts of Parishes of Talgarno, Bungil, and Bullioh.

Boundaries: border of Lake Hume from Forest Creek to Cottontree Creek, Granya-Bullioh Road, Bullioh to Talgarno *via* Georges Creek Road, and Forest Creek from Talgarno to Lake Hume.

2. Present tenure

Reserved forest: 2,837 ha (7,010 ac)
Unreserved Crown land: 3,351 ha (8,280 ac)
Camping and water reserve: 32 ha (80 ac)
Village reserve bordering Lake Hume
Public-purposes reserve, Kangaroo Creek
Public land around margins of Lake Hume
Various stream frontages and road reserves.

3. General description

A forested landscape of steep montane slopes culminates in broad ridges and a series of plateaux trending from Granya Gap in the south-east to Hore Hill in the north-west.

4. Present use

The forest is well used by apiarists, an average number of 8 sites being taken up when red stringybark is yielding nectar flows. Other than this, the public land receives little use. A fire tower is located at Mount Granya.

B. Nature of the Land

1. Climate

Average annual rainfall is between 710 mm and 813 mm (28 and 32 in.), with a winter maximum. Winters are generally cold and summers are mild to warm on the plateaux. Severe frosts affect the plateaux in areas where cold air is pooled. Warmer temperatures apply on northern aspects and at lower elevations.

2. Physiography and geology

Five main streams drain this block - Cottontree, Wises's, and Tallangatta Creeks flow in a northerly direction and

Georges and Kangaroo Creeks flow in a southerly direction.

Montane slopes rise from the valley floors at elevations of 240-400 m (800-1,300 ft), forming broad ridges and plateaux at elevations of about 610 m (2,000 ft), and trend from south-east to north-west. One plateau lies at the head of Cottontree Creek at an elevation of 260-480 m. Mount Granya, the highest peak in the block, has an elevation of 905 m (2,970 ft).

The main geological boundaries follow a north-west trend, and a probable fault line lies parallel to Georges Creek between Ordovician schists and gneisses. The schists are mainly situated on private property. The gneisses underlie about 40% of the public land, including Mounts Granya and Bolga. Lower Devonian granite underlies the eastern part of the block at localities such as Hore Hill and the plateau north of Mount Bolga.

Minor deposits of Tertiary gravels are situated near the head of Cottontree Creek.

3. Soils

Friable reddish gradational soils predominate on the plateaux. Weakly bleached massive gradational soils occur in shallow drainage lines and predominate on the steep montane slopes. Often the ridge-top soils are undifferentiated stony loams. Undifferentiated

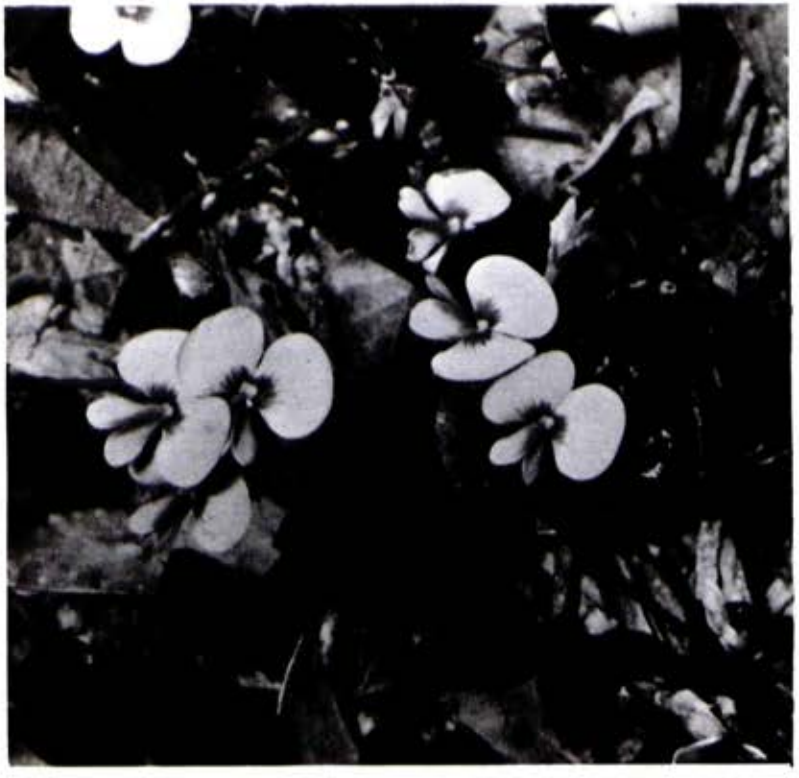
Georges Creek valley with Mt. Granya in background

sandy loams usually occur at the bases of very steep slopes.

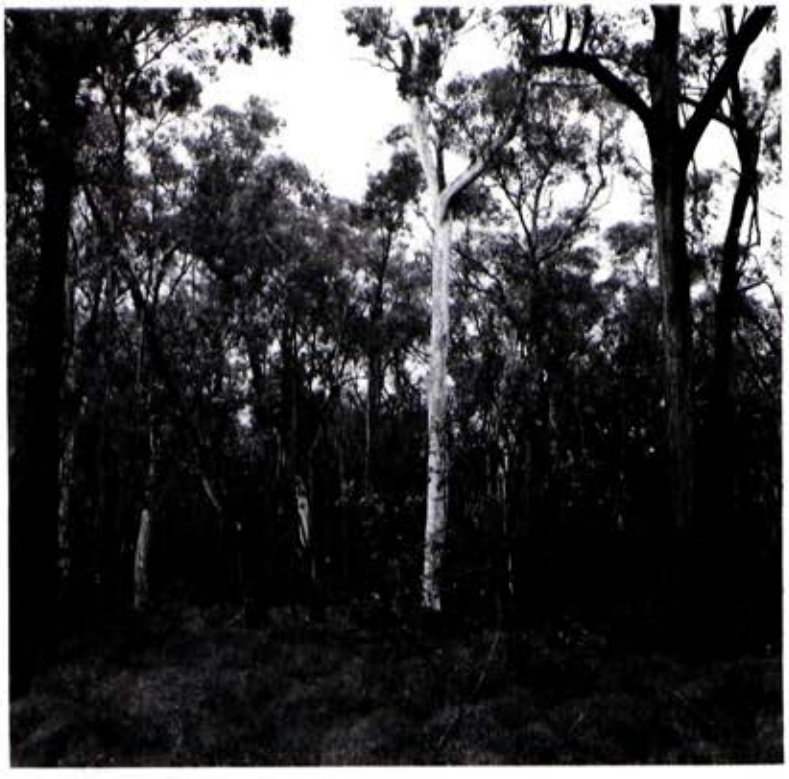
Friable reddish gradational soils and reddish duplex soils may occur on ridges, spurs, and less-steep slopes at the lower elevations.

4. Vegetation

The majority of the public land has a vegetative cover of red stringybark: long-leaf box open forest II. This is replaced by red stringybark:long-leaf



Handsome flat-pea - a common understorey plant



Broad-leaf peppermint forest north of Mt. Granya

box open forest I on the steepest northerly slopes, except for small areas of red cypress pine open forest I on some slopes facing the Murray River. The understorey of the red stringybark: long-leaf box forests varies from grassy (tussock grass mainly) to low shrubs, which include handsome flat-pea and grey bush-pea. Grasstrees grow on some of the driest aspects. On the plateau areas and on some southerly aspects, broad-leaf peppermint open forest II predominates, and this vegetation unit usually has a grassy to sparsely shrubby understorey. Narrow-leaf peppermint open forest III is restricted to moist gullies. Forest red gum open forest II and woodland II are restricted to hillocks near the Murray River. The forest floor of the forest red gum unit is mainly grassy, but some areas with shallow soils have a shrubby layer that

includes rock fern and nodding blue-lily.

5. Fauna

Little is known of the fauna of this block. The tiger cat and white-breasted sea eagle occur here. Birds recorded for the area include the grey goshawk, wedge-tailed eagle, red-browed finch, crimson rosella, sulphur-crested cockatoo, noisy miner, black-shouldered kite, and brown hawk. Animals recorded are the eastern grey kangaroo, black-tailed wallaby, and the wombat. Parrots probably nest in the forest red gum open forest adjacent to Lake Hume.

6. Land systems

Bungil land system 85%; Murray land system 10%; and Wagra land system 5%.

C. Capabilities

1. Flora

The block has medium value for flora conservation, with high values for some localities such as the slopes bordering the Murray Valley Highway near Granya Gap. These are covered with showy plants including some rare species. Plants include grey bush-pea *(Pultenaea cunninghamii)*, *P. polifolia*, *Grevillea polybractea*, and *Pimelea treyvaudii*.

Diversity in the flora ranges from those plants associated with narrow-leaf peppermint open forest to plants associated with the red cypress pine complex. One of the few examples of forest red gum open forest sited on public land occurs as an isolated block of some 32 ha (80 ac) adjacent to Lake Hume. Species include white box *(Eucalyptus albens)*, forest red gum *(E. blakelyi)*, and shrubs such as box-leaf wattle *(Acacia buxifolia)* and nodding blue-lily *(Stypandra glauca)*.

2. Fauna

Significant species here include the tiger cat, eastern grey kangaroo, black-tailed wallaby, wombat, white-breasted sea eagle, and grey goshawk. However, the varied range of habitats would indicate a range of resident wildlife populations. The sugar glider is likely to be more common than the greater glider, which is probably restricted to a few localities such as the Mount Bolga plateau. The block of public land is large enough to provide a viable habitat for the eastern grey kangaroo, black-tailed wallaby, and the wombat.

3. Hardwood timber

Granya block has very low capability for hardwood timber production.

4. Softwood timber

Except for some areas on the plateau that are marginal to suitable, the block is unsuitable for softwoods.

Grey bush-pea (Pultenaea cunninghamii))

5. Agriculture

Generally very low capability for agriculture exists here. Some land on the Mount Bolga plateau, on a low plateau north of Mount Granya, and in a low-level basin north-east of Mount Granya would be suitable for pasture establishment and grazing.

6. Honey

This area has a moderate to high capability for producing honey because of the predominance of red stringybark. Some potential exists for further sites to be used if access were improved. Average annual production is valued at about $2,000.

7. Water

About 90% of the public land is drained by streams that enter Lake Hume. Although these contribute a relatively insignificant volume of water, the forested public land has a high value in maintaining clear streams and protecting the land from erosion.

8. Minerals

Gold has been won from the Mount Granya area, but it is doubtful if significant reserves remain.

9. Recreation

The camping and water reserve adjacent to Lake Hume has value in providing a contrast to the farmlands that abut the shoreline of Lake Hume. Development for a picnic site would require careful planning. The main area of public land has values for driving for pleasure, sight-seeing (from the scenic lookout at Mount Granya), and hiking. Masses of grey bush-pea near Granya Gap and a waterfall on Cottontree Creek are attractions. The capability for recreation is moderate to high, mainly because of the block's close proximity to the rapidly expanding centre of Albury-Wodonga.

D. Hazards and Conflicts

The montane slopes have a high erosion hazard, and sheet erosion is evident in some areas. Damage or destruction of the protective ground cover on these slopes would lead to erosion. Thus protection from fire is necessary.

Fire hazard here is moderate. However, any wildfires starting in this block pose a threat to the pine plantation at Shelley, as the plantation lies in the path the fires would be likely to take under the influence of north-west winds. The presence of visitors during the summer months will increase the hazard, particularly as they would tend to use the shores of Lake Hume to the north of the forest, which would thus lie in the path of fires driven by northerly winds.

The erosion hazard is moderate on the plateau country, which has permeable soils, generally gentle slopes, and a more complete ground cover. Tracks in this area need to be well constructed because of the nature of the soil.

Conflicts are not likely to arise, because of medium to high capability for nature conservation and low capabilities for timber production, agriculture, and mining.

E. Significance

This block has significance for nature conservation, recreation, and maintenance of water quality.

3. LAWSON

A. General

1. Location

This large area between the Murray River and Koetong and east of Granya comprises 19,950 hectares (49,300 ac) of public land in the County of Benambra - Parishes of Thologolong, Bungil East, and portions of Bungil, Burrowye, Koetong, Bullioh, and Granya.

Boundaries: Bullioh-Granya Road, Murray River from Cottontree Creek to Burrowye Creek juntion, Burrowye-Koetong track, and the railway line from Koetong to Bullioh.

2. Present tenure

Reserved forest: 846 ha (2,090 ac)
Unreserved Crown land: 18,980 ha (46,905 ac)
Reserves: 124 ha (305 ac)
Public land around margins of Lake Hume
Various stream frontages and road reserves

3. General description

Most of the public land comprises the northern extension of the Koetong uplands. This elevated surface is strongly dissected along the major streams and almost entirely covered by forest. Farmlands occupy the valleys of the Kangaroo, Little Koetong, and Koetong Creeks, and the Murray River.

4. Present use

The public land is little used at present. Some red stringybark forests support honey production around Burrowye. Landscape diversity is provided by the northern portions of the main parcel of land, which form a backdrop of steep, rocky, forested escarpments. The Murray Valley Highway provides scenic drives. Some cleared and also forested land is used for grazing and forest grazing respectively near Bungil. About one hundred cattle are grazed at Koetong Creek. The fire lookout at Mount Lawson is used for fire protection purposes and occasionally as a scenic lookout by walkers.

No active mining occurs at present, but mineral leases have been sought for mining around Mount Firebrace and near Thologolong. Some gravel pits adjoin the Murray Valley Highway in the north. Timber utilization is negligible.

B. Nature of the Land

1. Climate

Average annual rainfall varies from 710 mm to 1,140 mm (28-45 in.), with a winter maximum. Snow occasionally falls on the higher country and several light falls may be expected in most winters. Severe frosts occur in areas of cold-air drainage on the plateaux. Winters are generally cold and summers are mild to warm on the plateaux. Warmer temperatures generally apply on northern aspects and at lower elevations. The northern valleys experience relatively hot and dry summers, with occasional thunderstorms.

2. Physiography and geology

The Koetong uplands form the major physiographic unit. This consists of a weakly to strongly dissected surface surrounded on the east, north, and west, by steep montane slopes, which rise from about 610 m (2,000 ft) elevation to 1,020 m (3,350 ft) at Mount Lawson. Dissection has resulted in a number of small plateaux at various elevations, sometimes separated by montane slopes. The lowest plateau is drained by Flaggy Creek and ranges in elevation from 460 m to 610 m (1,500-2,000 ft). The highest plateau, at Mount Lawson, has an elevation of about 920 m (3,000 ft). The major streams draining the uplands are Koetong and Flaggy Creeks. Hillocks, terraces, and stream flats at elevations

The Flaggy Creek plateau - viewed from Mt. Lawson

of 240-300 m (790-980 ft) surround the montane slopes and uplands. The bedrock is predominantly Lower Devonian grey granite, but outcrops of Ordovician schists lie at the north-eastern and north-western edges of the uplands, and a small tongue of Ordovician gneiss occurs at Granya Gap. Ancient river-gravel deposits, probably Tertiary age, are of very minor extent.

3. Soils

The dominant soils of the plateau country are friable reddish gradational soils, with weakly bleached massive gradational soils in shallow drainage lines and on some steep slopes. Often

Broad-leaf peppermint open forest with scrubby understorey

the ridge tops are very stony, and large outcrops of rock are common. The steep montane slopes mainly carry weakly bleached massive gradational soils Minor soils are undifferentiated sandy loams at the bases of very steep slopes, and friable reddish gradational soils or reddish duplex soils on some ridge tops and spurs. These latter two soil groups commonly occur on less-steep slopes at the lower elevations.

4. Vegetation

The vegetation is very diverse. The uplands, from the southern boundary of the block to just north of Mount Lawson, carry narrow-leaf peppermint open forest III, (with an understorey of bracken fern and silver wattle) on the plateaux and on moister sites, and broad-leaf peppermint open forest II (with a grassy or low scrubby understorey) on the ridges and drier sites. Tussock grass dominates the grassy layer, and the shrubby species include handsome flat-pea.

North of Mount Lawson, the predominant vegetation of the less-steep slopes and basins is red stringybark: long-leaf box open forest II with a grassy understorey on the deeper soils and red stringybark: long-leaf box open forest I with a sparse to scrubby understorey where the soils are shallower and more rocky.

Steep montane slopes experience very dry conditions generally and support stands of red stringybark: long-leaf box open forest I with a low and scrubby to sparse understorey.

The steepest, driest sites, which lie on the western and northern edges of the uplands, carry numerous stands of red cypress pine open forest I with a sparse ground layer or a shrubby understorey of common fringe-myrtle, wedge-leaf hop-bush, and other shrubs. Stands of forest red gum open forest II, of minor

extent, occur along some water-courses and on dry hillocks.

5. Fauna

The diversity of the vegetation indicates that the fauna is also diverse. Predatory birds recorded for the block include the boobook owl, peregrine falcon, grey goshawk, and nankeen kestrel. Other birds likely to be found include the common bronzewing, sulphur-crested cockatoo, superb lyrebird, spotted quail-thrush, white-throated tree-creeper, various honeyeaters, and the pied currawong. It is probable that the tiger cat lives in the area.

Other species likely to be present include the echidna, brown phascogale, tuan, long-nosed bandicoot, brush-tailed possum, ring-tailed possum, greater glider, feather-tail glider, wombat, eastern grey kangaroo, black-tailed wallaby, and the bush rat.

6. Land systems

Bungil land system 76%; Towong land system 10%; Koetong land system 10%; Wagra land system 2%; and Murray land system 2%.

C. Capabilities

1. Flora

Lawson block has a high capability for flora conservation because of the diversity of vegetation units. This is particularly so for the northern and western edges of the public land, where large stands of red cypress pine occur. Plant species associated with the pine include the rare *Grevillea polybractea*, as well as such interesting species as wedge-leaf hop-bush, cane wire-grass, river bottle-brush, guinea flower, and dropping sheoak. The significant species *Pomaderris velutina* has been recorded in the north-east of the block.

Red cypress pine open forest

The black-tailed wallaby (Wallabia bicolor)

Bougainville's skink (Lerista bougainvilli)

2. Fauna

Capability for native fauna is also high. The northern sector again is of particular interest. The scrubby slopes provide habitat for black-tailed wallabies and perhaps the tiger cat. The white-breated sea eagle possibly nests in this sector. Bougainsville's skink is found at Mount Firebrace, at the north-eastern limit of its range.

3. Hardwood timber

The capability for hardwood production is generally low. Narrow-leaf peppermint stands with a high proportion of blue gum have the highest capabilities. Such stands occur at Mount Lawson north of Koetong Creek and north of Darbyshire Creek.

4. Softwood timber

The less-steep areas carrying stands of narrow-leaf peppermint open forest III would be suitable for *Pinus radiata* growth. Sites carrying broad-leaf peppermint open forest with heights 24 m to more than 28 m (80 ft to more than 90 ft) are also suitable for radiata pine growth (site qualities IV to V). Marginal sites, which include broad-leaf peppermint open forest II on shallow or rocky soils, occur mainly north of Koetong Creek.

5. Agriculture

The main area suitable for grazing lies in the upper Flaggy Creek watershed. The slopes here are not too steep. A limited area in the Koetong Creek Valley, east-south-east of Mount Lawson, is suitable for grazing, and perhaps for horticulture.

6. Honey

Western and northern sectors of the public land have a high capability for honey production. Present annual value of the honey crop is put at $1,800. Up to 10 sites carry hives during a red stringybark flow year, and an estimated additional 24 sites could be utilized if access was improved.

7. Water

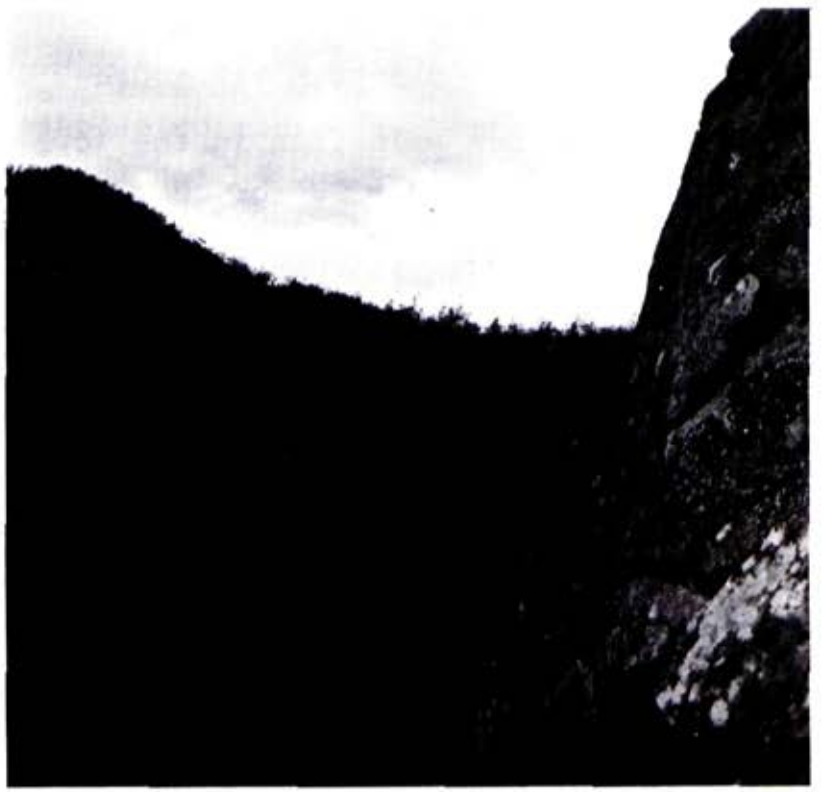
The main streams contributing to Lake Hume storage are Flaggy and Koetong Creeks. Koetong Creek flows directly into Lake Hume and has a much larger catchment than Burrowye Creek, which yields a mean annual discharge of about 20 million cu m (16,000 ac-ft). Little Koetong Creek discharges about 4 million cu m (3,400 ac-ft) annually.

8. Minerals

Tin, gold, copper, bismuth, molybdenum, and tungsten have been mined in the area. Mineral lease applications at Mount Firebrace and Flaggy Creek are current. The Granya gold-field on the slopes of Mount Firebrace has been worked to a limited depth and may have potential for further production.

9. Recreation

The block has quite a high capability for recreation such as driving for pleasure. The public land to the south



Flaggy Creek gorge

of the Murray Valley Highway forms a backdrop of steep, rocky scarps interspersed with scrubs and large stands of red cypress pine. These stands are interesting in their contrast to other vegetation types and have value for sight-seeing, nature walks, and hiking.

Features include:

* a spectacular waterfall and gorge on Flaggy Creek
* remains of mining at Thologolong, on Flaggy Creek, and near Koeting Creek
* aboriginal rock paintings in the lower Koetong Creek Valley and on Mount Porcupine near Thologolong
* "Thologolong" station, where the first of the now famous Murray grey cattle was bred
* fishing in Koetong Creek and the Murray River, the most predominant fish being brown trout, rainbow trout and redfin. Carp are present in reasonable numbers but Murray cod, Macquarie perch, and river blackfish are less abundant
* rock climbing on steep rocky slopes and rock outcrops
* a lookout on Mount Lawson, which affords excellent views of Lake Hume and the surrounding plateau country

D. Hazards and Conflicts

The steep granitic montane slopes in the north of the block usually have sparse to scrubby protective vegetation cover. The soils are prone to erosion, as evidenced by severe sheet erosion near Flaggy Creek and severe gullying of steeply graded tracks. The least erosion has occurred on the less-steep slopes in the south of the block, where rainfall is higher and the protective vegetation cover is more effective.

The fire hazard is high in the north but decreases in the south. However, any wildfires in this block present a hazard both to nature conservation and to the pine plantation in the adjacent Koetong block. Conflicts are unlikely over most of the public land, as its main values are for conservation. However, mining for molybdenum, tungsten, and bismuth around Flaggy Creek could conflict with nature conservation and soil conservation values. Clearing of land for pine plantations or agriculture around the headwaters of Koetong and Darbyshire Creeks could also conflict with nature conservation.

E. Significance

The block is primarily of significance for recreation and nature conservation. However, parts also have significance for pine plantations, agriculture, and mineral production.

4. WALWA

A. General

1. Location

The public land in this block is located near Walwa and comprises three parcels of land totalling 508 ha (1,256 ac) in the County of Benambra - parts of Parishes of Burrowye, Walwa, and Jinjellic.

Boundaries: Murray River from Burrowye Creek junction to Sandy Creek junction, Sandy Creek to Walwa, Walwa-Guys Forest-Burrowye roads, and Burrowye Creek from Murray Valley Highway to Murray River.

2. Present tenure

Unreserved Crown land, most of which is subject to mineral lease: 498 ha (1,232 ac)
Recreation reserve at Jinjellic bridge: 10 ha (24 ac)
Frontages on Murray River and other streams
Various road reserves

3. General description

The hilly landscape has mainly been cleared for grazing. Three areas of public land lie in the north of the block, where forested hills predominate.

4. Present use

The main parcel of public land is subject to open-cut mining for tin and associated minerals. Some honey is produced from river red gum, red stringybark, and forest red gum. Public land along the Murray supports grazing.

B. Nature of the Land

1. Climate

Average annual rainfall is about 760 mm (30 in.) near Walwa. More rain falls during the three winter months than during any other season, but the highest rainfall intensities occur in the summer. Summers are hot and winters are cool, with an autumn to spring incidence of frosts.

2. Physiography and geology

Lower Devonian granite and Ordovician schists are the main rocks outcropping in the block. Most of the public land lies on the schists. The associated

landscapes have a higher proportion of steep montane slopes than the granite.

The main area of public land adjoins the Murray Valley Highway at Red Bank Creek near Walwa. A small area is situated on a steep slope running into a creek to the west of Red Bank Creek, and another area of public land overlies Quaternary deposits beside the Murray River. The elevation of the Murray River terraces is about 200 m (700 ft) at this point.

Public land around Red Bank Creek comprises - almost entirely - very steep montane slopes, which rise to an elevation of about 520 m (1,700 ft). It lies at the northern end of a dissected plateau drained by this Creek. Tin-bearing dykes of various composition intersect the Ordovician schists.

3. Soils

The predominant soils are weakly bleached massive gradational soils and undifferentiated stony loams. On the public land adjacent to the Murray River, alluvial brownish loams predominate.

4. Vegetation

The vegetation of the hilly public land is predominantly red stringybark:long-leaf box open forest I, with a grassy understorey or no ground cover except a litter layer. Associated tree species include forest red gum and red box.

5. Fauna

Some birds such as the noisy and little friar-birds migrate along the Murray River and may also be found in the adjoining forest. The mammal populations are likely to be very restricted as to numbers and diversity.

6. Land systems

Towong sub system 85%; and Murray land system 15%.

C. Capabilities

1. Flora

Generally the block has a low capability for flora because the public land has only a limited range of vegetation units and is relatively small (500 ha). However, two species listed as being in danger of extinction - *Digitaria diffusa* and *Pterostylis hamata* - are recorded for Walwa. The significant species *Haekeria ozothamnoides* is recorded for the block.

2. Fauna

A low capability for fauna conservation results from the vegetation being mainly a low, dry, grassy forest that does not provide habitat for many animals.

3. Hardwood production

Capability is very low.

4. Softwood production

The land is unsuitable for softwood production.

5. Agriculture

Most of the public land has very low capability for grazing. However, public land by the Murray River has a high capability for grazing, cropping, or horticulture.

6. Honey

In view of its small extent, the public land produces a high return from honey production (about $2,900 per year). Five of the six bee sites mainly utilize the vegetation on stream frontages. River red gum is the main producer, followed by red stringybark and forest red gum.

7. Water

The water yield from public land is very low.

8. Minerals

The capability for tin production is high. One locality has proved reserves of 510,000 tons, with an average grade of about 0.2% tin, and another also contains a large reserve. Tantalite also occurs in many of these dykes at an approximate grade of 0.02% combined tantalum and niobium oxide.

Open-cut mining near Walwa

9. Recreation

The capability is moderate to low. Sight-seeing and driving for pleasure provide the main recreation pursuits. "The Glen" stud of Murray greys adjacent to public land near Burrowye and the tin-mining operations at Walwa attract visitors. The recreation reserve on the Murray could be used for camping, picnicking, and fishing. The predominant fish are brown trout, rainbow trout, and redfin. Carp are present in reasonable numbers but Murray cod, Macquarie perch, and river blackfish are less abundant.

D. Hazards and Conflicts

A moderate sheet and gully erosion hazard can be minimized by protection

Murray Cod

from fire. Mining could conflict with water quality and nature conservation. However, water used in the separation process at the Bounce and Mount Alwa mines does not re-enter the stream but is recirculated from pondages. The open-cut method is the only economic one. The Mines Department will not allow miners to open up fresh areas until they have paid bond money for reclamation work. Prospecting on an adjacent claim has resulted in some erosion.

E. Significance

The main significance of the public land is for tin-mining. The conflict with nature and soil conservation values can be minimized by ensuring that roads are properly constructed and proper reclamation work is carried out after mining of a particular area. Two plant species recorded for the block are listed as being in danger of extinction.

5. PINE MOUNTAIN

A. General

1. Location

The public land consists of one major area between Walwa and Tintaldra, a small area near Walwa, and various sites along the Murray River, all of which lie within the County of Benambra - parts of the parishes of Walwa, Tintaldra, Cudgewa, and Jemba. The total area is about 5,943 hectares (14,685 ac).

Boundaries: Cudgewa-Walwa road, Murray River from Walwa to Tintaldra, Tintaldra-Cudgewa North road.

2. Present tenure

Reserved forest: 959 ha (2,370 ac)
Unreserved Crown land: 4,869 ha (12,030 ac)
Crown land reserves (camping and water reserves): 59 ha (145 ac)
Crown land at Tintaldra: 56 ha (140 ac)
Various frontages, on Murray River and other streams, and road reserves

3. General description

A central massif, surrounded on the south and east by a low range of forested hills, follows a distinct divide and links with the Burrowa massif to the west. It has precipitous slopes covered with scrub and trees, with large rock outcrops in places. Broad mature valleys around the periphery of the block are cleared for agriculture.

4. Present use

The public land is largely unused at present. A fluospar mine on Pine Mountain Creek is currently operating, and a gravel pit adjoins the Murray Valley Highway. The public land along the Murray consists of river red gum flats and these are all grazed by cattle.

B. Nature of the Land

1. Climate

Average rainfall is between 710 mm and 890 mm (28 and 35 in.) annually, falling mainly in the winter months. Summers are hot and dry; winters are cool and wet.

2. Physiography and geology

The Pine Mountain massif dominates this block. It comprises hills of Lower

Aerial photo of the Pine Mountain massif

Devonian grey granite intruded by dykes of quartz porphyry and a steep-sided dome of Upper Devonian red granite that reaches an elevation of about 1,000 m (3,300 ft). Steeply graded ephemeral streams, some with waterfalls, radiate out from the centre of the massif. A number of small perched basins occur at various elevations on the massif.

Hills of Lower Devonian grey granite and Ordovician schists surround the massif to the south and east at elevations of about 610 m to 730 m (2,000-2,400 ft). These are generally steep, but encompass a large forested basin near the Cudgewa-Walwa road.

The major streams - Sandy, Pine Mountain Cudgewa, and Stony Creeks - have mature valleys. The main deposits of Quaternary alluvium occur in the Cudgewa Creek, Stony Creek, and Sandy Creek valleys.

3. Soils

Many of the soils formed on the steep slopes of the massif are shallow undifferentiated stony loams. Some areas lack a covering soil mantle, but sandy soil material has accumulated in depressions and cracks among bare rock faces. Undifferentiated sandy loams have accumulated at the foot of steep slopes. Other soils of the massif are weakly bleached massive gradational soils, which are more widespread, however, on the steeper slopes of the surrounding hills. The more gently sloping country usually has reddish duplex soils. Friable gradational soils occur to a limited extent in basins and sheltered gullies or on small plateaux.

Alluvial brownish loams predominate on the Murray River flats.

4. Vegetation

The structure of vegetation on the Pine Mountain massif ranges from open mossland, through closed to open heath, to open forest I and II. Red stringybark: long-leaf box open forest less than 15 m (50 ft) high is the dominant vegetation unit, but is mixed with vegetation characteristic of moister sites and also with a complex of mossland, heaths, and red cypress pine stands associated with dry rocky sites. The understorey varies from very sparse to scrubby. The amount of scrub has probably increased subsequent to a severe fire that swept this area in 1952. Understorey species include common fringe-myrtle, various grevilleas and wattles, tea-trees, epacrids, bush-peas, parrot-peas, daisies, orchids, and grasses.

The low hills around Wermatong Hill are private property. The vegetation here is red stringybark: long-leaf box open forest I with a grassy to scrubby understorey. Public land further west has similar dry vegetation on the northerly aspects, but has taller red stringybark: long-leaf box open forest on spurs on the southerly aspects, together with broad-leaf peppermint in the basins. Narrow-leaf peppermint open forest III occupies the moister sites in basins and gullies.

River red gum open-forest II and woodland II with a grassy understorey occurs on public land near the Murray River.

5. Fauna

The Murray River flats provide habitat for water-birds such as grebes, herons, egrets, bitterns, spoonbills, ibis, cormorants, and ducks. The vegetation along the river also provides food and shelter for migratory species such as the noisy friar-bird and dollar bird. Azure kingfishers have been recorded as nesting in the river bank at Tintaldra. It is likely that a number of honeyeaters frequent Pine Mountain because of the abundance and variety of heathy shrubs such as the grevilleas. There are few recent records of mammals in the area, but the brush-tailed rock wallaby was reported near Tintaldra at the turn of the century.

A mosaic of vegetation types on Pine Mountain

6. Land systems

Mittamatite sub-system 55%; Towong sub-system 24%; Magorra sub-system 18%; and Murray land system 3%.

C. Capabilities

1. Flora

Pine Mountain block has a very high capability for scientific interest and flora conservation, and indeed compares well with any other area in the north-east of Victoria. Appendix II gives some indication of its variety and the number of rare and interesting species.

Among the great diversity of species, the following have been listed as being in danger of extinction: *Acacia phasmoides* (restricted to Pine Mountain) *Dodonaea rhombifolia, Grevillea jephcotti,* and *G. ramosissima.* In addition, the following species have significance: *Brachychiton populneus* (Kurrajong), *Brachycome ptychocarpa, Dampiera purpurea, Dodonaea boroniifolia, Eucalyptus chapmaniana, Haeckeria ozothamnoides, Leptospermum micromyrtus, Olearia adenophora, Patersonia sericea, Phebalium* sp. nov. (restricted to Pine Mountain), *Pultenaea platyphylla, P. vrolandii,* and *Tetratheca glandulosa.*

2. Fauna

Very little is known of the population of mammal or bird species in this area and so its value cannot be determined.

3. Hardwood timber

Except for some gullies of blue gum and narrow-leaf peppermint, the area is unsuited to timber production. The forest has some value for small post and pole production because of its proximity to Corryong.

4. Softwood timber

The largest area capable of growing radiata pine is on the southern aspect of the low range of hills. Expected site qualities would be marginal to suitable. Broad-leaf peppermint forest forms the major vegetation unit and areas of narrow-leaf peppermint are minor in extent. Slopes are mostly less than 20 degrees. Other areas of public land are unsuitable for *Pinus radiata* growth.

5. Agriculture

The basins and spurs on the southerly aspects of the low range would support pasture establishment. Some recent clearing on private property is evident near Stony Creek. Fertilizer requirements on weakly bleached massive gradational soils and reddish duplex soils may be high.

6. Honey

The capability for honey production is

high, with an annual average value of $4,400 indicated. The bulk of production comes from the forest red gum stands along the Murray River and Cudgewa Creek. Six of the ten sites utilize vegetation on stream frontages and roadside reserves.

7. Water

The streams draining Pine Mountain discharge their flows quickly during and after rainfall, and these characteristics do not provide regular stream flows. More sustained water yield would be obtained from the basin north-east of Cudgewa North, but the amount would not be very great.

8. Minerals

The ore mined at Pine Mountain Creek contains 60-90% fluorite and is the only ore of this mineral produced in Australia. Other associated minerals are galena, sphalerite, and silver. The ore is contained in a steeply dipping lode. Fluorite also occurs at Sandy Creek, but reserves are not known.

Mineral lease applications are current on both public and private land. Sand deposits at the base of Pine Mountain have been quarried at one locality.

9. Recreation

The main recreation values in the Pine Mountain block are in driving for pleasure and sight-seeing. Its features are the steep rocky outcrops and the mine on Pine Mountain Creek, and it has scope for nature walks, hiking, and rock-climbing. The summits of the massif would afford fine views of the Snowy Mountains and the Murray River Valley.

Pine Mountain displays many steep rock outcrops

The public land adjoining the Murray River has high capability for camping, picnicking fishing, walking for pleasure, or nature walks.

The predominant fish of the Murray River and Cudgewa Creek are brown trout, rainbow trout, and redfin. Occasional Murray cod, Macquarie perch, and river blackfish may be caught in these streams.

D. Hazards and Conflicts

In addition to a considerable sheet erosion hazard on Pine Mountain, a moderate sheet and gully erosion hazard exists on the low range of hills to the south. Some flat basins in the south with friable reddish gradational soils have a low erosion hazard. A high fire hazard at Pine Mountain results from the combination of scrubby vegetation, steep northerly slopes, and dry summers. Recreational use would increase the risk of fire. Mineral production may conflict with flora conservation. Conflicts could also arise between grazing and recreation along the Murray River. Nature conservation of the low range of hills would conflict with clearing for agriculture or softwood plantations.

E. Significance

The Pine Mountain massif has outstanding scientific value for botanists, as well as significance for nature conservation, recreation, and mining. The range of hills has high significance for nature conservation, as it forms a corridor of native forest between two outstanding natural areas comprising the Mount Burrowa massif to the west and the Pine Mountain massif to the east. The Murray River flats have significance for migratory birds, water-birds, and recreation.

6. MITTAMATITE

A. General

1. Location

The public land in this block consists of a large part of the Mittamatite massif and some small isolated areas of reserves near the townships of Corryong and Towong, covering 4,622 ha (11,420 ac) in the County of Benambra - parishes of Tintaldra, Cudgewa, Towong, Colac Colac, and Wabba.

Boundaries: Beetoomba-Tintaldra road, Murray River from Tintaldra to Towong, Towong-Beetomba road.

2. Present tenure

Unreserved Crown land: 4,410 ha (10,900 ac)
Racecourse and recreation reserve at Towong: 40 ha (100 ac)
Public-purposes reserve at Colac Colac: 8 ha (19 ac)
Racecourse, recreation, and showground reserve at Corryong: 54 ha (133 ac)
Various stream frontages, including about 110 ha (270 ac) along the Murray River
Various road reserves

3. General description

A steep-sided massif rises to an elevation of about 1,000 m (3,300 ft) above a plain formed by the wide mature valleys of the Murray River and Corryong and Cudgewa Creeks.

4. Present use

The massif is little used at present. Mount Mitta Mitta carries a fire tower and also a Department of Civil Aviation installation. Visitors to the scenic lookout and hikers occasionally use the area.

About 100 ha (250 ac) of forest support grazing stock.

B. Nature of the Land

1. Climate

Average annual rainfall ranges from 660 to more than 760 mm (26 to more than 30 in.). Summers are hot and relatively dry and winters are cool and wet. Summer conditions are ameliorated at the higher elevations, where temperatures are cooler.

The Mittamatite massif viewed from Mt. Mitta Mitta

2. Physiography and geology

The Mittamatite massif is the dominating feature of the block. It resembles the Pine Mountain massif in being composed of Upper Devonian red granite and Lower Devonian grey granite intruded by dyke swarms of varying composition. Its perched basins are larger in extent than those at Pine Mountain. Most streams are ephemeral, have steep grades, and in places form waterfalls.

Horse Creek is the major stream draining the plateau massif. Quaternary alluvial deposits form the plains and river flats.

3. Soils

The particular nature of parent materials, topography, and climate has resulted in generally shallow infertile soils. Undifferentiated stony loams have been formed in steep, dry situations. On flatter country, weakly bleached massive gradational soils dominate. The soils along the Murray River are predominantly alluvial brownish loams.

4. Vegetation

Red stringybark:long-leaf box open forest I and II covers most of the public land. Where red granite is the parent material, the understorey is heathy and includes such species as common fringe-myrtle, woolly grevillea, common correa, purple coral-pea, and common beard-heath. Where grey granite is the parent material, the understorey is usually grassy with scattered silver wattle about 2-3 m tall. Some slopes and small sheltered basins on the south face of the massif carry stands of narrow-leaf peppermint open forest III. The understorey may be predominantly grasses or bracken fern, or a mixture of shrubs including common cassinia and hop

bitter-pea. Some small rocky areas have specimens of red cypress pine growing about them. The river flats carry river red gum woodland II.

5. Fauna

Birds recorded for the area include the painted honeyeater, crimson rosella, pied currawong, kookaburra, grey thrush, white-browed scrub wren, and superb blue wren. A number of small birds inhabit the heathy understorey in the block. A pair of brolgas nests regularly at Towong. Little is known of the mammals of the block, but the black-tailed wallaby, wombat, and eastern grey kangaroo are recorded for the area.

A dense mass of purple coral-pea

6. Land systems

Mittamatite sub-system 70%; Magorra sub-system 24%; and Murray land system 6%.

C. Capabilities

1. Flora

The large number of heathy species in the understorey leads to a high capability for flora conservation. These include common correa, woolly grevillea, common fringe-myrtle, and common beard-heath. The diversity is not so great as at Pine Mountain, although some small areas of red cypress pine occur and some small swampy areas carry species such as swamp gum, prickly tea-tree, and coral heath. Among the heathy species is the significant species, *Grevillea ramossisima*.

2. Fauna

The capability for fauna is moderate to high. On the massif, the black-tailed wallaby is likely to be more abundant than the eastern grey kangaroo because of the scrubby nature of the forest. This would also tend to provide habitat for many of the smaller ground-dwelling

mammals. The greater glider is not likely to be represented in any numbers here because of the small and stunted tree form. The painted honeyeater has been recorded for the Mittamatite massif. The river red gum forest and associated environment is important for such birds as the brolga, dollar bird, noisy friar-bird, and little friar-bird, and mammals such as the platypus and eastern water rat.

3. Hardwood production

The capability for hardwood production is very low.

4. Softwood production

Almost the entire area of public land is unsuitable for softwood production.

5. Agriculture

Only a small area in the headwaters of Horse Creek and two small perched basins in the far east of the main public land area could support pasture establishment and grazing. The rest of the massif is unsuitable.

6. Honey

The capability of river red gums along stream frontages for honey production is high, as are also those of the red stringybark:long-leaf box forest and stands of blue gum. Eight sites mainly utilize trees on stream and road frontages. The average annual return from these and two additional sites utilizing flora on private property is estimated at about $5,000 (the third-highest figure in the district).

7. Water

Low yields and rapid run-off result in a low capability for water production.

8. Minerals

The capability for mineral production is not known. However, deposits of sandy material suitable for road-making purposes lie at the base of some of the steep slopes.

9. Recreation

The Mittamatite massif has a moderate capability for recreation activities such as sight-seeing, driving for pleasure, picnicking, and nature walks. Attractions include numbers of eastern grey kangaroos, scenic viewpoints, steep rocky outcrops and scarps, and wildflowers. Corryong Creek provides excellent fishing for brown trout, rainbow trout, and redfin. Occasional murray cod may also be caught.

D. Hazards and Conflicts

The soil erosion hazard is high on the steep slopes and medium on less-steep areas. Horse Creek has been deeply gullied because of the clearing of most of

its catchment. Protection from fire and the maintenance of ground cover are essential erosion-preventive measures and roads need to be carefully constructed. The fire hazard is moderate. The uncontrolled use of vehicles is a hazard to recreation and nature conservation values, and some evidence of damage by vehicles has appeared at one lookout point on the massif. Low capabilities for timber production or agriculture ensure little likelihood of conflict between these and nature conservation.

E. Significance

The Mittamatite massif lies very close to the township of Corryong. Its significant values are primarily for nature conservation and secondarily for recreation. The major recreational features are accessible from the main road to the tower.

Corryong township as viewed from the Mittamatite massif

7. ELLIOT

A. General

1. Location

The public land in this block comprises two main parcels of land, one of 3,470 hectares to the east of Corryong and the other, south of Corryong at Nariel Gap, of 970 ha. Together they total 4,440 ha (10,970 ac) of public land in the County of Benambra - portion of parishes of Towong, Colac Colac, and Thowgla.

Boundaries: Colac Colac-Towong road, Murray River upstream to a point 1.6 km (1 mile) north of Biggara, the road westerly over Thowgla hills *via* McCormack's Gap to the junction 1.6 km (1 mile) south of Thowgla, and the road *via* Nariel Gap to Colac Colac.

2. Present tenure

Unreserved Crown land: 4,460 ha (11,020 ac)
Stream frontages on various creeks, including camping ground on Corryong Creek
Various road reserves

3. General description

The land consists of the northern extremities of forested ranges, which run south to the alpine regions, and the broad mature valleys of the Murray River and Corryong and Thowgla Creeks, which have been cleared for agriculture.

4. Present use

About 1,000 ha (2,600 ac) of forest are grazed around Mount Elliot and about 400 ha (1,000 ac) near Nariel Gap. Four bee sites utilize river red gum, red stringybark, and blue gum on road-side reserves and adjacent forest. The main streams provide fishing.

B. Nature of the Land

1. Climate

Average annual rainfall varies from about 710 mm (28 in.) to 810 mm (32 in.). Summers are hot and dry, and winters are cool and wet.

2. Physiography and geology

The steep montane slopes rise abruptly from the river flats and terraces of the main streams. North of Nariel Gap a group of hills rises to an elevation of about 820 m (2,700 ft). One relatively

flat basin in these hills drains into Thowgla Creek.

The northern extension of the Thowgla hills consists of steep slopes that rise to narrow ridges at elevations of 600-750 m (2,000-2,500 ft) except for an area in the headwaters of Spring Creek just south of Mount Elliot. This area is a dissected plateau with a number of perched basins at elevations of about 600-750 m (2,000-2,500 ft). Mount Elliot reaches an elevation of 893 m (2,930 ft), the highest point in the block. Most of the hills are drained by Spring Creek, which flows eastwards to the Murray River.

Lower Devonian granites underlie the block north of Nariel and Towong Gaps and Ordovician schists the area south of Towong Gap.

3. Soils

The soils of the steeper, less-stable slopes on granite are usually weakly bleached massive gradational soils, but those on the Ordovician schists may be friable brownish gradational soils, particularly on southern aspects. Friable reddish gradational soils occur on flatter and moister areas such as broad ridge tops and southern aspects.

The steeper slopes on the hillocks and terraces mainly have weakly bleached massive gradational soils. Reddish duplex soils occur on gently sloping

View of Thowgla hills and Murray River valley, south-east from Towong Gap

upper terraces, while the lower terraces or flats mainly carry alluvial brownish loams.

4. Vegetation

The predominant vegetation of the hills north of Nariel Gap is red stringybark: long-leaf box open forest I and II on the drier sites. Red stringybark: long-leaf box open forest I has a sparse grassy (tussock grass) layer with occasional grasstrees. The taller red stringybark: long-leaf box forests have a sparse to grassy understorey, sometimes

with scattered handsome flat-pea. Some southern aspects carry stands of broad-leaf peppermint open forest II and narrow-leaf peppermint open forest III. The understorey for both units is typically grassy (tussock grass). Scattered bracken fern and silver wattle is associated with narrow-leaf peppermint open forest. A small stand of river red gum woodland II occurs on Thowgla Creek.

Grasstree on a steep slope in red stringybark: long-leaf box forest

A similar vegetation pattern exists south of Towong Gap with, however, relatively larger proportions of broad-leaf peppermint open forest II on the broader ridges and moister aspects. Narrow-leaf peppermint open forest II is found mainly in the high-elevation basins just south of Mount Elliot and on sheltered sites at lower elevations.

5. Fauna

Birds recorded for the block include the emu at forest margins and various waterbirds along the Murray River flats. Other birds of the forests would probably include spotted quail-thrush and grey thrush. The dollar bird, little friar-bird, and noisy friar-bird are likely species along the Murray River and in the nearby forest. A pair of brolgas frequents a locality near Towong. Mammals recorded for the block include numerous eastern grey kangaroos around Mount Elliot, and the platypus probably inhabits the Murray River. Smaller mammals are also likely to be represented.

6. Land systems

Magorra sub-system 90%; Murray land system 10%.

C. Capabilities

1. Flora

The public land has a moderate to high capability for flora conservation. Both parcels of land have been subjected to disturbance such as mining in the past and to grazing, which has continued over a long period of time. One significant species *(Grevillea polybractea)* has been recorded for Mount Biggara and three significant species *(Spiranthes sinensis, Spirodela polyrhiza,* and *Viola caleyana)* for Towong. The endangered species *Lemna polyrhiza* is recorded for lagoons around Biggara and Towong.

2. Fauna

The capability for fauna conservation is probably moderate. The eastern grey kangaroo and the emu are of interest in the forest areas. The water-birds and migratory species likely to frequent the river environs (such as the dollar bird, little friar-bird, and noisy friar-bird) are significant. The habitat is also suitable for the brolga.

3. Hardwood production

The block has a low capability for hardwood production. Some blue gum stands in moist gullies would be suitable for sawlog production but these, although close to Corryong, are relatively inaccessible. A small steep area situated to the north-east of Nariel Gap carries blue gum stands suitable for hardwood production.

The emu is often seen near forest margins

4. Softwood production

Small areas suitable for radiata pine growth lie in the basin south of Mount Elliot and further south again in the basin of Packhorse Creek. However, capability for softwood production is low because of the small area involved.

5. Agriculture

The predominance of steep slopes results in a low capability for agriculture. A narrow strip of river flats along Spring Creek (northern branch) would be suitable for pasture establishment and grazing.

6. Honey

Honey production on the four sites used in this block mainly depends on river red gums that grow along road and stream reserves, but the red stringybark and blue gum areas nearby also contribute. Average annual yield is estimated at $1,000. Possibilities for further production are limited.

7. Water

Spring Creek, a minor tributary of the Murray River, yields relatively little water. However, the potential recreation use makes it important to maintain water quality in this and other streams.

8. Minerals

The gold-fields around Mount Elliot have apparently been worked out. The capability for further production is therefore likely to be low.

9. Recreation

The capability of the parcel of land north of Nariel Gap for recreation is low, whereas that for many forms of recreation around Mount Elliot is high. Mount Elliot affords magnificent views of Corryong and the Mittamatite massif. Permanent water from springs on the plateau make the area suitable for hiking and camping. Additional attractions include the eastern grey kangaroo population and the old gold-mines. The Murray River provides opportunities for canoeing. This stream and Thowgla Creek are well stocked with brown and rainbow trout.

D. Hazards and Conflicts

A high sheet erosion hazard affects the steep slopes that predominate on the public land. The risk of erosion can be minimized by maintenance of ground cover and protection from fire. Grazing of the steep slopes would conflict with soil conservation. The plateau area near Mount Elliot has a lower erosion hazard. Conflicts are not likely to arise in the use of this block because it has only low capabilities for agriculture and timber production. Recreation usage could conflict with nature conservation if not controlled.

E. Significance

The primary significance of the Mount Elliot area lies its potential for recreation because of its natural characteristics and its close proximity to the population centres of Khancoban, in New South Wales, and Corryong. For nature conservation, the forested areas have a moderate capability and the river environs a moderate to high one.

8. BUNROY

A. General

1. Location

The consolidated area of hilly land to the south of Thowgla comprises 19,578 hectares (48,380 ac) of public land in the County of Benambra - parts of parishes of Thowgla, Nariel, and Kancobin.

Boundaries: the road from Crawford Crossing to Thowgla *via* Nariel Gap, Thowgla-Biggara road over McCormack's Gap to a point 1.6 km (1 mile) north of Biggara, Murray River upstream to the southern boundary of district, and westwards along the southern boundary to Crawford Crossing.

2. Present tenure

Reserved forest: 4,370 ha (10,800 ac)
Unreserved Crown land: 15,176 ha (37,500 ac)
State school forest plantation: 32 ha (80 ac)
Various stream frontages and road reserves.

3. General description

The area consists almost entirely of steep to very steep montane slopes, with limited flat to gently undulating land along some creeks.

4. Present use

About 1,600 ha (4,000 ac) support forest grazing around Bunroy hut. Gravel pits are situated at Nariel Gap and at either end of the McCormack Gap road. A state school pine plantation near Nariel Creek occupies about 32 ha of land. An average of 10 bee sites utilize long-leaf box and candlebark gum. Both Nariel Creek and the Murray River provide trout fishing, and this section of the Murray River is very popular with canoeists.

B. Nature of the Land

1. Climate

Average annual rainfall ranges from about 760 mm up to about 1,020 mm (30 in. to 40 in.), with a winter maximum. Snow falls occasionally on the higher areas. Summers are hot and dry; winters are cool and wet at the lower elevations, but summer temperatures are milder and winter temperatures colder at the higher elevations.

View eastwards across Thowgla valley towards Mount Unicorn

2. Physiography and geology

The area consists almost entirely of montane slopes rising to elevations of more than 900 m.(3,000 ft) such as at Mount Unicorn. It contains restricted areas of hillocks, and some stream terraces and flats along Teapot, Bunroy, Burbibyong, and Star and Jones Creeks. An area of less-steep slopes is situated in the headwaters of Kangaroo and Bullocky Creeks.

Fine-grained sedimentary or metamorphic rocks underlie most of the steep hilly country. Outcrops of granite are usually associated with less-steep slopes and basins, for example near Bunroy Hut and in Burbibyong Creek (eastern branch).

The summit of Mount Unicorn is composed of quartz porphyry rock. Thowgla Creek valley contains a number of gold-bearing quartz reefs.

3. Soils

Friable brownish gradational soils usually cover the steeper montane slopes with northern aspects. Undifferentiated stony loams may be found on the narrow ridge tops. Friable reddish gradational soils occur on flatter and moister areas, mainly on the broader ridge tops and southern aspects.

The soils of the hillocks and steeper terrace slopes are mainly weakly bleached massive gradational soils.

4. Vegetation

The upper slopes in the north of the area usually carry stands of red stringybark:long-leaf box open forest I and the lower slopes carry stands of red stringybark:long-leaf box open forest II. Understoreys are mainly tussock grass or sparse with occasional grass-

trees. Broad-leaf peppermint open forest II usually occupies the drier montane slopes in the south of the block. Understoreys here mainly comprise tussock grass and occasionally bracken fern and hop bitter-pea.

Narrow-leaf peppermint open forest III is found on moister sites such as broad ridge tops, gullies, and southern aspects. The understorey varies from ferns such as common groundfern in gullies to bracken fern, hop bitter-pea, and silver wattle.

5. Fauna

Birds recorded for the block include the emu, the spotted quail-thrush, which is often seen on dry ridges, and the satin bower-bird, lyrebird, and wonga pigeon, which mainly frequent the gullies and moister hillslopes. The greater glider has been reported near McCormack Creek but little is known of other mammals.

6. Land systems

Magorra sub-system 66%; Dart syb-system 30%; and Murray land system 4%.

C. Capabilities

1. Flora

The flora strongly resembles that of the Wabba block, and is representative of the flora to be found in the higher-rainfall foothill areas of the north-east. *Pomaderris velutina* is a significant species recorded for the block. The endangered species *Lemna polyrhiza* is recorded for lagoons around Biggara. The capability is moderate to low.

2. Fauna

The block has a high capability for fauna conservation, being a consolidated area of relatively undisturbed land. Significant species include the greater glider, black-tailed wallaby, platypus, satin bower-bird, and wonga pigeon.

3. Hardwood production

The capability is low. Narrow-leaf peppermint forests in the headwaters of Bullocky and Kangaroo Creeks and in the Bunroy basin have the highest capabilities, but are remote and limited in area.

4. Softwood production

Only the limited areas of narrow-leaf peppermint discussed above are suitable for radiata pine growth, and their small size and remote location result in a low capability for softwood production.

5. Agriculture

Agricultural capability is low, being limited to areas along some stream flats suitable for pasture establishment and grazing.

6. Honey

An annual average of 10 sites utilize forested land near Nariel Creek, returning approximately $1,000 per annum. The potential for further production is limited.

7. Water

The block has a moderate to high capability for water production. The Murray River and Thowgla Creek are the main streams draining it.

Fishing in the Murray River at Bunroy

8. Minerals

Gold has been won in the past from reefs and alluvium along the Thowgla Creek and some of its tributaries, but the possibility of any further production is low.

9. Recreation

The capabilities for fishing, hiking, camping, walking, and driving for pleasure are high. Both the Murray River and Thowgla Creek are well stocked with brown and rainbow trout. Attractions include the Murray River, the historic Bunroy hut, and the old mining areas around Thowgla Upper.

D. Hazards and Conflicts

The sheet erosion hazard on the steep slopes is moderate around Biggara and Bunroy, but becomes moderate to high over most of the steep slopes elsewhere. Maintenance of ground cover and protection from fire is therefore important, despite the generally low fire hazard. Fire protection is also important in this block because of its proximity to the adjoining Kosciusko National Park and the presence of large stands of alpine ash to the south of the block.

The blackberry presents a serious hazard to some forms of recreation and to nature conservation in some localities.

It forms dense tangles along Thowgla Creek near private property.

Generally, conflicts are not likely, as the capabilities of the block are high for nature conservation but low for most other forms of use. Some conflict could arise between recreation use along the Murray River and nature conservation.

E. Significance

The primary significance of this block is its capability for nature conservation and recreation. It adjoins the Koscuisko National Park to the east and large unbroken areas of public land to the south, which include alpine ash stands and sub-alpine environments.

9. WABBA

A. General

1. Location

The Wabba block consists of an unbroken tract of land to the south-west of Corryong known as the Wabba hills (or Wabba country). It comprises 25,380 hectares (62,720 ac) of public land in the County of Benambra - portions of parishes of Wabba, Colac Colac, Canabore, Adjie, Nariel, and Welumla.

Boundaries: road from Colac Colac to Crawford crossing; west along southern district boundary to the head of Reedy Creek (east branch); along this stream to Lucyvale, thence along Lucyvale-Beetoomba road; Beetoomba-Colac Colac road.

2. Present tenure

Reserved forest: 10,490 ha (25,920 ac)
Unreserved Crown land: 14,890 ha (36,800 ac)
Various stream frontages and road reserves.

3. General description

In this primarily unbroken area of forested country, the only access is by four-wheel-drive vehicles. It has a steep and much dissected topography with ridges rising to elevations of 1,000 m (3,500 ft) in the south.

4. Present use

The block supports very limited honey production around Nariel Creek and a little forest grazing around the forest margins near Lucyvale and Rawes Creek. Local scouting groups also use it for adventure hiking.

B. Nature of the Land

1. Climate

Average annual rainfall ranges from 760 mm to 1,270 mm (30-50 in.) - 760 mm near Colac Colac and 1,270 mm in the headwaters of Log Bridge Creek. More rain falls in winter than in the other seasons. Some snow may fall on the higher peaks during winter, but this is not a common event. Summer maximum temperatures are moderately high and winter maximum temperatures are low.

2. Physiography and geology

Steep montane slopes occur over most of

the block, with hillocks, stream flats, and terrace land forms around the northern and eastern margins of the hills. Major valley floors lie at about 300-450 m (1,000-1,500 ft). Valley floors in the montane country occupy elevations of about 450-750 m (1,500-2,500 ft), with ridge-top elevations up to about 900-1,000 m (3,000-3,500 ft). Most of the rivers have cut into Ordovician schists or unaltered sandstones, shales, and slates, giving rise to highly dissected topography with steep slopes and narrow ridges and valley floors. However, a north-south belt of Lower Devonian granite, lying mainly in the Wabba Creek watershed, has resulted in topography with broader ridges and valley floors. Quaternary deposits form broad upper terraces and alluvial flats in the Cudgewa and Corryong Creek valleys. A relatively narrow strip of alluvium has been deposited along Rawes Creek.

3. Soils

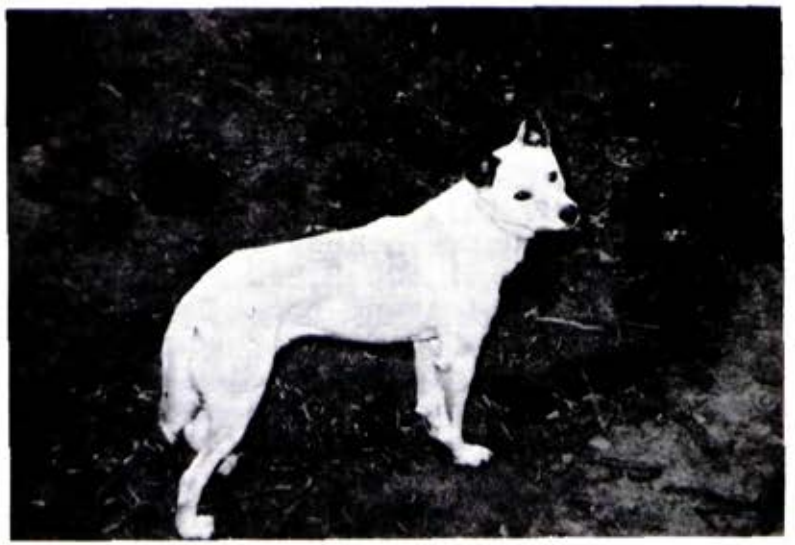
Friable brownish gradational soils are the most widely distributed soils on the montane slopes and some of the higher ridges. Undifferentiated stony loams are common on the narrow ridge tops and steeper slopes with northerly aspects. Under lower-rainfall conditions in the northern section, weakly bleached massive gradational soils predominate and may be associated with undifferentiated sandy loams where a sharp break in slope occurs. On less-steep country, friable reddish gradational soils occur where rainfall is high, and reddish duplex soils dominate under lower rainfalls.

Narrow-leaf peppermint forest on broad granite ridge

4. Vegetation

The pattern of vegetation is one of narrow-leaf peppermint open forest III in the valley floors and moist aspects, with some occurrences on broad ridge tops in the higher-rainfall areas. The

The spotted quail-thrush often frequents ridges



The dingo (Canis familiaris) *occurs in the Wabba block*

understorey may consist of bracken fern or may be scrubby with such species as hop bitter-pea, common cassinia, and prickly bush-pea.

Most of the drier sites in the south of the block carry stands of broad-leaf peppermint open forest II, but in the north the driest aspects carry stands of red stringybark:long-leaf box open forest II. Some steep northern or western aspects are timbered by red stringybark:long-leaf box open forest I. The understorey under the drier type of stand may be predominantly tussock grass or may be a low scrubby layer that includes handsome flat-pea and sometimes hop-bitter-pea.

5. Fauna

Little is known of the fauna of the block. Birds recorded for the area include the spotted quail-thrush, often seen on ridges, and the pied currawong and white-winged chough, which often frequent creeks. Large numbers of emus and sulphur-crested cockatoos have been recorded near Rawes Creek.

The black-tailed wallaby, eastern grey kangaroo, and dingo occur in the area.

6. Land systems

Dart sub-system 95%; Murray land system 3%; and Thowgla sub-system 2%.

C. Capabilities

1. Flora

It is not known if the block contains any species of botanical significance. Its main value is as a natural area representative of the higher-rainfall, steep foothill country of the north-east. It has a moderate capability for flora conservation.

2. Fauna

Little is known of the fauna of this block. Its relative remoteness and inaccessibility mean that the fauna are likely to be in an undisturbed condition, except perhaps for any introduced predators, so the capability is moderate to high.

3. Hardwood timber

The capability for hardwood production is low. Some narrow-leaf peppermint and candlebark gum stands in the headwaters of Wabba Creek have been logged, but these are small in extent and are in a remote locality.

4. Softwood timber production

A considerable area of land in the headwaters of Wabba Creek and in Rawes Creek is suitable for radiata pine growth and lies within a reasonable distance of the existing plantation at Shelley. Although the slopes are generally less than 20 degrees, the terrain is well dissected. The capability for softwood production is moderate.

5. Agriculture

Most of the block is too steep for consideration as agricultural land. A narrow strip of river flats along Rawes Creek would permit pasture establishment and grazing. However, vermin and weed problems and competition from native herbivores already limits suitability on adjacent private property.

Land in the headwaters of Wabba Creek would have suitable soils and slopes, but is relatively remote and would have short growing seasons.

6. Honey

No sites utilize the public land in this block and the capability for honey production is low.

7. Water

The capability for water production is moderate. Log Bridge and Wabba Creeks contribute to Cudgewa Creek flows. Rawes Creek contributes to Corryong Creek just upstream from the intake for Corryong's water supply.

8. Minerals

No economic minerals are known to occur in the block.

View of timbered ridges from a viewpoint in the Wabba country

9. Recreation

This block has considerable potential for a number of types of recreation, due to the broken nature of the landscape, the common occurrence of narrow ridge tops high above the valley floors, and the fact that access within the public land is restricted to four-wheel-drive vehicles. Ridge tops frequently afford views both of the timbered ridge to the south - which forms the catchment boundary between the Dart River system and the Corryong-Cudgewa Creeks system - and the cleared valleys and plains to the north. Traversing the block gives a clear impression of three-dimensional space. The area would be suitable for cross-country driving, hiking, and camping. The block also has values for solitude. The tracks are well constructed and not likely to deteriorate, except perhaps in some sections in the north where weakly bleached massive gradational soils occur. Brown and rainbow trout may be caught in Corryong and Nariel Creeks and also in the smaller streams.

D. Hazards and Conflicts

Erosion is not a problem on public land at present because of the undisturbed condition of the vegetation. However, sheet erosion could occur on the steeper, drier slopes if the area was cleared or severely burnt. The fire hazard is low to medium. Fires in this area, however, would constitute a hazard to alpine ash stands situated to the south of the block.

Conflicts could arise between softwood production and both nature conservation and recreation requiring solitude in the Wabba and Rawes Creek valleys. Agriculture may also be a competing use in the lower Rawes Creek valley. The main conflict likely to arise, however, is

between recreation uses - for example cross-country driving could conflict with hiking and camping. It appears likely that use by vehicles, if not controlled, could cause physical damage to the environment.

E. Significance

The main values of significance are for nature conservation and recreation. Due to its comparative remoteness and inaccessibility, the block is relatively undisturbed and would have some scientific value. It has high capability for recreation. The headwaters of Simpson and Log Bridge Creeks, although outside the study district, could also be considered as part of this natural unit. The block adjoins a large area of forested land, some of which comprises regrowth stands of alpine ash.

10. MOUNT CUDGEWA

A. General

1. Location

A consolidated area of public land comprises 16,370 hectares (40,450 ac) in the County of Benambra - portions of parishes of Canabore, Adjie, Wyeebo, Keelangie, and Welumbla.

Boundaries: Tallangatta Creek (eastern branch) and Cooeeing Woman's Creek, across the ridge and thence along Lucky Hit, Cudgewa, and Reedy Creeks to Reedy Creek (eastern branch), thence along this stream to the southern boundary of the district and eastwards to Bucheen Creek at Cravensville, and Tallangatta Creek to its junction with Tallangatta Creek (eastern branch).

2. Present tenure

Reserved forest: 85 ha (210 ac)
Unreserved Crown land: 16,285 ha (40,240 ac)
Various stream frontages and road reserves

3. General description

In this primarily mountainous tract of land, steep montane slopes surround a central plateau at Mount Cudgewa.

4. Present use

Current forest grazing - in the Reedy Creek basin, in the headwaters of Cooeeing Woman's and Lucky Hit Creeks, and in the basins of Rogers, Little Bucheen and Lucky Hit Creeks at low elevations - covers about 3,000 ha (7,500 ac).

Tin-mining operations at Mount Cudgewa are limited in extent.

The red stringybark: long-leaf box forests on steep slopes rising up from the Tallangatta Creek and its eastern branch are heavily used by beekeepers.

B. Nature of the Land

1. Climate

Average annual rainfall ranges from 890 mm to more than 1,270 mm (35-50+ in.), with a winter maximum. Observation of vegetation patterns indicates that the lower-rainfall areas (35-40 in.) are in Tallangatta Creek valley, while areas at the higher elevations and near Lucyvale experience high rainfall (40-50 in.).

2. Physiography and geology

The highest country of this block forms the divide between the Tallangatta Creek and Cudgewa Creek catchments and lies at a general elevation of 920 m (3,000 ft). It reaches 1,100 m (3,600 ft) at Mount Cudgewa and just over 1,200 m (4,000 ft) in the south. For the most part the divide is a narrow ridge, but it broadens out to form a plateau at Mount Cudgewa and again in the far south to form a broad flat-topped ridge.

The topography falling away from the main ridge mostly consists of steep montane slopes. A broad basin lies in the headwater of Rogers Creek, with its base at an elevation of about 730 m (2,400 ft). Less-steep land is situated in the Tallangatta Creek and Tallangatta Creek (eastern branch) valley floors, which are at elevations of 305-430 m (1,000-1,400 ft), and in the Cudgewa and Reedy Creek valley floors at elevations of 460-790 m (1,500-2,600 ft).

Two outcrops of grey granite, one extending northwards from Mount Cudgewa and the other in the Reedy Creek watershed, are the dominant geological features. The outcrops are surrounded by a zone of Ordovician schists up to 3 km (2 miles) wide. Ordovician sedimentary rocks outcrop around Cravensville and extend northwards along the Tallangatta Creek valley towards Wyeebo. A belt of Silurian rhyodacite (Mitta Mitta volcanics), which extends southwards to the Gibbo-Mitta Creek junction, outcrops at the Gibb Range road in the far south of the block. Quaternary deposits occur along the main streams.

3. Soils

Friable reddish gradational soils occur on the plateau at Mount Cudgewa. Friable brownish gradational soils are the most widely distributed soils of the montane slopes, and also occur on broad ridge tops at the highest elevations. Undifferentiated stony loams are common on the narrow ridge tops and steeper slopes with northerly aspects. Reddish duplex soils occur on the less-steep hills. Some weakly bleached massive gradational soils formed on granite are found on steep slopes in the Reedy Creek catchment.

4. Vegetation

Narrow-leaf peppermint open forest III is found on the plateau, on southern aspects, and in moist siutations. The understorey varies from bracken, to shrubby with wattles and hop bitter-pea, to the moist gully type of blanket-leaf, austral mulberry, and hazel pomaderris. A forest floor of kangaroo grass, other grasses, and handsome flat-pea is common at lower elevations near Cravensville and Reedy Creek. Small communities of swamp gum open forest found in the headwaters of some creeks have quite a distinctive flora and also animal complement. The mountain tea-tree and black-

wood attain heights of 12 m and form a canopy over a tall shrub layer (that includes mountain pepper and hazel pomaderris) and a ferny layer (that includes alpine water-fern and fishbone fern.

Hazel pomaderris is found in gullies under narrow-leaf peppermint forest

A small stand of alpine ash open forest IV occurs on a flat ridge along Gibb Range road. It is mainly regrowth with some mature trees. The understorey comprises a low scrubby layer of hop bitter-pea and snow grass on exposed sites and a tall shrubby layer of buffalo wattle, prickly bush-pea, and forest lomatia on sheltered sites.

The broad-leaf peppermint open forest II with tussock grass and handsome flat-pea understorey on ridges and upper exposed slopes in the higher-rainfall areas gives way to red stringybark:long-leaf box open forest I and II in the lower-rainfall areas on dry northerly aspects. The understorey here is low scrub to tussock grass.

5. Fauna

The birds of the block are distributed according to the various habitats. The most restricted habitat is the swamp gum open forest of the swampy headwaters of some creeks and the moist gullies in narrow-leaf peppermint open forest. Species to be found here include the white-browed scrub-wren, rufous fantail, superb lyrebird, and red-browed finch. Other species found here and also in the narrow-leaf peppermint forest include the grey fantail, sulphur-crested cockatoo, southern yellow robin, crimson rosella, red-browed tree-creeper, wonga pigeon, grey thrush, white-throated tree-creeper, and pied kurrawong. Birds of the drier forests include the spotted

quail-thrush and white-winged chough.

The large mammals include the common wombat, eastern grey kangaroo, and black-tailed wallaby. Other mammals likely to occur here are the gliders, possums, phascogales, and native rodents.

6. Land systems

Dart sub-system 68%; Magorra sub-system 24%; Koetong land system 4%; Murray land system 2%; and Lucyvale sub-system 2%.

C. Capabilities

1. Flora

Mount Cudgewa block has a moderate to high capability for flora conservation. It shows a gradation from the red stringybark:long-leaf box open forest typical of the drier northern sections of the district to alpine ash open forest typical of large areas to the south of the district. Significant species recorded for Cravensville are *Merbelia oxyloboides* (mountain mirbelia) and *Pimelea treyvaudii*. *Chiloglottis pescottiana* (now presumed to be extinct) has also been recorded at Cravensville.

2. Fauna

The capability for fauna is moderate to high. The large herbivores and the gliders, possums, and phascogales would all be well represented. The dingo also appears in this area from time to time.

The southern yellow robin

The birds of this area are typical of the wet open-forest areas elsewhere in the north-east. Common birds include the white-throated tree-creeper, grey thrush, and crimson rosella. The birds of the moist gullies and swampy streams, such as the superb lyrebird, white-browed scrub-wren, and rufous fantail, have particular interest. Reptiles would be well represented and amphibians less so.

3. Hardwood timber

Some of the district's main commercial stands of timber lie in this block - blue gum stands in the Rogers, Lucky

Narrow-leaf peppermint forest in the Reedy Creek valley (eastern branch)

Hit, and Reedy Creeks watersheds and an alpine ash regrowth stand on the Gibb Range. The Mount Cudgewa plateau has a high potential for hardwood production, although present stands carry low sawlog volumes. Pulpwood production would also be a possibility. Altogether, this block has one of the highest capabilities for hardwood production in the district, and is also situated *en route* to areas of alpine ash stands to the south.

4. Softwood timber

The main areas suitable for softwood plantations are on the Mount Cudgewa plateau and in the watersheds of Lucky Hit and Rogers Creeks. These can produce radiata pine, predominantly site qualities II to IV. The Reedy Creek basin is suitable to marginal for radiata pine growth (site qualities III to VI). Other areas are either limited in extent or are unsuitable because of steep slopes and/or dry sites.

On the plateau area and some sourthern aspects, douglas fir could be considered as an alternative to radiata pine and would produce similar quantities of timber to radiata pine stands of site qualities II to III.

5. Agriculture

The Mount Cudgewa plateau could be suitable for pasture establishment and grazing of sheep or cattle, but winter cold limits the growing season. Occurrences of winter snow and remoteness give it a low to moderate capability.

At lower elevations the climate is not so severe, and the main areas suitable for pasture establishment for grazing are a narrow valley floor along Georges Creek, a broad valley floor along Cudgewa Creek south of private property, and a relatively remote area along the eastern branch of Reedy Creek, which is currently used for forest grazing.

6. Honey

The red stringybark:long-leaf box forests of the montane slopes in the Tallangatta Creek valley have a very high capability. A total of 16 sites, all utilizing forest, return an average annual sum of between $6,000 and $7,000. Potential for further honey production is only limited as the main vegetation types have low capabilities.

7. Water

The block has a capability for water production. The higher catchments are subjected to high rainfall and occasional snow. The main streams contributing to Lake Hume are the Tallangatta Creek tributaries (the eastern branch and Rogers and Bucheen Creeks) and Cudgewa Creek with its Reedy Creek and Lucky Hit Creek tributaries.

8. Minerals

Reserves of tin are likely to be small. Gold has been recorded at Cravensville, but the area has been worked over and reserves are probably low.

9. Recreation

The block has a moderate value for recreation. The main capabilities would be fore nature walks, hiking, camping, fishing, and driving for pleasure.

Tallangatta and Reedy Creeks provide fishing for brown trout and rainbow trout.

D. Hazards and Conflicts

The sheet erosion hazard on the steep montane slopes of the lower Tallangatta Creek Valley is high. Protection from fire, and management to improve or maintain ground cover is necessary to minimize or prevent erosion. A lower erosion hazard exists on montane slopes around Mount Cudgewa and Cravensville, but sheet erosion could occur with mismanagement of these areas. The soil erosion hazard is low on the plateau and broad ridges. The fire hazard is generally low in this block. However, wildfires burning in it would constitute a hazard to stands of alpine ash to the south-east.

Conflicts could arise between softwood production and nature conservation of fauna and flora in the central and southern parts of the block. Agriculture could conflict with nature conservation in the Cudgewa Creek Valley. This latter area and an area in the Burrowa block comprise the only examples of the Lucyvale sub-system that are still uncleared.

E. Significance

The block is primarily of significance for nature conservation, softwood timber production, and hardwood timber production.

11. LUCYVALE

A. General

1. Location

This block is situated to the south of Bullioh-Beetomba section of the railway line to Cudgewa. It comprises 18,000 hectares (44,480 ac) of public land in the County of Benambra - portions of parishes of Granya, Berringama, Wyeebo, Canabore, and Wagra.

Boundaries: the railway line from Bullioh to Beetomba, upstream along Cudgewa and Lucky Hit Creeks, across the ridge and down Cooeeing Woman's Creek, Tallangatta Creek (eastern branch), and Tallangatta Creek to Bullioh.

2. Present tenure

Reserved forest: 3,584 ha (8,855 ac)
Unreserved Crown land: 13,523 ha (33,420 ac)
Occupied Crown land: 813 ha (2,010 ac), including approximately 120 ha (300 ac) of S.E.C. easement for a transmission line.
Water and ballast reserve - Koetong Creek 30 ha (75 ac)
Reserves along various streams and roads
High school plantation reserve: 50 ha (120 ac)

3. General description

A slightly dissected, timbered plateau at about 760-920 m (2,500-3,000 ft) elevation is bounded on the east and west by steep to very steep montane slopes, also timbered. Hillocks in the lower valley situations and stream flats are mainly under pasture.

4. Present use

About 6,400 ha (15,800 ac) of native forest on the plateau around Avondale and Koetong are leased for grazing. Sheep graze this area at stocking rates of up to one sheep per acre of forest land, and also a cleared area of public land of about 400 ha (1,000 ac). About 50 ha (120 ac) of high school plantation is planted to radiata pine. Some forest land supports honey production around Berringama, Bullioh, and Darbyshire. A P.M.G. repeater station occupies some land at Hunters' Hill. About 120 ha of public land, cleared for an S.E.C. transmission line easement, dissects the block.

B. Nature of the Land

1. Climate

Average annual rainfall varies from 1,020 mm to more than 1,140 mm (40 to more than 45 in.) on the plateau and decreases to about 890 mm (35 in.) in the lower Tallangatta Creek Valley. The rainfall pattern on the plateau has a definite winter maximum, and light snowfalls may occur several times during the winter. Frosts are common and often severe, particularly in local, low-lying areas.

Temperatures in summer are generally milder than in the adjacent valleys and winter temperatures are colder. The montane slopes and hillocks of the Tallangatta Creek Valley receive annual rainfalls of 760-890 mm (30-35 in.), with hot dry summers and cool wet winters. Frosts occur from autumn through to spring.

Rainfall on the montane slopes and hillocks of the Cudgewa Creek Valley varies from about 1,020 mm to more than 1,140 mm (40 to more than 45 in.), and summer temperatures are milder and winter temperatures cooler than in the Tallangatta Creek Valley.

2. Physiography and geology

The plateau around Koetong comprises the central section of this block. It has a rolling to hilly topography at elevations of 610-920 m (2,000-3,000 ft) for the most part. Some hills rise above the plateau, but these are rarely more than about 50 m (a few hundred feet) higher than the general level. Below the steep to very steep montane slopes at the edge of the plateau, rolling to steep hillocks and undulating valley floors lie at elevations of about 300-450 m (1,000-1,500 ft). The main streams flow westwards into Tallangatta Creek or eastwards into Cudgewa Creek.

The rock type is Lower Devonian grey granite, except for minor occurrences of Tertiary gravels and Quaternary colluvial-alluvial deposits.

3. Soils

The predominant soils of the plateau are friable reddish gradational soils, usually about 1-2 m (3-6 ft) deep. Weakly bleached massive gradational soils occur on and at the bases of the steeper slopes. Granite boulders commonly outcrop on the tops of low hills and ridges. Granite floaters occur in the soil in many places, and decomposing rock is encountered at shallower depths on hills and ridges than elsewhere.

The predominant soils of the steep montane slopes are weakly bleached massive gradational soils in the drier situations and friable brownish gradational soils on the moister sites. On the less steep slopes of the hillocks and valley floors, reddish duplex soils predomin-

Narrow-leaf peppermint open forest III on the Koetong uplands

ate, and friable reddish gradational soils may occupy gentle slopes where the rainfall is higher.

4. Vegetation

Narrow-leaf peppermint open forest II covers most of the uplands. The understorey on the plateaux and exposed sites is commonly a fairly continuous sward of tussock grass with scattered shrubs, mainly hop bitter-pea but sometimes handsome flat-pea. On sheltered aspects and in basins the understorey commonly comprises dense bracken fern with scattered small trees of silver wattle and blackwood.

Broad-leaf peppermint open forest II commonly occurs on drier ridges and slopes on the plateau. The understorey is typically tussock grass or tussock grass in mixture with handsome flat-pea. Red stringybark:long-leaf box open forest I and II occupy many of the narrow ridges and steep northern slopes in the Tallangatta Creek valley. The understorey may consist of sparsely distributed grasses or small shrubs.

Swamp gum open forest II is found in and bordering some perennial streams or in low-lying swampy areas on the plateau. The understorey around Lake Findlay consists of coral heath and sometimes sphagnum moss, but at lower elevations the understorey mainly consists of ferns, including fishbone water-fern and soft treefern.

5. Fauna

Little is known of the fauna of the block. Surveys in the adjacent areas to the north, however, indicate what may be expected. Birds recorded for this block include the emu, collared sparrow-hawk, satin bower-bird, lewin honeyeater, white-eared and white-naped honeyeaters,

gang-gang cockatoo, sulphur-crested cockatoo, golden whistler, crimson rosella, and white-winged chough. Such birds as the magpie-lark, black duck, white-necked heron, and white-winged chough frequent small areas of wetland in the Lake Findlay locality.

The eastern grey kangaroo has been recorded in this block. Probable species include the long-nosed bandicoot, and some of the gliders, possums, phascogales, and native rodents. More information on the mammal population in this area is needed to assist in making wise decisions on land use.

C. Capabilities

1. Flora

Perhaps the most interesting flora grows around the swamps and swampy drainage lines at Lake Findlay and along such creeks as Lucyvale Creek. Interesting plants include the coral heath, sphagnum moss, and small-fruited hakea.

The plateau supports few rare or interesting species. The main value of this area lies in the fact that the plateau environment, including its flora, is not found anywhere else in Victoria, although similar environments are found on the Stanley plateau near Beechworth, and the Mount Samaria and Strathbogie plateaux near Mansfield. This gives the area a moderate to high value for flora conservation.

2. Fauna

The capability for fauna conservation, although largely unknown, probably rates from moderate to high. The plateau

Coral heath (Epacris microphylla)

The lewin honeyeater

country supports or is likely to support a number of significant species, including the satin bower-bird, lewin honeyeater, long-nosed bandicoot, greater glider, wombat, black-tailed wallaby, and eastern grey kangaroo.

3. Hardwood production

Most of the block has a moderate capability for hardwood production. Scattered areas of blue gum regrowth totalling about 730 ha (1,800 ac) have high growth rates, and could be used for pole and sawlog production. Generally, the main potential could be for pulpwood or wood-chip production.

4. Softwood production

This block has a high capability for softwood production. Site qualities of II to IV could be expected over most of the plateau country and on the slopes into Cudgewa Creek. Areas of poor drainage - such as along the Lucyvale Creek - and dry sites - such as some of the slopes into Tallangatta Creek - are marginal to unsuitable for radiata pine. Some sheltered sites in the block are suitable for douglas fir plantings and would yield amounts of softwood timber equivalent to those produced by radiata pine stands of site quality II to III.

5. Agriculture

Public land in this block has a high to moderate capability for agriculture and includes some of the most suitable potential agricultural land in the study district. Most of the land suitable for softwood timber production in this block would also support agriculture.

The best use of land after clearing would be for perennial pastures for cattle and sheep production, although the soil is suitable for horticulture and some crops such as potatoes, apples, and strawberries. Much of the forested public land is also leased for grazing by sheep and could continue to be used in this way.

The major factors limiting the capability of the area for agriculture are

the cold winters, which limit pasture growth, and the present lack of good access roads to the plateau areas. The soils could also require fairly heavy applications of superphosphate and the use of the trace element molybdenum for successful pasture establishment. Fully developed permanent pasture areas should be capable of carrying 4-6 dry sheep per acre or their equivalent in other stock.

Development (including clearing, fencing, and sowing down to perennial pastures) could cost up to $80 an acre. Cattle and sheep for stocking would be an additional cost.

There is scope for complete farm units to be located on the plateau, but it is more probable that the plateau country will be developed for spring, summer, and autumn grazing, in association with lower, generally warmer country to which stock can be moved if necessary during the winter months. Alternatively, fodder conservation could supplement winter feed requirements.

6. Honey

At present, only about two sites utilize forest, producing an average annual honey crop, based on red stringybark, of about $500. Little further potential exists in the western section of the block, but the eastern slopes descending from the plateau have some further potential. Generally, capability is low.

7. Water

The capability for producing water is high. The main streams contribute significant volumes of water to Tallangatta and Cudgewa Creeks. Cudgewa Creek supplies the township of Cudgewa. The major streams in the block include Dry Forests, Lucyvale, Lucky Hit, and Kane Creeks. The headwaters of Koetong Creek are also included in the block.

8. Minerals

At present, a mineral lease application is current near Dry Forest Creek. The tin reserves in this area are likely to be small, as they are mainly alluvial in nature and stream flats are not very wide.

9. Recreation

The capability for recreation is moderate. The plateau area is quite suitable for driving for pleasure, nature walks, hiking, and camping. The block contains a number of fishing streams in which brown trout and rainbow trout may be caught. The tin-mining sites around Dry Forest Creek are also attractions.

D. Hazards and Conflicts

Erosion hazard on the uplands is quite low due to the permeable nature of the dominant soils. Surface washing of roads and slumping of road batters can be a problem. No erosion is evident on

the uncleared montane slopes in the block. However, sheet erosion is likely if adequate ground cover is not maintained on the steeper slopes. The fire hazard is low.

The major conflicts are likely to be between softwood production and nature conservation. Conflicts between softwood production and fauna conservation can be minimized by leaving adequate strips along streams, corridors for animal movement, and areas of native vegetation in the plantation area. As all of the uplands could support softwood production, and as they are a feature not found elsewhere in the State, consideration should be given to reserving a viable area for scientific and educational purposes. This will involve conflict with the productive use of the land, whether for softwood or agriculture. Fuel-reduction burning on steep slopes in the advent of softwood plantations could conflict with soil conservation as well as nature conservation.

E. Significance

The main significance of this block is the suitability of the uplands for softwood production and agriculture and its values for nature conservation. It should be noted that little is known of the mammal and bird populations of the block.

12. KOETONG

A. General

1. Location

Most of the public land consists of a consolidated area situated between the Koetong-Beetoomba section of the railway line and Burrowye in the north. The public land totals 15,540 hectares (38,400 ac) in the County of Benambra - portions of parishes of Burrowye, Koetong, Jinjellic, Granya, and Berringama.

Boundaries: the railway line from Koetong to Beetoomba, Beetoomba to Guys Forest *via* Jewells Lane, Ben Lomond Road, and the Shelley-Walwa road, Guys Forest-Burrowye road, and Burrowye-Koetong track.

2. Present tenure

Reserved forest: 3,155 ha (7,795 ac)
Occupied Crown land: 5,940 ha (14,680 ac)
Unreserved Crown Land: 6,507 ha (16,080 ac)
Camping and water reserve at Koetong: 8 ha (20 ac)
Water reserve at Pheasant Creek: 65 ha (160 ac)
Various stream frontages and road reserves.

3. General description

This dissected plateau near Koetong and Shelley is bordered on the north and east by steep montane slopes in the Burrowye Creek and Guys Creek valleys. The block is mainly timbered by native forest or softwood plantations.

4. Present use

About 5,020 ha (12,400 ac) support softwood production. Approximately 200 ha (500 ac) of forest are grazed north-east of Koetong Creek, and currently about 500 sheep graze the plantation area south-east of Shelley.

B. Nature of the Land

1. Climate

Average annual rainfall varies from about 890 mm (35 in.) near Burrowye to about 1,140 mm (45 in.) at Shelley. The rainfall pattern shows a definite winter incidence and light snow may fall on the plateau several times during the winter. Frosts are common and often severe,

particularly in low-lying areas on the plateau. Maximum temperatures of the northern slopes and hillocks during summer are fairly high and winter maxima are moderately low. Frosts occur from autumn through to spring.

Hop bitter-pea is a common understorey species on the plateau

2. Physiography and geology

The Guys Forest Creek-Burrowye Creek divide and the Koetong Creek watershed form a dissected plateau of rolling to hilly topography, at a general elevation of 600-700 m (2,000-2,600 ft). Steep to very steep montane slopes in the Burrowye Creek and Guys Forest Creek valleys flank the plateau. These pass into rolling to steep hillocks at about 300-450 m (1,000-1,500 ft) elevation. Most of the landscape has been formed on Lower Devonian grey granite, with the exception of some hillocks and montane slopes in the northern section of the block formed on Ordovician schists.

3. Soils

Friable reddish gradational soils predominate on the plateau. Outcrops of granite boulders commonly occur on the tops of low ridges and hills. Granite floaters occur in the soil in many places, and decomposing rock is encountered at shallower depths on hills and ridges than elsewhere. Soil depth is usually about 1-2 m (3-6 ft). Weakly bleached massive gradational soils occur on the steeper slopes of the plateau and predominate on the montane slopes. Narrow ridge tops and the steepest slopes are occupied by undifferentiated

stony loams. Friable brownish or reddish gradational soils may occur in sheltered gullies that have a southerly aspect. The more gently sloping country of the hillocks land form has reddish duplex soils.

Undifferentiated sandy loams and weakly bleached massive gradational soils occur on alluvial fans and cones.

4. Vegetation

Radiata pine plantations at present comprise about 40% of this block. They have mainly replaced narrow-leaf peppermint open forest III, which is the predominant vegetation of the remainder of the plateau land. This vegetation unit also extends down valleys and sheltered gullies in the north and east. Its understorey on the plateau usually comprises a dense sward of tussock grass with scattered shrubs (mainly handsome flat-pea), or mainly a bracken fern or hop bitter-pea layer. The understorey in the moist gullies includes bracken fern, fishbone water-fern, hazel pomaderris, and blackwood.

Broad-leaf peppermint open forest II occupies most of the drier sites, except for some red stringybark:long-leaf box open forest II on the driest northerly aspects. The broad-leaf peppermint open forest has a grassy to scrubby understorey. Shrubs include handsome flat-pea and purple coral-pea. The grass is mainly tussock grass.

The greater glider - an inhabitant of the plateau country

Minor stands of swamp gum open forest II are located in the headwaters of Pheasant Creek. The understorey forms a dense cover and includes mountain tea-tree, the common reed, and fishbone water-fern.

5. Fauna

Brief surveys of the mammals, reptiles, and amphibians of this block were

carried out by the National Museum and P.A. Rawlinson in 1971/72. The populations can be thought of as occupying three main habitat types: the plateau areas form one type, the ridges and slopes form another, and moist gullies form the third.

Eastern grey kangaroos are common on the plateau and broad ridges, preferring to browse in the grassy forest. Small ground-dwelling mammals such as phascogales were not trapped, but are nevertheless expected to be present on the plateau. Greater gliders were present. Brush-tailed possums, sugar gliders, and feathertail gliders also contribute to the arboreal population. Bats are common around cleared areas. A specimen collected at Shelley was identified as the lesser long-eared bat.

The fauna of the ridges and slopes was not studied, but the wide-ranging mammals of both plateau and gully habitats should be present.

The gully habitat of tall eucalypts and dense understorey of mountain tea-tree, ferns, and grasses supports a variety of mammals, including the black-tailed wallaby, long-nosed bandicoot, brown phascogale, dusky phascogale, and the bush rat. Wombats were present in all habitats.

The spur-winged plover breeds here in clearings. The noisy friar-bird has been recorded in forest near Little Koetong Creek. Species such as the superb blue-wren, grey thrush, and grey fantail frequent the moist gullies. The white-throated tree-creeper and kookaburra occur throughout the forest.

Five amphibians and twelve reptiles have been recorded for the block. The garden skink (*Leiolopisma guichenoti*) and the three-toed skink (*Hemiergis decresiensis*) are very common over the entire area. Other species such as black rock-skink (*Egernia saxatilis*), three-lined skink (*L. trilineatum*), and weasel skink (*L. mustelinum*) have been recorded.

6. Land systems

Towong sub-system 50%; Koetong land system 40%; Dart sub-system 6%; Thowgla sub-system 2%; and Lucyvale sub-system 2%.

C. Capabilities

1. Flora

The capability for flora conservation is moderate to high. The species present are associated with the narrow-leaf peppermint, broad-leaf peppermint, swamp gum, and red stringybark:long-leaf box forests. A list completed for the Shelley area appears in Appendix II. It includes the significant species *Echinopogon cheelii*, *Mirbelia oxylobioides*, *Pimelea treyvaudii*, and *Spiranthes sinensis*.

2. Fauna

This is the only block for which a reasonable amount of information on mammals, reptiles, and amphibians is available. The gullies have a high capability for fauna conservation. The long-nosed bandicoot, black-tailed wallaby, two phascogale species, the bush rat, and common wombat were recorded for the gully habitat. In addition many less common reptiles occurred in gullies.

The plateaux and ridges have a high to moderate capability. This habitat contains the large herbivores and the feathertail and greater gliders. Although small mammals were not trapped in this habitat, the brief nature of the survey precludes any assumption that they are absent. A number of the common bird species occur in the area. The noisy friar-bird has also been recorded for the block.

3. Hardwood production

The capability for hardwood production is moderate. Stands of blue gum occur in some gullies and on sheltered sites at the higher elevations.

4. Softwood production

The block has a high to moderate capability for softwood production. Areas of narrow-leaf peppermint forest on the plateaux and less-steep slopes would be capable of producing radiata pine of

The long-nosed bandicoot is common in moist gullies

site qualities II to III. Some broad-leaf peppermint stands grow to about 20-38 m (70-90 ft), and such sites should prove suitable to marginal (site qualities IV to VI). The main areas suited to softwood production are the upland areas in the headwaters of Burrowye Creek, the catchment drained by Koetong Creek, and the less-steep headwaters of small tributaries that flow

into Burrowye and Little Koetong Creeks. The more dissected land in the Burrowye and Lighfoot Creek valleys and to the north of the present plantation is mainly marginal to unsuitable for softwood production.

5. Agriculture

The less-steep upland areas adjoin private property in the west and south of the block. These have a high to moderate capability not only for cattle and sheep production on perennial pasture but also for horticulture, including production of potatoes, apples, and strawberries. Elsewhere, the capability is low. The major factor limiting the area's capability for agriculture is the cold winters, which limit pasture growth. The soils could also require fairly heavy applications of superphosphate and the use of the trace element molybdenum for successful pasture establishment. Fully developed permanent pasture areas should be capable of carrying 4-6 dry sheep per acre or their equivalent in other stock.

Development (including clearing, fencing, and sowing down to perennial pastures) could cost up to $80 an acre. Cattle and sheep for stocking would be an additional cost.

There is scope for complete farm units to be located on the plateau, but it is more probable that the plateau country will be developed for spring, summer, and autumn grazing, in association with lower, generally warmer country to which stock can be moved if necessary during the winter months. Alternatively, fodder conservation could supplement winter feed requirements.

6. Honey

As the block mainly carries narrow-leaf peppermint, broad-leaf peppermint, and candlebark gum, it has only a low capability for honey production. It has some limited potential on red stringybark:long-leaf box sites in the north.

7. Water

The block has a moderate to high capability for water production. Burrowye, Guys Forest, Beetoomba, Pheasant, Koetong, and Little Koetong Creeks drain the land. Burrowye Creek at Burrowye has a mean annual discharge of 19.6 million cu m (15,900 ac-ft). Beetoomba and Pheasant Creeks contribute directly to Cudgewa's water supply.

8. Minerals

The capability for production of tin and tungsten from both alluvial and lode deposits is low.

9. Recreation

Koetong block has a moderate capability for recreation. Features for sightseeing, picnicking, and driving for

pleasure include Lawrence Lookout and the pine plantation and nursery at Shelley. Areas in the headwaters of Burrowye and Pheasant Creeks are suitable for nature walks. Burrowye and Koetong Creeks provide fishing for brown and rainbow trout.

D. Hazards and Conflicts

The soil erosion hazard on the plateau areas is low. However, the intensive road system associated with the pine plantation can be a source of erosion if the roads are not properly constructed. A moderate sheet and gully erosion hazard affects the more dissected country, for example in the Guys Creek and Burrowye Creek valleys. The fire hazard is moderate in the northern section of the block and low in the southern section. The potential hazards to the pine plantation have been discussed in Chapter 13.

The main conflicts likely are between softwood production and nature conservation. These can be minimized by leaving strips along streams, corridors for animal movement, and natural areas of plateau country. Conflict may also arise between fuel-reduction burning associated with protection of the plantation and soil and nature conservation.

Strips and areas of natural forest left during pine plantation establishment

E. Significance

This block is primarily of significance for softwood production and nature conservation. It also has some significance for agriculture.

13. BURROWA

A. General

1. Location

This block comprises 14,240 hectares (35,180 ac) of public land to the north of Cudgewa, popularly known as Cudgewa Bluff. It lies in the County of Benambra - portions of parishes of Walwa, Burrowye, Jinjellic, Jemba, Cudgewa, Berringama, and Wabba.

Boundaries: The Beetoomba-Cudgewa North road, Cudgewa North-Walwa road, Walwa to Beetoomba *via* Walwa-Shelley road, Ben Lomond road, and Jewells Lane.

2. Present tenure

Reserved forest: 7,840 ha (19,370 ac)
Occupied Crown land: 1,370 ha (3,380 ac)
Unreserved Crown land: 5,020 ha (12,410 ac)
Recreation reserve on Cudgewa Creek: 8 ha (20 ac)
Various stream frontages and road reserves

3. General description

The timbered massif has small plateaux at elevations between 1,000 and 1,200 m (3,500 and 4,000 ft), and cliffs and very steep montane slopes descending to valley floors at about 300-450 m (1,000-1,500 ft). The valleys are mainly pasture land.

4. Present use

Of the main uses at present, a small area of 240 ha (600 ac) near Koetong Creek supports softwood production, another small area in the north-west carries grazing stock, and visitors picnic and use walking tracks near Cudgewa Falls to explore the nearby cliffs. Some hardwood logging has occurred in a branch of Keelangie Creek.

B. Nature of the Land

1. Climate

Average annual rainfall is probably 760 mm to more than 1,020 mm (30 to more than 40 in.). A rainfall station at Berringama indicates an annual rainfall of 1,020 mm (40 in.). Summers are generally hot and relatively dry and winters are cool and wet. Temperatures would be cooler at the higher elevations.

2. Physiography and geology

The central feature of the block is a massif consisting of steep montane slopes with occasional perched basins and small high-level plateaux at 1,000-1,200 m (3,500-4,000 ft). Mount Burrowa, with an elevation of 1,278 m (4,194 ft), forms the highest point on the massif. Cliffs around the massif have given rise to the popular name of Cudgewa Bluff. Rock screes are common. Rolling to hilly land at the base of the massif generally reaches about 300-450 m (1,000-1,500 ft) elevation.

Most of the massif comprises Jemba rhyolite, an acid volcanic rock of Upper Devonian age. A north-south trending belt of Ordovician schists underlies this and extends beyond it to the north, east, and south. Lower Devonian granite has a common boundary with the rhyolites to the east and west. Limited outcrops of Middle Devonian quartz prophyry and quartz felspar porphyry are probably associated with a ring dyke from which the rhyolites originated. Alluvial cones, fans, and terraces at the base of the massif are deposits of Quaternary age.

3. Soils

The dominant soils of the montane slopes are weakly bleached massive gradational soils with a coarse sandy texture. On the steepest, driest slopes, bare rock faces or shallow undifferentiated stony

Cliff on Burrowa massif

loams occur, with undifferentiated sandy loams at the foot of steep slopes. In the basins and on the plateaux at the higher elevations, friable reddish and brownish gradational soils are to be found. Weakly bleached massive gradational soils are associated with drainage lines on the plateaux. The landscapes at lower elevations around the massif are characterized by weakly bleached massive gradational soils where the slopes are steep and reddish duplex soils on rolling to undulating land forms.

4. Vegetation

This block contains the most diverse vegetation in the district. Differences

in local climate due to the great range in elevation from 300 m (1,000 ft) to more than 1,200 m (4,000 ft) - and the marked effect of aspect due to a high degree of dissection have caused this diversity. Differences in parent materials also play some part. The full range of native vegetation units in the district is represented, with the exception of the forest red gum and river red gum units. Candlebark gum:snow gum open forest caps the ridges at the highest elevations. Mature and regrowth stands of alpine ash occupy some sheltered situations below the highest ridges, and the understorey associated with this species often consists of small trees and tall shrubs.

Wonga vine (Pandorea pandorana)

Because of the topography, much of the block follows a pattern trending from north-east to south-west, comprising narrow-leaf peppermint open forest III on the plateaux, broad ridges, and southern aspects, and broad-leaf peppermint open forest II on the dry ridges and northern aspects.

The understorey under narrow-leaf peppermint varies from a layer of tussock grass to bracken fern to a tall shrubby layer in moist gullies and in sheltered situations. Many of the gullies are quite attractive when species such as wonga vine *(Pandorea pandorana)* mountain oxylobium *(Oxylobium ellipticum)*, Victorian Christmas-bush *(Prostanthera lasianthos)*, and Australian clematis *(Clematis aristata)* are in flower. Other species include musk daisy-bush, blanket-leaf, forest lomatia, and silver wattle.

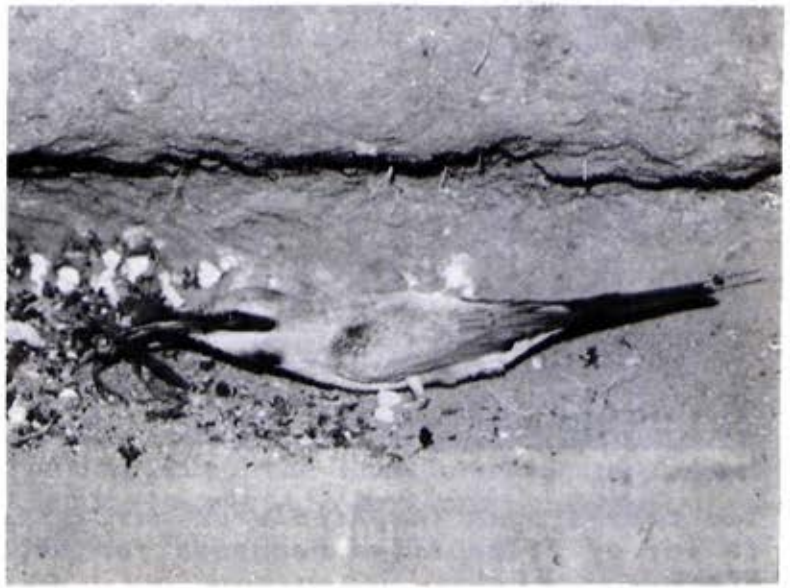
The understorey associated with broad-leaf peppermint forest comprises mainly a grassy (tussock grass) layer or one of grass and low shrubs that include handsome flat-pea, hop bitter-pea, gorse bitter-pea, and purple coral-pea.

Some rocky slopes carry stands of red cypress pine open forest I, with Kurrajong as an associated tree species and closed to open heaths of common fringe-myrtle and other shrubs. Other dry northerly slopes have stands of red stringybark: long-leaf box open forest I and II. The understorey on the northerly slopes is normally sparse to scrubby. These vegetation units represent the drier end of the vegetation range and occur mainly in the north of the block. Swamp gum open forest II is found on the plateau, with an understorey that includes alpine bottle-brush *(Callistemon sieberi)* and prickly tea-tree *(Leptospermum juniperinum)*.

5. Fauna

Little is known of the fauna in this block, but it probably covers a great range because of the large range of climatic conditions and vegetation.

Birds recorded for the block include the wedge-tailed eagle, bee-eater, dusky wood shallow, satin flycatcher, white-browed scrub-wren, grey thrush, red wattle-bird, and crimson rosella. The block probably also carries a large number of mammal species. Animals



Rainbow bee-eater

recorded include the eastern grey kangaroo, greater glider, and common wombat.

Burrowa block contains quite a range of reptile species, including at least 10 of the 25 reptiles recorded for this district, some cool temperate species amont them. The coppertail skink *(Ctenotus taeniolatum)* has been recorded on the lower slopes of the Burrowa massif near Guys Forest.

6. Land systems

Jemba sub-system 67%; Magorra sub-system 17%; Towong sub-system 6%; Lucyvale sub-system 5%; and Murray land system 5%.

The tree-dragon (Amphibolurus muricatus) is one of 25 reptiles recorded for this block.

C. Capabilities

1. Flora

This block has a very high capability for flora conservation because of the great diversity in vegetation types, which vary from candlebark gum:snow gum open forest to the red cypress pine complex. The many attractive shrubs and plans include the wonga vine, Australian clematis, and various species of orchids - greenhoods, caladenias, and the bird orchid *(Chiloglottis gunnii)*. The endangered species *Grevillea jephcottii* has been recorded for Mount Burrowa. *Pimelea treyvaudii*, a significant species, has also been recorded.

2. Fauna

It is highly likely that this block has a high capability for fauna conservation because of the wide range in vegetation and climate. The large herbivores (eastern grey kangaroo, wombat, and black-tailed wallaby) are represented as well as the possums and gliders, and phascogales and native rodents probably occur here also. Similarly, the block contains many and varied bird species, and almost half of the reptiles recorded for the district, including the tree dragon, grass skink, garden skink, three-lined skink, eastern water skink, and tiger snake.

3. Hardwood timber

The capability for hardwood production is generally low, although parts of the plateau south of Black Mountain would have some potential. Areas of regrowth and mature stands of alpine ash could produce high volumes, but would be accessible only with costly and difficult road construction.

4. Softwood production

The most suitable area of any extent occurs in the Keelangie Creek basin in the south-west of the block. It could produce pine stands of site quality II-IV. An area in the Stony Creek basin would be suitable to marginal for radiata pine growth (site quality IV to VI).

5. Agriculture

The main areas suitable for clearing and grazing sheep or beef cattle lie in the lower basins of Keelangie and Stony Creeks and largely coincide with areas suitable for softwood production.

6. Honey

The block has a low capability for honey production. No sites utilize it at present, and it has only limited potential.

7. Water

The capability for water is moderate to high. The main streams are Stony Creek and Keelangie Creek. The south-western section of the block forms part of the catchment supplying the township of Cudgewa.

8. Minerals

The block does not contain any known mineral deposits.

9. Recreation

Burrowa block has a high capability for various forms of outdoor recreation, including driving for pleasure, sightseeing, picnicking, nature walks, walking for pleasure, and fishing. The public land at present has a road to the south-western sector of the massif, and a road to Cudgewa Falls, but very little other vehicular access. When combined with rugged topography and various viewpoints from which panoramas of the surrounding countryside may be seen, this gives the block high values for hiking, camping, and rock climbing. At the same time these features make the block excellent for driving for pleasure and sight-seeing.

Walking tracks for protection and recreation purposes have been constructed near the Cudgewa Falls. Various scenic viewpoints afford excellent views of Pine Mountain, the Upper Murray valley, the Snowy Mountains, the Mittamatite massif, and the Koetong uplands.

Cudgewa Creek is stocked with brown trout, redfin, and occasional Murray cod.

D. Hazards and Conflicts

The erosion hazard is high on steep slopes, where weakly bleached massive gradational soils or undifferentiated sandy loams carry sparse vegetation. Despite the moderate fire hazard, erosion and other considerations make protection from fire of great importance. Visitors using this area could contribute to the hazard of fires.

The use of the block as a natural area suitable for recreation activities could conflict with even the minimum of hardwood logging because of the nature of

the land. Recreation activities such as hiking, camping, nature walks, and picnicking would not conflict with nature conservation. Cross-country driving would conflict with these other forms of recreation.

Softwood production and agriculture would conflict with nature conservation and recreation at the lower elevations. The land to the east of Keelangie Creek represents one of the uncleared remnants of the Lucyvale sub-system. Other areas, with the exception of some public land in Lucyvale block, have been cleared for agriculture or softwood production. The grassy narrow-leaf peppermint forests provide a suitable habitat for the eastern grey kangaroo and other animals.

E. Significance

The main significance of this block is for nature conservation, including scientific interest, because of its relatively natural condition, its wide range of vegetation, and the many outstanding recreational features, including cliffs, scenic viewpoints, and waterfalls. It is linked with the Pine Mountain massif by public land, which forms a low range of forested hills.

Appendix I - CLIMATIC DATA

Table A
AVERAGE RAINFALL IN INCHES[1]

	Station						
	Bethanga	Burrowye	Corryong	Koetong[2]	Nariel Creek	Tallangatta E[3]	Walwa
January	1.78	1.80	2.00	2.49	2.21	1.89	2.04
February	1.88	1.99	2.02	2.46	2.27	2.08	2.04
March	2.19	2.48	2.51	3.65	2.82	2.43	2.38
April	2.55	3.03	2.21	3.15	3.03	2.50	2.46
May	2.65	3.37	2.36	3.56	3.48	2.79	2.76
June	3.25	4.58	2.79	6.19	4.48	3.40	3.41
July	3.32	4.68	3.11	5.49	4.56	3.58	3.53
August	3.22	4.62	3.05	4.94	4.92	3.64	3.53
September	2.40	3.30	2.60	4.47	3.47	2.78	2.88
October	3.31	3.97	3.40	3.95	4.36	3.54	3.57
November	2.54	2.85	2.50	2.92	3.11	2.59	2.67
December	2.16	2.41	1.96	3.18	2.61	2.13	2.21
Year	31.25	39.08	30.51	46.45	41.32	33.35	33.48

1. Conversion: 1 in. = 25.4 mm
2. Figures for standard 30-year period, 1931-60. Koetong figures have been taken from an earlier period and averaged for 29 years of records
3. Formerly Tallangatta; the name was changed when the town was transferred to its new site

Table B

AVERAGE RAIN PER WET DAY (points)[1]

	Station					
	Bethanga	Corryong	Burrowye	Nariel Creek	Walwa	Tallangatta E
January	41.0	33.3	45.0	44.2	40.8	47.3
February	38.8	33.7	49.8	45.4	51.0	52.0
March	42.4	41.8	49.6	47.0	47.6	48.6
April	26.1	27.6	43.3	37.9	35.1	35.7
May	23.9	26.2	42.1	38.7	34.5	40.0
June	25.3	23.3	45.8	37.3	34.1	37.8
July	22.8	23.9	42.5	35.1	32.1	32.5
August	19.4	21.8	42.0	35.1	32.1	33.1
September	21.6	23.6	41.3	31.5	36.0	34.8
October	24.3	28.7	44.1	39.6	35.7	39.3
November	26.0	27.8	47.5	38.9	38.1	43.2
December	25.2	28.0	48.2	37.3	36.8	42.6

1. Conversion: 100 points = 25.4 mm

Table C

TANK EVAPORATION IN INCHES[1]

Month	Hume Reservoir	[2]South-eastern part of district	[2]North-western part of district
January	7.2	5.5	7.5
February	5.7	4.5	5.5
March	4.6	4.0	4.5
April	2.8	2.5	2.5
May	1.4	1.5	1.5
June	0.9	1.0	1.0
July	0.9	1.0	1.0
August	1.1	1.5	1.5
September	1.9	2.0	2.5
October	3.1	3.0	3.5
November	4.7	4.0	4.5
December	6.5	5.5	6.5
Year	40.7	36.0	42.0

1. Conversion: 1 in. = 25.4 mm
2. Estimated from Commonwealth Bureau of Meteorology Maps of Tank Evaporation, in inches, Australian Sunken Tank

APPENDIX II

VASCULAR PLANTS AT FIVE LOCALITIES

(From combined lists recorded by J.H. Willis, between 1962 and 1971, on Mt. Granya, Mt. Lawson, Shelley, Mt. Burrowa (except highest peak), and Pine Mountain)

These lists cannot be used for strict comparison as they involve differing areas covered and time spent in collection of the data, but do indicate the relative diversity of the localities.

*(asterisk) indicates a naturalized alien.

G = Mount Granya
L = Mount Lawson
S = Shelley
B = Mount Burrowa
P = Pine Mountain

Census	G	L	S	B	P
PTERIDOPHYTA					
Ophioglossum coriaceum					X
Culcita dubia				X	X
Anogramma leptophylla					X
Pellaea falcata					X
Cheilanthes distans					X
C. tenuifolia	X	X		X	X
Adiantum aethiopicum		X	X	X	X
Pteridium esculentum	X	X	X	X	X
Polystichum proliferum				X	
Asplenium flabellifolium	X	X		X	X
Pleurosorus rutifolius		X		X	X
Blechnum nudum		X	X	X	X
Selaginella humillima					X
Isoetes humilior					X

Census	G	L	S	B	P
SPERMAPHYTA					
GYMNOSPERMAE					
Callitris endlicheri		X			X
**Pinus radiata*			X		
ANGIOSPERMAE					
Typhaceae					
Typha domingensis				X	X
Gramineae					
Hemarthria uncinata					X
Bothriochloa ambigua					X
Themeda australis	X		X		X
**Setaria geniculata*					X
Microlaena stipoides				X	X

Census	G	L	S	B	P
**Bromus diandrus*	X		X		X
**B. mollis*	X	X	X		X
**B. madritensis*					X
**Vulpia bromoides*	X	X	X	X	
**V. myuros*					X
**Lolium perenne*			X		X
Poa australis (agg.)	X	X		X	X
P. tenera				X	X
**P. annua*			X		
**Briza minor*	X	X	X	X	X
Phragmites australis			X		
Eragrostis brownii					X
Agropyron scabrum	X				X
**Hordeum leporinum*			X		
Agrostis avenacea			X		X
Deyeuxia rodwayi					X
Dichelachne crinita		X			X
D. sciurea			X		X
Pentapogon quadrifidus					X
Echinopogon ovatus		X		X	X
Cynodon dactylon			X		
**Anthoxanthum odoratum*				X	
**Holcus lanatus*		X	X		X
**Aira caryophyllea*	X	X	X	X	X
Danthonia pallida	X		X		
D. longifolia					X
D. eriantha					X
D. pilosa					X

Census	G	L	S	B	P
D. penicillata	X				
Stipa hemipogon				X	X
Cyperaceae					
Cyperus lucidus			X		
Scirpus inundatus				X	
S. subtilissimus					X
S. antarcticus					X
Eleocharis atricha					X
Schoenus apogon					X
Lepidosperma laterale	X	X		X	X
L. sp. (filiform)				X	
Carex appressa		X	X	X	X
C. breviculmis					X
Centrolepidaceae					
Centrolepis aristata					X
C. strigosa					X
Juncaceae					
Luzula campestris (agg.)		X		X	X
Juncus bufonius					X
**J. capitatus*	X				X
J. filicaulis					X
J. usitatus	X		X		
Liliaceae					
Xanthorrhoea australis	X	X			X

Census	G	L	S	B	P
Lomandra longifolia	X	X		X	X
L. multiflora				X	X
Burchardia umbellata	X				X
Anguillaria dioica			X		X
Bulbine bulbosa	X	X	X	X	X
Thysanotus patersonii	X				X
T. tuberosus	X				X
Dichopogon strictus		X			X
Arthropodium minus					X
Stypandra glauca	X			X	X
S. caespitosa				X	X
Dianella revoluta	X			X	X
D. tasmanica		X		X	
Iridaceae					
Patersonia sericea					X
Orchidaceae					
Dipodium punctatum					X
Thelymitra aristata	X				
T. pauciflora		X		X	X
T. media				X	
Calochilus robertsonii	X				X
Microtis parviflora					X
M. unifolia	X				X
Acianthus exsertus					X
A. reniformis		X		X	
Corybas dilatatus	X				X

Census	G	L	S	B	P
Chiloglottis gunnii		X		X	
Glossodia major		X		X	X
Caladenia menziesii					X
C. dilatata				X	X
C. angustata		X	X	X	X
C. carnea		X	X	X	X
Diuris maculata		X		X	X
D. sulphurea	X	X		X	X
Pterostylis longifolia		X		X	X
P. nutans				X	X
P. pedunculata				X	
P. mutica			X		
Casuarinaceae					
Casuarina stricta					X
Urticaceae					
Parietaria debilis					X
Proteaceae					
Persoonia rigida	X				X
P. chamaepeuce		X		X	X
Grevillea ramosissima					X
G. jephcottii				X	X
G. lanigera	X				
G. polybractea	X				
Lomatia fraseri		X		X	
L. myricoides					X

Census	G	L	S	B	P
Banksia marginata		X	X		X
Santalaceae					
Exocarpos cupressiformis	X	X	X	X	X
E. strictus		X		X	
Omphacomeria acerba					X
Choretrum pauciflorum			X	X	
Loranthaceae					
Amyema pendulum		X		X	X
Polygonaceae					
Rumex brownii	X	X	X		X
**R. acetosella*	X	X	X		X
Polygonum prostratum					X
Portulacaceae					
Montia fontana				X	
Caryophyllaceae					
Spergularia rubra	X		X		
**Polycarpon tetraphyllum*			X		
**Cerastium glomeratum*	X	X	X	X	X
Stellaria pungens	X	X		X	X
**Petrorhagia prolifera*					X
Ranunculaceae					
Clematis aristata	X	X		X	X

Census	G	L	S	B	P
Ranunculus lappaceus	X	X	X	X	X
R. pachycarpus					X
**R. muricatus*					X
R. collinus				X	
R. sessiliflorus	X	X		X	
Lauraceae					
Cassytha melantha		X		X	X
C. pubescens					X
Cruciferae					
**Nasturtium officinale*					X
Droseraceae					
Drosera auriculata	X	X	X	X	X
D. peltata					X
Crassulaceae					
Crassula sieberana		X		X	X
Pittosporaceae					
Bursaria spinosa	X	X		X	X
Rosaceae					
**Rosa rubiginosa*			X		X
Rubus parvifolius	X	X	X	X	X
**R. procerus*			X	X	X
Acaena anserinifolia		X	X	X	

Census	G	L	S	B	P
A. ovina		X	X	X	X
Mimosaceae					
Acacia buxifolia					X
A. dealbata	X	X	X	X	X
A. kettlewelliae				X	
A. lanigera				X	X
A. melanoxylon	X	X	X	X	X
A. phasmoides					X
A. rubida	X	X		X	X
A. siculiformis			X		X
A. ulicifolia					X
A. verniciflua	X	X			X
Papilionaceae					
Mirbelia oxyloboides		X	X	X	
Oxylobium ellipticum		X		X	X
Gompholobium huegelii	X				
Daviesia latifolia	X	X	X	X	X
D. ulicifolia	X	X		X	
Pultenaea cunninghamii	X				
P. humilis					X
P. platyphylla					X
P. polifolia	X				
P. paleacea (var.)		X			
P. procumbens		X			X
P. vrolandii		X			X
Dillwynia retorta (var. *phylicifolia*)	X			X	X

Census	G	L	S	B	P
D. sericea					X
Platylobium formosum	X	X	X	X	X
Bossiaea buxifolia				X	
Hovea heterophylla	X	X	X	X	X
Desmodium varians		X		X	
**Trifolium arvense*	X		X		X
**T. campestre*	X		X		X
**T. dubium*			X		
**T. glomeratum*			X		
**T. repens*	X		X		
**T. subterraneum*			X		
Indigofera australis		X		X	X
Glycine clandestina	X	X	X	X	X
Hardenbergia violacea	X	X	X	X	X
Geraniaceae					
Geranium potentilloides	X			X	X
G. solanderi		X	X	X	
Pelargonium australe		X		X	X
Oxalidaceae					
Oxalis corniculata		X		X	X
Rutaceae					
Boronia nana var. *hyssopifolia*		X	X	X	X
Crowea exalata					X
Phebalium lamprophyllum				X	X
P. sp. nov.					X

Census	G	L	S	B	P
Asterolasia asteriscophora				X	X
Correa reflexa		X		X	X
Tremandraceae					
Tetratheca ciliata		X	X	X	X
T. glandulosa					X
Polygalaceae					
Comesperma ericinum				X	X
Euphorbiaceae					
Poranthera microphylla		X	X	X	X
Micrantheum hexandrum				X	X
Callitrichaceae					
**Callitriche stagnalis*			X		X
Stackhousiaceae					
Stackhousia monogyna	X	X	X	X	X
S. viminea					X
Sapindaceae					
Dodonaea cuneata		X		X	X
D. boroniifolia					X
D. rhombifolia					X
Rhamnaceae					
Pomaderris aspera		X		X	

Census	G	L	S	B	P
Spyridium parvifolium		X		X	X
Malvaceae					
**Modiola caroliniana*			X		
Sterculiaceae					
Brachychiton populneus					X
Dilleniaceae					
Hibbertia obtusifolia	X	X	X	X	X
H. sericea					X
H. serpyllifolia				X	
Hypericaceae					
Hypericum gramineum	X		X	X	X
**H. perforatum*			X		
Violaceae					
Viola betonicifolia	X	X		X	X
V. hederacea	X	X	X	X	X
Thymelaeaceae					
Pimelea axiflora				X	
P. linifolia	X	X	X	X	X
P. treyvaudii			X		
Myrtaceae					
Eucalyptus bridgesiana					X

Census	G	L	S	B	P
Eucalyptus camphora		X	X	X	
E. chapmaniana					X
E. dalrympleana				X	X
E. delegatensis				X	
E. dives	X	X	X	X	X
E. goniocalyx	X	X		X	X
E. macrorhyncha		X			X
E. mannifera	X	X		X	X
E. obliqua	X				
E. pauciflora				X	
E. radiata	X	X	X	X	
E. rubida			X		
E. st-Johnii	X	X	X	X	
E. blakleyi					X
Leptospermum grandifolium			X		
L. juniperinum	X	X	X	X	X
L. micromyrtus				X	X
L. phylicoides		X		X	X
Kunzea parvifolia		X		X	X
Callistemon pallidus				X	X
C. sieberi				X	
Calytrix tetragona		X		X	X
Micromyrtus ciliatus					X
Onagraceae					
Epilobium cinereum	X	X	X	X	X

Census	G	L	S	B	P
Haloragaceae					
Haloragis tetragyna	X	X	X	X	X
H. elata					X
H. micrantha					X
Araliaceae					
Tieghemopanax sambucifolius				X	X
Astrotricha ledifolia				X	X
Umbelliferae					
Hydrocotyle laxiflora	X	X	X	X	X
H. sibthorpioides		X		X	
H. callicarpa					X
Oreomyrrhis eriopoda			X		
Daucus glochidiatus	X	X		X	X
Epacridaceae					
Melichrus urceolatus	X	X	X	X	X
Leucopogon attenuatus				X	X
L. ericoides					X
L. rufus					X
L. virgatus		X			X
L. biflorus				X	
Acrotriche serrulata	X	X	X	X	X
Monotoca scoparia		X		X	X
Brachyloma daphnoides		X			X
Epacris breviflora		X		X	

Census	G	L	S	B	P
E. impressa	X				
E. microphylla			X		
Primulaceae					
**Anagallis arvensis*	X	X			X
Gentianaceae					
Gentianella diemensis				X	
**Centaurium pulchellum*	X	X		X	X
**Centaurium minus*			X		
Sebaea ovata					X
**Cicendia filiformis*					X
Convolvulaceae					
Dichondra repens			X		X
Boraginaceae					
Myosotis australis	X	X	X	X	
Cynoglossum australe					X
C. sauveolens				X	
**Echium lycopsis*					X
Polemoniaceae					
**Navarretia squarrosa*	X				
Labiatae					
Mentha australis	X				
**M. pulegium*					X

Census	G	L	S	B	P
Prunella vulgaris					X
Scutellaria humilis					X
Prostanthera lasianthos				X	
P. rotundifolia					X
Westringia eremicola					X
Ajuga australis		X	X	X	X
Scrophulariaceae					
**Verbascum virgatum*					X
Gratiola peruviana				X	X
Euphrasia collina	X	X		X	
Veronica derwentiana	X	X		X	X
V. perfoliata				X	X
V. calycina				X	
**V. arvensis*				X	
**V. anagallis-aquatica*			X		
**Parentucellia latifolia*	X		X		X
Bignoniaceae					
Pandorea pandorana				X	
Lentibulariaceae					
Utricularia dichotoma					X
Plantaginaceae					
Plantago varia		X	X	X	X
P. lanceolata			X		

Census	G	L	S	B	P
Rubiaceae					
Coprosma hirtella		X		X	
C. quadrifida		X		X	
Opercularia varia					X
Galium gaudichaudii	X	X		X	X
G. parisiense				X	
Asperula scoparia	X	X	X	X	
Campanulaceae					
Wahlenbergia gracilenta					X
W. quadrifida	X		X		X
W. stricta	X	X		X	X
Lobeliaceae					
Lobelia gibbosa					X
Isotoma axillaris					X
I. fluviatilis					X
Goodeniaceae					
Dampiera purpurea					X
Brunoniaceae					
Brunonia australis		X			X
Stylidiaceae					
Stylidium graminifolium	X	X		X	X
S. inundatum					X

Census	G	L	S	B	P
Compositae					
Olearia adenophora					X
O. argophylla				X	
O. erubescens		X	X	X	X
**Conyza bonariensis*			X		X
Lagenophora stipitata	X				
Brachycome angustifolia var. *heterophylla*	X				
B. diversifolia		X		X	X
B. multifida	X				
B. ptychocarpa					X
B. scapiformis	X				X
Sigesbeckia orientalis					X
Cassinia aculeata		X	X	X	X
C. longifolia	X	X	X	X	X
Haeckeria ozothamnoides		X			X
Helichrysum bracteatum				X	X
H. scorpioides	X	X	X	X	
H. semipapposum	X			X	X
Helipterum albicans					X
H. australe					X
Stuartina muelleri	X	X		X	
Gnaphalium involucratum					X
G. japonicum	X	X	X	X	X
G. purpureum					X
Craspedia glauca	X	X	X	X	
Senecio lautus		X			X
S. linearifolius		X		X	X

Census	G	L	S	B	P
S. hispidulus		X		X	X
S. quadridentatus	X	X	X	X	X
Bedfordia salicina				X	
Cymbonotus preissianus	X	X	X	X	X
**Arctotheca calendula*	X		X		
**Carduus pycnocephalus*	X				X
**Cirsium vulgare*	X	X	X	X	X
Microseris scapigera	X	X		X	X
**Taraxacum officinale*				X	
**Chondrilla juncea*					X
**Hypochoeris radicata*	X	X	X	X	X
**H. glabra*				X	X
Sonchus oleraceus				X	X
**S. asper*			X	X	X
Total no. of species -	112	137	92	178	263
No. of naturalized aliens -	(19)	(8)	(32)	(12)	(32)

APPENDIX III

NORTH-EASTERN AREA, DISTRICT 1

NATIVE FAUNA LIST

This lists native birds and mammals recorded for the area, with an indication of the habitats in which they are most likely to be observed and their status. Records of accidental or rare visits have been omitted, as land use changes in the study district will have no significant effect on the populations of these species.

Records for birds have been obtained from reliable observers and have been checked with the Museum staff. Records for mammals have mostly come from official collections. Other mammals included in the list are sightings from reliable sources.

Asterisks indicate species that have special significance in this district and that are referred to in Chapter 11.

HABITAT TYPES

1. Wetland (swamp communities, rivers, lakes, dams)
2. Open-forest (wet) (candlebark gum: snow gum, alpine ash, narrow-leaf peppermint open-forests)
3. Open-forest (dry) (broad-leaf peppermint, red stringybark: long-leaf box open-forests)
4. Woodland (dry hillocks) (forest red gum open-forest)
5. Woodland (river flats) (river red gum open-forest)
6. Semi-cleared areas and forest margins
7. Heath (including red cypress pine stands)
8. Grassland
9. Air

STATUS

The codes given below denote status or manner of occurrence, on a relative basis, with reference to available habitat within the study district. The estimates are based on general experience rather than actual counts. The situation is changing constantly.

The first letter in the code indicates distribution of suitable habitat:

W = habitat widespread in the study district
R = habitat restricted to relatively few parts of the study district

The second letter in the code indicates population density within areas of suitable habitat:

C = commonly observed
U = uncommonly observed
R = rarely observed
N = nomadic, number observed varying greatly from time to time

Additional letters may be used to indicate:

S = migratory species observed in the study district during summer
W = migratory species observed in the study district during winter
H = commonly uses hollows in trees for nest site

BIRDS

	Habitat									Status
	1	2	3	4	5	6	7	8	9	
Emu			X		X	X		X		WR
Pelican	X									RU
Darter	X									RU
Black cormorant	X									RC
Little black cormorant	X									RC
Pied cormorant	X									RR
Little pied cormorant	X									RC
Little grebe	X									RC
Hoary-headed grebe	X									RR
Great crested grebe	X									RR
White-necked heron	X				X					WU
White-faced heron	X				X					WC
White egret	X				X					WC
•Little egret	X				X					WR
Plumed egret	X				X					WR
Nankeen night heron	X									RU
Brown bittern	X									RR
White ibis	X							X		WC,N
Straw-necked ibis	X							X		WC,N
Royal spoonbill	X									RR
Yellow-billed spoonbill	X									RC
Black swan	X									RC
Mountain duck	X							X		WU,H
Black duck	X									RC
Grey teal	X									RC,H
Chestnut teal	X									RU
Blue-winged shoveler	X									RU
Pink-eared duck	X									*RU,N*
White-eyed duck	X									RU
Wood duck	X					X		X		RC,H
Musk duck	X									RR
Black-shouldered kite						X		X		WC
Whistling eagle	X			X	X	X		X		WC
•Grey goshawk		X	X							RR
Australian goshawk		X	X	X	X	X				WC
Collared sparrowhawk		X	X	X	X	X				WU
Australian little eagle				X	X	X				WU
Wedge-tailed eagle		X	X	X	X	X		X		WC
•White-breasted sea eagle	X									RR
Spotted harrier								X		WR
Swamp harrier	X							X		WC
Peregrine falcon		X	X	X	X	X				WU
Little falcon		X	X	X	X	X				WU
Nankeen kestrel						X		X		WC
Brown hawk						X		X		WC
Stubble quail								X		WC
Brown quail	X							X		WU
Painted quail			X	X	X	X				WR
•Brolga	X							X		WR

	Habitat									Status
	1	2	3	4	5	6	7	8	9	
Banded landrail	X							X		RU
Marsh crake	X									RU
Australian spotted crake	X									RR
Dusky moorhen	X									RC
Swamphen	X									RC
Spur-winged plover	X							X		WC
Banded plover	X							X		WR
Double-banded dotterel	X									RR,NW
Black-fronted dotterel	X									RC
Japanese snipe	X							X		RU,S
Green shank	X									RU,S
Sharp-tailed sandpiper	X									RU,S
Red-necked stint	X									RU,S
White-headed stilt	X									RU
Southern stone curlew				X	X	X		X		WR
Silver gull	X									RU
Whiskered tern	X									RR
Peaceful dove				X	X					RU
Common bronzewing		X	X	X	X	X				WC
Brush bronzewing		X	X							WU
Crested pigeon				X	X	X		X		WR
•Wonga pigeon		X	X							RU
Musk lorikeet		X	X	X	X	X				WN,H
Little lorikeet		X	X	X	X	X				WN,H
Swift parrot		X	X	X	X	X				WN,H
Yellow-tailed black cockatoo			X	X						WU,H
Gang-gang cockatoo			X	X						WC,H
Sulphur-crested cockatoo			X	X	X	X		X		WC,H
Galah				X	X	X		X		WC,H
King parrot		X								RR,H
Crimson rosella		X	X	X	X					WC,H
Eastern rosella				X	X	X				WC,H
Red-rumped parrot				X	X	X		X		WC,H
Blue-winged parrot						X		X		WU,H
Pallid cuckoo			X	X	X	X				WC,S
•Brush cuckoo		X	X							WR,S
Fan-tailed cuckoo		X	X	X						WC,S
Horsefield bronze cuckoo				X	X	X	X			WC,S
Golden bronze cuckoo		X	X	X						WR,S
Boobook owl		X	X	X	X	X				WC,H
Barn owl		X	X	X	X	X				WU,H
Tawny frogmouth		X	X	X	X	X				WC
Owlet-nightjar			X	X	X	X				WU,H
Spine-tailed swift									X	WC,S
Fork-tailed swift									X	WU,S

	Habitat									Status
	1	2	3	4	5	6	7	8	9	
•Azure kingfisher	X									RR,S
Laughing kookaburra		X	X	X	X	X				WC,H
Sacred kingfisher	X		X		X					WC,SH
Rainbow bee-eater				X	X	X				WC,S
•Dollar bird					X	X				WU,SH
Superb lyrebird		X								RC
Singing bushlark								X		WU
Welcome swallow	X								X	WC
Tree-martin	X			X	X	X		X	X	WC,SH
Fairy-martin	X				X	X		X	X	WC,S
Australian pipit								X		WC
Black-faced cuckoo-shrike		X	X	X	X	X				WC
Little cuckoo-shrike			X	X	X	X				WU
•Cicada bird			X							WR,S
White-winged triller				X	X	X				WU,S
Australian ground-thrush		X								RR
Spotted quail-thrush			X	X						WC
Golden-headed fantail-warbler	X						X			RC
Little grassbird	X									RC
Reed warbler	X									RC,S
Brown songlark								X		WR,S
Rufous songlark	X				X	X				WU,S
Superb blue wren		X	X	X	X	X				WC
•White-throated warbler			X	X		X				WR,S
Western warbler				X	X	X	X			WR,S
Weebill				X	X	X				WR
Striated thornbill		X	X	X	X	X				WC
Little thornbill				X	X	X				WU
Brown thornbill		X	X	X	X	X				WC
Buff-rumped thornbill		X	X	X	X	X				WC
Yellow-rumped thornbill				X	X	X		X		WC
White-browed scrub-wren		X	X	X	X	X				WC
Large-billed scrub-wren			X							RR
Speckled warbler			X	X	X	X				WU
Pilot bird		X								RR
White-fronted chat	X									RR
Jacky winter			X	X	X	X				WC
Scarlet robin		X	X	X	X	X				WC
•Red-capped robin				X	X	X				RU
Flame robin		X	X	X	X	X		X		WC
Pink robin		X	X							RR
Rose robin		X	X							RR
Hooded robin				X	X	X				WR
Southern yellow robin		X	X	X						WC
Grey fantail		X	X	X	X	X				WC
Rufous fantail		X								RU,S
Willie wagtail	X			X	X	X				WC
Leaden flycatcher		X	X							WU,S
Satin flycatcher		X	X							WU,S
Restless flycatcher			X	X	X	X				WU

	Habitat									Status
	1	2	3	4	5	6	7	8	9	
Golden whistler		X	X	X	X	X				WC
Rufous whistler		X	X	X	X	X				WC
Olive whistler		X								RR
Grey shrike thrush		X	X	X	X	X				WC
Shrike-tit		X	X	X	X	X				WC
Eastern whipbird		X								RR
Orange-winged sittella			X	X	X	X				WC
Brown tree-creeper				X	X	X				WC,H
White-throated tree-creeper		X	X	X	X	X				WC,H
•Red-browed tree-creeper		X	X							RU,H
Mistletoe bird		X	X	X	X	X				WC
Spotted pardalote		X	X	X	X	X				WC
Eastern striated pardalote			X	X	X	X				WC
Striated pardalote			X	X	X	X				WC
Grey-breasted silvereye		X	X	X	X	X				WC
•Lewin honeyeater		X								RR
Fuscous honeyeater			X	X	X	X				WU
Yellow-faced honeyeater		X	X	X	X	X				WC
White-plumed honeyeater				X	X	X				RU
White-eared honeyeater		X	X	X	X					WC
Yellow-tufted honeyeater				X	X	X				WU
Brown-headed honeyeater			X	X	X	X	X			WC
White-naped honeyeater		X	X	X	X	X				WC
•Little friar-bird			X	X	X	X				WR
•Noisy friar-bird			X	X	X	X				WR
Crescent honeyeater		X					X			RR
•Painted honeyeater					X	X				RR
Regent honeyeater				X	X	X				WR
Eastern spinebill		X	X	X		X				WC
Noisy miner				X	X	X				WC
Red wattle-bird		X	X	X	X	X				WC
Diamond firetail				X	X	X				WU
Red-browed finch		X	X	X	X					WC
Zebra finch				X	X	X		X		WR
Olive-backed oriole			X	X	X	X				WC,S
Magpie lark					X	X				WC
White-winged chough			X	X	X	X				WC
Masked wood-swallow				X	X	X				WU,S
White-browed wood-swallow				X	X	X				WU,S
Dusky wood-swallow				X	X	X				WC
Pied currawong		X	X							WC
Grey currawong		X	X	X	X					WU
Grey butcher-bird		X	X	X	X	X				WU
Black-backed magpie					X	X				WC
White-backed magpie					X	X				WU
•Satin bower-bird		X	X							WU
Australian raven				X	X	X		X		WC
Little raven						X		X		WC

MAMMALS

Common name	Scientific name	Habitat 1	2	3	4	5	6	7	8	Status
Echidna	*Tachyglossus aculeatus*		X	X	X	X	X	X	X	WC
*Platypus	*Ornithorhynchus anatinus*	X								RU
*Tiger cat	*Dasyurus maculatus*		X	X						WR
Brown phascogale	*Antechinus stuartii*		X	X	X		X			WC
Dusky phascogale	*Antechinus swainsonii*		X	X			X			WC
Tuan	*Phascogale tapoatafa*			X	X					WR,H
*Long-nosed bandicoot	*Perameles nasuta*	X	X	X			X			WC
Brush-tailed possum	*Trichosurus vulpecula*		X	X	X	X	X			WC,H
Ring-tailed possum	*Pseudocheirus peregrinus*	X	X	X	X	X				WC
Sugar glider	*Petaurus breviceps*		X	X	X	X				WU,H
*Greater glider	*Schoinobates volans*		X	X						WC,H
Feathertail glider	*Acrobates pygmaeus*		X	X	X	X				WU,H
*Wombat	*Vombatus ursinus*	X	X	X			X			WC
*Eastern grey kangaroo	*Macropus giganteus*		X	X	X	X	X		X	WC
*Black-tailed wallaby	*Wallabia bicolor*	X	X	X	X	X	X			WC
Bush rat	*Rattus fuscipes*		X	X	X	X	X			WC
Eastern water rat	*Hydromys chrysogaster*	X								RC
Lesser long-eared bat	*Nyctophilus geoffroyi*		X	X	X	X	X			WC,H
Dingo	*Canis familiaris*		X	X			X			WU

PROBABLE AMPHIBIAN SPECIES

Common name	Scientific name
(tree frogs)	HYLIDAE
+Golden bell frog	*Hyla aurea raniformis*
Tree frog	*Hyla ewingi*
Rocky river frog	*Hyla lesueuri*
Tree frog	*Hyla peroni*
(non-tree frogs)	LEPTODACTYLIDAE
+Brown froglet	*Crinia signifera*
Froglet	*Crinia parinsignifera*
+Froglet	*Crinia victoriana*
Bullfrog	*Limnodynastes dumerili*
+Bullfrog	*Limnodynastes interioris*
Marsh frog	*Limnodynastes fletcheri*
+Striped marsh frog	*Limnodynastes peroni*
Spotted grass frog	*Limnodynastes tasmaniensis*
Spadefoot toad	*Neobatrachus pictus*
+Toadlet	*Pseudophryne bibroni*
Toadlet	*Pseudophryne dendyi*
Toadlet	*Uperoleia rugosa*

\+ recorded for district

FISH

++Rainbow trout	*Salmo gairdneri*
++Brown trout	*Salmo trutta*
++Carp	*Carassius* sp.
Murray cod	*Maccullochella peeli*
Trout cod	*Maccullochella macquariensis*
Macquarie perch	*Macquaria australasica*
++Red fin	*Perca fluviatalis*
Blackfish	*Gadopsis marmoratus*

++ introduced species

Species recorded for District 1	Common names	Distribution of reptile species in Victoria by zoogeographic regions					Habitats								Biological characteristics (see notes 1-3)
		Eyrean		Bassian			1	2	3	4	5	6	7	8	
		True Eyrean	Murray River corridor only	Warm temp. zone	Cool temp. zone	Cold temp. zone									
CHELYIDAE															
Chelodina longicollis	Long-necked tortoise	-	+	+	+	+	+	-	-	-	+	-	-	-	TO
AGAMIDAE															
Amphibolurus muricatus	Tree dragon	+	-	+	-	-	-	-	+	-	-	-	+	-	HO
SCINCIDAE															
LYGOSOMINAE															
Anotis maccoyi	Skink	-	-	-	+	-	-	+	-	-	-	-	-	-	TO
Ctenotus robustus	Striped skink	+	-	+	-	-	-	-	+	+	-	+	+	+	HO
Ctenotus taeniolatum	Copperтail skink	-	-	+	-	-	-	-	-	-	-	-	+	-	HO
Hemiergis decresiensis	Three-toed skink	-	-	+	-	-	-	+	+	+	-	+	+	+	TV
Leiolopisma entrecasteauxi	Grass skink	-	-	-	+	+	-	+	-	-	-	-	-	-.	HV
L. guichenoti	Garden skink	-	-	+	+	-	-	+	+	+	+	+	+	+	HO
L. mustelinum	Weasel skink	-	-	+	+	-	-	+	-	-	-	-	-	-	TO
L. trilineatum	Three-lined skink	-	-	+	+	-	-	-	+	+	-	+	+	+	HO
L. weekesae	Skink	-	-	-	+	+	-	+	-	-	-	-	-	-	HV
Lerista bougainvilli	Bougainville's skink	+	-	+	+	-	-	-	-	+	-	-	-	-	TV
Morethia lineocellatus	Snake-eyed skink	+	-	+	-	-	-	-	-	+	-	-	-	+	HO
Sphenomorphus tympanum (warm temperate form)	Eastern water skink	-	-	+	-	-	-	+	+	-	-	+	-	-	HV
SCINCINAE															
Egernia saxatilis	Black rock skink	-	-	+	+	-	-	+	-	-	-	-	-	-	HV
E. striolata	Tree skink	+	-	+	-	-	-	-	-	-	+	-	-	-	HV
E. whitei	White's skink	-	-	+	+	+	-	+	+	-	-	+	-	-	HV
Tiliqua nigrolutea	Southern bluetongue	-	-	-	+	-	-	+	-	-	-	-	-	-	HV
T. scincoides	Common bluetongue	-	-	+	+	-	-	+	-	-	-	-	-	-	HV
ELAPIDAE															
Demansia textilis	Brown snake	+	-	+	-	-	-	-	+	+	-	+	-	+	HO
Denisonia coronoides	White-lipped snake	-	-	-	+	+	-	+	+	-	-	+	-	-	TV
D. superba (highlands form)	Copper-head	-	-	-	+	+	+	+	-	-	-	+	-	-	HV
Notechis scutatus	Tiger snake	-	+	+	+	-	+	+	+	-	+	-	-	-	HV
Pseudechis porphyriacus	Black snake	-	+	+	-	-	+	-	-	-	+	-	-	-	HV
TYPHLOPIDAE															
Typhlops nigrescens	Blind snake	+	-	+	-	-	-	-	+	-	-	-	-	-	TO

1. Method of thermoregulation

   T = Thigmotherm (non-basking reptiles). This type of reptile selects suitable temperatures in shaded situations and is thus limited directly by environmental temperatures.

   H = Heliotherm (basking reptile). This type of reptile uses the energy in solar radiation to elevate body temperature and so can remain active in low environmental temperatures, given access to sunshine.

2. Mode of reproduction

   O = Oviparous. These are egg-laying reptiles and require warm, dry sites for laying eggs.

   V = Viviparous. These reptiles give birth to live, fully developed young.

3. The only ovoviviparous species, *Anotis maccoyi*, is listed with the oviparous species.

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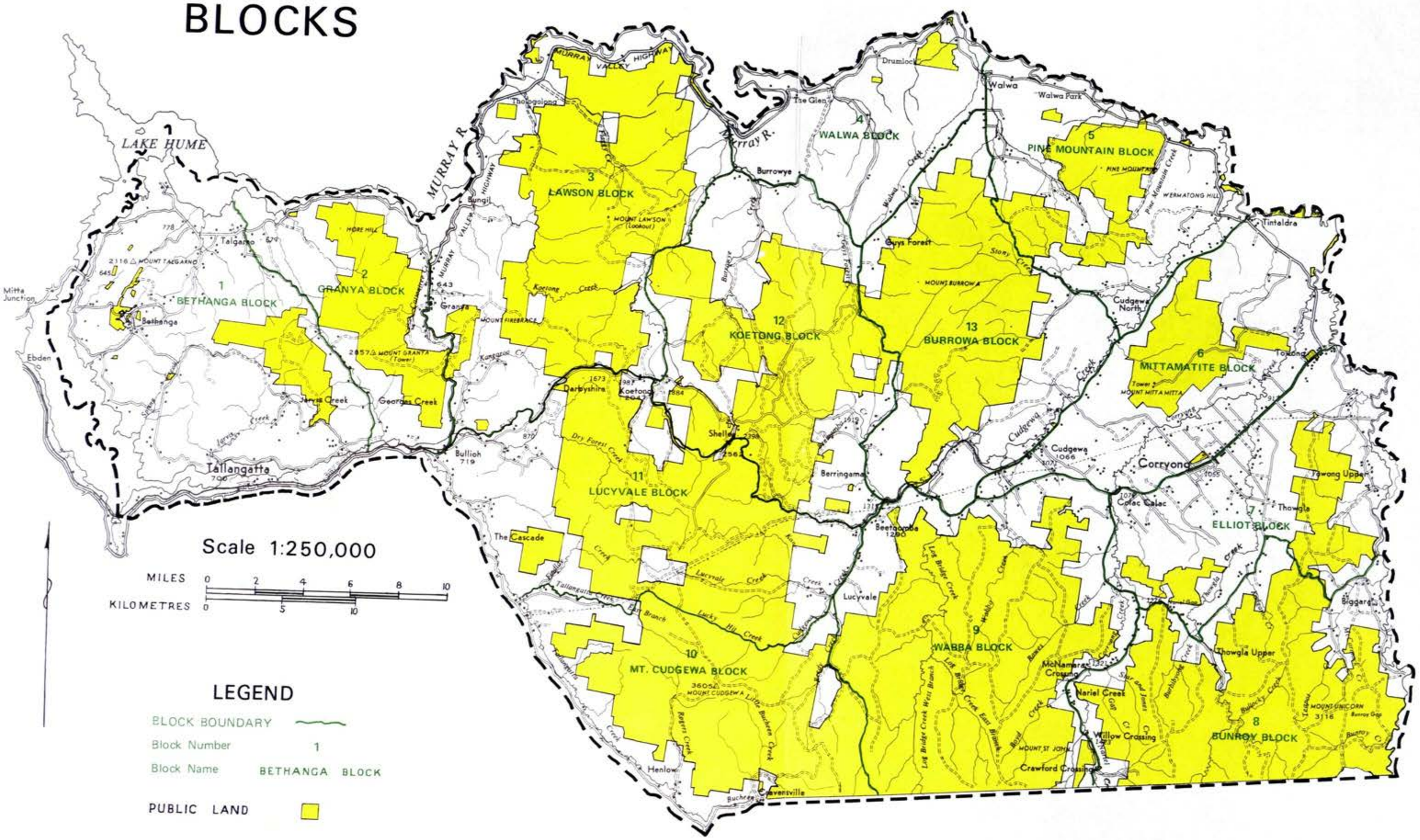
PUBLIC LAND AND DESCRIPTIVE BLOCKS

LAND CONSERVATION COUNCIL
VICTORIA

NORTH EASTERN AREA

DISTRICT 1



LEGEND

BLOCK BOUNDARY

Block Number 1

Block Name BETHANGA BLOCK

PUBLIC LAND

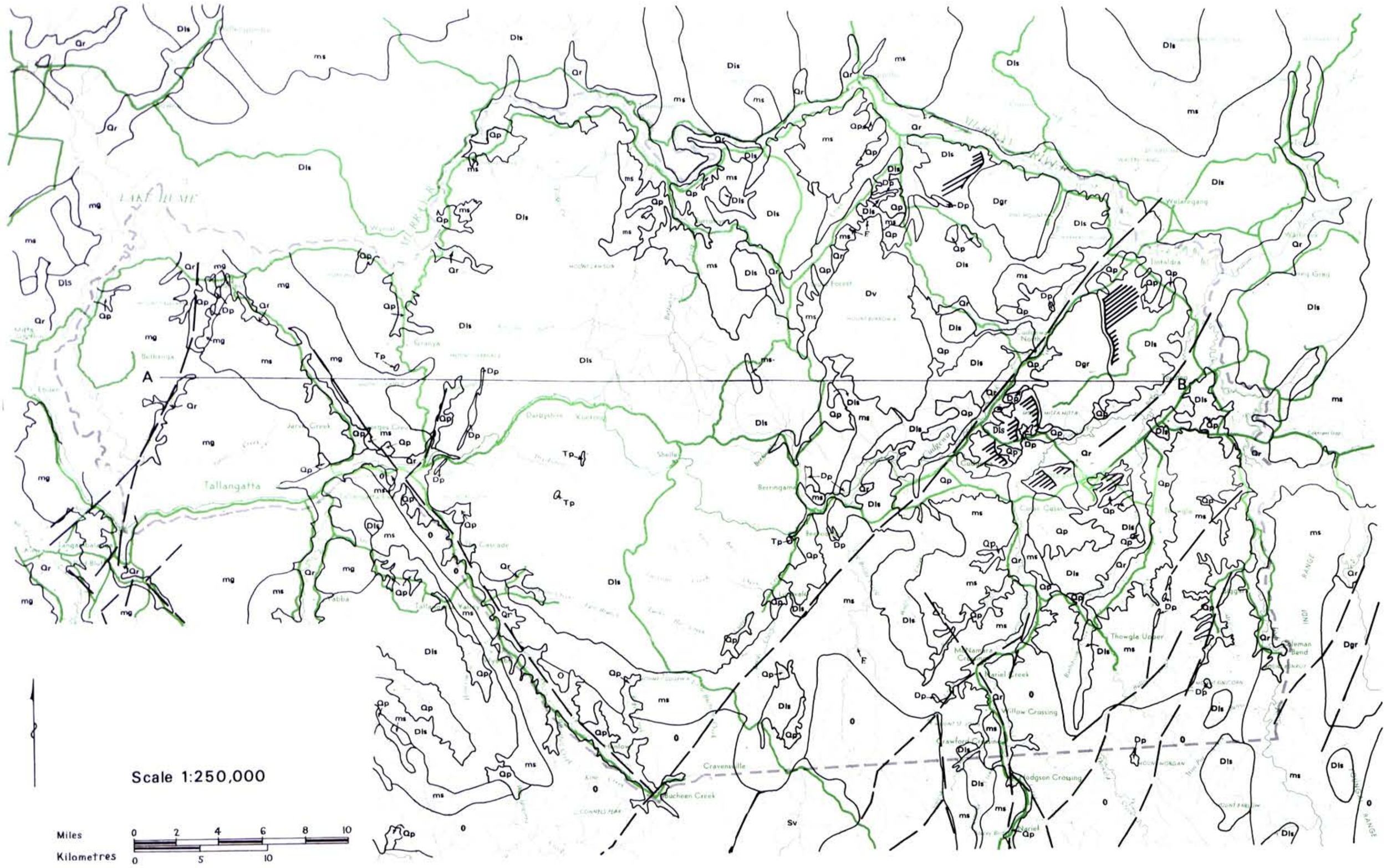
GEOLOGY

LAND CONSERVATION COUNCIL

VICTORIA

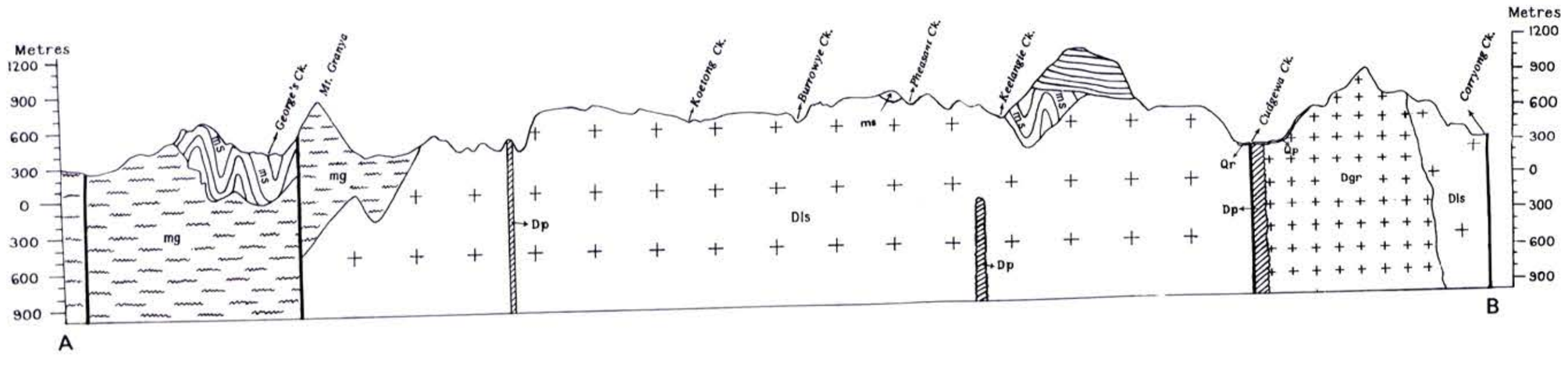
NORTH EASTERN AREA

DISTRICT 1



DIAGRAMMATIC SECTION

Scale: $\frac{V}{H} = 6.35$



Reference

DISTRICT BOUNDARY

Geological boundary

Probable fault

Dyke swarm

Fossils F.

Road

COMPILED FROM INFORMATION AND MAPS SUPPLIED BY THE GEOLOGICAL SURVEYS OF VICTORIA AND NEW SOUTH WALES.

		SEDIMENTARY: Colluvial, Alluvial, Lacustrine	SEDIMENTARY: Marine	IGNEOUS: Extrusive	IGNEOUS: Intrusive	Metamorphic
QUATERNARY	RECENT	Qr				
QUATERNARY	PLEISTOCENE	Qp				
TERTIARY	PLIOCENE	Tp				
DEVONIAN	UPPER			Dv	Dgr	
DEVONIAN	MIDDLE				Dp	
DEVONIAN	LOWER				Dls	
SILURIAN				Sv		
ORDOVICIAN			O			ms, mg

	Qr	*Stream alluvium, swamp deposits; sand, gravel, silt*
	Qp	*High river terraces and alluvial flats, colluvial–alluvial fans; sand, silt, clay, gravel*
	Tp	*Gravel, unconsolidated conglomerate, clay, sand*
JEMBA RHYOLITE	Dv	*Rhyolite, rhyolite breccia, tuff*
	Dgr	*Granite, leuco-granite*
	Dp	*Quartz porphyry, quartz feldspar porphyry*
	Dls	*Granite, rhyolite, granodiorite, tonalite*
MITTA MITTA VOLCANICS	Sv	*Rhyodacite with minor rhyolite, tuff, agglomerate and sediments*
	O	*Sandstone, shale, slate, quartz veins, minor conglomerate.*
	ms	*Schist predominant*
	mg	*Gneiss predominant*

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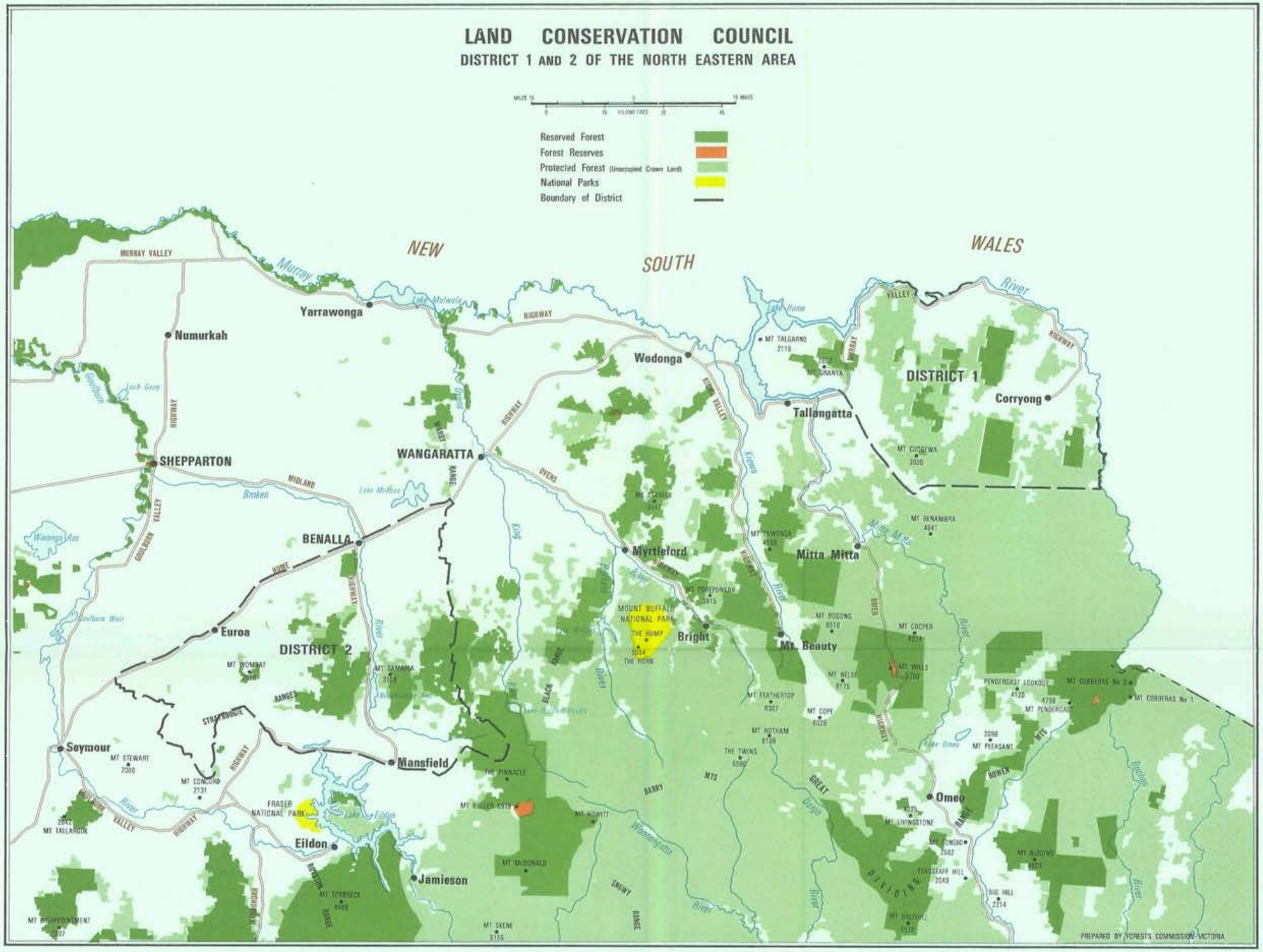
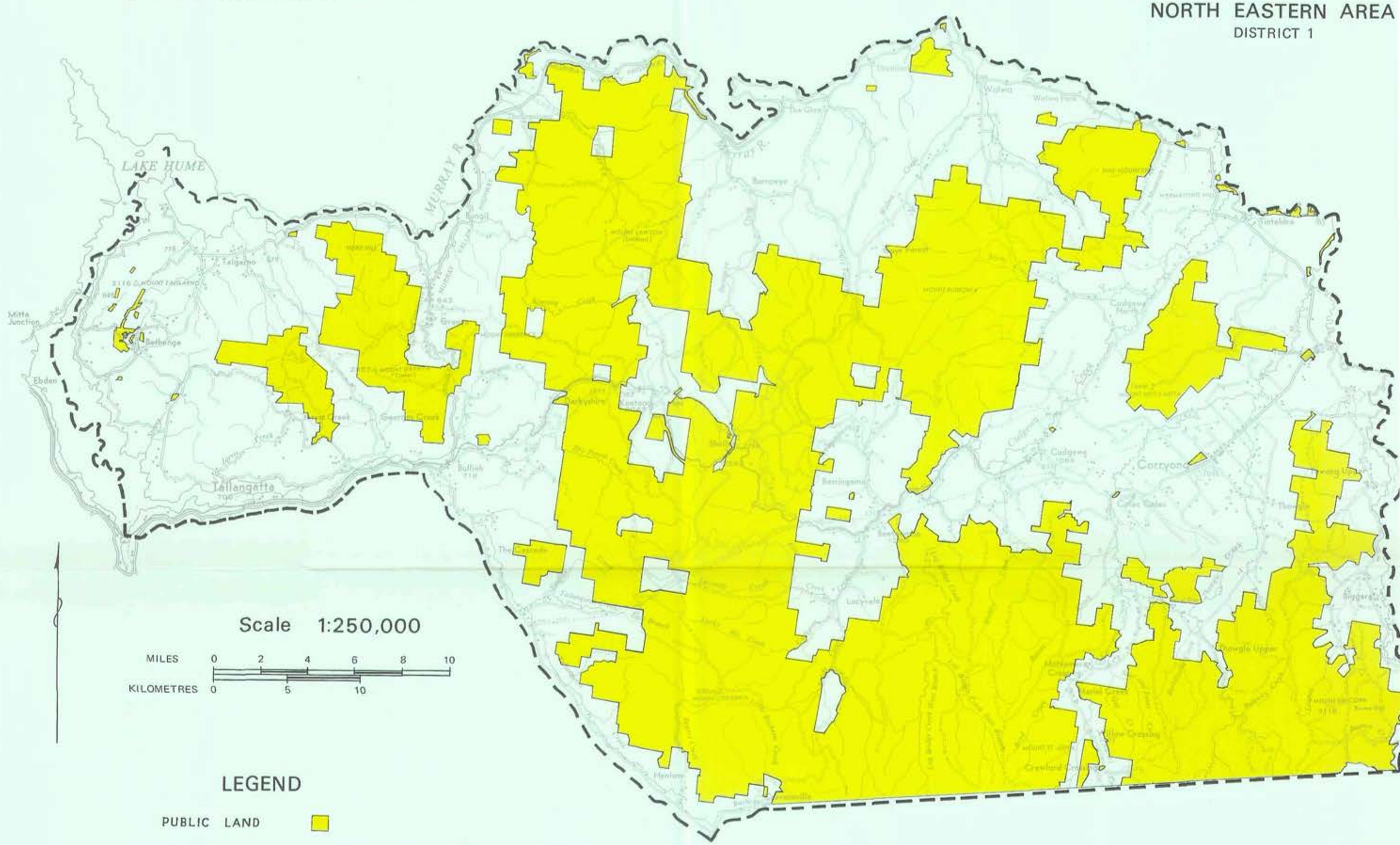
DISTRICT 1 AND 2 OF THE NORTH EASTERN AREA



SUBMISSIONS

LAND CONSERVATION COUNCIL
VICTORIA

NORTH EASTERN AREA
DISTRICT 1



VEGETATION

LAND CONSERVATION COUNCIL

VICTORIA

NORTH EASTERN AREA

DISTRICT 1

Scale 1:100,000

MILES 0 2 4 6

KILOMETRES 0 2 4 6 8 10

VEGETATION UNITS

Map Symbol	Typical Structural Form(s) (at Maturity)	Major Tree Species (Common Name of Unit)	Associated Tree Species	Major Understorey Species
1	Open-forest I	Candlebark Gum: Snow Gum	Broad-leaf Peppermint	Snow Grass; Hop Bitter-pea, Handsome Flat-pea, Leafy Bossiaea, Golden Oxylobium
2 *r–regrowth m–mature	Open-forest IV	Alpine Ash	Candlebark Gum Blue Gum	Snow Grass; Hop Bitter-pea; Common Ground Fern; Silver Wattle,
3	Open-forest III	Narrow-leaf Peppermint	Candlebark Gum Manna Gum Blue Gum Brittle Gum Broad-leaf Peppermint Red Stringybark	Tussock Grass; Bracken Fern, Hop Bitter-pea; Common Cassinia, Silver Wattle, Blackwood; Blanket-leaf, Musk Daisy-bush, Hazel Pomaderris.
4	Open-forest II	Broad-leaf Peppermint	Candlebark Gum Red Stringybark Long-leaf Box Blue Gum Narrow-leaf Peppermint But-But (Apple Box)	Tussock Grass; Bracken Fern, Hop Bitter-pea, Handsome Flat-pea
5a	Open-forest II	Red Stringybark: Long-leaf Box	Candlebark Gum Broad-leaf Peppermint Red Box But-But (Apple Box)	Tussock, Kangaroo and Wallaby Grasses; Handsome Flat-pea, Golden Guinea-flowers, Purple Coral-pea; Grass tree; Silver Wattle
5b	Open-forest I	Red Stringybark: Long-leaf Box	Forest Red Gum Broad-leaf Peppermint But-But (Apple Box) Red Cypress Pine Candlebark Gum	Tussock Grass; Grasstree, Common Fringe-myrtle, Dagger Wattle, Woolly Wattle
6	Open-forest I, Closed to Open-heath, Open-mossland	Red Cypress Pine (Complex)	Forest Red Gum Long-leaf Box Kurrajong	Lichens and Mosses; Common Fringe-myrtle, Wedge-leaf Hop-bush, Dagger Wattle, Woolly Wattle, Drooping She-oak
7	Open-forest II, Woodland II	Forest Red Gum	White Box Long-leaf Box But-But (Apple Box) Yellow Box Red Box	Wallaby Grass, Kangaroo Grass
8	Open-forest II, Woodland II	River Red Gum	–	Common Reed
9	Open-forest II	Swamp Gum	Black Sallee	Tussock Grass, Sword Sedge, Tea-tree
10	Softwood Forest			
11	Grassland and/or scrub			

Redrawn from Vegetation map supplied by Forests Commission, Victoria, 1972.