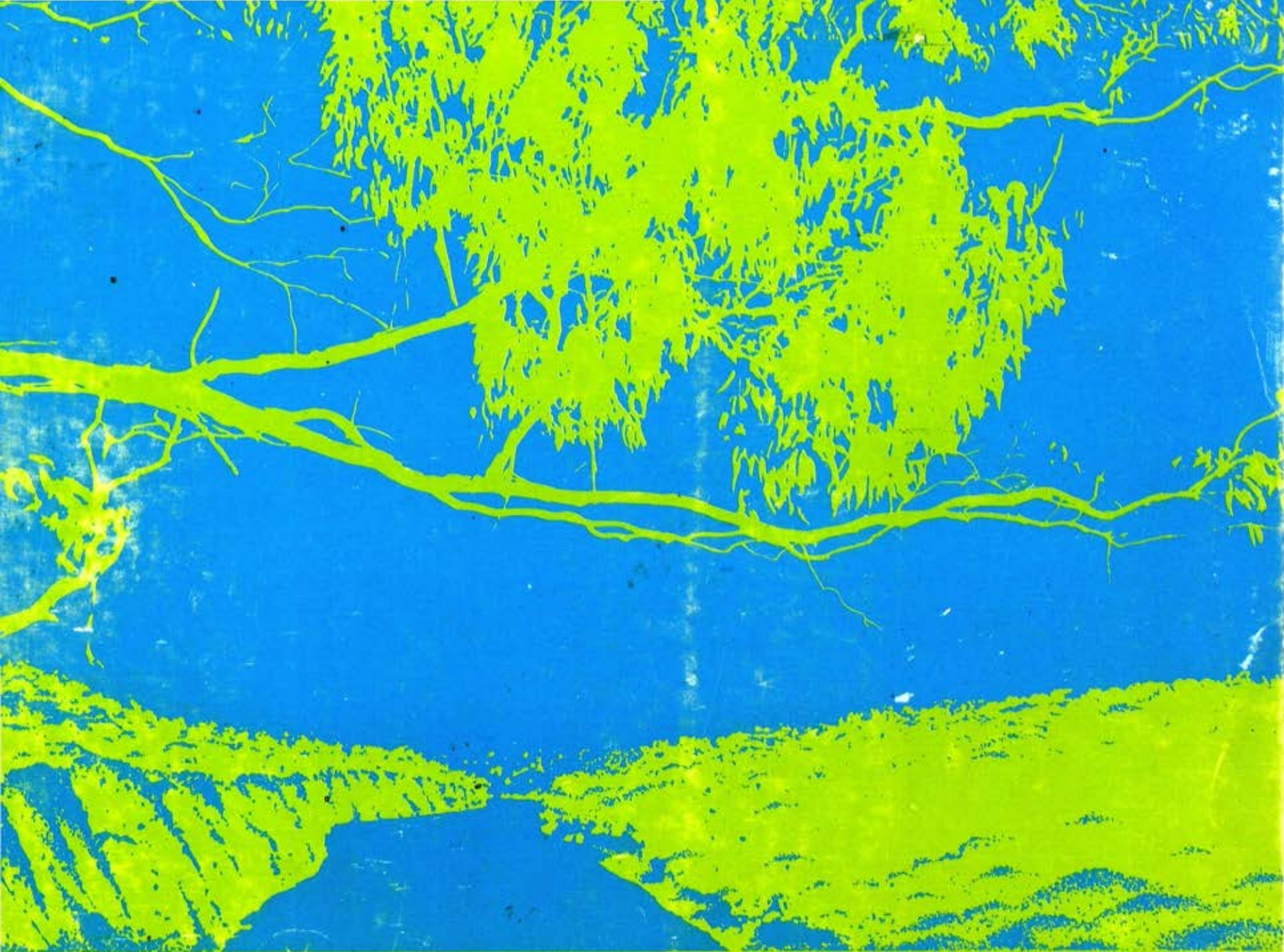




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GOVERNMENT OF VICTORIA

LAND CONSERVATION COUNCIL

464 ST. KILDA ROAD, MELBOURNE, VICTORIA, 3004

REPORT

SOUTH GIPPSLAND AREA, DISTRICT 2

This Report is published to allow all who are interested in the use of public land the opportunity to comment by making written submissions to the Land Conservation Council.

All such submissions must reach the Secretary no later than Monday 8th December, 1980.

These submissions will be considered by the Council before Proposed Recommendations are made on the use of public land in the study area.

A handwritten signature in dark ink, appearing to read 'I. Kunaratnam', is written above the printed name.

I. KUNARATNAM
Secretary
Land Conservation Council

REPORT
on the
SOUTH GIPPSLAND STUDY AREA, DISTRICT 2

Land Conservation Council, Victoria
Melbourne: October, 1980

ISBN 0 7241 9136 4

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FOREWORD

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

This report sets out to describe and assess the natural resources of the public land in the South Gippsland study area, District 2 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 itself will 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 those 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.

Land Conservation Council
464 St. Kilda Road
MELBOURNE 3004



S.G. McL. DIMMICK
Chairman

LAND CONSERVATION ACT 1970

EXTRACT

Public land

Section 2.

- (1) "Public land" means -
- (a) land which is not within a city town or borough and is -
 - (i) unalienated land of the Crown including land permanently or temporarily reserved under section 14 of the *Land Act* 1958 and State forest;
 - (ii) vested in any public authority (other than a municipality or a sewerage authority within the meaning of the *Sewerage Districts Act* 1958); or
 - (iii) vested in the Melbourne and Metropolitan Board of Works; and
 - (b) any other land which the Governor in Council declares under sub-section (2) to be public land for the purposes of this Act

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

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

- (a) any Minister of the Crown in whom any land is vested; or
- (b) the Minister responsible for a public authority in which any land is vested -

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

Functions of the Council

Section 5.

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

- (b) make recommendations to the Governor in Council as to the constitution and definition of water supply catchment areas under the *Soil Conservation and Land Utilization Act* 1958; and
 - (c) advise the Soil Conservation Authority concerning policy on the use of land (whether public land or any other land however vested) in any water supply catchment area.
- (2) In making any recommendation the Council shall have regard to the present and future needs of the people of Victoria in relation to -
- (a) the preservation of areas which are ecologically significant;
 - (b) the conservation of areas of natural interest beauty or of historical interest;
 - (c) the creation and preservation of areas of reserved forest;
 - (d) the creation and preservation of areas for national parks;
 - (e) the creation and preservation of areas for leisure and recreation, and in particular of areas close to cities and towns for bushland recreation reserves;
 - (f) the creation and preservation of reserves for the conservation of fish and wildlife;
 - (g) the preservation of species of native plants; and
 - (h) land required by government departments and public authorities in order to carry out their functions.
- (3) Where the Council recommends the alienation of any land the recommendation shall include the Council's opinion as to the best method of alienating the land to ensure the most satisfactory use and management of the land in the public interest.
- (4) Any person or body may make submissions to the Council as to how any public land can be better used to meet the needs of the people of Victoria and the Council shall consider any such submissions before making any recommendation under paragraph (a) of sub-section (1).

Investigations, Notices and Reports

Section 9.

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

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

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

- (a) publish a report of the investigation;
- (b) give notice in the *Government Gazette* of the publication of the report, the address where copies of the report may be obtained or inspected and stating that any submissions to the Council in relation to such report will be considered by the Council if they are made within 60 days of such notice; and
- (c) publish notice in a newspaper circulating throughout the State and in a newspaper circulating particularly in or in the vicinity of the area or district investigated of the

publication of the report, the address where copies of the report may be obtained or inspected and stating that submissions may be made to the Council and the date before which they should be made.

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

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

Section 10.

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

- (a) the Council of any municipality in the municipal district of which any part of the area or district to which the recommendation relates is situated;
- (b) any other public authority or government department that in the opinion of the Council has an interest in the area of the proposed recommendation; and
- (c) any person or body who made a

submission under section 9 -

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

- (2) Where any recommendation is made to the Minister under this Act it shall be accompanied by a copy of any submissions received from any person body department authority or council pursuant to the provisions of sub-section (4) of section 9 or sub-section (1) of this section.
- (3) Where the Council has made a recommendation to the Minister under paragraph (a) of sub-section (1) of section 5 the Minister may, after he has given not less than fourteen days notice of his intention so to do to the Minister administering a government department or responsible for a public authority recommend to

the Governor in Council that notice of the recommendation or that part of the recommendation that affects the government department or public authority be given to the government department or public authority concerned and where notice of that recommendation or part is so given by the Governor in Council it shall be the duty of the government department or public authority to use all diligence and dispatch to give effect to such recommendation so far as it affects any land vested in or controlled by it.

Copy of every recommendation and of proposals to be tabled in Parliament

Section 11.

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

ACKNOWLEDGEMENTS

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

The following bodies supplied information for maps and chapters: the Departments of Agriculture, Crown Lands and Survey, and Minerals and Energy; the Fisheries and Wildlife Division; the Forests Commission; the National Museum; the National Parks Service; the Soil Conservation Authority; the State Electricity Commission; the State Rivers and Water Supply Commission and the municipal councils representing the area. Several of these bodies supplied photographs.

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

Drs. E. Bird and R. Twidale kindly gave permission for published material of theirs to be used in Chapter 6.

PART I
INTRODUCTION

1. AIMS AND METHODS

This report describes the physical nature of the land in the study area, examines existing and potential forms of land use, and assesses the hazards associated with such uses. The report itself does not contain recommendations, but aims at providing a factual basis on which recommendations for the future use of public land can be formulated.

Although the use of public land has been emphasized, the report also considers relevant aspects of all land in the study area, so that the public areas can be seen in perspective.

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

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

Part II deals with the main features of the environment in the whole study area. The maps relating to this part show geomorphology, topography, geology, rainfall and water resources, vegetation on public land, and land systems.

Part III examines the main forms of land use that are likely to make demands on public land. Hazards associated with these land uses, such as soil deterioration and fire, are also discussed. Recreational features, primary production, and mineral deposits are mapped. In addition, an indication of resources may be obtained from the vegetation and primary production maps.

Part IV provides more detailed information on the study area, which has been divided here into six blocks, for convenience. Consistent headings are used so that the reader can readily find specific information for any block and compare it with the others.

A number of appendices, including lists of flora and fauna, complete the report.

2. CONSERVATION PRINCIPLES

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

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

Natural Resources

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

Non-renewable resources

The quantity of these resources does not increase significantly with time, and use consumes them. In the last century

the expansion of Victoria's economy was based on the exploitation of gold - a non-renewable resource. The oil and gas fields of Bass Strait provide another example.

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

Renewable resources

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

Conservation of renewable resources requires a thorough understanding of ecological principles and development of sound management techniques based on those principles. An ecosystem typically contains many interrelated components. A change in any one of these will have effects elsewhere in the system. In general, an ecosystem with a diverse

range of species will be better able to adapt and absorb the impact of sudden change - such as that caused by fire, disease, or Man's activities - than a simple ecosystem with few species.

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

Relations Between Resource Uses

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

For example, the relation between timber production and picnicking within a forest may be complementary in the sense that picnickers gain access along tracks and use open spaces created during timber operations. It may become competitive if logging makes the forest an unsuitable picnic area, and at other times

picnickers may present a considerable fire risk.

In general, decisions on land use will involve selecting major land uses for a particular area, determining other uses compatible with these, and specifying the intensity of use above which they become incompatible.

The Principles of Land Use

In the past our society has grown (and the economic welfare of the people improved) through mining, farming, timber production, and industrial development. These industries have usually been given prime importance when deciding the use of natural resources. The present pattern of land use is, of course, a result of these past decisions.

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

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

These needs should be clearly stated as aims.

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

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

define major aims and to assess levels above which secondary uses are unacceptable.

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

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

3. THE STUDY AREA

South Gippsland study area, District 2, is important to Victoria for several reasons. It contains the State's largest deposits of brown coal. It is the centre of the Australian Kraft paper industry and its agriculture is highly productive. Victoria's best-known national park, Wilsons Promontory, is to be found in the area, and the coastline and ranges are major tourist attractions.

General description

The study area comprises portions of the Latrobe Valley, Strzelecki Range and South Gippsland coastal plains, and all of Wilsons Promontory. It adjoins South Gippsland study area, District 1, Melbourne study area, and Stradbroke area, all of which have been investigated by the Land Conservation Council.

The Strzelecki Range is defined as "all of the ranges south of the Princes Highway between Nyora and Carrajung, but not including Wilsons Promontory".

About 2,100 sq km (35%) of the total area of 6,000 sq km is public land as defined in the *Land Conservation Act*

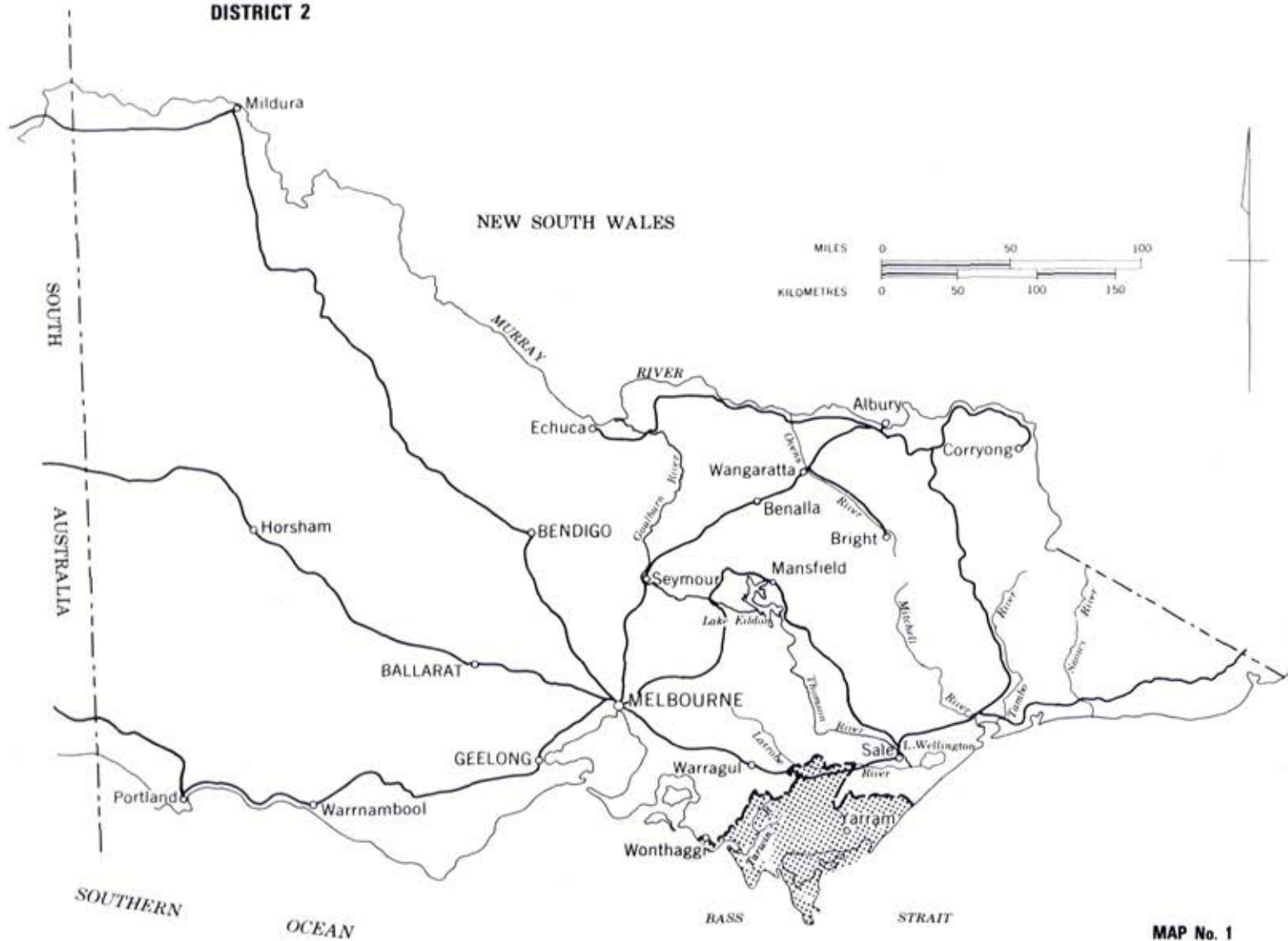
1970 (see page vi). Most is in the eastern half of the study area, particularly in the eastern Strzelecki Range and its low south-eastern foothills, and on Wilsons Promontory. The main categories of this public land are reserved forest, national park, State Electricity Commission areas of operation, and unoccupied Crown land.

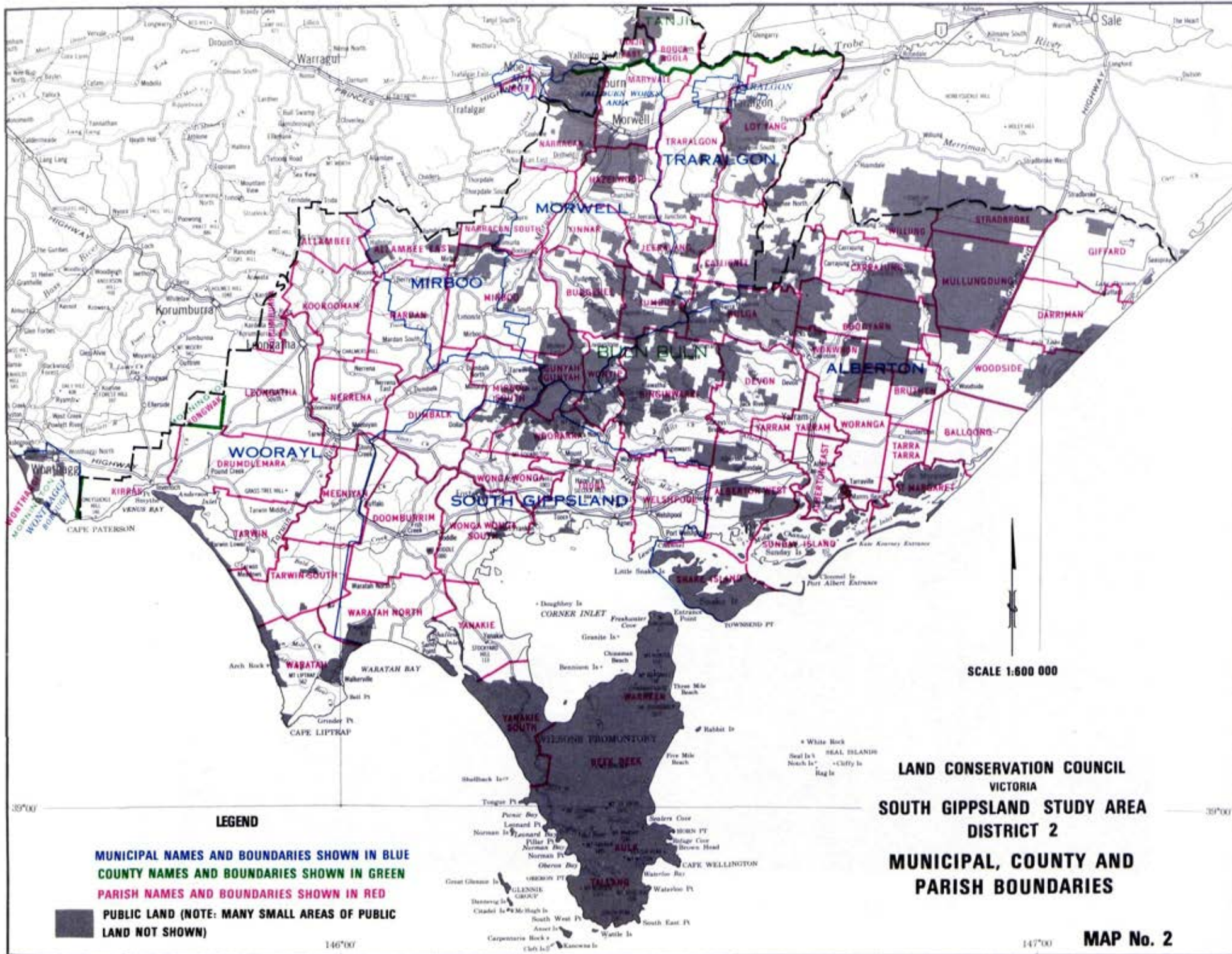
Six shires make up the study area - Alberton, Mirboo, Morwell, South Gippsland, Traralgon, and Woorayl - and it also embraces Yallourn Works Area but not the City of Traralgon, since Crown land within cities is not included in the definition of public land specified in the *Act*. Maps 1 and 2 delineate the boundaries of the study area, the various municipalities, and individual parishes.

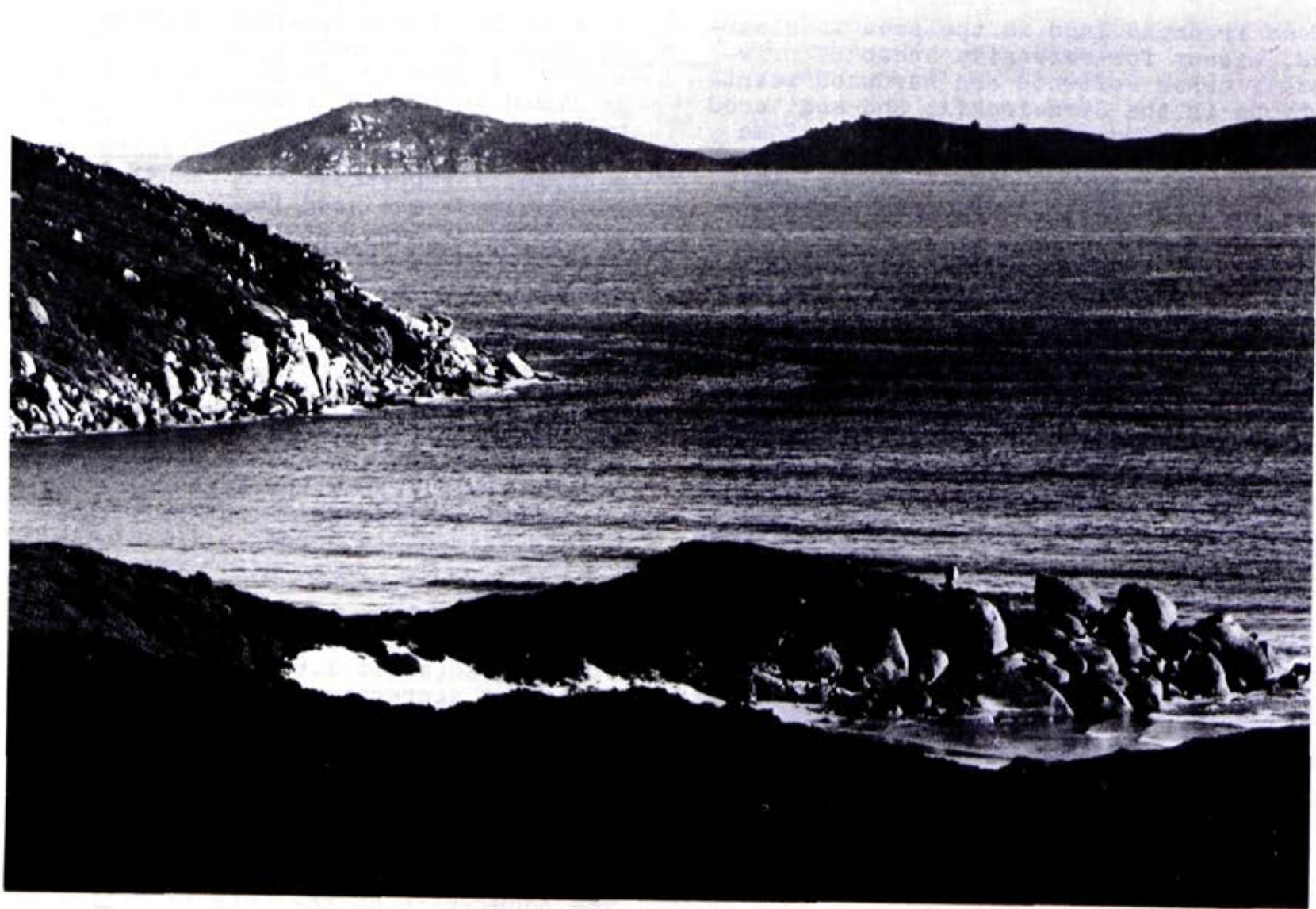
Apart from the coastal plains and the valley of the Latrobe River, the region is hilly to mountainous and both the Strzeleckis and Wilsons Promontory have peaks more than 700 m in elevation. The annual rainfall is high in these hills (900--1,500 mm) and declines to 550--600 mm in the east and north-east. Many of the streams are used for local water

LAND CONSERVATION COUNCIL
VICTORIA
SOUTH GIPPSLAND STUDY AREA
DISTRICT 2

LOCALITY PLAN







Great Glennie Island and Picnic Bay, Wilsons Promontory National Park

supplies but, as yet, no large reservoirs have been constructed.

Most freehold land in the area is cleared, except for extensive areas of privately owned softwood and hardwood plantations in the Strzeleckis, and scattered remnant stands of native forest. Some of the clearing is recent; most of the coastal scrub of the lower Tarwin valley, Cape Liptrap, and Yanakie has been developed for farming only in the last 30 years. Dairying, sheep and cattle raising, and potato-growing are the main agricultural activities.



Yallourn W power station

Native vegetation covers all of the public land apart from softwood plantations, farmland acquired by governmental authorities for coal-winning or reforestation, and certain other limited areas. A variety of plant communities is found on Wilsons Promontory, and the majestic forests of mountain ash in the gullies of the eastern Strzeleckis are especially impressive. Obviously these public lands are used for recreation and conservation, but they also produce logs, pulpwood, water, minerals and gravel, forage, and honey.

State boundaries

The Victoria--Tasmania boundary lies along latitude $39^{\circ} 12'$, 8 km south of the southern tip of Wilsons Promontory. Rodondo Island, the spectacularly steep island visible from the lighthouse on South East Point, falls, therefore, within Tasmania's border.

Population

Just over 64,000 people live in the study area (about 1.8% of the 1976 Victorian aggregate of 3,646,981), two-thirds in the Latrobe Valley. Table 1 lists figures from three post-war censuses and indicates the most important industries in each municipality. In addition, the following can be inferred from the data.

The population of the Latrobe Valley is slowly spreading as the smaller town

Table 1
POPULATION STATISTICS
SOUTH GIPPSLAND STUDY AREA, DISTRICT 2

Municipality	Total popu- lation 1947	Total popu- lation 1954	Total popu- lation 1971	Population 30 June 1976			Average annual per- centage rate of change over last 5 years	Main centres	Main industries
				Males	Females	Total			
Alberton Shire	5,246	5,602	5,803	2,919	2,754	5,673	- 0.45	Yarram, Port Albert, Alberton, Woodside	Farming, fishing, tourism, forestry
Mirboo Shire	1,611	1,862	1,964	1,006	899	1,905	- 0.61	Mirboo North	Farming, forestry
Morwell Shire	6,210	13,033	22,453	11,714	10,940	22,654	0.18	Morwell, Chur- chill, Yinnar, Boolarra	Coal-winning, briquette manufacture, elec- tricity generation, char production, farming, forestry, light industry
South Gippsland Shire	4,203	4,882	5,408	3,016	2,651	5,667	0.94	Foster, Toora, Welshpool, Fish Creek, Port Welsh- pool, Yanakie	Farming, milk process- ing, tourism, offshore oil servicing, fishing, forestry
Traralgon City *	(4,545) **	(8,845) **	14,666	7,608	7,481	15,089	0.57	Traralgon	Cement & brick manu- facture, light industry
Traralgon Shire	5,396 (851)	10,036 (1,191)	1,336	910	865	1,775	5.85	Traralgon out- skirts, Tyers	Power station develop- ment, farming, forestry
Woorayl	6,088	7,046	9,145	4,839	4,686	9,525	0.82	Leongatha, Inver- loch, Dumbalk, Meeniyar, Koon- warra, Mardan	Farming, milk pro- cessing, tourism
Yallourn Works Area	5,736	5,580	3,204	970	855	1,825	-10.65***	Yallourn	Coal-winning, electri- city generation
	34,490	48,041	63,979	32,982	31,131	64,113	+ 0.04		

* Note that this municipality is technically not within the study area.

** In 1961 Traralgon separated from Traralgon Shire. A borough at first, it became a city in 1964.

*** Yallourn is being vacated to allow coal-winning to proceed. Most residents are resettling within the study area and at Moe and Newborough.

Sources: a. Australian Bureau of Statistics b. Central Planning Authority. 'Resources Survey West Gippsland Region. (Government Printer: Melbourne 1968.)

ships and rural districts attract settlers prepared to commute to the larger towns. As secondary industry expands and farming becomes more mechanical, the Strzeleckis are becoming depopulated through migration to the towns and cities. Another reason has been the widespread purchase, for reforestation, of properties in the eastern Strzeleckis that have become agriculturally unprofitable.

Such processes have also occurred in the Shires of South Gippsland and Woorayl, but here losses have been more than balanced by an influx of settlers, many retired, to the coastal towns.

Since the 1976 census, however, the commencement of the Loy Yang scheme has attracted many construction workers and their families to the Latrobe Valley.

Transport

The topography of the study area makes transport and travelling difficult. Most of the railways were hard and very expensive to construct, and many lines have closed (see Appendix 2A).

The Princes and South Gippsland Highways are good quality roads encircling the Strzeleckis, but travel on most routes crossing the range from north to south is slow because of their narrow widths, steep gradients, and sharp bends. Grand Ridge Road is the main east--west route within the ranges and runs between Mount

Eccles and Carrajung. Although wider and of gentler grade than most other routes in the hills, it is very winding.

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4. HISTORY

Maritime Exploration

In December 1797, George Bass left the Sydney settlement in a whaleboat, sailing south to explore the coastline and determine if Van Diemen's Land was an island or connected to New South Wales. On his way he discovered Wilsons Promontory and Western Port, where he remained a fortnight exploring the shoreline and overhauling his boat, but lack of food forced him back to Sydney without confirming his suspicion of the nature of Van Diemen's Land. At that time Bass was also mistaken about the status of Wilsons Promontory - he thought it part of the Furneaux Group until he returned with Flinders in the 'Norfolk' late in 1798 during their circumnavigation of Van Diemen's Land.

During this first exploration, Bass named Sealers Cove and on his return to Sydney reported an abundance of seals on the Bass Strait islands. An intensive sealing industry immediately developed and by mid 1804 Sydney traders were receiving large shipments of seal oil and skins.

The industry was uncontrolled and attracted ships from all over the world.

Inevitably the numbers of seals declined rapidly, so by the 1840s sealing became a minor trade. It persisted in Bass Strait until around 1860, but by then the three species in the area, the Australian and New Zealand fur seals and the less commercially valuable Australian sea lion, were almost extinct. (The elephant seal had been exterminated from the islands of Bass Strait within a few years of Bass' voyage.) Whaling was similarly shortlived. The shore-based whaling stations quickly decimated the inshore herds and by the late 1840s most hunting was done in the Antarctic seas, with the stations being used occasionally for processing.

Bands of sealers and, later, whalers (collectively 'straitsmen') probably lived at various locations along the south-eastern coast of Victoria between 1805 and 1825. They did not penetrate inland and left as the seals and whales disappeared. However, Hume and Hovell explored central Victoria in 1824--25, and investigated the hinterland of Port Phillip Bay.

A party including Hovell settled at Corinella on Western Port in 1826 and, before they abandoned the site in 1828,

Hovell explored the coast as far as Cape Paterson. The rush to colonize the area round Port Phillip Bay led by Batman and Fawcner, in 1835, resulted in land being taken up rapidly north and west of the infant Melbourne. To the east, settlement stopped on the margins of Western Port because of the immense swamps inland and, beyond them, the densely forested ranges.

Meanwhile attempts were being made to penetrate unexplored eastern Victoria from the Monaro, the region around Cooma, New South Wales. In 1835 the Hobart pastoralist, George McKillop, journeyed from the upper Murrumbidgee to what was to become Omeo. Other graziers soon followed with stock and established runs in the Tambo valley, the southernmost being Tongio.

The Scot, Angus McMillan, was despatched in 1839 by his employer Lachlan MacAlister, a Goulburn squatter, to find new lands for grazing. McMillan had been in Australia for 13 months, and on this trip, accompanied by a Monaro Aborigine, Jimmy Gibber, saw from one of the foothill peaks near modern Buchan the vast coastal plains to the southwest.

McMillan returned in September of the same year and established a station at Numblamunjie (now Ensay). From there, during a series of journeys over the next 2 years, parties led by McMillan explored portion of the Gippsland Lakes

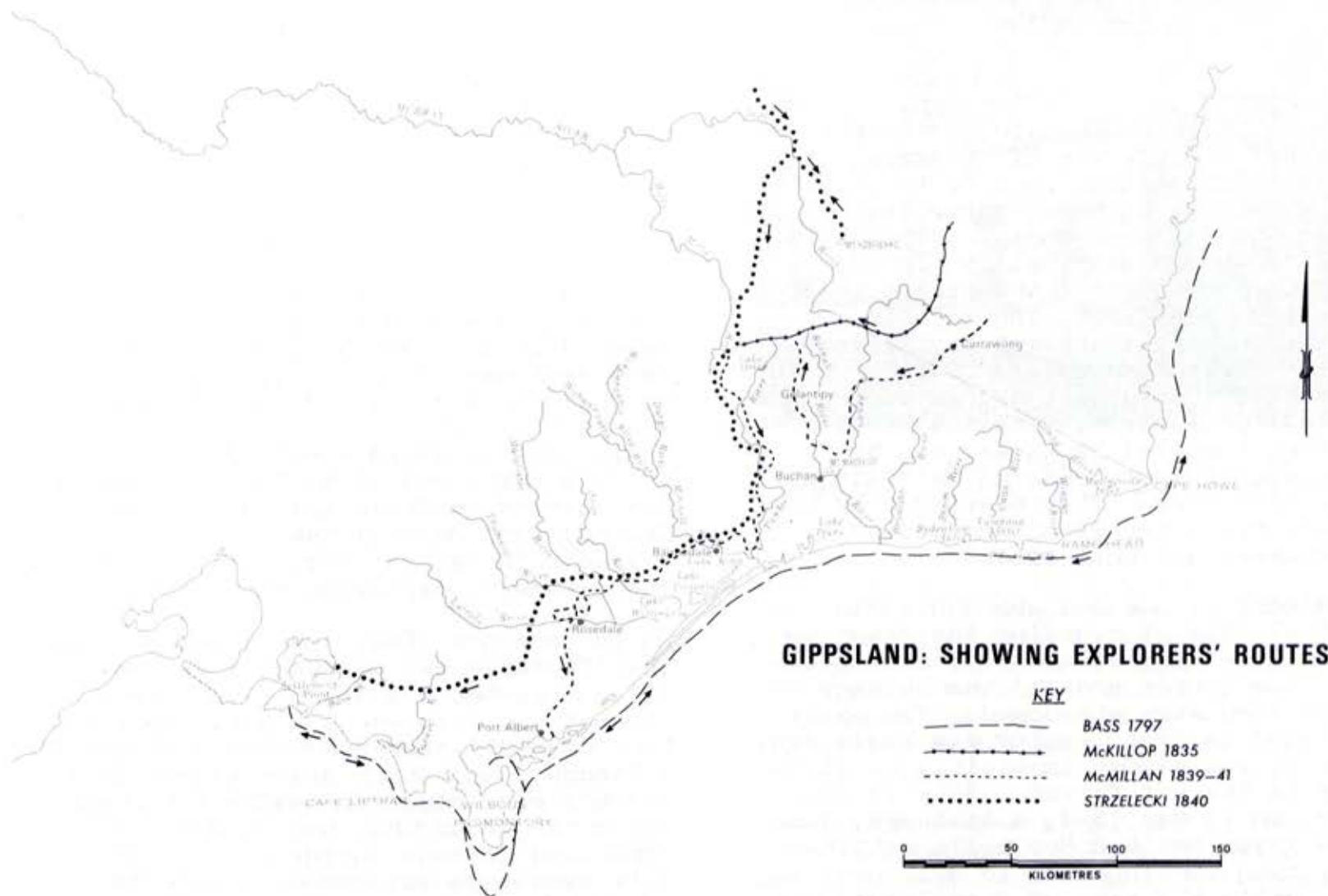
and the plains to the west. Judging it to be highly suited to grazing, especially of cattle, he called the region Caledonia Australis, named several other features, and started a station for MacAlister; he left men and cattle near the Avon River in October 1840. One aim of these expeditions was to find an accessible place on the coast from which stock could be shipped.

Meanwhile, another party of Europeans had penetrated the country between the Tambo River and Port Phillip. Early in 1840, the self-styled 'Count' Paul Strzelecki, a Polish adventurer who was eventually knighted, had organized an expedition to travel overland and explore the country between the head of the Murrumbidgee and Western Port. In particular, he wanted to find a cross-country route from eastern Victoria to the bayside settlements. James Macarthur, son of John Macarthur of Camden, financed this venture and was one of the party. Although a friend of Lachlan MacAlister, he was apparently ignorant of McMillan's explorations; it seems MacAlister wanted to have the pick of the eastern Victorian lands for himself.

Travelling south through the Australian Alps, Strzelecki reached Numblamunjie in late March 1840. McMillan was away exploring to the south and Strzelecki followed his tracks for some distance before heading west across the plains beyond the western limits of the Scot's travels. He later called the entire

FIGURE 1

LAND CONSERVATION COUNCIL
VICTORIA
SOUTH GIPPSLAND STUDY AREA, DISTRICT 2



region Gippsland after Sir George Gipps, Governor of New South Wales. Some of his other names for geographic features are also still in use, including the Thomson River, Perry River, and Lake King.

Strzelecki's party of five men, including an Aborigine, Charlie Tarra, pushed on across the Latrobe River and up the valley of Traralgon Creek to the foot of the heavily timbered range that bears their leader's name today. Strzelecki noted 'wide and deep valleys to the north-west, and hills and ranges to the south and south-west, innumerable creeks, and the exuberant vegetation of a moist, untouched soil'. Further into the ranges the forests became denser and scarcely penetrable, with the party's movement hampered by hunger and by Strzelecki's insistence on maintaining a direct course. This bearing took them between the sites of modern Boolarra, Korumburra, and Corinella.

Strzelecki by now had abandoned his original idea of crossing the range to Corner Inlet and eventually, near Boolarra, the horses and all the baggage except food were abandoned. The party continued on foot, eating raw koala meat since it was almost impossible to light fires in the wet forest. Some 22 days later, on 12 May 1840, a tattered, famished group reached Corinella settlement, then continued on to Melbourne to make public the news of Gippsland's potential for squatting.

At a later stage, Tarra and another member of the party, Riley, returned to the Morwell River by a different route and retrieved the extensive collection of specimens from the forest.

Inspired by Strzelecki's reports the first, mostly Scottish, squatters soon took stock to Gippsland via the Monaro and the Tambo valley.

Port Albert Earliest Centre of Commerce

Rapid development of Port Albert allowed access by sea, brought on by the accidental discovery of the harbour. The paddle-steamer 'Clonmel', bound for Melbourne from Sydney, had run aground off the Port Albert entrance on 2 January 1841. All on board survived, and while a small party sailed to Port Phillip the rest camped on Snake Island (or Clonmel Island) with much of the cargo to await rescue. These, naturally, filled in their time by exploring the inlet.

On 14 February 1841, just 5 weeks after the 'Clonmel' was wrecked, Angus McMillan reached the sea for the first time at Old Settlement Beach. Meanwhile the 'Clonmel' passengers had arrived in Melbourne, and their descriptions of the inlet's potential for navigation encouraged the group that had formed the Gippsland Company during January 1841. This syndicate was composed chiefly of overlanders seeking new grazing runs; it chartered the 'Singapore' and reached

Corner Inlet about the time McMillan broke through to the shores of Port Albert at Old Settlement Beach.

The vessel searched for a landing site around Corner Inlet for 2 weeks, then finally headed for the wreck of the 'Clonmel', to find a deep channel between the islands, which led to a peninsula separating two rivers. These rivers were named after Albert, the Prince Consort, and Charlie Tarra.

The party landed stores and horses and built the first hut at Old Port Albert (that is, Old Settlement Beach). The ship returned to Melbourne, leaving some of the syndicate to travel overland with Charlie Tarra to Port Phillip Bay.

Figure 1 shows some of the coastal and overland routes taken by explorers in Gippsland. For a short time after, the new Gippsland runs may have been stocked by sea, but Port Albert soon developed into a centre for exporting rural produce, landing incoming settlers and importing supplies. Later, other squatters drove mobs from Western Port along the coast to Port Albert.

Two special surveys enabled entrepreneurs to obtain early title to a large proportion of the immediate hinterland of Port Albert, and these lands were sub-divided into small allotments. The harbour of the first settlement was found to be inferior to that of Port Albert, even though the latter had no



Maritime Museum (formerly Bank of Victoria), Port Albert; built 1861

fresh water and was owned by the merchants Turnbull, Orr and Company. By late 1844, the town had been moved with water being brought in by dray, and a slow process of growth began. Early official surveyors established three government townships nearby - Palmerston (adjoining Port Albert), Tarraville, and Alberton.

Tarraville became a centre for the teamsters who carted supplies to and from the port, and farmers and small-holders on the adjoining Reeve's Special Survey rented their paddocks of clover so that

squatters bringing stock for export could rest and fatten their beasts. In 1848 it boasted a brewery, a private school with 40 pupils, a druggist, two hotels, and a reputation for drunkenness, violence, and wholesale trafficking in stolen cattle. A decade later two more hotels were catering for Tarraville's residents and transients, but, to balance this, an Anglican church had been established under the Reverend Willoughby Bean. The tiny church still stands.

The township of Alberton had been planned to include a market and a customs house, even though it was well inland and remote from deeper water. In con-



Anglican church at Tarraville, built 1856

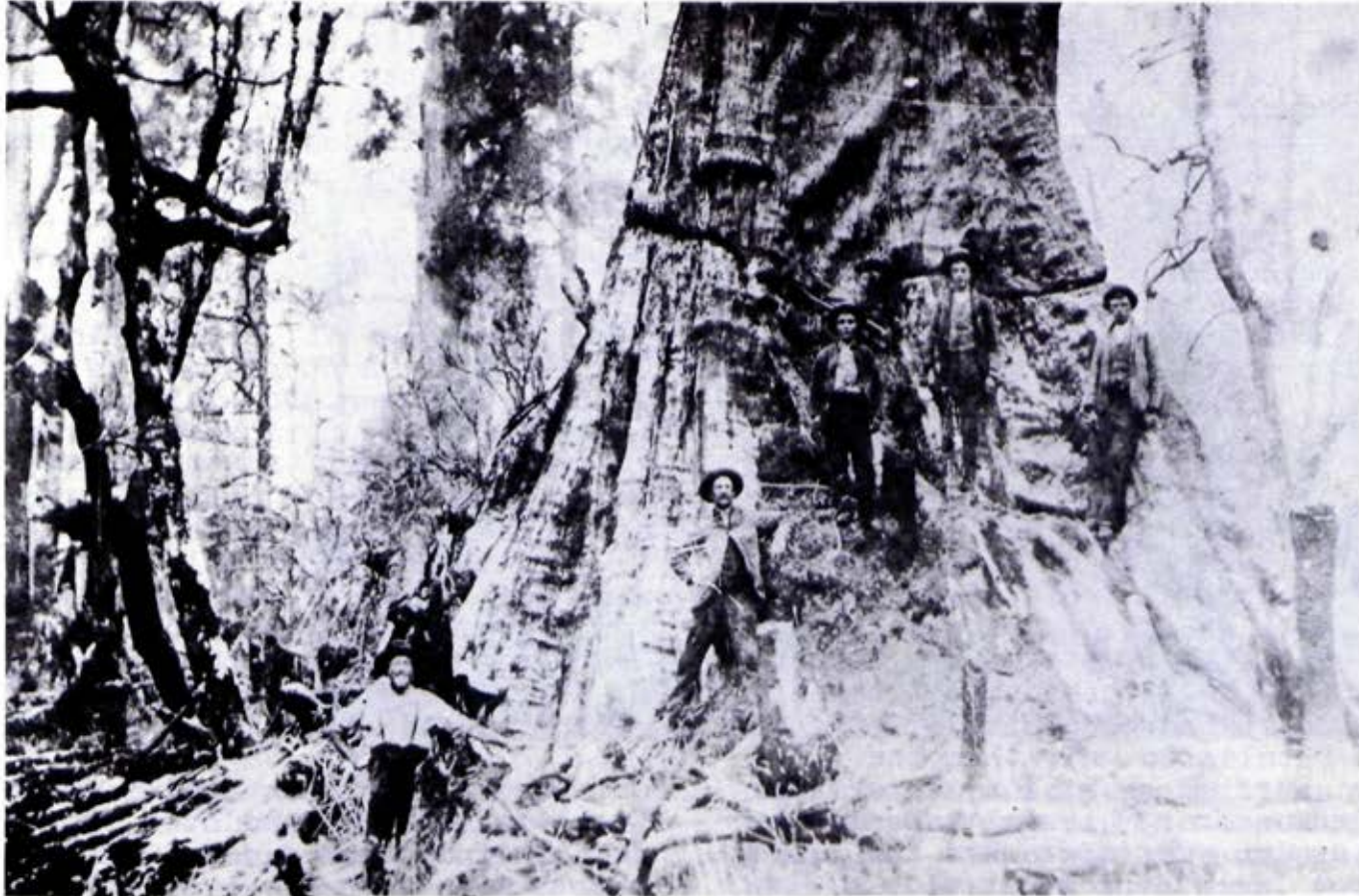
sequence its growth, and that of the adjacent private township of Victoria on the edge of Orr's Special Survey (they functioned as one village), was slow and based mainly on agriculture.

Thus the cluster of hamlets making up Port Albert and its nearer neighbours dominated trade in central Gippsland in the 1850s and 1860s until several developments rendered the port commercially redundant. The first step in this process was the gradual construction of roads. In 1845 a sergeant in the police force named Walshe cut a track from the edge of the plains (probably near Tyers) upstream along the northern side of the Latrobe and Moe Rivers to the Bunyip district. A rough road had formed on this route by May 1846, and it was used thereafter by drovers taking stock to Melbourne in summer.

Several further developments contributed to the decline of Port Albert. In 1858 the unstable natural entrance to the Gippsland Lakes was used by a cargo vessel for the first time, a route that became increasingly popular. The Melbourne--Sale railway was completed in 1879 and Bairnsdale was connected in 1888. In 1892, Port Albert itself was linked by rail with the metropolis.

The Aborigines

The remains of middens along the coast and near the Latrobe River, and the occasional scarred trees are almost the



Mountain ash, probably in Blackwarry area, c. 1895

only evidence nowadays of an Aboriginal occupation of the study area that may have lasted 10--20,000 years, or even longer. According to Howitt, a line between Mount Baw Baw and Cape Liptrap separated the Bunurong's land of Western Port and Port Phillip from that of the Kurnai of Gippsland. The latter were estimated to total 2,500 individuals at

the beginning of European settlement. Two Kurnai clans coexisted within the study area; the Brayakaulung lived north of the Strzelecki watershed and the Brataualung to the south.

The distribution of Aboriginal relics today gives an indication where and how the Aborigines lived then. The coastal

beaches and estuaries were a rich source of food, as were the inland plains, but the rockier coasts of Wilsons Promontory were less commonly visited. Some authorities have held that the forests of the Strzeleckis were generally avoided, but early settlers reported finding many artefacts among the trees. An Aboriginal workshop is known from Mount Worth. It is thought that the Aborigines regularly burnt the drier coastal and foothill forests to encourage game to graze there.

The story of the Aborigines' contact with the first European arrivals is depressingly similar to that elsewhere in Victoria. Fearing the pastoralists, the natives attacked isolated out-stations and small groups of travellers. Settlers were killed; stock were abducted for food. The Europeans felt threatened physically and economically and naturally retaliated. To them the assaults justified reprisals, especially with their sense of cultural superiority and belief that they now owned the land.

Perhaps the worst incident occurred in July 1843. After the murder of Ronald MacAlister, Lachlan MacAlister's nephew, settlers massacred a large group of Aborigines, possibly numbering 60 to 90, that was camped near the site of modern Darriman. Angus McMillan was reputed to have led this punitive raid.

Disease, alcohol, inter-tribal warfare, and demoralization gradually reduced the

Aboriginal population until by the early 1850s the tribes had been devastated. Ten years later their remnants congregated at two Gippsland missions, Lake Tyers (established 1861) and Ramahyuck near Meerlieu (founded 1863 but later closed).

The Gippsland Gold Rushes

In the early 1850s, central and southern Gippsland had a population of about 1,500 (including 140 Aborigines) living entirely on the plains and involved in grazing, logging, transport, and construction. The main centres were settlements around Port Albert (c.450), Sale (c. 120), and Corner Inlet (c. 130), with small hamlets developing at Anderson Inlet, Traralgon, and Rosedale. Scattered throughout the plains were station homesteads, each probably supporting several families.

Gold was first discovered in western Victoria in 1851, and over the next decade finds were made at Omeo (late 1851), Nicholson River (1854), Russell Creek (1859), Jordan and Woods Point (1861--62), and Crooked River and Dargo (1863). However, the opening of the Walhalla field in January 1863 by Griffiths, McGregor, Stringer, and Thompson had perhaps the greatest effect on the region's economy.

The fields were provisioned at first, at great cost, from north-eastern Victoria, but in early 1862 the merchants in Sale



*Tin-mining, Mount
Hunter, c. 1925*

offered a reward to the first party to find a route from Central Gippsland. Once it had been found the cost of food and equipment at the diggings was greatly reduced, Sale prospered, and Rosedale and Port Albert also benefitted.

When alluvial mining commenced at Walhalla, the cutting of a new track direct from Toongabbie made the latter hamlet an important depot for supplies. Reef mining, however, stagnated for a time for want of capital, but when it ultimately got under way, after the Toongabbie road was improved and mining

machinery could be brought in, an era of prosperity began. For more than 50 years the most productive mines yielded high dividends to investors, some of whom, like William Pearson of Kilmany, were original Gippsland squatters.

Walhalla was connected by road to Moe in 1882 and the Moe--Walhalla narrow-gauge railway was completed in 1910, only to see the collapse of the mining industry just before the start of World War I.

Mineral prospects within the study area were limited. In 1866 a syndicate leas-

ed an area on Mount Singapore, but this was soon abandoned. Workable gold was discovered at Stockyard Creek (later Foster) in 1870, although the area had been known to carry gold since 1856. Various mines operated around Foster township and Bennison Creek until the early 1900s.

In 1872 the rich alluvial field at Turtens Creek was worked intensively but after a year it was largely exhausted. Mining operations occasionally

yielded gold at Waratah Bay, along the Tyers River and, reportedly, from some of the tributaries of the Latrobe that originate from the northern slopes of the Strzeleckis.

Walkerville Lime Kilns

Between 1878 and 1924 the cliffs at Walkerville were quarried for limestone and the industry supported a settlement nearby. The limestone was burnt in large kilns (the remains of which still



*Pioneer Street,
Foster; c. 1909*

stand), bagged for use as lime in agriculture and building, and transported by sea to Melbourne.

Farming in the Strzeleckis

As the mining industry declined from the 1860s onwards, agitation for land culminated in the passage of the *Land Act* 1869, which allowed an individual to select and settle on 130 ha (320 acres), with option to purchase after 3 years.

The flat, well-watered country in Victoria that was available for selection was quickly occupied, so the landless looked towards the Strzeleckis, reasoning that dense forest indicated great agricultural potential. By 1900 most parts of the Strzeleckis had been settled. The land was cleared with axe and saw, and the timber burnt on the ground. Unfortunately some of these fires escaped into the remaining forest, so huge quantities of prime timber were wasted.

Dairying rapidly became the most important industry and butter was exported by coastal traders from Inverloch, or by rail from the towns in Central Gippsland. Sheep did moderately well despite the wet climate, but were prey to dingoes; some farms raised beef cattle. Most properties grew maize and oats. Pigs, fed on skim milk, were important everywhere.

Cultivation of pastures and crops was not without difficulties. Caterpillars,

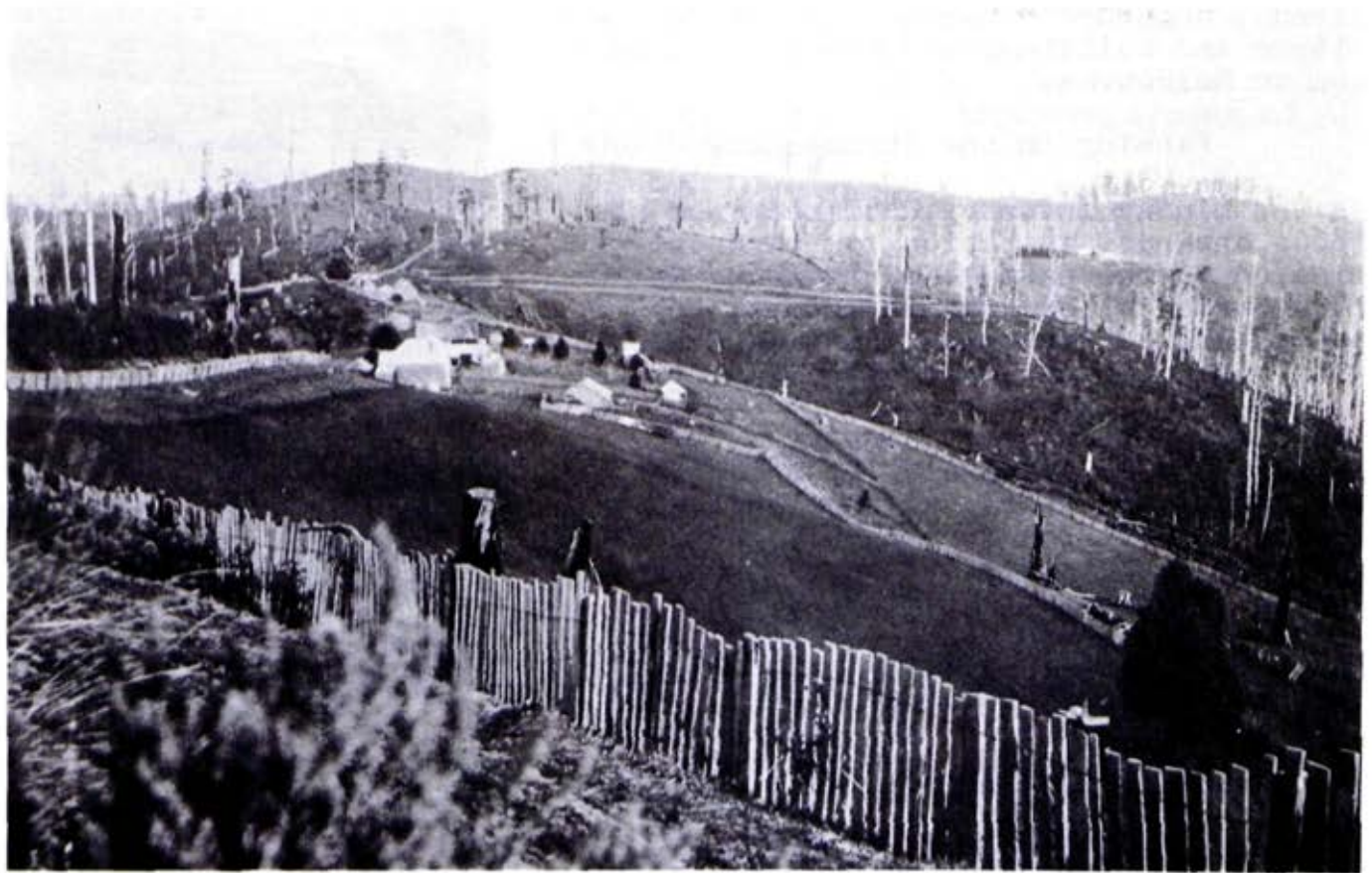


Settlers in the eastern Strzeleckis used sledges for transport

wallabies, wombats, and rabbits were all pests, although rabbits gave supplementary income once freezers were in widespread use. Various exotic weeds also reduced productivity, as did the native vegetation, which was exceedingly difficult to control for some years after the forest had been cleared.

Bushfires also caused great damage, especially in 1898, but eventually farming in the western parts of the range succeeded. The rolling plateaux were well suited to dairying, with potato-growing profitable on the most fertile sites. Despite changes in the regional economy (such as the centralization of milk pro-

*Farming in
the eastern
Strzeleckis,
Budgerie
East, 1913;
Scanlon's
selection
on today's
Midland
Highway*



cessing), Australian agriculture, and world trade generally, the region has remained fairly prosperous. Settlement was more difficult in the east, however. The terrain was too rugged for cultivation; the dense forests of mountain ash were hard to clear; pasture was almost impossible to maintain against the resilient native vegetation; animal pests were very destructive. In addition, the region was isolated from transport and

the markets, and so by 1901--05 some settlers had abandoned their properties to the scrub.

Towards the end of World War 1 other areas were taken up for soldier settlement and the roads were improved, but during the Depression (1928--38) even more were forced from the area. Today the eastern Strzeleckis sustain one of the largest reforestation schemes in

Australia (see chapters on timber production) with pine and eucalypt plantations gradually replacing the bracken and dogwood of the derelict farms.

Wilsons Promontory

At various times between its discovery by Bass in 1798 and its reservation as a national park in 1905 and 1908, Wilsons Promontory has supported several colourful primary industries.

From the earliest days of coastal navigation, vessels sheltered from storms in Sealers Cove and Refuge Cove (formerly Lady Bay). Wilsons Promontory lighthouse was built in 1859, and around 1860 a pilot was stationed at Mount Singapore to conduct ships through Corner Inlet. The Clifffy Island light was completed in 1884.

Sealing was carried on in the early 1800s, and a whaling station operated briefly at Refuge Cove early in the 1840s.

In the late 1840s the Turnbull company of Port Albert commenced trading in split timbers (such as barrel staves and posts and rails) from the forests around Sealers Cove. A pitsaw was set up in 1850, and a sawmill around 1853, and later 27 km of tramway were constructed. No shipments of timber were recorded after 1858. The industry had apparently shifted to the Toora and Port Franklin districts.

A quarry operated at Refuge Cove briefly around 1859, supplying granite for road construction at Port Albert, and around this time the Turnbulls grazed cattle on the Promontory. The gold-field at Mount Singapore was short-lived but a tin mine continued working granitic sands at nearby Mount Hunter from 1920 to 1936. Fishermen exploited this section of Bass Strait intensively and in 1865 steamers sailed regularly to Queenscliff and Melbourne with fresh fish. Various place names in use today, for example Johnny Souey Cove, commemorate the Chinese involvement in this trade.

Black Coal

Black coal has been mined on a small scale in the study area at Berry Creek at Boolarra; however, much larger collieries operated at Korumburra, Jumbunna, Outtrim, and Wonthaggi, just outside the boundary. The Korumburra--Jumbunna--Outtrim measures were worked for about 30 years after 1883. Strikes in New South Wales in 1909 caused a coal shortage and led to the commencement of the Wonthaggi mines. Coal was shipped from Inverloch until the construction of the Wonthaggi railway in 1910. Most of the coal produced at Wonthaggi was used by the Victorian Railways. The gradual replacement of steam engines by diesel and electric locomotion, and the difficulty and cost of working the characteristic thin, fault-ridden coal seams, led to the closing of the Wonthaggi mines in 1968.

Brown Coal

A prospector, David Ryan, is reported to have discovered lignite beds in the Haunted Hills in 1873. These small surface outcrops were only an indication of the vast resources of brown coal lying below the surface of the Latrobe Valley. A more detailed description of these deposits and a history of their utilization are given in the chapter on Energy. The development of the Latrobe Valley coal-fields has been a major factor in the growth of the region since the 1920s.



Turning the first sod at Yallourn Power Station, 1921; Sir John Monash is second from right

Industrial Development

Apart from butter factories, sawmills and the manufacture and repair of agricultural machinery, there was little secondary industry in the study area before the 1930s. Exploitation of the brown coal deposits since then has been accompanied by considerable industrial development in the Latrobe Valley. The largest secondary industry now is paper-making. Australian Paper Manufacturers Ltd has operated since 1939 using the native hardwood forests of central Gippsland and plantations of exotic softwoods as a source of pulpwood. Since World War II this plant has been progressively enlarged and now, with four machines, supplies most of Australia's Kraft paper.

Other industries produce cement, bricks, pipes, and char, and the Latrobe Valley supports a wide range of light processing plants including electronics, clothing and chemical factories.

Local Government

The first municipal body was the Alberton Roads District, formed in 1855 and proclaimed Alberton Shire in 1864. In 1894 it was divided; the western portion became the Shire of South Gippsland.

Traralgon Shire was created in 1879, Woorayl Shire (centred on Leongatha) in 1888, Morwell Shire in 1892, and Mirboo Shire in 1896. The Yallourn Works Area

was severed from Morwell Shire in 1947. Moe and Traralgon were declared Boroughs in 1955 and 1961; in 1963 and 1964 they were elevated to city status.

Railway History

Appendix 2A gives details of railway lines existing and defunct in the study area.

Place names

Appendix 2B gives the origins of some of the place names in South Gippsland.

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PART II
NATURE OF THE LAND

5. GEOLOGY

Reference to the stratigraphy table (Table 2), the simplified geological history (Figure 2), and Maps 3, 8, and 13 (Geomorphology, Geology, and Mining and Quarrying) will assist the reader to understand the geology of the study area. The text describes successively the rocks of each period, from oldest to youngest. In addition, there is a glossary at the end of this chapter defining many of the technical terms used here.

Geological History

About 550 million years ago, during the Cambrian period, a large north--south marine trough known as the Tasman Geosyncline extended from Tasmania into New South Wales. During this period the oldest rocks in the study area were laid down in the trough, the initial fill consisting of extensive sheets of lava spreading over the sea floor from submarine fissures and volcanoes. Volcanic activity ceased during the Cambrian period, but the trough continued to subside until stabilized during the middle Devonian. During this time intermittent marine sedimentation had continued. Stabilization was followed closely, in places, by injection of magma, several kilometres beneath the earth's surface.

For the 250 million years succeeding the middle Devonian period the study area was subjected to erosion, which produced a nearly flat plain.

Then, during the Jurassic period about 150 million years ago, the separation of Australia and Antarctica began. Large east--west troughs or rift valleys developed, in which thick piles of non-marine sediments were deposited during the early Cretaceous. The trend of the east--west troughs was in marked contrast to the north--south direction of the older Palaeozoic trough.

During the middle Cretaceous to early Palaeocene, the Lower Cretaceous sediments were warped upwards, faulted, and tilted, then eroded to form a subdued terrain on which broad shallow depressions developed. Cainozoic sediments were deposited in these depressions, which continued to develop until the outlines of the Southern Uplands were first defined, although the topography was still subdued. Locally there was appreciable faulting, and very thick volcanic sequences accumulated.

Continued subsidence of the land surrounding the Strzelecki Ranges allowed

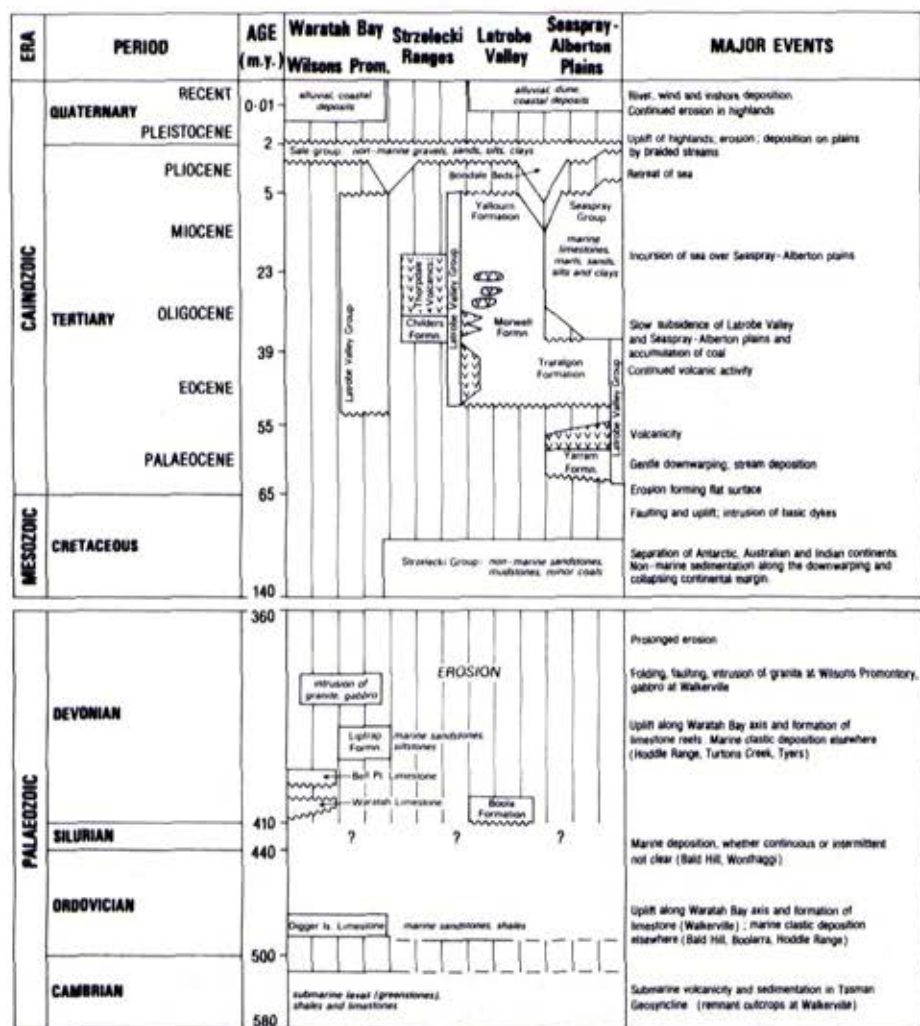


TABLE 2 SOUTH GIPPSLAND STUDY AREA, DISTRICT 2 :
CORRELATION OF ROCKS WITH THE GEOLOGICAL TIME SCALE

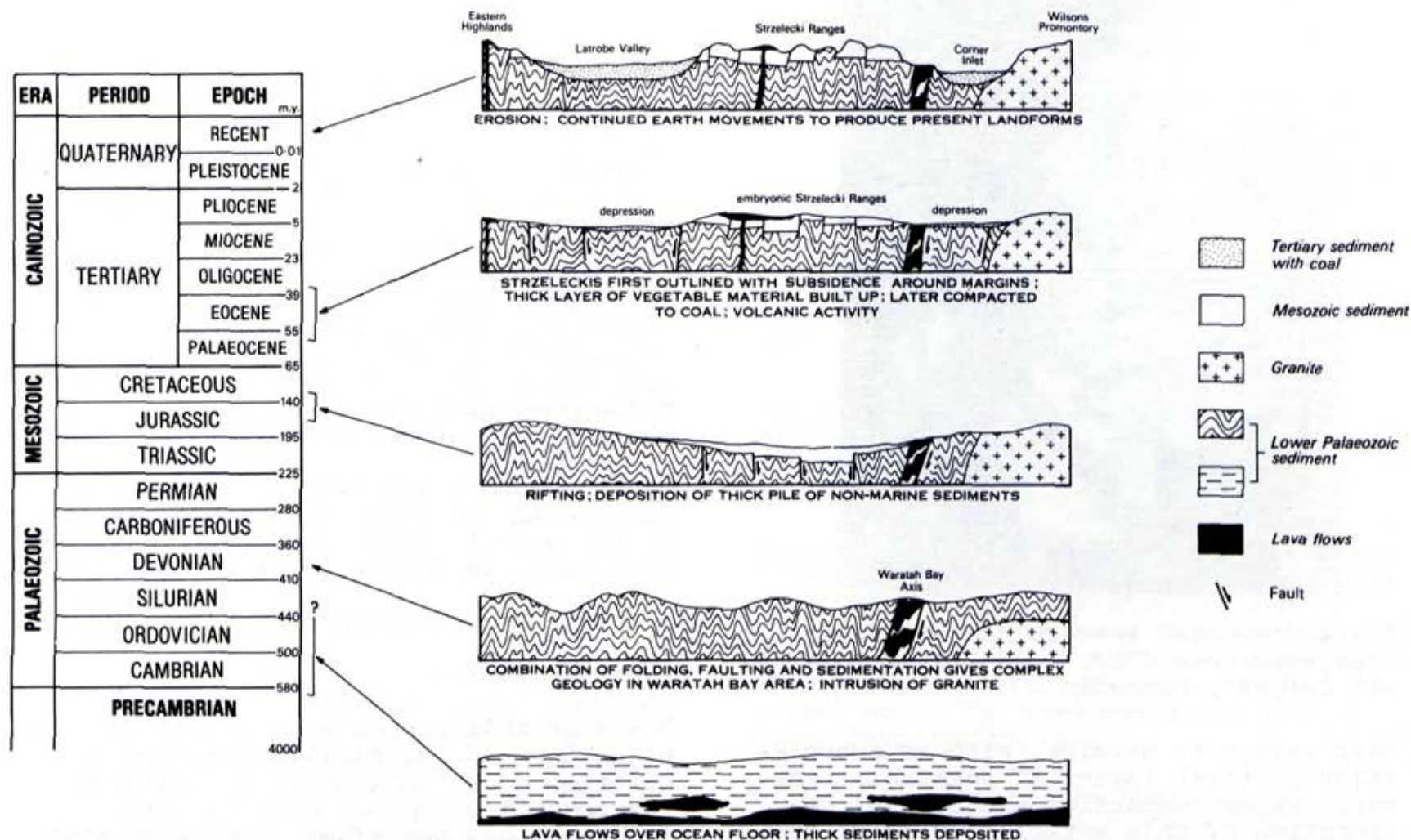
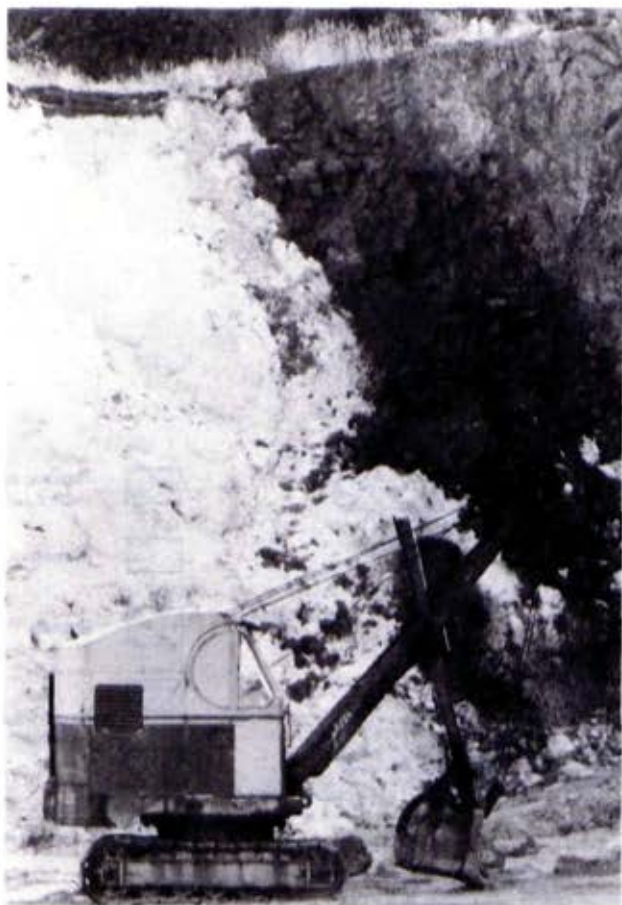


FIG. 2 SIMPLIFIED GEOLOGICAL HISTORY : SOUTH GIPPSLAND TWO STUDY AREA



*Faulted contact between weathered Meso-
zoic siltstone (left) and Cainozoic bas-
alt (right), Dumbalk*

vast swamps to develop, with an accumulation of thick layers of vegetable matter. Later compaction and partial dehydration of this material produced the extensive deposits of brown coal beneath the Latrobe Valley and elsewhere.

In the mid Miocene the sea inundated the eastern, northern and southern parts of the study area. As the sea retreated, rivers flowing across the plains deposited their sediments, forming sands, gravels and clays.

Strong earth movements were again initiated during the late Pliocene, which uplifted and defined the main topographic units as we see them today, although earth movements have continued in diminished form up to the present. Erosion of the higher landforms has caused Quaternary sediments to build up on the flood-plains of streams throughout the study area and along much of the coast. Remnants of the Cambrian volcanics and sediments now form the Liptrap peninsula, while the middle Devonian granitic rocks have given rise to the rugged Wilsons Promontory landscape.

Oscillation of sea levels during the Pleistocene to Recent times has resulted in several complex barrier systems developing in Corner Inlet.

Stratigraphy

Cambrian period

Rocks of this period were formed between about 580 and 500 million years ago. Cambrian rocks outcrop on the Waratah Bay coastline east of Cape Liptrap. Assigned this age after comparison with similar rocks elsewhere in Victoria, they consist mainly of fine-grained

greenstones (altered submarine lavas) with tuffs, agglomerates, and dolerite dykes.

Slight metamorphism of the Cambrian strata is indicated by the presence of serpentine minerals, albitized feldspar, and rare lenses of dark, recrystallized limestone. The presence of strongly sheared shale indicates that the rock has been subject to extensive faulting. Interbedded marine sediments and possible pillow structures in the lavas show these were extruded over the sea floor. The Cambrian strata represent the initial phase of rock accumulation in the Tasman Geosyncline.

Ordovician--Devonian period

Marine sedimentation continued in the Tasman Geosyncline from the early Ordovician to the early Devonian. In the study area these deposits form the spine of the Liptrap peninsula, and outcrop at Bald Hill, Boolarra, Foster, Turtons Creek, Tyers, Wonthaggi, and in the Hoddle Range.

Ordovician period

Rocks of this period were formed between 500 and 400 million years ago as sediments laid down under marine conditions in the Tasman Geosyncline. Only small areas of Ordovician rocks outcrop in the study area; they are at Walkerville, Boolarra and Bald Hill and in the Hoddle Range.

Walkerville. This area exhibits altered limestone of Upper Ordovician age, with a fault bounding it to the east and west. Known as Digger Island Limestone, it is exposed along the coast from Walkerville south to Bell Point, including Digger Island.

The rock is a recrystallized limestone interbedded with massive grey mudstone and grey-green shale. All strata contain trilobites, brachiopods, and other fossils that indicate the age of the enclosing rocks.

Boolarra. The graded sandstones of Boolarra are of similar age but contrasting lithology to the Digger Island rocks. These graded sandstones, interbedded with green and dark grey siltstones, occur in a small inlier on Sassafras Creek near Boolarra. They contain a Lancefieldian (that is, Lower Ordovician) fossil fauna.

Hoddle Range. The Hoddle Range consists of rocks of two different ages separated by a fault zone. The southern end of the range is formed from sandstones, siltstones and black shales containing graptolites of Gisbornian (Upper Ordovician) age. The northern rocks are Lower Devonian in age.

Bald Hill. Restricted outcrops of fine to medium, locally fossiliferous sandstone, and minor siltstones, occur at Bald Hill. They contain Bolindian (Upper Ordovician) graptolites.

Silurian period

Rocks of this period were formed between 440 and 410 million years ago as marine sediments laid down in the Tasman Geosyncline.

Certain types of graptolites and other fossils are indicators of the Silurian, and these have been found in small outcrops of grey sandstones, minor white siltstones, and grit in the vicinity of Bald Hill and Ten Mile Creek. Similar rocks outcrop as a ridge of bedrock between two Cretaceous coal-bearing basins at Wonthaggi, where the younger strata have been eroded away to expose the older Palaeozoic core.

Devonian period

Rocks of this period were formed between 410 and 360 million years ago. They were marine sediments and constituted the youngest strata laid down in the Tasman Geosyncline.

The Liptrap peninsula has the largest outcrop of Devonian rocks within the study area; others occur in the northern part of the Hoddle Range, around Foster, Turtons Creek, Yanakie, and north-west of Tyers.

Tyers. Lower Devonian sandstones and mudstones, with small lenses of limestone that can be assigned to the Boola Formation, outcrop extensively north of the study area, and occur just within it

to the north of Tyers. These are the oldest of the Lower Devonian strata in the study area.

Waratah Bay. In this area intermittent earth movements during the Devonian raised and lowered the surface and disrupted sedimentation, thus causing breaks in the sedimentary sequence. As a result, some of the Devonian strata were unconformably deposited on other Devonian sediments. During sedimentation, seas were often shallow and much limestone was laid down, derived from the skeletons and shells of the creatures adapted to live in such an environment. The sequence exposed at Waratah Bay consists of two limestone units, the Waratah and Bell Point Limestones, and a thick sandstone and mudstone sequence, the Liptrap Formation.

The oldest Devonian rocks on the peninsula are those of the Waratah Limestone. This formation has three main outcrops - at Walkerville near the kilns and at Bird Rock, at the southern extremity of Bell Point, and at Point Grinder.

The Waratah Limestone is divided into three members. The oldest, called the Bird Rock Member, is part dolomitic and part muddy limestone. The middle, or Kiln Member, is a light grey limestone, and the Bluff Member, the youngest, is a thickly bedded dark grey limestone named after a coastal cliff that has been quarried in the past for agricultural lime.

Corals and related stromatoporoids dominate the fossil fauna, especially in the Bluff Member, and brachiopods and molluscs are also present.

The Bell Point Limestone unconformably overlies the Waratah Limestone. It is a well-bedded, dark-grey, muddy limestone, 40 m thick, interlayered with lighter grey limestone and black shales, and containing diverse coral, hydrozoan, gasteropod, brachiopod, and ostracod fossils.

The youngest Devonian sedimentary rocks in the Waratah Bay area belong to the Liptrap Formation, which consists of finely laminated siltstone and sandstone, with minor gritstones and conglomerates. (Folding, small-scale faulting, and many other geological features are displayed so splendidly on the shore platform from Morgan Beach to Point Grinder that there is great interest in its preservation as a geological reference area.) Similar quartz-rich siltstones and sandstones outcrop in the northern part of the Hoddle Range, at Foster North (where they are revealed well in road cuttings), Turtons Creek and Yanakie.

The Liptrap Formation always occurs in faulted contact with older rocks, so its relation to them is not yet fully known. The general lack of fossils hampers correlation further - they are restricted to plant remains (found at Livingstone Creek) and corals and brach-



Folding in Lower Devonian mudstone at Cape Liptrap

io pods derived from the older Waratah Limestone by erosion.

Two types of intrusive rocks of Devonian age outcrop in the study area. Basic intrusions into Lower Ordovician limestone are exposed on the shore platform

at three places between Bell Point and Digger Island. They are probably middle to late Devonian in age, and the predominant rock type is medium-grained green serpentized gabbro with frequent veins of calcite and limonite. Common opal has been found along some joint planes. These rocks are the first kind of Devonian intrusion. The second is known as the Wilsons Promontory Batholith.

The granites that constitute Wilsons Promontory are generally grey, coarse-grained biotites, although more than ten main types have been recognized. As



Wilsons Promontory granite - xenolith arrangement indicates turbulent flow before magma cooled

with most granites the predominant minerals are quartz, orthoclase, plagioclase, and biotite, but in this case the somewhat unusual accessory minerals include pink garnet and blue-grey cordierite. Cassiterite (tin ore) associated with tourmaline weathered from granite and concentrated in gravels near Mount Hunter was mined intermittently from 1920 to 1936. Radiometric dating puts the rocks at 384 ± 7 million years old, or from the middle Devonian.

These granites resulted from the partial melting of sedimentary rock deep within the earth's crust and its resolidification under pressure. Some of the sediments that were not fully liquefied are now included as the common dark xenoliths that, in places, give the granite a 'plum pudding' appearance. During and after the cooling of the granites, regional stress caused faulting and jointing in the rocks, which have guided the development of drainage lines and led to the formation of tors on the Promontory.

Finer grained dykes intrude into the granite, particularly in its eastern sections, and one at South East Point was quarried to build the lighthouse in 1859.

Middle Devonian--Cretaceous periods

For more than 250 million years, between the middle Devonian and the beginning of the Cretaceous, extensive erosion took place in the study area. Sediment some

kilometres thick must have been stripped away to expose the granite of Wilsons Promontory (as granites only develop at these depths below the earth's surface). No rocks from these periods (Carboniferous, Permian, Triassic, Jurassic) are known from the study area. If deposition did take place, then the rocks laid down have either been eroded away subsequently or covered by younger strata.

Cretaceous period

Rocks of this period were formed between 140 and 65 million years ago.

After the Jurassic period of great tectonic movements involving the Australian and Antarctic continents, the early Cretaceous period saw a rift valley developing as the Tasmanian subplate was partially detached from the main Australian plate. About 1,000 m of felspathic sandstones and mudstones with minor coals were deposited as lakes and rivers formed in the rapidly subsiding basin.

Called the Strzelecki Group, these rocks outcrop throughout the Strzelecki Range, along the coast at Cape Paterson, and at Boola Boola. The main minerals making up these sediments are oligoclase and orthoclase feldspar, and quartz. Calcite, biotite (which has been partly altered to chlorite), hornblende, and andesite fragments are also present in lesser amounts. The sandstones, when freshly exposed, are very hard, and have a dark blue-green colour. In the beds

of streams and on the coast, where relatively fresh, they are grey-green. When weathered they are a buff colour and friable.

Stream channelling is sometimes visible in the sediments. For instance, at the junction of the Grand Ridge Road and the Hyland Way at Carrajung, the road cutting reveals a large, saucer-shaped channel cut into the lower beds and filled by younger Cretaceous strata. The mudstones frequently bear plant fossils. A road cutting near Koonwarra revealed a lake deposit containing a remarkable variety of fish, insect, and plant remains, together with bird feathers of early Cretaceous age.

The black coals that were mined at Wonthaggi between 1909 and 1968 are part of the Strzelecki sequence. The few seams present (which are up to 3 metres thick, but normally much thinner) are strongly affected by two sets of faults. Vertical displacements range from a few centimetres to 230 m, and the resulting jumble of fault blocks greatly complicated mining of the coal.

Tertiary period

Rocks of this period were formed between 65 and 2 million years ago.

There are three main groups of Tertiary sediments. Oldest to youngest, they are the Latrobe Valley, the Seaspray, and Sale Groups.

Between the late Cretaceous and the Palaeocene, earth movements opened the Gippsland Basin to the evolving Tasman Sea. Deposition of the non-marine Latrobe Valley Group began in the east of the study area, and a little later in the Latrobe Valley Depression and Moe Swamp Basin, which were both north-western lobes of the Gippsland Basin. (Figure 3 shows the extent of the Gippsland Basin.)

Broad subsidence of the land continued, and during the early Oligocene a major marine transgression inundated the eastern section of the study area, laying down the sediments of the Seaspray Group.

Marine regression across the eastern part of the study area during the late Miocene and early Pliocene was accompanied and succeeded by deposition of non-marine sediments of the Sale Group.

Latrobe Valley Group

The Latrobe Valley Depression and the Moe Swamp Basin are filled by Eocene to Plio--Pleistocene continental clastic sediments and thick brown coal seams (of the Latrobe Valley Group) with associated basic volcanic rocks (the Older Volcanics).

The earliest representatives of the Latrobe Valley Group are the Palaeocene clayey to coarse-grained fluvial sediments of the Yarram Formation. These

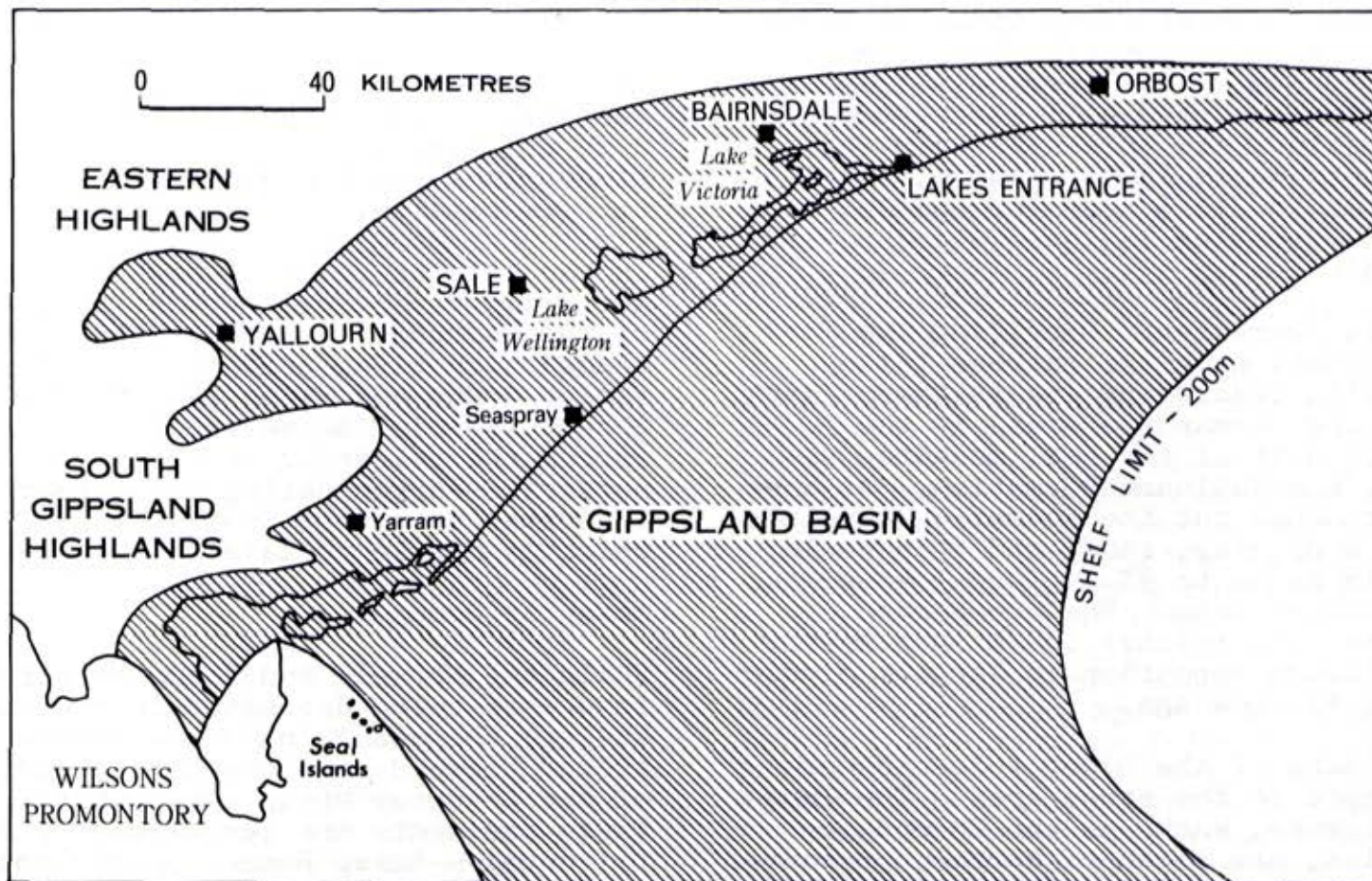
outcrop in the south-east of the study area along the Yarram Monocline, for example at Jack River and Won Wron. In the Morwell--Yallourn area the Latrobe Valley Group is younger. Its basal member, known as the Childers Formation, occurs as erosional remnants of the Narracan and Tarwin blocks of the South Gippsland Highlands.

Conifers form much of the plant material from which the coals were derived. Coal seams occur in three main units within the Latrobe Valley Group - the Traralgon, Morwell, and Yallourn Formations.

Traralgon Formation. These strata form the base of the Latrobe Valley Group in the Loy Yang and Gormandale areas. Immediately above the basal beds is the Traralgon 2 coal seam. It is the oldest in the Latrobe Valley Depression and is up to 70 m thick around Gormandale. Above the Traralgon 2 seam, separated from it by clay and sand, is the Traralgon 1 seam, which is up to 120 m thick at Gormandale and tends to split into two or three smaller seams. Above this layer in the Loy Yang area is 60 m of clay and sand and minor coal; the latter thickens locally to up to 35 m near Gormandale.

Coal from the Traralgon Formation has been mined at Won Wron; equivalents occur at Gelliondale. Because of their greater age and, at times in the past, greater depth of burial, these coals have a lower moisture content and a

FIGURE 3



GIPPSLAND BASIN

higher energy value than the younger seams. The Traralgon Formation is middle Eocene to late Oligocene in age.

Morwell Formation. This is a complex unit of thick coal seams with subordinate interseam sediments. The Formation is widespread in the Latrobe Valley Depression, Haunted Hill Block, and Moe Swamp Basin. Its thickness near the Morwell open cut is 150--180 m, and it increases to 210 m near Gormandale. The Morwell Formation is late Oligocene to early Miocene in age.

Yallourn Formation. Overlying the Morwell Formation in the Latrobe Valley Depression (excluding its southern flank and in the Gormandale area) is the youngest unit of the coal measures sequence, the Yallourn Formation. At the Yallourn open cut the Formation consists of 120 m of clay, sand, and thin coals, overlain by up to 97 m of coal known as the Yallourn Seam. The overburden of clay and sand reaches 100 m in places. The Yallourn Formation is largely middle to late Miocene in age.

Basic lavas of the Older Volcanics are widespread in the study area. The largest outcrops, known as the Thorpdale Volcanics, are north of Mirboo, preserved in uplifted and dissected blocks of the South Gippsland Highlands. Other outcrops occur around the eastern and south-eastern margins of the ranges, and in the Leongatha and Dumbalk areas. They have also been recorded from numer-

ous bores, interbedded with the Latrobe Valley Group. They are up to 60 m thick in the Thorpdale area, 120 m thick beneath the Traralgon seam at Loy Yang, and 106 m in the Yarram 1 and Darriman 1 wells.

The Older Volcanics are olivine to iddingsite basalt lava with subordinate dyke and pyroclastic rocks. Around Mirboo North they have weathered locally to form bauxite.

In the Latrobe Valley Depression and the Moe Swamp Basin, sub-surface equivalents of the Thorpdale Volcanics are interbedded with older parts of the Latrobe Valley Group and range back to the early Eocene (50 million years ago). North of Yarram the volcanics are older still; potassium--argon dating of surface rocks indicates an age of 55-57 million years, which is middle to late Palaeocene.

Seaspray Group

While the Morwell and Yallourn Formations were being deposited in the Latrobe Valley, the sea flooded the plains around Woodside and the marine sediments of the Seaspray Group were built up. These sediments are best-known from the Bairnsdale--Lakes Entrance area and rarely outcrop in South Gippsland, but drilling has established their existence below the surface in the study area.

The following sequence is recognized within the Seaspray Group:

- . The basal Lakes Entrance Formation, of gravels and sands, represents the initial transgression of the sea during the Oligocene.
- . The Gippsland Limestone, consisting of richly fossiliferous limestones and marls, was deposited when the flooding was at its maximum during the early Miocene. This formation outcrops near Darriman, where it is quarried, and also on Bruthen Creek almost due west of Darriman.
- . The Tambo River Formation, made up of marls and limestones, and the shelly sands, silts, and clays of the Jemmys Point Formation were deposited as the sea level fell during the Miocene.

Sale Group

This consists of non-marine gravels, sands, silts, and clays that were deposited as, and after, the sea receded.

Within the study area silts and clays of the Boisdale Formation outcrop only on Monkey Creek. The later Haunted Hills Gravels are more extensive, and the characteristic clayey, fine quartz gravels of the Formation, with lesser sands, silts, and clays, outcrop as broad sheets across the Latrobe Valley, the lower Tarwin valley, the plains around Woodside, and in the foothills of the Strzeleckis. They also occur restrictively in the elevated parts of the Tarwin and Morwell catchments. These gravels

are considered to be a product of the erosion that followed the Pliocene and Pleistocene earth movements in Gippsland.

Quaternary period

Movements during the late Cainozoic within the South Gippsland Highlands increased the rates of erosion by the streams that drain the ranges. When the streams leave the hills, the burden of eroded material is deposited as sediment, so there is now a thin veneer of alluvial sands, silts, and clays over much of the plains.

Wind has reworked some of the surface sediments of the plains to form dunes. Examples can be seen around Giffard and Monkey Creek, consisting of white or orange, well-sorted, medium to coarse quartz sands. Between the dunes, the surface sediments are generally finer, with a proportion of clay.

The barrier dunes and beach deposits of Ninety Mile Beach, Snake and Sunday Islands, and Entrance Point on Wilsons Promontory are well sorted, clean, quartz sands. The dunes on the Yanakie isthmus, at Waratah and Venus Bays, and near Cape Paterson are predominantly calcareous. In the sheltered inlets - Corner Inlet, Shallow Inlet, and Anderson Inlet - and behind the barriers, calmer conditions prevail and finer sediments - sands, silts, and clays - are deposited.

Structural History

The contacts between the Palaeozoic, Mesozoic, and some of the early Tertiary units are faulted. The Palaeozoic rocks generally show a NE--SW direction of folding, faulting, and cleavage. The Waratah Bay axis has risen intermittently since at least the early Ordovician along the Walkerville fault, west of which the spectacularly folded Liptrap Formation now outcrops.

Movements occurred during the intervals between the deposition of the lower Palaeozoic limestones on the axis, so an angular unconformity exists, as between the lower Devonian Waratah and Bell Point Limestones; in other situations a slice of older rock has been caught up in the movement, as in the case of the lower Ordovician Digger Island Limestone.

The Strzelecki Ranges were formed by block-faulting and uplift of part of the Strzelecki Group. Within the study area most of the Strzelecki Group is represented in the Balook block, which is bounded on all sides by faults and monoclines, generally with NE--SW or

east--west trends, and is domed, at least to its north-eastern end, along an anticlinal structure. Thus, the bedding dips at angles of 40--60° to the north near Calignee and at 20--30° to the south-east near Won Wron. There are smaller faults and folds, but the deformation of the rocks is insufficient for cleavage to develop.

The Gelliondale, Narracan, and Tarwin blocks are similar structures. (See Map 3 - Geomorphology.)

The Strzelecki Group sediments were first uplifted in the late Cretaceous, and the succeeding Tertiary sediments and volcanics were deposited on an eroded surface with angular unconformity. Later uplifts, climaxing in Pliocene and early Pleistocene times, produced extensive monoclinal warping and minor faulting of the Tertiary coal and terrigenous sequences. These structures resulted in the preservation of much of the brown coal.

Minor movements have continued up to the present; South Gippsland generally is one of the most seismically active areas in Australia.

Glossary

Agglomerate	- a chaotic assemblage of coarse, angular pyroclastic material
Albitization	- introduction of, or substitution by, albite (a sodium feldspar), which usually replaces a more calcic plagioclase
Alkali feldspar	- a group of feldspars (including orthoclase), which contains alkali metals but little calcium

Basalt	- dark-coloured, fine-grained, extrusive igneous rock
Basin (sedimentary)	- an area in which sediments accumulate
Bauxite	- an off-white to reddish-brown impure mixture of various hydrous (water-bearing) aluminium oxides and hydroxides; the principal commercial source of aluminium
Biotite	- an important rock-forming mineral of the mica group; generally black or dark brown, it is found in many igneous and metamorphic rocks
Brachiopod	- any solitary marine invertebrate belonging to the phylum Brachiopoda - they range in age from the Cambrian to the present
Calcite	- a crystalline form of calcium carbonate, which is the principal mineral constituent of limestone
Cassiterite	- tin oxide, the principal tin ore; found in lodes, alluvial deposits, and igneous rocks such as granite
Chlorite	- platy, greenish minerals with prominent ferrous iron and lacking calcium and alkalis; resembling mica, the chlorites are widespread in metamorphic and igneous rocks
Clastic rock	- a consolidated sedimentary rock composed of broken fragments of a pre-existing rock transported mechanically to its place of deposition
Cleavage	- property of a rock, produced by deformation or metamorphism, to split along a plane
Dolerite	- an intrusive rock (forming sills and dykes) containing labradorite, pyroxene, quartz and alkali feldspar
Dolomite	- a sedimentary rock containing largely a mixture of calcium and magnesium carbonates
Dyke	- a planar body of igneous rock cutting across the structure of adjacent rocks or filling a fissure in massive rocks
Fault	- zone of rock fracture along which strata on one side have been displaced relative to strata on the other - vertical displacement or 'throw' may be anything from a few centimetres to a few kilometres in scale
Feldspar	- aluminous silicates of calcium, potassium, and sodium, divided into alkali feldspars and plagioclases; they make up 60% of the earth's crust, are the most widespread minerals, and occur in all kinds of rocks
Gabbro	- a dark-coloured, basic, intrusive rock
Garnet	- a coloured, crystalline mineral found in metamorphic rocks

Gasteropod	- mollusc from the class Gasteropoda - they range in age from Upper Cambrian to the present
Geosyncline	- large, generally linear trough, measured in scores of kilometres, which subsides deeply over a long period, and in which a succession of sediments and possibly volcanic lavas accumulates
Granite	- plutonic rock, usually grey or pink in colour, containing a high proportion of quartz and alkali feldspars
Graptolite	- colonial marine fossil organism of class Graptolithina - they range from Middle Cambrian to Carboniferous
Iddingsite	- silicate mineral formed by alteration of olivine - in basalts it shows as rust-coloured patches
Igneous	- rock or mineral solidified from molten material
Limestone	- sedimentary rock formed organically or inorganically and consisting mainly of calcium carbonate
Limonite	- brown hydrous iron (ferric) oxides without definite crystal structure
Metamorphic rocks	- rocks formed in the solid state by pronounced changes in temperature, pressure, and chemical environment at depths greater than 2 km below the surface
Monocline	- unit or strata dipping or flexing from the horizontal in one direction only
Olivine	- common, greenish-coloured mineral of basic igneous rocks; a silicate of iron and magnesium
Opal	- hydrous form of silica without a definite crystalline structure; the proportion of water varies, as does the colour
Orthoclase	- a white or pink alkali feldspar; a silicate of potassium and aluminium
Ostracod	- an aquatic crustacean of the subclass Ostracoda - they range from Lower Cambrian to the present
Pillow structure	- feature of certain igneous rocks extruded underwater; the peculiar shape is due to rapid cooling of the lava
Plagioclase	- a series of feldspars subdivided according to their anorthite content; green or white complex aluminosilicates of calcium and sodium
Pyroclastic	- rock composed of broken fragments derived from the effect on pre-existing rock of a volcanic explosion
Quartz	- crystalline silica; the second-most common rock-forming mineral

Radiometric dating	- method of determining age of geological materials; based on rates of nuclear decay of natural elements found in the specimens
Rift valley	- elongated, depressed crustal unit bounded on its longer sides by faults
Serpentine	- greenish mineral found in igneous and metamorphic rocks; formed by alteration of magnesium-rich silicates such as olivine
Shale	- fine-grained, hardened sedimentary rock formed by the consolidation of clay, silt or mud; characterized by fine laminae parallel to the bedding
Stratigraphy	- branch of geology that deals with the definition and description of major and minor divisions of rocks
Terrigenous deposits	- shallow marine sediments consisting of material eroded from the land surface
Tourmaline	- black crystalline mineral often found in igneous (especially granite or pegmatite) and metamorphic rocks; complex borosilicate of aluminium and alkali metals or iron and magnesium
Trilobite	- any fossil marine arthropod of the class Trilobita; they range from the Lower Cambrian to the Permian
Tuff	- compacted pyroclastic deposit of volcanic ash
Unconformity	- where adjoining beds are not parallel due to a break in deposition over a substantial period
Xenolith	- a fragment included in an igneous rock to which it is not generically related; normally considerably metamorphosed by the magma

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6. GEOMORPHOLOGY

Reference to the Geomorphology map (Map 3) facing page 46 and the glossary on pages 61 and 62 will aid the reader of this chapter.

Geomorphic Evolution

Geomorphology is the study of land forms and the evolution of the landscape.

The oldest land surfaces in the study area are probably early Tertiary in age (that is, more than 50 million years old); they are associated with some of the areas of Older Volcanics that cover parts of the South Gippsland Highlands. During the late Cretaceous to early Palaeocene, erosion produced a broad flat topography over much of the study area, and the Older Volcanics were extruded onto this surface. Broad shallow depressions began developing at this time also; probably fault-controlled, they represented the embryonic Gippsland Basin.

Fault and monoclinal movements occurred, particularly during the early Tertiary, around the margins of what are now the Southern Uplands, and it was then that the outlines of these uplands first became clearly delineated, although the

topography was still gentle and drainage ill-defined.

Appreciable movement must have occurred in places, as very thick volcanic sequences accumulated locally, for example in the Moe Swamp Basin. To the east, north, and south of the boundaries of the uplands subsidence continued and, in the Latrobe Valley and around Gelliondale and Stradbroke, extensive areas of fresh-water sediments containing thick layers of vegetable matter were deposited. These later formed brown coal.

The lack of coarse sediment and the presence of thick coals indicates that the uplands and the highlands overlooking these two basins were stable and relatively flat. The streams flowing from them did not transport significant quantities of sediment to the depressed areas to interrupt the massive accumulation of vegetable matter.

By the mid Miocene the sea had reached its maximum transgression from the east and south, lapping the southern, eastern, and northern margins of the South Gippsland Highlands. During the late Tertiary the sea regressed, probably partly in response to earth movements,

and this was marked by an increase in deposition of coarse-grained material as fresh-water conditions spread over the newly exposed marine deposits.

During the late Pliocene there were renewed earth movements on a large scale. Called the Kosciusko Uplift, they reached a maximum during the late Pliocene to early Pleistocene and have continued in diminished form up to the present. It was this renewed tectonic activity that firmly established the broad geomorphic framework that has led to the present contrasting landscapes of the study area.

The influence of faulting was marked in the South Gippsland Highlands, where various blocks were differentially elevated, and sometimes tilted, by movements along both pre-existing and new fault lines. As a result the drainage pattern is controlled mainly by faults.

As the uplands were elevated, streams were rejuvenated, the surface became deeply dissected, and outwash fans con-

taining conspicuous gravel (Haunted Hills Gravels) were deposited outwards from the structural scarps. Movements continued after the main depositional phase so that fluvial deposits were themselves warped and dissected.

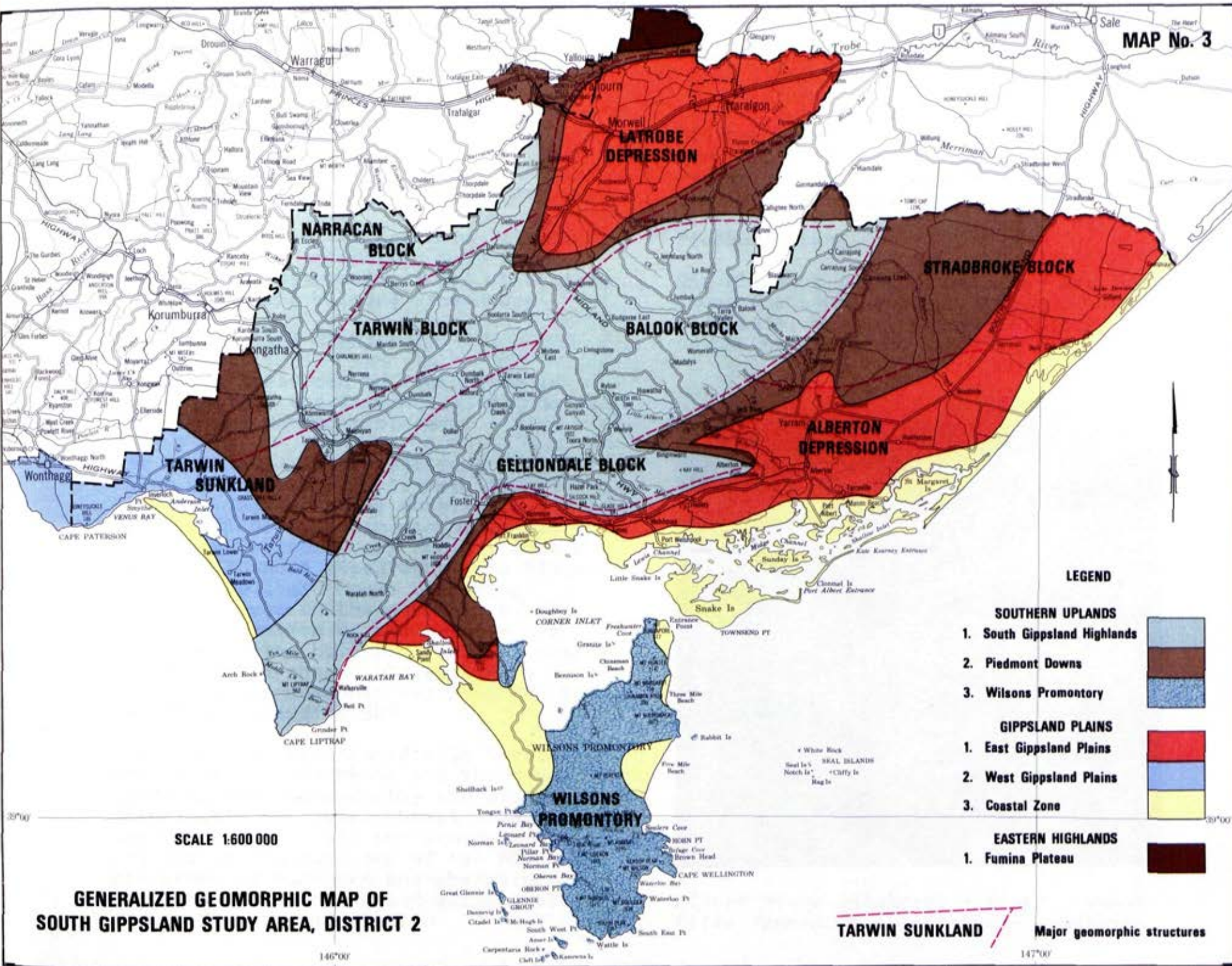
Since the waning of the early Pleistocene earth movements, fluctuating sea levels have influenced to some extent the drainage in the southern part of the study area, and coastal barriers have been responsible for stream diversions. Changes in base level during the Quaternary, due especially to oscillation in sea level but also to earth movements, have caused alternate valley excavation and partial or complete alluvial filling accompanied by estuarine and deltaic deposition in the lower reaches of streams.

Changing sea levels have also been responsible for several barrier systems, remnants of which are evident today along much of the coastline of the study area, particularly in and around Corner Inlet.

Geomorphic Subdivisions

There are several distinct landscapes within the study area. The plains between Alberton and Seaspray differ from those of the Latrobe Valley and the lower Tarwin valley; all contrast greatly with Wilsons Promontory and the Strzelecki Ranges, both of which have their own characteristic scenery.

Three important Victorian physiographic divisions - the Southern Uplands, the Gippsland Plains, and the Eastern Highlands - are represented in the study area, most of which are fault-bounded. Displacements along faults have uplifted and warped the Strzelecki Ranges and the Stradbroke block, while the Latrobe and



Alberton depressions and the Tarwin sunkland have subsided.

Southern Uplands

The landforms in the Southern Uplands can be divided into three main types; those of the highlands proper, the piedmont downs, and Wilsons Promontory

South Gippsland Highlands

Four main areas can be recognized in this section; the Tarwin, Balook, Gelliondale and Narracan blocks.

The highlands vary in altitude from 150 m on their margin to more than 740 m at Mount Tassie. They consist mainly of Strzelecki Group sediments of Mesozoic age, which weather very rapidly into a smoothly rounded topography. In places Tertiary volcanic rocks overlying sediments rest on the Mesozoic strata. Strong dissection of the country has produced convex hill profiles and nearly symmetrical V-shaped valleys, with valley slopes commonly reaching 40° and sometimes exceeding 50° .

Landslips are associated with Tertiary volcanics and sediments and the Mesozoic bedrock, and consequently the hills are notoriously unstable. Small landslips scar many bare hills in farming country, and the smooth outlines of the hills are disturbed by hummocks and scarps produced by the slumping and sliding of soil and weathered rock.

Flatter profiles have resulted in the northern half of the Tarwin block, where extensive mid Tertiary lava flows cap many of the hills.

Piedmont Downs

The Piedmont Downs (foothills) are found along the south-western margin of the highlands, on the Stradbroke block, and on the northern and southern flanks of



Albert River catchment - steep, rounded hills formed from Cretaceous sediments

the Latrobe depression. They range from 80 to 350 m above sea level and are covered almost entirely by sheet deposits of Haunted Hills Gravels. Because the sediments generally are unconsolidated, the hills are concavo-convex with smooth profiles. Slopes are gentle to medium (10° – 25° on the flanks of the spurs) and dissection of the streams is moderately advanced.

Wilsons Promontory

Wilsons Promontory is a former granite island that has been joined to the mainland by the formation of a tombolo of marine and non-marine sediments overlain by Pleistocene dune deposits (aeolianite) capped by recently formed dunes. The highest point is Mount Latrobe, about 755 m. Numerous small granite islands ring the mainland outcrop. The granite hills are steep, rugged and littered with tors. Protruding headlands, such as Cape Wellington and Oberon Point, alternate with bays containing sandy beaches and dunes like Sealers Cove and Oberon Bay. These indented bays may be backed by swamp and extensive colluvial slopes, as, for instance, at Chinaman Creek or in the country behind Five Mile Beach.

Excavations at the Toora tinfields indicate that late Cainozoic faulting may have played some part in determining the general topography of Wilsons Promontory, but the extent of this influence cannot be determined.

Gippsland Plains

These extensive plains flank the South Gippsland Highlands.

East Gippsland Plains

These flat lowlands, ranging in altitude from 50 to 80 m, are an emerged coastal plain covered with Cainozoic deposits of marine, estuarine, fluvial, and aeolian origin. They can be divided into three areas: Alberton depression, Latrobe depression, and Stradbroke block. The aeolian deposits occur on some of the older parts of the flood-plain; they include longitudinal sand dunes trending east--west, showing that westerly winds must have prevailed during their formation. The swales between the dunes are commonly swampy. In the Mullungdung State forest and around Giffard, some of these dunes have been stabilized by native vegetation and hence are well preserved. Others are eroded down to a series of low elongated mounds and commonly carry bracken.

West Gippsland Plains

Combined coastal, aeolian, alluvial, and lacustrine deposits have filled in the area between the Liptrap peninsula--Hoddle Range and the Bass Range in the adjoining Melbourne study area. In places Mesozoic sediments and Older Volcanics protrude through the sediment to form low hills. A barrier system now connects the lagoonal areas with the

open sea. The entrance, currently near Inverloch, has, at various stages in the past, been located further south-east and closer to the Liptrap peninsula.

Coastal zone

Fringing the East and West Gippsland Plains is a coastal zone of low Quaternary dune formations, which is described in the final section of this chapter dealing with the entire shoreline of the study area.

Eastern Highlands

A small section of the far north of the study area is part of the Fumina Plateau in the foothills of the Eastern Highlands. Basically it is the lower portion of the ridge between Tyers River and Rintoul Creek on the northern side of the Latrobe Valley. It consists of Palaeozoic, Mesozoic, and Cainozoic sediments, the first two series being capped by residual mid Tertiary lava.

Drainage

Faulting strongly influences drainage in the area. On the Balook block a radial pattern of long drainage lines has developed, with tributaries entering at right angles. The courses of some of the southward-flowing streams, like Jack River, Tarra River, and Merriman and Monkey Creeks, are a response to block tilting, so their valleys are cut in the direction of the tilt of the block and

across the trend of the bedding. These are termed consequent streams, but others have developed long straight sections on encountering fault lines - for example, parts of the Morwell and Tarwin Rivers, and Traralgon Creek.

Uplift of the Gelliondale block rejuvenated the Agnes River, causing the stream to develop a more youthful valley in its lower reaches. At the knick point where this intersects the older valley are the Agnes Falls, a drop of some 40 m.



Agnes Falls

Narrow flood-plains develop where streams leave the ranges and flow onto the lowlands; they do not develop within the highlands. Examples occur along the Tarra River and Merriman Creek.

At Wilsons Promontory the drainage is characterized by short streams with steep gradients. In places, faulting and/or jointing control the location of watercourses, as in the upper reaches of Tidal River.

The East and West Gippsland Plains exhibit a range of features typical of the meandering streams: meander cut-offs that form ox-bow lakes (that is, abandoned channels); sets of terraces above the sea level of the modern flood-plain;

and deltas. South of Won Wron, the Yarram--Traralgon road crosses a very old and partly eroded terrace that rises some 10 m above the level of present alluvial development.

The Tarwin River has formed a delta at its mouth, which progrades into Anderson Inlet. The delta is a flat, swampy flood-plain, which is constricted by the Venus Bay dune barrier to the south and a former sea cliff, Townsend Bluff, to the north. A delta complex linking the mouths of Tarra River, Albert River, and Nine Mile Creek was swamp until it was drained around 1900. Organic matter, now decayed to peat, comprised the bulk of the sediment accumulating in these swamps.

The Coastline

The varied form of the coastline of the study area developed from a combination of wave, tidal, wind, and depositional processes in response to various sea levels between the Pleistocene period and the present.

Much of the seashore in the study area, however, is made up of low-lying areas of soft sediments, so the coastline and dunes can be rapidly changed and barriers breached during a single storm. Human activities such as recreation and industrial development along the coast can also worsen the situation by weakening the natural defences of the shoreline against the sea.

The coastline of South Gippsland is an important conservation area and popular for recreation. It is also the site of various settlements and industrial developments. Because of this, the geomorphology of the South Gippsland coastline will be discussed here in detail.

Past coastal land forms

During the early Pleistocene the sea level, which was considerably lower than that of the present, began to rise as glaciers melted, eventually reaching to 6 m above the present level before receding. Calcareous dunes developed on the swampy areas at Yanakie in response

to this rising sea level and these are now preserved as aeolianite on the isthmus between the Darby River and Yanakie.

During this period the western coastline of the study area was irregular, with rocky cliffs cut into Lower Palaeozoic sediments (as at Cape Liptrap), somewhat lower cliffs in the Mesozoic and early Cainozoic sediments (for example east and west of Inverloch), and offshore islands composed of granite.

From Corner Inlet eastwards beyond Jack Smith Lake the shoreline was marked by a low cliff 3--5 m high indented by narrow inlets at the mouths of streams flowing from the South Gippsland Highlands. This cliff, now a 'dead' cliff some distance inland, is still traceable from McLoughlins Beach to Seaspray.

A barrier complex developed that extended from Barry Beach in the west to St Margaret Island in the east, a distance of 40 km. Only remnants of this barrier now exist; they are separated by estuaries such as the Tarra and Albert Rivers, and by tidal channels. This coastal belt of sand sheets and ridges is marked on the geology map as Qpb.

Later, when the sea had dropped to a level some 3 m above the present, a second phase of barrier formation commenced. The main remnants of this complex are preserved on Snake, Little Snake, and Sunday Islands, and along the Ninety

Mile Beach extending as far north-east as Woodside Beach. These deposits are marked on the geology map as Qrd.

Most of the deposits in the Venus Bay barrier system are probably equivalent to the two barrier systems described above.

The coastline today

The present coastline consists of cliffs, shore platforms, long sandy beaches, and shallow inlets, with numerous islands and mudflats. Between Wilsons Promontory and Seaspray the outer shoreline is a barrier system developing in part on the previous barrier system (that is, the system marked as Qrd and, in places, as Qpb).

Buried shell beds and Aboriginal midden deposits are commonly found in sand dunes all along the coastline of Wilsons Promontory. The oldest of these have been dated at 6,550 years and can be seen along the west coast between Yanakie and Darby River, indicating that current sea levels in the study area were attained about 7,000 years ago.

Important coastal forms are discussed below and depicted in Figure 4, on pages 54--6.

Beaches

To the east of Wilsons Promontory the coastline has been oriented by the pre-



*Ninety Mile Beach near Jack
Smith Lake*

vailing easterly to south-easterly waves from the Tasman Sea. In a westerly direction the prevailing south-westerly swells from the Southern Ocean are the dominant force. The beaches are typically aligned perpendicular to the incident waves.

Along both coasts large quantities of sand migrate in either direction along the beach and in the breaker zone, according to the conditions of the sea and incident waves at a particular time; this migration is called longshore drift but the net direction of sand drift is, however, still debatable.

Much of the coastline of the eastern half of the study area is sandy beach

facing the open sea, on average about 20 m wide, and part of the Ninety Mile Beach. In profile the upper shore zone beyond the reach of ordinary tides (the backshore) slopes down to one or two sandbanks or berms along the waterline.

On the ocean side of Corner Inlet the beaches are curved strips of sand separated by tidal channels (for example, the seaward side of Clonmel Island). In places they lack rearward dunes so that waves at high water may wash over the beach onto the sand flats behind.

The spectacular coastline of Wilsons Promontory exhibits bays lined with wide sandy beaches and separated by headlands of granite tors.

The Promontory forms a dividing line between two main sand types in southern Australia; its western beaches are generally formed from yellow lime-rich (more than 30% calcium carbonate) sands, while those on the east are white and rich in silica. This division started during a period of high sea level, about 100,000 years ago, when Wilsons Promontory was an island. The white sand drifted westward across what is now Corner Inlet and the Yanakie Isthmus and down the west coast. These sands usually occur inland of the present yellow beach and dune sands, such as at Norman Bay. Squeaky Beach is a notable exception; here the foredune inland from the beach is made up of white silica sand of well-rounded and even-sized grains. If the dry silica sands are walked on, they will squeak as the grains rub together. The beach originated from the erosion of the dunes, but some yellow sands from offshore can be seen.

Yanakie isthmus is a tombolo that formed when the sea level dropped 85--100 m during the last glacial age, creating a land bridge with Tasmania and blocking the movement of silica sand. Beaches of sand and broken shells, formed at these lower sea levels, were blown up into dunes to form the part of the initial barrier system described above (and labelled Qpb on the map) that is the core of the isthmus.

Waratah and Venus Bays have long, curved sandy beaches, with the headland of Cape

Liptrap at the end of the Hoddle Range between them. Corner, Shallow, and Anderson Inlets are sheltered from the open ocean and their narrow beaches are either muddy or sandy, merging into the sands and mud-flats exposed at low tide within the inlet.

Barriers and spits

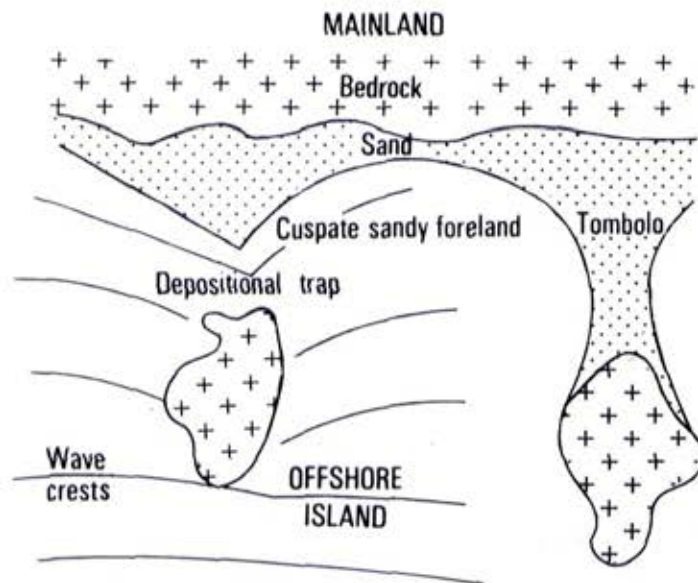
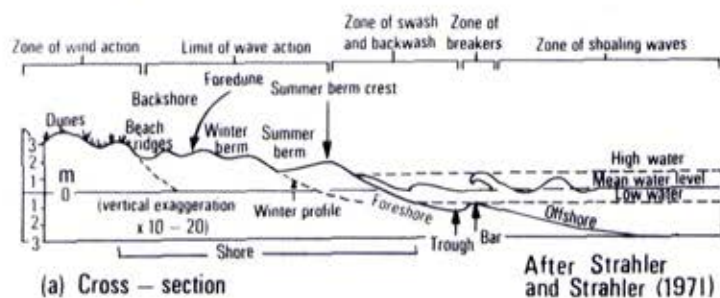
East of Wilsons Promontory the outer barrier carrying the ocean beaches is formed by a series of barrier islands and spits (such as Clonmel Island) lying end to end and separated by narrow entrances. Along Ninety Mile Beach these have joined and incorporated with fragments of earlier barriers to form a narrow, unbroken barrier running north-east through Seaspray.

Recurved barrier spits have developed on either side of the Port Albert and Kate Kearney entrances, and, within the inlets, tidal shoals and mudbanks have formed parallel to large tidal channels.

The north-eastern tip of Wilsons Promontory, many of the islands, and part of Ninety Mile Beach south-west of Woodside Beach all display remnants of earlier barrier systems. On Snake Island the pattern of beach ridges, which grew on berms by a combination of wave and wind action, is evidence of the complexity of the former barrier system. During its development it included long, narrow, barrier islands with recurved spits at both ends, and cusped forelands.

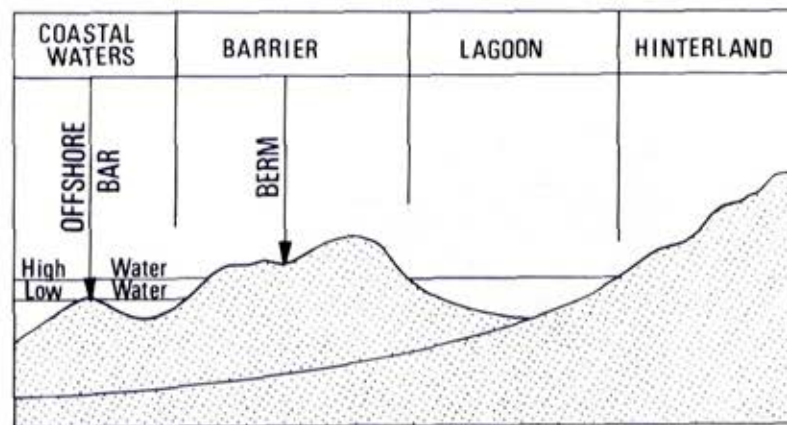
FIGURE 4 COASTAL GEOMORPHOLOGY

1. BEACHES



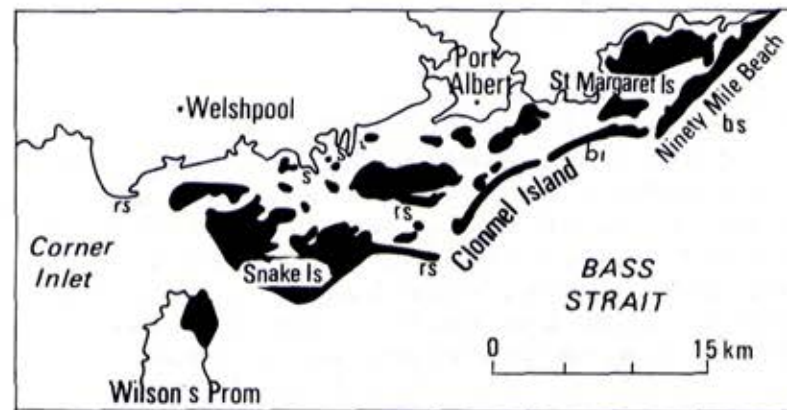
(b) Development of a tombolo

2. BARRIERS AND SPITS



(a) Nomenclature of a barrier system

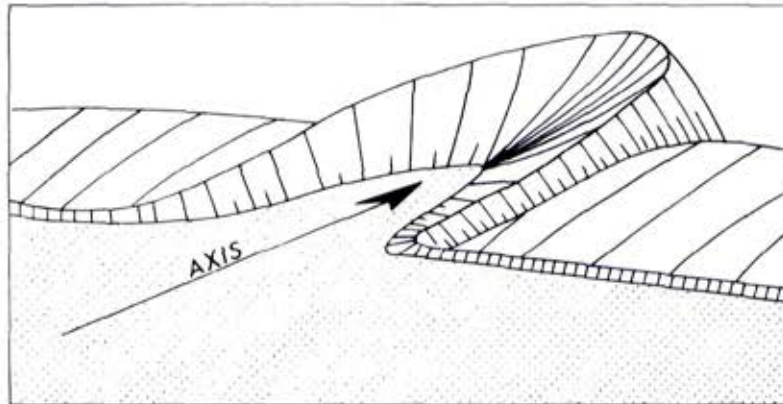
After Bird (1972)



(b) Sandy barrier islands of Corner Inlet

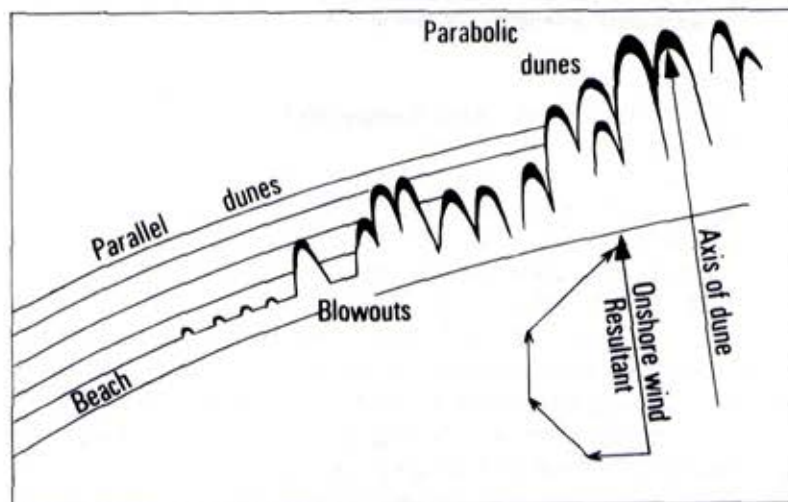
After Bird (1972)

3. SAND DUNES



(a) Parabolic dunes

After Bird (1972)

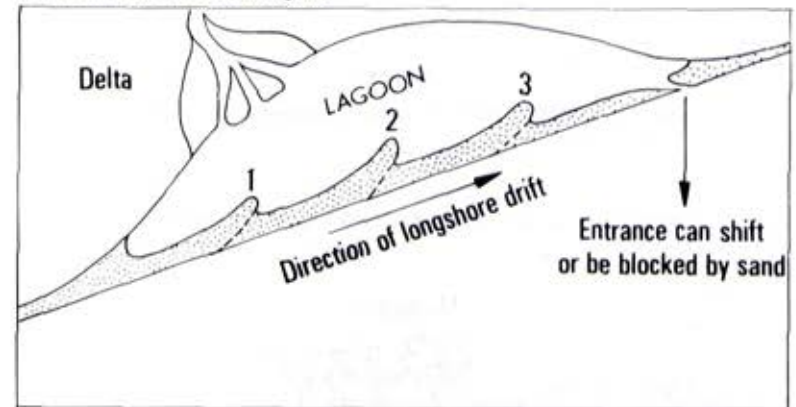


After Bird (1972)

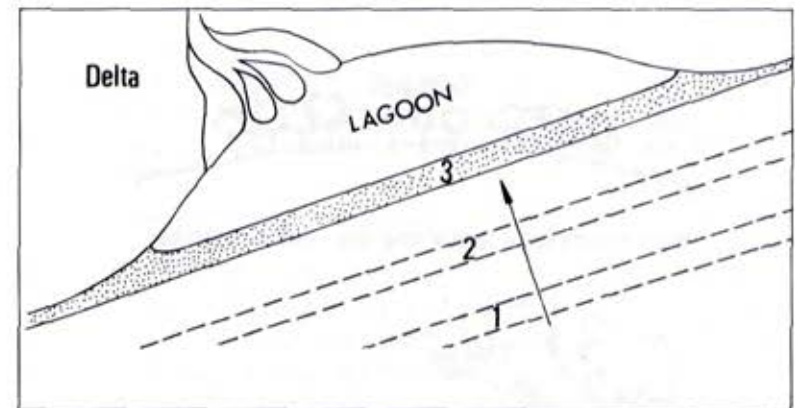
(b) Blowouts and parabolic dunes interrupting parallel dunes along a coast and showing axes aligned with the onshore wind resultant

4. COASTAL SWAMPS

(a) Formation of a coastal lagoon



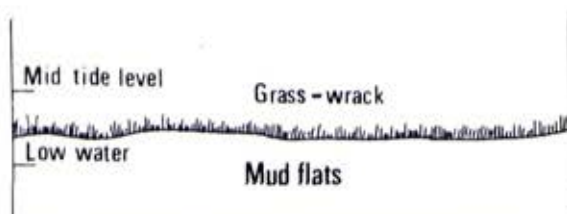
i By the prolongation of a spit



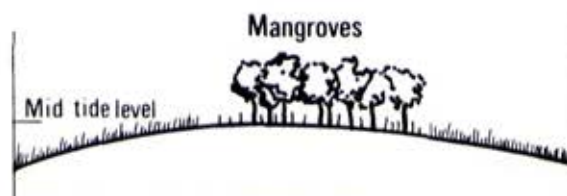
ii By the shoreward migration of a barrier

After Bird (1972)

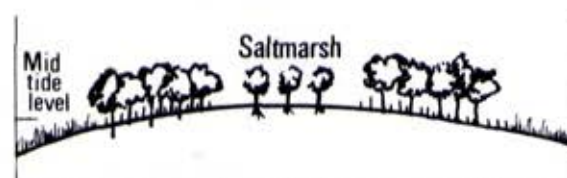
(b) Role of vegetation in land formation



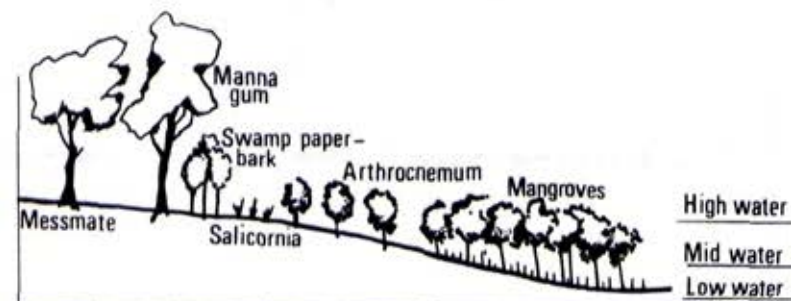
- i Thick growth of grass-wrack accelerates the deposition of sediment



- ii Sediment builds up until it protrudes from water at lower tides: mangroves are able to colonize the site



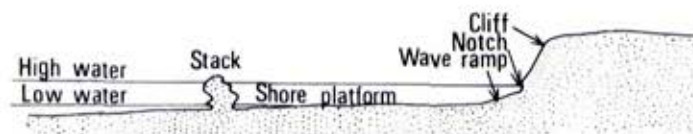
- iii Mangroves die out as level of land rises: saltmarsh develops



- iv When soils on the higher ground become less saline, coastal woodland and scrub are able to establish there

After Bird (1971)

5. CLIFFS



i Nomenclature



- ii Variation in form of cliffs and bluffs with variations in intensity of wave attack, weathering and type of rock

After Twidale (1968)

The sweeps of Venus and Waratah Bays abut barrier systems capped with more recent dune and back swamp deposits. These connect the Liptrap Peninsula--Hoddle Range ridge with Wilsons Promontory and form the lowlands from Anderson Inlet to Cape Liptrap.

Sand dunes

Wherever there is an expanse of loose, dry sand along a beach some will be blown inshore, where it is trapped, usually by vegetation, to become part of a growing foredune immediately behind the beach. Such foredunes are common along ocean beaches in the study area (for instance, Venus Bay, Waratah Bay, and Ninety Mile Beach), and commonly approach 8 m in height (for example, on Clonmel Island).

Often they are vegetated incompletely, so wind erosion renders them irregular in both plan and elevation and sand is lifted and transported inland, where various secondary forms of dune develop. Such secondary dunes also evolve from dunes associated with the older barrier systems. Wind erosion of a sandy terrain can produce blowout depressions, in places down to the water table. Secondary features range from annular ridges surrounding depressions through elongated U-shaped forms to pairs of parallel ridges. In the older dunes south-west of Gelliondale there are several almost perfectly circular dunes produced by deflation.

Coastal swamps

Mangrove and fresh-water swamps and salt marshes are also common along the coastline.

Corner Inlet has large areas of shallow water relatively sheltered from wave action and tidal scour, which form an ideal environment for the development of coastal swamps. Mangrove swamp or salt marsh, or both, may occur at the heads of bays and blind inlets, in sheltered situations behind spits and islands, on the higher parts of sand and mudflats, and at the sides and heads of estuaries. Mangroves extend some 3 km inland up the Tarra and Albert Rivers.

Once established, coastal vegetation accelerates the accumulation of sediment thus causing the formation of new land along the shore. The mechanism is as follows. Mud and sand flats, either separate or attached to the land, develop strong colonies of marine plants at an early stage. These allow a bank of sediment to build up, until eventually a level is reached that will sustain mangroves. These plants form low thickets, which trap more sediment (to which they add organic matter), raising the bank level further, until a height is reached where the salt marsh begins to develop colonies of plants. Mangroves whose aerial roots are not regularly inundated start to die off, more sediment is trapped by the action of currents and wind, and eventually part of the bank reaches

a height above that of normal high tides and so forms an island. Rain-water leaches salt from the soil allowing tea-tree and grassland to become established on the high banks, which are surrounded by mangrove-fringed salt marsh. As the bank becomes higher, each zone advances seaward, the vegetated area expands, and the island increases in size and vegetational complexity.

This pattern of succession is common in Corner Inlet; it is found on both sides of Port Albert Channel, along Shoal Inlet, at Possum Island near Port Welshpool, and at Barry Beach. Mangrove swamp and salt marsh can also develop around remnants of spits, beach ridges, and sand flats on which tea-tree, scrub, and grassland are already present.

Salt marsh surrounds Jack Smith Lake and Lake Denison and sometimes projects into the water as tongues. The form of Jack Smith Lake suggests that it was once a bay that has now been isolated from the sea by the development of a sandy barrier and partly infilled with sediment. Warrigal Creek and other streams have formed a small delta at the northern end of the lake. Once part of the Lake Reeves lagoonal system, Lake Denison has been isolated from the rest of the lagoon by the formation of the Merriman Creek delta at Seaspray (and partly infilled by sediment from this stream).

Coastal brackish and fresh-water swamps are common in swales between ridges and

dunes where groundwater occurs and in blowouts in sandy terrain that have been excavated down to the level of the water table. The development of deltas also results in the formation of swamps; the lower reaches of the Tarwin, Albert, and Tarra Rivers were very swampy before being drained for agriculture.

On Wilsons Promontory alluvial and swamp deposits, consisting mainly of detritus derived from the weathering of the granite, extend to the coast from the foot of the granite mountains and hills. Large low-lying areas of poorly drained country occur, for example to the north of the Vereker Range where the streams flow into Corner Inlet. Coastal dunes form swamps behind most beaches, and cause the creeks to flow parallel to the coast for some distance before entering the sea. The swamp and creeks behind Sealers Cove provide a fine example. An extensive swamp has formed behind Five Mile Beach and similar features occur at Three Mile Beach, Darby Beach, Norman Bay, Oberon Bay, and Waterloo Bay.

Cliffs

The formation of cliffs depends both on environmental processes - such as sea action (physical and chemical), tidal conditions, and changes in sea level and climate - and on local geology, particularly rock type and structure.

Steep vertical and overhanging wave-cut cliffs are preserved where Strzelecki

Group sediments face the open sea. At the foot of each cliff, a wave ramp, often covered with sand, slopes seaward to meet the gently sloping shore platforms. Small volcanic necks have been exposed in the shore platform at Cape Paterson and Townsend Bluff.

Within Anderson Inlet, at Townsend Bluff, wave action is much reduced and erosion by the action of rain and runoff is noticeable. The cliff is vegetated and more gently sloping; there is no shore platform but a broad wave ramp.

The shore platforms and high cliffs at Cape Liptrap and Walkerville are developed from Lower Palaeozoic sedimentary rocks. These land-forms, especially the platforms, display superbly many structural and sedimentary features in the sandstone and mudstone strata.

Rock stacks are found on the shore platform at several places between Cape Paterson and Cape Liptrap, the most notable being Eagles Nest Rock near Inverloch. These are localized, craggy masses of resistant rock protruding from the shore platform high out of the water, which have become detached from the eroding mainland cliffs.

On the mainland coast of Corner Inlet, a low discontinuous cliff, only a metre or so high and cut through sands and clays, is being actively eroded. This process can be seen at Foster Beach, Port Welshpool, Port Albert, and McLoughlins Beach

and measures to conserve the soil are often required to check the rapid retreat of this cliff. Waves generated in Corner Inlet by westerly winds erode sandy beach ridges on the west side of Snake and Little Snake Islands, and at Barry Beach. At Foster Beach, southerly winds cause cliff erosion.

Former cliffs, now separated from the sea by strips of salt marsh, occur on the mainland and on the larger islands (Snake Island, Sunday Island, St. Margaret Island). The inner margin of the lagoonal flats, extending north-east from McLoughlins Beach and skirting Jack Smith Lake and Lake Denison, is a continuous old sea cliff.



Tors on coast at Wilsons Promontory



Cleft Island ('Skull Rock') off Wilsons Promontory; Rodondo Island in the distance

Shore profiles in the granite at Wilsons Promontory are usually steep and plunge directly into the sea at the headlands. The large rounded tors typical of this landscape result from erosion along joint planes in the rock.

Marine erosion has also carved sea caves into the jointed granite on both the east and west sides of the Promontory and on its offshore islands. On Great Glennie Island a cave some 25 m deep occurs behind the beach in a sheltered cove. On the same island a large gully on the north-eastern side has resulted

from the collapse of the weathered roof of a sea cave.

Cleft Island ('Skull Rock') has a spectacular example of cave development. The top cave is more than 20 m above sea level with a 60-m-high roof. It probably originated when sea levels were much higher.

Tidal features

A system of main tidal channels encircle the larger islands at Corner Inlet. In the westernmost section a number of radiating channels converge to join inside the entrance.

In most cases the main channels are continuous with streams on the mainland such as the Franklin, Albert, and Tarra Rivers. Other channels grade towards their heads into a fine system of reticulate runnels developed on sand flats.

In certain localities tidal currents may transport sand and mud picked up from the sea bed, but this occurs only where the currents are concentrated and flow at speeds of several knots. Tidal scour channels have developed between some of the islands in Corner Inlet and, at times, in the various breaches in the outer barrier. In other areas, where tidal currents are checked, they may deposit sand and mud. The conformation of the floor of the inlet can often change markedly over periods of several years.

Glossary

Aeolian	- resulting from the action of the wind
Aeolianite	- dune sand that has been cemented by calcite from percolating solutions
Aggrade	- to build up a surface by deposition
Backshore	- upper shore zone beyond the reach of ordinary waves and tides
Barrier	- a continuous elongated offshore ridge, usually of sand, built up by the longshore drift and waves; the barrier follows the line of breakers instead of the shoreline and gradually rises above high tide level
Barrier island	- a long, low, narrow, wave-built sandy island above high tide and parallel to the shore; it commonly has dunes, vegetated zones, and, if developed sufficiently, swampy areas extending from the ocean beach to the lagoon behind
Barrier spit	- a former barrier or island, now connected to the mainland
Beach ridge	- an essentially continuous mound of beach material that has been heaped up, by wave or other action, beyond the limits of ordinary tides; the ridges roughly parallel the shoreline and represent successive positions of an advancing shoreline
Berm	- a nearly horizontal or backward sloping portion of the beach or backshore formed by the deposition of material by waves
Block	- more correctly known as a 'fault block'; a unit of land bounded on some or all sides by normal faults: blocks vary in elevation and often their margins are sharply defined - by a fault scarp or stream or both
Built terrace	- gently sloping deposits on the seaward side of a shore platform
Colluvium	- unconsolidated material deposited towards the base of a slope by surface run-off and mass wasting
Concavo-convex	- concave one side, convex the other
Cusps	- naturally formed low mounds of beach material separated by crescent-shaped troughs spaced at more or less regular intervals along the beach face
Deflation	- the lifting and removal of loose material from the earth's surface by wind
Depression	- a low place of any size on a plain surface with no natural outlets for surface drainage
Dune	- mounds and ridges of wind-blown sand

Embayment	- an indentation in a shoreline forming an open bay
Fluvial	- pertaining to rivers
Foredune	- dune developed at the landward margin of a beach ridge
Foreland	- a deposit of sediment projecting from the land into the sea
Foreshore	- beach zone regularly covered and uncovered by the rise and fall of ordinary tides
Isthmus	- a narrow strip of land bordered on both sides by water, connecting two larger areas of land
Knick point	- a place of abrupt change in the gradient of a stream
Lacustrine	- pertaining to a lake
Ox-bow lake	- a crescent-shaped body of water situated in the abandoned channel of a meander after the stream has cut through the neck of the original bend and silted up its ends
Pleistocene	- an epoch of the Quaternary period, roughly 15,000 to 1.8 million years ago
Progradation	- a seaward advance of the shoreline resulting from the near-shore deposition of sediments brought to the sea by rivers
Quaternary	- a period thought to cover the last two or three million years
Recurved spit	- a spit with a landward hook or recurve formed by wave action on sediment drifting along the outer shore of the spit
Rejuvenated stream	- a stream that, after having developed to maturity or old age, has reverted to a more youthful stage as a result of faulting or tilting of a land surface
Shore	- zone between extreme high and low water marks
Shore platform (wave-cut terrace)	- a horizontal, or gently sloping, surface produced along a shore by wave erosion
Spit	- an area of land projecting into a body of water from the shore; generally formed from sediments deposited by long-shore drift
Sunkland	- a low-lying trough formed by two parallel faults
Terrace	- a narrow, relatively flat surface, bounded along one edge by a steeper descending slope and by a steeper ascending slope on the other - this gives a step-like profile
Tombolo	- a sand or gravel bar (or spit) connecting a former island with the mainland
Tor	- an upstanding surface boulder separated from the parent rock by erosion along joint planes - usually from granitic rock
Wave ramp	- undermined and dislodged cliff material actively undergoing wave erosion, sometimes sand-covered, lying at the base of cliffs at the inner edge of the shore platform

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7. CLIMATE

The study area has a temperate climate, weather coming generally from the west as an irregular succession of anticyclones and depressions (highs and lows).

The region represents a transition from the winter rainfall maximum typical of the southern Australian coastline to the more uniform rainfall of coastal south-eastern Australia. Prolonged droughts are uncommon. Precipitation is highest in winter, but the summer months average 40--50 mm of rain, or more at higher elevations. The areas around Giffard, Rosedale, Seaspray, Stradbroke, and, to a lesser extent, Traralgon have less seasonal variation in their rainfall than areas further west. This tendency away from the Mediterranean-type climate (winter maximum rainfall) is due to the marginal influence of the east coast depressions, which are the chief source of rain in East Gippsland.

The most detailed analyses by the Bureau of Meteorology of the climate of the study area are contained in the Central Planning Authority report 'Resources Survey: West Gippsland Region'. In fact, much of this chapter is based on data published by the Authority, but the most recent records for rainfall, tem-

perature, and several other meteorological statistics have also been included.

Rainfall

Appendix 3A lists monthly and annual average rainfalls for 32 stations in the study area, which has a rainfall variability among the lowest in Australia. Rainfall is generally well distributed throughout the year, and is highest from May to October. While the whole region shows a winter rainfall maximum, this becomes so reduced to the north-east of the Strzeleckis that this zone may be considered as having a uniformly distributed rainfall. (According to Gaffney (1971), if

$$\frac{1 \text{ (Nov--Apr.) median rainfall}}{1.3 \text{ (May--Oct.) median rainfall}} < 1.3,$$

then rainfall distribution is uniform.)

The wettest parts of the Strzeleckis average some 1,500 mm of rain annually; for almost all of the ranges the average exceeds 900 mm. The easternmost portion of the study area is in the lee of the Strzeleckis, which means that the rainfall declines sharply from the main ridge to the foot of the range. From

Madalya to Yarram, a distance of 18 km, the decrease is 550 mm (compared with a rise from Koo Wee Rup to Korumburra of 400 mm in 38 km). There is a further drop of 170 mm across the plains between Yarram and Seaspray. Rainfall decreases also in the Latrobe Valley from Yallourn eastwards to Flynn. Map 10 (Topography, Rainfall, and Catchments) shows the regional distribution of rainfall. The easternmost parts of the study area receive only some 550--600 mm each year.

Heavy falls of rain (50--100 mm) have occurred throughout the study area during all months, but in the wetter districts such downpours can be even more intense; Boolarra has recorded 193 mm of rain in 24 hours. These are more likely during summer, when the atmosphere is capable of holding more water vapour than in the colder months. (Boolarra's extreme occurred in February.) However, the wettest 10 days ever recorded in South Gippsland were between 14 and 23 June 1952, when Carrajung received 475 mm; Callignee South 447 mm; and Blackwarry 609 mm. The Latrobe Valley was extensively flooded after the first couple of days of this period.

Length of growing season

Statements on the length of growing seasons are based on the criterion of 'the month of normally satisfactory rainfall', during which there is a better than 50% chance of exceeding 'the effective rainfall'. The latter quantity is,

in simple terms, 'the amount of rain necessary to start germination and to maintain growth' and it depends on both rainfall and evaporation. At the end of the period of effective rainfall, the water stored in the soil allows plant growth to continue for some time.

The growing season in the wetter parts of the study area usually lasts at least 10 months, and it is only slightly shorter elsewhere. Low winter temperatures, however, can affect plant growth and interrupt the growing season - this effect is probably greatest in the eastern Strzeleckis. Conversely, irrigation and fallowing have extended the length of the growing season; the former provides water in dry months and the latter conserves water in the soil. The most favourable periods for plant growth are the late spring and to a lesser extent the autumn, because the rainfall then is usually adequate and temperatures are favourable.

Flooding

Despite the high rainfall, floods in the ranges are infrequent and short-lived. The soil is often quite permeable and streams rapidly discharge floodwaters. Downstream, however, in the broader, flatter valleys and on the plains, flooding is an annual problem that has been partly solved by engineering works.

The Latrobe River, in the north of the study area, drains an extensive area of

Gippsland's wetter country and is particularly liable to flooding.

In addition, floods are not necessarily confined to winter. The disastrous floods of 1934--35 occurred after a period of abnormally high summer rains. (The Princes Highway at Rosedale was 1.8 m under water.) Serious flooding also occurred in 1954 and 1978.

Drought

The plains around Giffard have had the greatest number of recorded droughts and dry spells in the area, with the flat country around Flynn slightly more assured of effective rainfall. On the other end of the scale the Strzeleckis rarely go for longer than a month without rain, but the northern slopes dry

out to a greater degree in summer than those in the south.

Temperature

Meteorological stations with lengthy records of temperature are infrequent in rural Victoria, but two in the study area give an indication of regional trends. In addition, figures from East Sale and Yallourn will be considered.

All parts of the study area have occasionally experienced temperatures greater than 38°C (100°F). Four representative maximum temperatures are: Leongatha 43.9°C; Olsens Bridge 39.9°C; Wilsons Promontory 41.1°C; and Yallourn, 44.4°C. The highest maxima are usually recorded on the plains inland from the coast and in the Latrobe Valley.

Table 3

MINIMUM TEMPERATURES (°C)				
	Olsens Bridge	Wilsons Promon- tory	Yallourn	East Sale
January				
Absolute minimum	- 0.8	5.5	4.0	3.5
Average minimum	9.5	14.0	12.9	12.9
July				
Absolute minimum	- 6.1	- 1.0	- 3.8	- 5.5
Average minimum	1.8	8.0	4.8	3.3

Days above 38°C occur about three times a year on average in the Latrobe Valley, about twice annually at Leongatha, and less frequently along the coast and in the ranges - for example, once during each 5-year period, on average, at Wilsons Promontory.

Average minimum temperatures throughout the year are highest on the coast, and the limited data in Table 3 illustrate this point.

Table 4 shows that the average daily range of temperatures is highest inland and fluctuates only slightly along the coast. For any month of the year, maximum temperatures are likely to be highest and minimum temperatures lowest in the far north of the study area in the Latrobe Valley.

Table 4

AVERAGE DAILY RANGE OF TEMPERATURE (°C)			
Olsens Bridge	Wilsons Promon- tory	Yallourn	East Sale
Least range			
Jul 9.0	Jun 4.0	Jun 6.9	May) Jun) Jul) 10.2
Greatest range			
Jan 14.2	Dec 6.5	Jan 12.0	Jan 12.5

Topography has a considerable effect on temperature. Each increase of 100 m in altitude decreases temperatures by about 1°C. Thus, Olsens Bridge (183 m) has the lowest maxima and minima of the four stations discussed here, and higher altitudes in the Strzeleckis would have correspondingly lower temperatures. North-facing slopes receive more sun than those facing south; cold air can drain overnight into the lower parts of valleys. Local cloudiness and fog will also lower local temperatures.

Appendix 3B lists further details of temperatures and relative humidity for particular localities in the study area.

Relative humidity

Relative humidity varies little throughout the year on the coast (it is usually 70--80%). As well winter levels are generally high in the Strzelecki Ranges. Relative humidities during summer at the inland stations are generally similar.

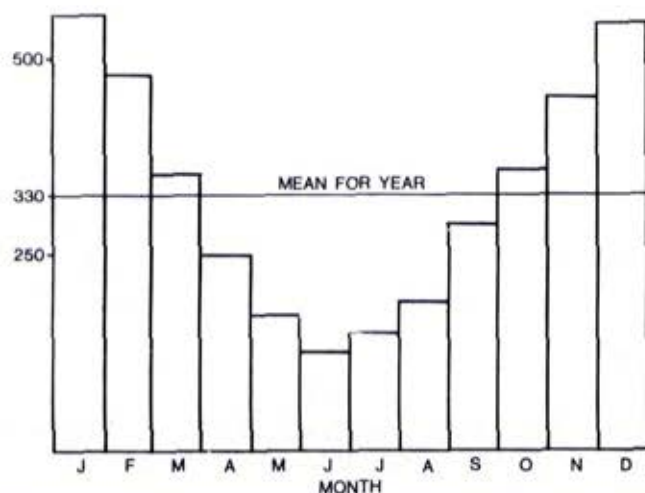
Sunshine

The following is quoted directly from the Central Planning Authority's report of 1968 on West Gippsland, but relates fairly closely to the study area.

'The annual total hours of sunshine approximate to 2,000 hours in the cloudiest part of the Strzelecki Ranges. Elsewhere totals are higher than this and, in the sunniest section in the ex-

FIGURE 5
SOLAR RADIATION

Mean daily solar radiation for Yallourn
based on the period November 1974-
April 1977 expressed in $\text{cal cm}^{-2} \text{ day}^{-1}$



treme south-east, are probably over 2,250 hours. Totals along the exposed coast are probably slightly lower than over the interior lowlands.

January is the month of greatest sunshine with totals at most places ranging between 225 and 250 hours. February totals are just under 200 hours in parts of the far south and north but elsewhere are slightly greater. March totals are very little less than those for February. In April the hours of sunshine range between just under 150 and 175 whilst May totals are between 125 and

150 with slightly higher values in the far south-east. November hours range between 180 in the far north and approximately 220 in the south-east, whilst in December averages are chiefly over 225 and are over 250 hours in the far south-east.'

The mean number of hours of sunshine recorded at Yallourn totals about 2,120. The average for June is 106 hours, but the monthly total has been as low as 85 hours.

Solar radiation flux

Figure 5 indicates the incident monthly solar radiation at Yallourn, based on the period between November 1974 and April 1977.

Values are likely to be higher in the eastern and north-eastern parts of the study area and lower in the ranges to the south.

Evaporation

Data on evaporation are available for a number of locations in the study area (see Table 5). Data in Table 5 have been corrected to allow a comparison between stations. Evaporation is measured as the loss of water from a pan of standard diameter. It is highest in the north, from Yallourn towards East Sale, and decreases towards the coast (Dutson Downs) and in the more mountainous areas of the Strzeleckis where radiation input

is lower. Only 4 months of Class A pan data were available from Tidal River, but comparison with the corresponding period at Yallourn showed that the Tidal River evaporation was some 76% of that at Yallourn. Thus a Class A pan evaporation of about 1,060 mm is suggested for Tidal River. The coastal plains in the vicinity of Yarram would experience an annual evaporation of some 1,200 to 1,300 mm. Thus, over much of the study area, but especially the northern and eastern areas, annual evaporation exceeds annual rainfall.

Monthly levels of evaporation generally follow the variation in radiation input,

and range from a low of about 35 mm in winter throughout the area to a high in summer of between 120 mm at the coast and 200 mm to the north of the study area.

Fog

A mist is recorded as a fog when visibility, observed around 0900 hours, is less than 1,000 m.

The condition is relatively common in the Latrobe Valley in the cooler months, due to strong radiation cooling and cold air drainage. Coastal fogs are caused more by radiation cooling and moisture

Table 5

ANNUAL CLASS A PAN EVAPORATION IN CENTRAL GIPPSLAND

Station	Latitude (S.)	Longitude (E.)	Evaporation (mm)
Dutson Downs ^A	38°13'	146°19'	1,315
East Sale ^A	38°06'	147°08'	1,466
East Tarwin ^A	38°32'	146°15'	1,080
Hazelwood	38°17'	146°23'	1,370
Maryvale ^B	38°14'	146°25'	1,130
Yallourn	38°11'	146°22'	1,400

A Original observations were multiplied by 1.07 to allow for effect of birdguard.

B Original observations were multiplied by 1.20 to convert from Australian Sunken Tank to Class A pan evaporation.

Table 6

MEAN NUMBER OF FOG DAYS FOR SOUTH GIPPSLAND AND OTHER STATIONS

Station	Period	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Total for year
Warragul	1962--75	0.3	0.7	0.6	2.1	2.1	3.4	2.8	1.9	0.9	0.2	0.1	0.2	15.4
Wilsons Promontory	1957--75	2.0	2.1	1.0	0.8	0.3	0.3	0.1	0.5	0.4	1.7	1.5	1.4	12.0
Yallourn	1957--75	0.9	1.6	3.9	5.8	5.4	6.8	5.7	4.9	3.6	2.4	1.1	1.0	43.1
Olsens Bridge	1962--75	0.5	0.9	0.9	1.4	3.2	3.9	3.3	1.9	0.6	0.6	0.2	0.1	17.4
Noojee	1965--75	0.2	0.5	1.2	2.5	6.2	7.5	6.5	4.2	1.5	0.5	0.1	0.2	31.0
Cape Schanck	1962--75	0.4	0.5	0.2	0.7	0.6	0.8	0.4	0.3	0.2	0.5	0.3	0.2	5.0
Maffra	1965--75	0.2	0.9	2.5	1.5	1.7	3.0	1.1	0.7	0.2	0.7	0.2	0	12.7
Erica	1965--75	0.4	0.6	0.9	0.7	0.5	0.6	0.3	0.4	0.2	0.5	0.5	0.4	6.1

advection from the south-east or east. Sea fog occurs infrequently over the Tasman Sea but may be moved onshore with easterly winds.

Table 6 shows the mean number of fog days for each month and for the year for several Gippsland stations. The greatest incidence of fog has been recorded at Yallourn and Noojee, both of which are in the lower parts of valleys where cold air drainage favours the formation

of fog. The maximum monthly frequency for inland stations occurs in late autumn or early winter, when clear night skies allow strong radiation cooling.

Coastal stations have a rather different pattern. Cape Schanck shows a weak autumn or winter maximum while Wilsons Promontory shows a maximum in late summer with a minimum in winter. This latter variation is also evident at Lakes Entrance and Point Hicks.

Frosts

Marine influences and local aspect have a considerable effect on minimum temperatures and hence on the occurrence of frost. Frosts are very rare on the exposed coastline of the study area. Moving inland across the plains, the period without frosts decreases rapidly to around 7 months of the year. In higher areas, especially in valleys, the frost-free period is shorter. Frosts have occurred during all months at Olsens Bridge.

Snow

Snow settles on the highest parts of the eastern Strzeleckis two or three times a year, even less frequently on the hills around Mirboo North and Korumburra, and in the west of the range in general, and seldom on the peaks of Wilsons Promontory. On 31 May 1977, however, exceptionally heavy snow fell over much of the study area, including, surprisingly, parts of the coastline. It disrupted road traffic briefly and lay for several days in sheltered localities in the hills.

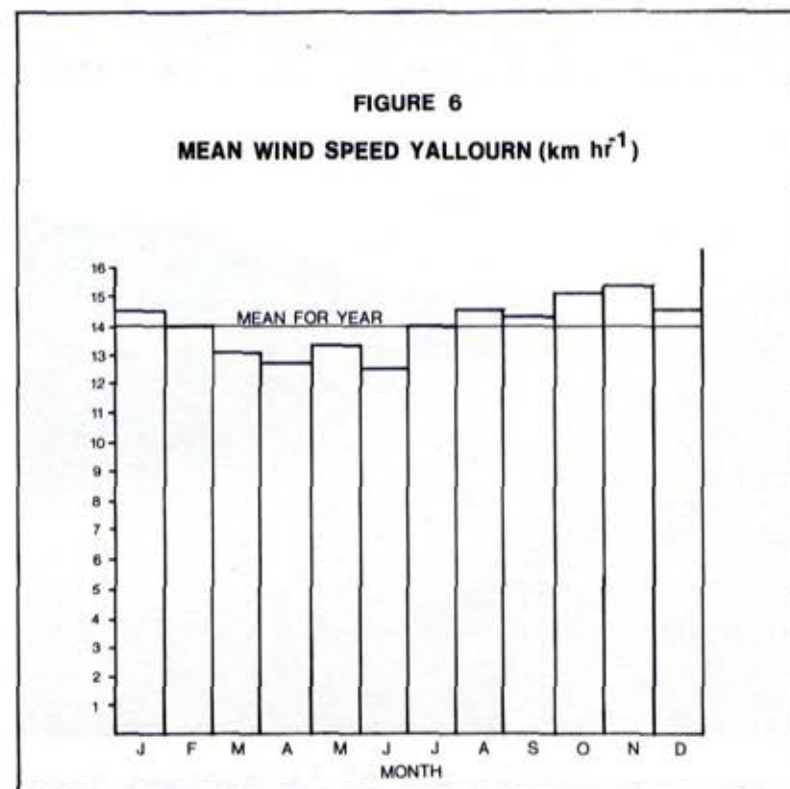
Wind

Winds are most frequently westerly, with easterlies and north-westerlies occurring less frequently in winter. During summer, westerlies and easterlies predominate, with south-westerlies less common.

Sea breezes, roughly perpendicular to the coastline, often occur along the coast during summer.

Wind speed and direction are affected by topography and therefore considerable local variation occurs, especially in valleys. On clear, still nights, local drainage winds occur, which flow down slopes and along the valleys.

Mean wind speed for Yallourn at 12 m height (based on data from 1955 to 1972)



is shown in Figure 6. The highest wind speeds observed at Yallourn during this period were between 73 and 99 km per hr.

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8. WATER RESOURCES

As can be seen from the previous chapter, the region is reliably and well watered compared with northern and western Victoria. Topography, rainfall, and catchments are detailed on Map 10.

Surface Water

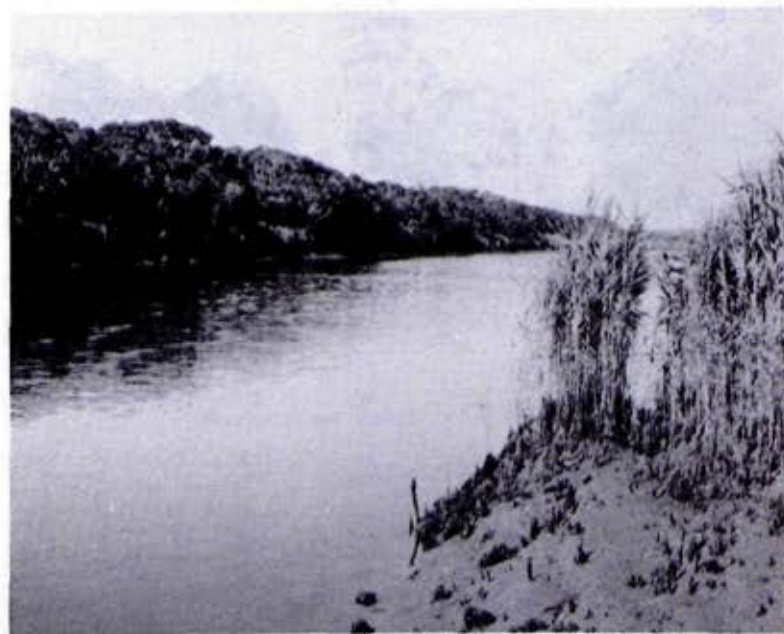
Major streams

A 30-km stretch of the Latrobe River, including its junction with the Tyers River, falls within the study area. The other main streams flow either north or south from the Strzeleckis. The northern watercourses drain into the Latrobe River and those in the south flow into coastal inlets or discharge directly to the sea.

Coastal streams

The most important streams along the coast from west to east are the Tarwin, Franklin, Agnes, Albert, Jack, and Tarra Rivers, and Bruthen and Merriman Creeks. All drain to the sea, and, apart from the Tarwin River and Merriman Creek, are relatively short with small catchments, as are the streams on Wilsons Promontory.

The aggregate annual yield from these streams, as measured at existing gauging stations, is around 430,000 ML. Many of these are in the upper parts of the catchments, however, and consequently do not register flows of lower tributaries. The combined area of the catchments is 3,210 square km, of which 80% is in the study area.



Lower reaches of Tarwin River

Latrobe River basin

This basin is around 4,000 square km in area. Apart from the Latrobe and Tyers Rivers, the main streams within the study area that are part of the Latrobe drainage system are, from west to east, Morwell River (with its tributaries Little Morwell River and O'Grady, Middle, and Billy Creeks), and Waterhole, Traralgon, and Flynn Creeks. The tributaries have a total annual yield of about 79,000 ML. Their combined catch-



Bend on Latrobe River

ment of 1,140 square km, 90% of which is in the study area, constitutes a quarter of the Latrobe River drainage basin. They contribute about 20% of the Latrobe River's flow at Rosedale.

Stream gauging

The quantity of water yielded by a catchment depends on the total annual precipitation, minus the proportion lost as evaporation, transpiration, and seepage through to the water table.

In most instances, stream-flows in the study area have been recorded for only the last 20 years. It is therefore hard to predict with certainty the extremes of flow that are likely to occur in South Gippsland. Stream-gauging sites are recorded on Map 10.

As with most Victorian streams, the watercourses in the study area show great variations in flow from year to year because of the difference in total annual rainfall. During most years, however, only 5--15% of the annual discharge occurs in summer.

Table 7 shows the characteristics of the main streams in the study area; Figure 7 shows the variability of stream-flow for four of these rivers.

Water quality

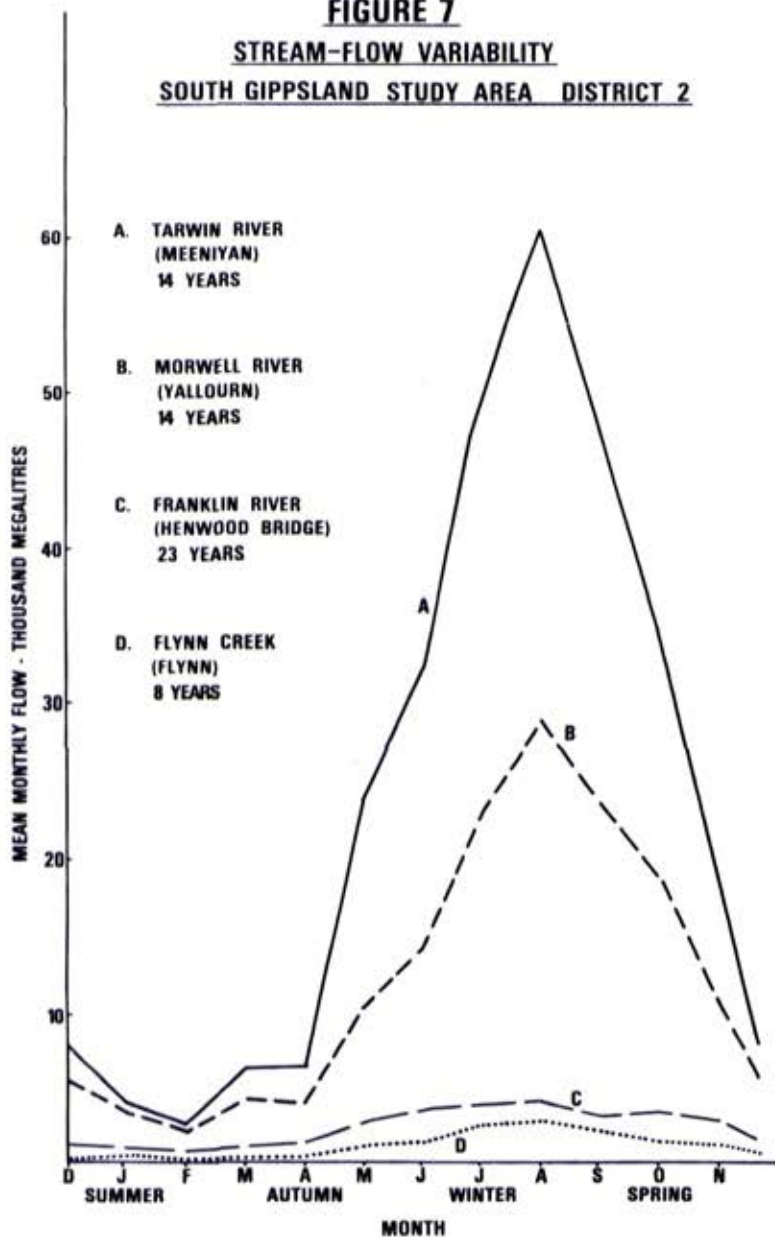
The suitability of water for domestic, stock, and irrigation use is affected by

Table 7

STREAM CHARACTERISTICS

STREAM CHARACTERISTICS														
Stream	Gauge location	Seasonal flow (%)				Area of catchment (km ² above gauge)	Average annual discharge ('000 ML)			Flow variability (ML/day)		Recorded salinity (flow, ML/day)		Total catchment area (km ²)
		Aut.	Win.	Spr.	Sum.		Max.	Min.	Mean	Max.	Min.	Max.	Min.	
Southward-flowing streams														
Tarwin River	Meenyan	12	50	34	4	1,067	467 1960--61	73 1967--68	275	18,200	7	500 (86)	58 (3,548)	1,529
Lilly Pilly Creek	Tidal River	21	33	32	14	5	2.8 1970--71	0.6 1972--73	1.4	54	0.2	280 (2)	90 (1)	6
Franklin River	Henwood Bridge	17	40	32	11	47	49 1952--53	5.5 1967--68	24	5,700	0.5	250 (13)	19 (276)	160
Agnes River	Agnes Falls	17	41	33	9	67	45 1970--71	7 1967--68	26	2,100	0.7	300 (9)	30 (42)	100
Albert River	Hiawatha	13	41	33	13	31	44 1970--71	6 1967--68	17	2,900	2.7	160 (9)	60 (9)	384
Jack River	Madalya	13	40	33	14	26	28 1952--53	7 1959--60	14	2,300	2	125 (7)	50 (174)	92
Tarra River	Yarram	14	41	32	13	218	141 1952--53	8 1972--73	47	6,800	-	333 (5)	27 (147)	336
Bruthen Creek	Yarram--Traralgon Rd	17	36	32	15	18	14 1956--57	1 1972--73	6	1,200	-	491 (1)	45 (86)	215
Merriman Creek	Gormandale	19	29	34	18	36	25 1969--70	6 1967--68	17	958	1.4	148 (7)	53 (51)	483
Northward-flowing streams														
Little Morwell River	Boolarra	14	42	32	12	54	17 1964--65	5 1967--68	10	347	3.6	227 (112)	80 (67)	51
Middle Creek	Yinnar South	21	46	33	8	69	37 1956--57	5 1967--68	20	1,588	-	255 (3)	100 (99)	98
Billy Creek	Yinnar	9	52	34	5	40	17 1956--57	2 1967--68	8	1,026	-	445 (0.2)	124 (43)	48
Morwell River	Yallourn	12	45	36	7	621	273 1956--57	42 1967--68	141	9,018	9.7	678 (flow rates not known)	96	622
Traralgon Creek	Koornalla	12	45	33	10	88	52 1956--57	8 1967--68	28	3,500	0.7	243 (137)	60 (392)	320
Flynn Creek	Flynn	7	52	29	6	92	21 1956--57	6 1959--60	10	1,400	-	1,782 (-)	127 (119)	105
Latrobe River	Rosedale	15	35	36	14	4,144	3,253 1952--53	272 1967--68	942	127,000 (June 1978)	117	504 (117)	30 (not known)	4,810 (above Sale)

FIGURE 7
STREAM-FLOW VARIABILITY
SOUTH GIPPSLAND STUDY AREA DISTRICT 2



a number of properties, one of the most important of which is the salinity, measured as the total quantity of dissolved solids (TDS). In general, 500 mg per L is the upper limit for domestic and industrial use, and 1,000--1,500 mg TDS per L the upper limit for irrigation. Water with 1,500--3,000 mg TDS per L is suitable for most livestock, and can sometimes be used for irrigation.

The streams flowing into the Latrobe River have been sampled intensively for salinity since 1957. Maximum TDS has been 1,782 mg per L at Flynn Creek; at this time the stream had ceased to flow. In contrast, the minimum value at the same location was 127 mg per L when rate of flow was 119.2 ML a day. Lower salinities are usually found in most other streams, for instance, the maximum value that has been measured for the Tarwin River is 500 mg TDS per L in May 1976.

Lakes

There are no lakes in the study area except for those industrial, domestic, and agricultural storage lakes produced artificially, and some abandoned, water-filled quarries. There are many swamps along the coast, some of which are extensive (for example, Jack Smith Lake and Lake Denison), and a few inland in the Mullungdung State Forest (such as the privately owned Kangaroo Swamp). The coastal swamps may be either freshwater or saline and can vary greatly in size, depending on seasonal rainfall.

Groundwater

Groundwater is contained in, and flows through, bodies of permeable rock known as aquifers. There are two main types of aquifer in the study area - the more productive, permeable strata of the foothills and plains, and the less important fractured rock aquifers of the Strzelecki Range, Hoddle Range, and Wilsons Promontory.

Figure 8 shows the general locations of the aquifers of South Gippsland, and

Table 8 details the most useful aquifers.

Permeable Rock Aquifers

The most important aquifers in the study area are the unconsolidated sands and gravels within the Latrobe Valley Group and the Boisdale Formation. Recent alluvial and coastal deposits are also important in some areas. Two other formations, Gippsland Limestone and the Haunted Hills Gravels, are less significant.

Table 8

AQUIFER CHARACTERISTICS

Area	Leongatha	Thorpdale	Moe	Morwell	Yarram	Woodside	Tarwin
aquifer system	Basalt	Basalt	Latrobe Valley Group			Boisdale Formation	Equivalent to Boisdale Formation
Depth of aquifer (m)	10--80	10--80	25--250	25--350	150--350	25--70+	3--6
Quality (mg TDS per L)	130--2,000	100--400	120--130	300--500	150--840	500--1,500+	250--500
Yield* (L per sec.)	Medium	Low--high	High	High	High--very high	Very high	Low--medium

Data: Department of Minerals and Energy.

* Bore hole diameter is generally c. 150 mm. Yields: low, 0--0.2 L per sec. (suitable for stock and domestic water supplies); medium, 0.2--1 L per sec.; high, 1--10 L per sec.; very high, > 10 L per sec. (suitable for town supplies and for irrigation).

Latrobe Valley Group

This group contains sands, gravels, clays, and brown coals, and is the main aquifer system in the Moe Swamp Basin, the Latrobe Valley, and along the south-eastern margin of the Strzelecki Ranges. The aquifer is recharged by run-off from areas of outcrop along the flanking highlands, and the water is usually of good quality. At Morwell, the salinity



A fern gully marks the course of Turtons Creek, tributary of the east branch of the Tarwin River

is 300--400 gm TDS per L; around Yarram and Welshpool, salinities range from 500 to 1,000 mg per L. Yields from bores of up to 50 L per sec. are usual.

Groundwater ranging in temperature from 20 to 70°C flows from State Electricity Commission bores at Morwell and Yallourn. The cause of this heating has been assigned variously to oxidation *in situ* of the coal within the Latrobe Valley Group, or to an above-normal temperature gradient caused by a heat source at shallow depth. The water is cooled in the Hazelwood Cooling Pond and helps satisfy the need for water for industrial use and firefighting at Morwell open cut.

The excavation of coal at Morwell is made difficult by groundwater under pressure forcing up the floor of the open cut as coal is removed. This situation necessitates an extensive program of pumping to reduce aquifer pressure. Currently, 2 tonnes of water are removed for each tonne of coal produced. The removal of this water has lowered the regional groundwater by up to 120 m at Morwell.

The lowering of pressures, and other circumstances, have led to horizontal displacements and vertical subsidence as great as 2 m at the edge of the Morwell open cut. The southern part of Morwell township is affected by such movements. Similar effects are foreseen for the Loy Yang open cut.

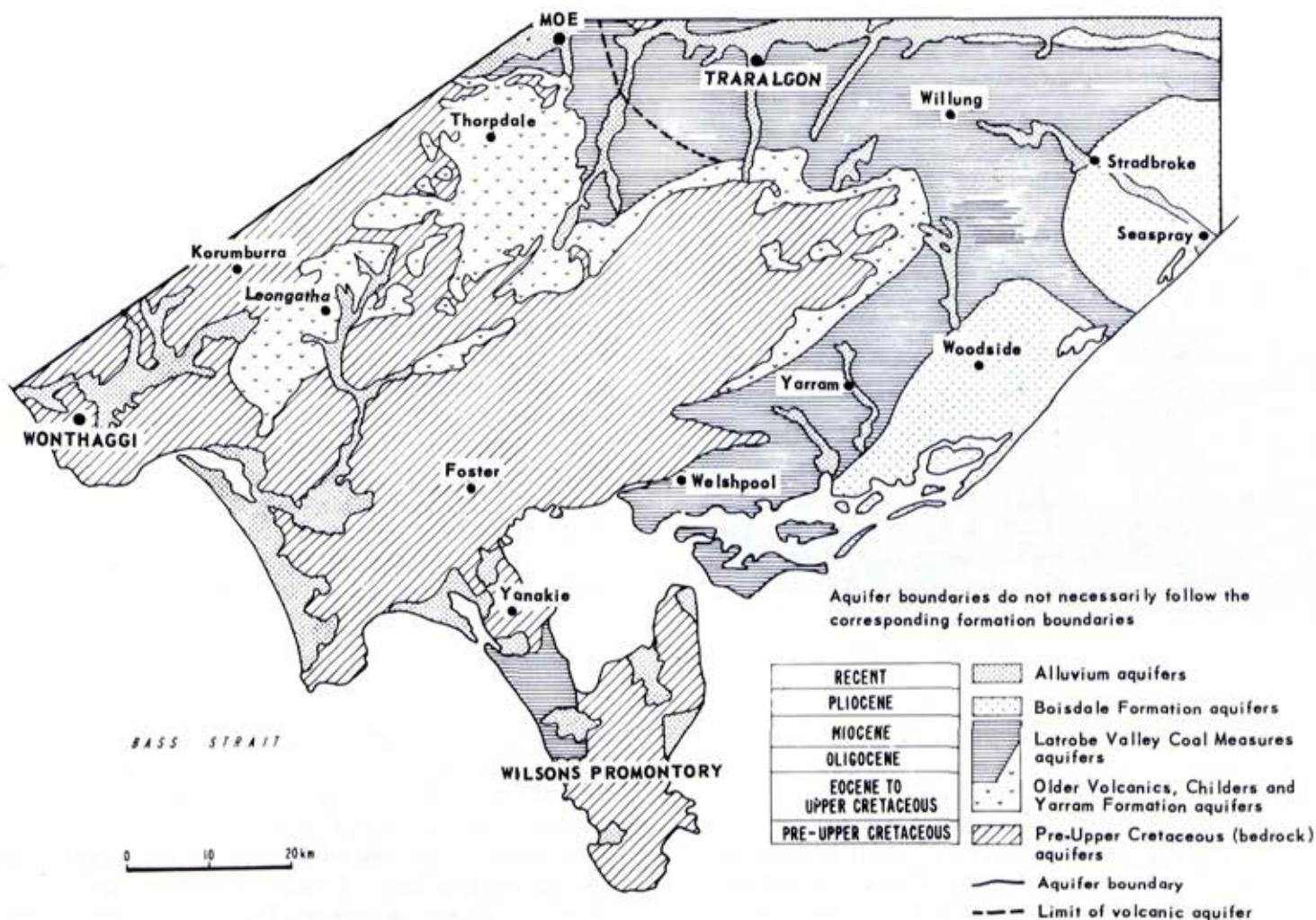


Fig. 8 DISTRIBUTION OF MAIN AQUIFER SYSTEMS, SOUTH GIPPSLAND (after Nahm, 1977)

Boisdale Formation

In the Woodside area, the Latrobe Valley Group is overlain by sands and clays of the Boisdale Formation. These strata contain one of the most important aquifer systems in Gippsland and it has been extensively tapped around Sale for irrigation and domestic purposes. Salinities range from 500 to 3,000 mg TDS per L, with high concentrations of iron. If the water is to be used for drinking, then it must be aerated beforehand to precipitate some of this impurity. Within the study area it is used primarily for stock.

Gippsland Limestone

This formation contains some groundwater but is generally a poor aquifer because of its impermeability. Locally however, the limestone contains abundant shell fragments and pore spaces, and yields reasonable quantities of water for stock and domestic purposes.

Alluvial and coastal deposits

The alluvial deposits of the present rivers probably contain good groundwater, but they are largely undeveloped. At Shallow Inlet and Venus Bay, coastal sands yield small quantities of water suitable for use domestically and by stock.

Low yields of groundwater of a reasonable quality (around 600 mg TDS per L)

have been obtained from the lower part of the aeolianite dunes and from the underlying non-marine sediments at Yanakie. Excessive use of groundwater in coastal areas could lead to saltwater intrusion and permanent damage to the aquifers.

Fractured Rock Aquifers

The highlands of the study area consist of consolidated rocks that have yielded only minor flows of groundwater. Composed principally of Palaeozoic and Mesozoic rocks, they are represented in Figure 8 as a pre-Tertiary aquifer system.

Palaeozoic rocks

These rocks consist mainly of sandstone, shales, and granites and, although locally faulted and jointed, their groundwater potential is considered low.

Mesozoic rocks

Felspathic sandstones and mudstones of the Strzelecki Group are usually of low permeability, but yield moderate quantities of groundwater of 1,000--3,000 mg TDS per L at Meeniyah. Springs formed by groundwater from this system contribute to some stream-flows in the area.

Older Volcanics

Tertiary basalts occur along the southeastern and northern flanks of the

Strzelecki Ranges, and in a belt extending from Moe through Mirboo and Leongatha to Koonwarra.

They often yield reasonable quantities of good-quality water, generally of less than 1,000 mg TDS per L. Where the basalts have weathered, however, their permeability is reduced; complete weathering results in an impervious clay.

Some of the small areas of basalt preserved by faulting often contain quantities of high-quality groundwater. For example, a restricted block of lava at Leongatha contains groundwater with a salinity of less than 500 mg TDS per L. High yields can be obtained, but only briefly, as the total amount of water in storage is typically limited due to the restricted size of the basaltic outcrops.

At Thorpdale, groundwater from these aquifers is used for irrigating potatoes on the red 'volcanic' soils.



Lower reaches of Tidal River, Wilsons Promontory

Glossary

Aquifer	- a water-bearing geological formation
Artesian water	- subsurface water under sufficient pressure to force it to rise up a borehole to the surface without the need for pumping
Basin	- a tract of country drained by a river and its tributaries
Confined aquifer	- an aquifer, bounded above and below by beds of distinctly lower permeability, in which the water is under artesian pressure
Groundwater	- All subsurface water

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9. SOILS

Five factors influence soil formation: parent material; topography; climate; biological influences; and the length of time over which the soil has developed. In certain environments the soils show clearly that the influence of one or two factors has predominated.

The type of parent material may override other factors, but, although rock type may influence the dissection and slope of the country, in certain situations the topography will determine the soil type. In the study area this has occurred on the swamps of the coastal plain, where high rainfall, flat topography, year-round stream-flow, and a shallow regional water table have led to the formation of permanent swamps in which peaty soils have developed.

In steep areas the greater erosion means that weathered material does not accumulate, but is moved downslope by water and gravitation. In large areas of the Strzeleckis, however, deep soils have evolved due to the easily weathered sedimentary rock, high rainfall, and relatively stable forest vegetation. In other very steep areas only a thin skeletal soil may cover the fragmented parent material.

Rainfall has affected soil development throughout the study area, forming strongly leached soils that are generally infertile and acidic.

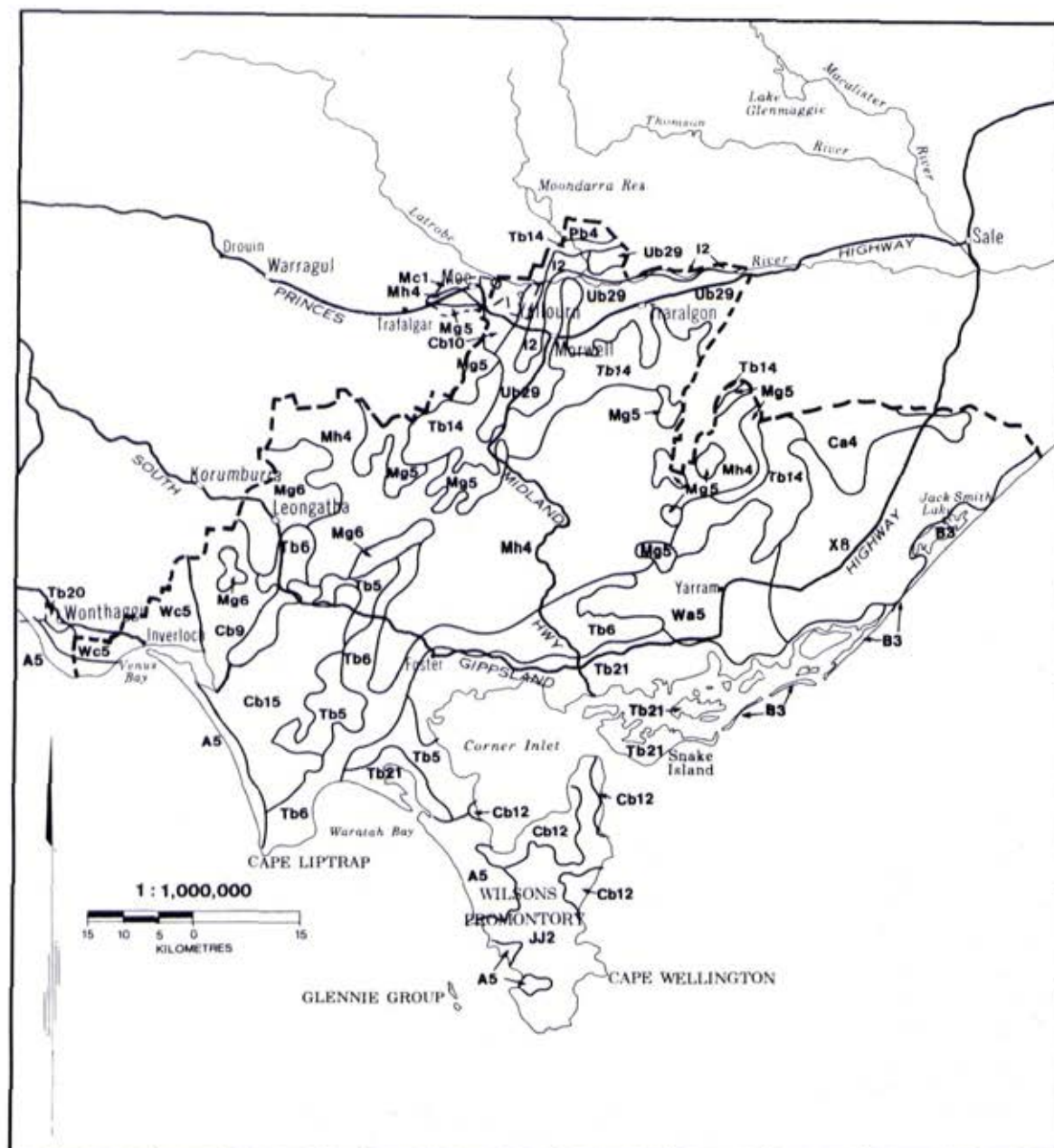
Regional Soil Surveys

The soils of the study area have been surveyed broadly and certain tracts have been investigated in detail. A.P.M. Forests Pty Ltd has mapped its plantations and forests; the Department of Agriculture has made several local studies; and the Soil Conservation Authority is currently delineating the land systems of the catchments of the Gippsland Lakes.

Map 7 shows the land systems of the study area, and this can be used, with the land systems table in Chapter 12, to locate the main groups of soils. Figure 9 also gives a generalized delineation of the distribution of soils. In the field, distribution is much more complicated.

Soil Properties and Plant Growth

The physical nature of the soil together with the prevailing climate and topography govern the soil's ability to



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LEGEND

UNIFORM TEXTURE

- A5** Calcareous sands
B3 Siliceous sands
Ca4 Leached sand with a coloured but not compacted layer below the bleach
Cb9-15 Leached sand with a compact or pan-like layer below the bleach
JJ2 Sand soils without a B horizon
I2 Dark plastic clays of various kinds

GRADATIONAL TEXTURE

- Mc1** Wet earths
Mg5-6 Red friable porous earths - no A2 horizon present
Mh4 Brown friable porous earths - no A2 horizon present

DUPLEX TEXTURE

- Pb4** Hard acidic red soils - pedal subsoils
Tb5-21 Hard, acidic, yellow mottled soils - bleached A2 horizon
Ub29 Hard, neutral, yellow mottled soils - bleached A2 horizon
Wa5 Sandy, acidic, yellow mottled soils - bleached A2 horizon - pedal subsoils
Wc5 Sandy, acidic, yellow mottled soils - unbleached A2 horizon - apedal subsoils
X8 Sandy, neutral, yellow mottled soils - bleached A2 horizon

Taken from Division of Soils, C.S.I.R.O. "Atlas of Australian Soils"
(C.S.I.R.O. Melbourne 1961)

FIG. 9 : REGIONAL SOILS

store water, while the soil's chemical properties determine the supply of plant nutrients. Physical properties include texture, structure, permeability, and shrinking and swelling characteristics.

Sands are permeable and well drained when the water table is deep. This water is, however, unavailable for use by most plants during the dry season. Many clay soils can store large amounts of water, but are often waterlogged in winter in the study area. Horizons of clay, or ironstone concretions ('coffee rock') may impede the movement of water and roots. On the other hand, water trapped above a layer of coffee rock at depth may form an important reservoir for deep-rooted herbaceous plants at times when the surface soil layers have dried out.

The most important chemical properties are the quantities of nutrients available to plants, the amounts of clay minerals and organic matter, the degree of acidity or alkalinity, and the presence of any toxic concentrations of chemicals such as salt.

Classification of Soil Types

Northcote (1971) evolved a system with four primary divisions for classifying Australian soils.

- * Organic soils--all soils containing more than 20% organic matter

- * Uniform soils--the texture changes little down the profile
- * Gradational soils--those that have no sharp changes in texture down the profile, but gradually become more clayey with depth
- * Duplex soils--these show a sharp change of texture between the surface horizons and the subsoil, the subsoil being much more clayey than the topsoil

Table 9 shows the soil groups in the study area, largely derived from the work of soil scientists in CSIRO and the Soil Conservation Authority of Victoria (see references).

The most widespread soils are described in more detail below.

Organic Soils

Peaty soils

Peats are formed in environments of low biological and chemical activity where the rate of accumulation of organic matter exceeds the rate of decomposition.

The study area has no pure peats, but peaty soils have been formed locally in many of the coastal swamps, floodplains, and tidal zones of the study area, particularly in the Tarwin valley, at Yanakie, on the delta of the Albert

Table 9

SOIL GROUPS, NOMENCLATURE AND DISTRIBUTION IN THE STUDY AREA

S.C.A. (1975) *	Stace <i>et al.</i> (1968)	Skene (1968) **	Northcote <i>et al.</i> (1975)	Distribution
UNIFORM TEXTURE				
Peaty black clays	Humic gleys	Acid swamp soils	Dense dark pedal non-cracking clays (on plains) (Uf 6.42)	Small areas: Powlett and Tarwin valleys, shores of Anderson Inlet, Yanakie isthmus, delta of Albert and Tarra Rivers, Wilsons Promontory, Hedley
Calcareous sand soils, uniform texture	Calcareous sands	Calcareous dune sands	Whitish calcareous sands (on aeolian dunes) (Uc 1.11)	Yanakie isthmus, Venus Bay
Coarse sand soils, uniform texture	Siliceous sands	Skeletal soils	Pale-grey brown sands (on hills) (Uc 4.11)	Wilsons Promontory
Leached sand soils with hardpan, uniform texture	-	Sandy podsols	Bleached sands with pan (on aeolian deposits) (Uc 2.33)	Lower Tarwin valley, Tarwin Meadows
Weakly differentiated pale sand soils, uniform in texture	Siliceous sands	Skene did not map	Whitish siliceous sands (Uc 1.21)	Dunes lining the Ninety Mile Beach
GRADATIONAL TEXTURE				
Brown gradational soils	Brown podsollic soils	Yellowish grey friable earths	Brown acid structured earths with rough-ped fabric (on hills) (Gn 4.31)	Strzelecki Ranges

Table 9 (Continued)

A. (1975) *	Stace <i>et al.</i> (1968)	Skene (1968) **	Northcote <i>et al.</i> (1975)	Distribution
gradational s, fine structure (i.e. structured)	Krasnozems	Krasnozems	Brown acid structured earths with rough-ped fabric (on hills) (Gn 4.31)	Strzelecki Ranges -- basalt residuals
EX TEXTURE				
low duplex s	Yellow podzolic soils	Upland soils on miscellaneous rocks	Hard, pedal, acid mottled-yellow duplex soils with bleached A2 horizon (on undulating country and low hills and ridges) (Dy 3.41)	Hoddle Range, Hedley Range, Leongatha area, Tarwin and Powlett valleys, Rintoul Creek area
low duplex s	Yellow podzolic soils	Lowland soils on clay sediments	Hard, pedal, neutral mottled-yellow duplex soils with bleached A2 horizon (on undulating country) (Dy 3.42)	Latrobe Valley plains and downs
low duplex s	Yellow podzolic soils	(a) Lowland soils on clay sediments (b) Lowland sandy soils	Sandy, pedal, acid (a) and neutral (b) mottled-yellow duplex soils (on undulating country) (Dy 5.41, Dy 5.42)	(a) Mullungdung and Boodyarn Forests (b) Plains around Yarram and Woodside

Contained in internal publications

In : Central Planning Authority. 'Resources Survey West Gippsland.' (Central Planning Authority : Melbourne 1968.)

and Tarra Rivers, and on Wilsons Promontory. They also occur on the floodplain of the Morwell River.

The typical native vegetation on these soils is a dense scrub of swamp paperbark with scattered emergent swamp gums, but many areas have been drained for dairy farming and cropping (especially, of late, potato-growing). After drainage, the organic matter in these soils rapidly decomposes and the subsequent changes in their structure may lower productivity.

Phosphorus and copper are the main deficiencies. Lime may be necessary for pasture establishment, and potassium for subsequent growth. Sufficient nitrogen may be supplied by sowing clover, but, if crops such as oats are grown, nitrogenous fertilizers should be applied.

Soils of Uniform Texture

Calcareous sand soils

These coarse-textured soils occur on the Recent unconsolidated dunes that have been stabilized by vegetation along the coast, and to some distance inland, between the Yanakie isthmus and Cape Paterson. They are alkaline, from an abundance of shell fragments, and occasionally the surface 3--30 cm will contain organic matter, which is observable as a grey or dark-grey horizon. Typically these soils are loose (though sometimes very weakly bonded to form soft

crumbs) and susceptible to wind erosion.

Calcareous sands are highly permeable and drain readily; hence drought-resistant or deep-rooted species predominate where these soils still carry natural vegetation (usually heath or coastal scrub and grassland). Cleared and developed (as at Yanakie) they can support a good pasture of grasses and clovers, provided phosphorus and potassium are added and any deficiencies in copper are corrected.



Leached sand soil on old dune on Gellions Run



Deeply leached sands exposed in sandpit at Won Wron - humus and iron pans are prominently coloured black and brown

Coarse sand soils

These shallow soils have developed on the highly siliceous granitic rocks of Wilsons Promontory. They tend to be loose, porous, and hard when dry. The surface loamy sand and light sandy clay loams grade rapidly into weathered rock.

Such soils carry a variety of forest and scrub. In the study area the topography (and shallow depth and low fertility of the soils) discouraged their development for agriculture last century, and hence Wilsons Promontory remained in its natural state.

Leached sand soils with hardpan

Deep, acid soils, developed in highly siliceous materials in moist coastal country, are found on the coastal plains between Inverloch and Cape Liptrap, at Yanakie, in the Mullungdung and Boodyarn Forests, and in the Traralgon South--Callignee area. They are also extensive on sandy quartzitic deposits near Grass-tree Swamp, and between Darriman and Monkey Creek.

Accumulated organic matter colours the surface horizon, which is a prominent, usually thick, bleached horizon over-

lying a very dark brown to black hardpan formed from organic matter, and iron sesquioxides (coffee rock) leached down the profile. Thus the upper horizons are highly permeable, with an impervious hardpan below. Besides being difficult for roots to penetrate, this can cause seasonal perched water tables, and swamps will form if the hardpan is very shallow.

Farmers largely ignored the Tarwin coastal plains until the 1950s, when it was found that, with the addition of superphosphate, potash, lime, and copper and provision of shallow drains, these soils grew good pasture. Development for grazing quickly followed and now only a few areas remain under the original vegetation of heath and low woodland.

Siliceous sand soils

Where shell fragments were never present in a sand, or have been largely dissolved and leached away, siliceous sand soils will develop. In the study area these slightly acid soils occur on a relatively narrow strip behind Ninety Mile Beach. They are highly permeable, generally infertile, and susceptible to wind erosion if their plant cover is removed.

Small areas have been sown to pasture in conjunction with agricultural development on more suitable neighbouring soils. The remaining areas of siliceous sands mainly carry coastal grassland.

Gradational Soils

Brown gradational soils

These deep, yellow to brown, acid clayey soils with good structure are found on Cretaceous sediments in the Strzeleckis. The texture of the soil changes down the profile from loam or clay loam to medium and heavy blocky clays at 2 m or more.



Brown gradational soil exposed in cutting on Midland Highway near Budgeree East

Such soils are highly permeable and naturally fertile, with some nutrients derived from weathered rock and brought to the surface by roots. The levels of phosphorus, organic matter, and nitrogen decline rapidly with intensive use, however, and the addition of molybdenum is often necessary for pasture growth. The soils used to carry a tall native forest of mountain ash and messmate until large areas were cleared for dairying. Much of this land reverted to scrub when farming proved uneconomic, however, and some has been reforested.

Red gradational soils

These are deep, red, acid clayey soils with good structure (formerly called krasnozems) found on residuals of early Tertiary basalt in the Strzeleckis and around Tyers. In many respects, including nutrient content, they resemble brown gradational soils. Because they 'fix' phosphorus (that is, react chemically with the element to render it unavailable to plants), deficiencies are common, and additions of potassium and molybdenum may also be necessary under agriculture.

Almost all areas of this soil type have been cleared of their original tall forest of messmate and grey gum. Today they are valued for dairying and potato-growing, especially the less steep country, which is more suitable for machinery than the steeper hills of Cretaceous sediments.



Red gradational soil exposed in cutting at Callignee

Duplex Soils

Duplex soils are difficult to classify without intensive surveys, and the following three regional examples have many similarities.

Acid, mottled yellow duplex soils

These soils occur in the Hedley and Hoddle Ranges, east and west of Leon-gatha, on some areas of Mesozoic rocks, in parts of the Powlett and Tarwin vall-

eys, in the catchment of Rintoul Creek, and in the lowlands and foothills on the unconsolidated Tertiary outwash deposits. A thin layer of organic matter may accumulate at the surface.

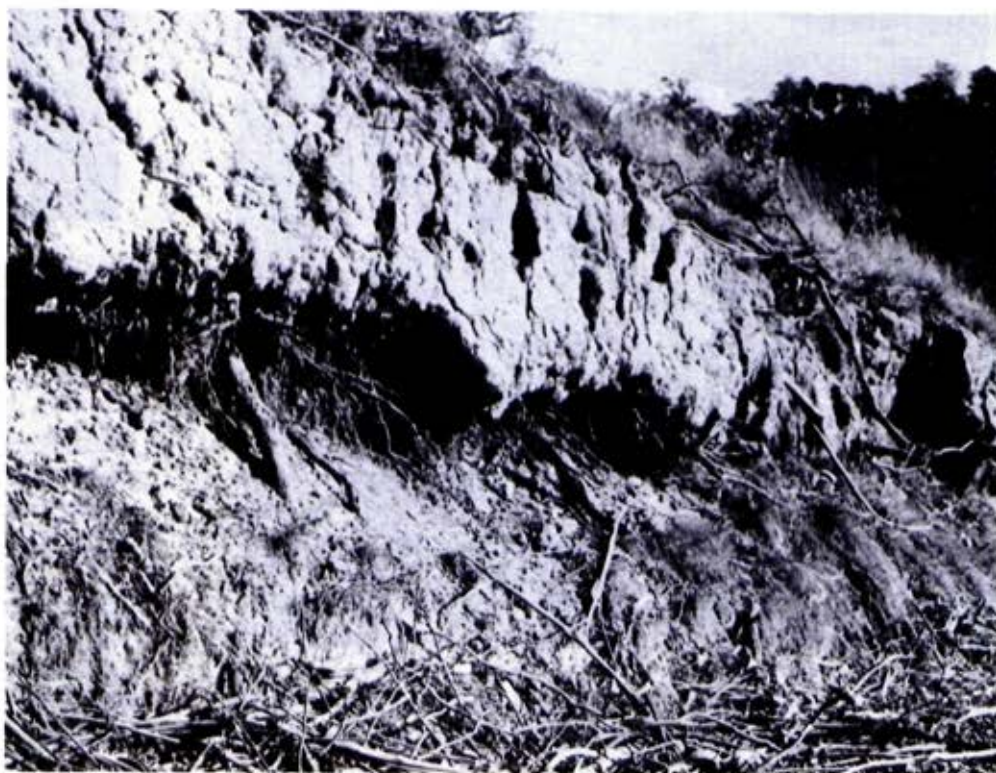
Sandy or loamy horizons overlies a clayey horizon, which is mottled yellow-brown or yellow-grey due to the chemical effects of repeated waterlogging. The boundary is usually abrupt, except perhaps when the upper horizon is sandy. In many soils ironstone concretions occur at this boundary.

They tend to be relatively impermeable, so waterlogging is likely where the upper sandy or loamy layer is shallow. Fertility is often limited, with severe deficiencies of phosphorus, potassium, and nitrogen (offset in pastures by clover) usual.

Neutral, mottled yellow duplex soils

Resembling the last group in appearance, these are found on the plains and downs of the Latrobe Valley. A few areas carry native forest of rough-barked manna gum,

Duplex soils with hard-setting topsoil and finely structured subsoil; developed on Cretaceous sediments in Western Strzeleckis



but-but, and narrow-leaf peppermint, and coniferous plantations are a common form of land use.

Sandy, acid and neutral duplex soils

The contrast in texture in these soils is between loose sandy upper horizons and mottled yellow or yellow-grey clayey horizons. They have developed on sandy parent materials in the Mullungdung and Boodyarn Forests and on the plains east of Woodside. Black ferro-manganiferous nodules and coffee rock may be present in these soils.

These soils are deficient in phosphorus and various trace elements, particularly zinc, copper, and molybdenum, and so are not very fertile. Natural vegetation is low open eucalypt forest, which includes yellow stringybark, Gippsland grey box, yellow box, and but-but. Most of the Woodside Plains have been at least partially cleared and are used for the production of fine wool.

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10. VEGETATION

Although the study area is relatively small and has been widely developed for agriculture, it nevertheless has a wide range of plant communities. Most have been subject to logging, grazing, road-ing, and burning, however, so their present condition differs from that pre-vailing before European settlement.

Vegetation Prior to Settlement

Originally open forest grew on the foot-hills of the Great Dividing Range, in the Hedley and Hoddle Ranges, and in the Strzeleckis proper. Tall open forest occurred where soils were deep and fertile with an annual rainfall of more than 1,000 mm. The sheets of sand and gravel and exposed or very steep slopes carried low open forest with heathy understorey. Much of this vegetation has been cleared.

The valleys of the Latrobe and Morwell Rivers were swampy. Thickets of paper-bark with emergent swamp gums predominated on poorly drained basins, and the drier ridges carried low open forest of manna gum, but-but and narrow-leaf peppermint, which gave way from Traralgon eastwards to a tall woodland of red gum. Practically all of these areas

were cleared for agriculture, but some road reserves still carry samples of the vegetation.

The Tarwin valley also carried large areas of swamp vegetation, interspersed with low open forest of messmate and narrow-leaf peppermint on the more fertile elevated sites, and with heaths on the poorer soil. The majority of this land has been converted to pasture, as have the swamps and heathlands of the northern part of the Yanakie isthmus.

The coastal plain running eastwards from the Hoddle Range across the Albert and Tarra deltas to Merriman Creek, the eastern boundary of the study area, carried a variety of native vegetation. Patches of tall open forest and swamp fringing Corner Inlet in the Foster and Toora areas gave way to low woodlands, heathlands, and swamps from Welshpool and Gelliondale to east of Tarraville.

Inland, on the plains north of Yarram, swamps and tall open forest (including pure stands of blue gum) occurred. East of Tarraville the country was sandier, better drained with a lesser rainfall, and so carried low open forest and woodland. Large areas of coastal vegetation

and non-perennial swamps occurred behind Ninety Mile Beach. Agricultural development, including drainage works, has led to the elimination of most of this vegetation.

Despite wildfires, grazing, and the introduction of the rabbit, the native vegetation of Wilsons Promontory and its offshore islands, and the islands of Corner Inlet, has been little altered compared with that elsewhere in the study area. In contrast, the stands of native vegetation on the plains and foothills surrounding the Strzelecki Ranges have been utilized economically by the community, and only limited areas in the highlands, such as Bulga and Tarra Valley National Parks, reflect the grandeur of the forests of mature mountain ash that grew there last century.

Around 2660 different species of indigenous vascular plants grow in Victoria, with more than 1,000 species in the study area. Twelve endemic Victorian vascular plants are known in the study area (see Appendix 4B), but all are found elsewhere in the State.

Significance of Native Vegetation

Native vegetation is important to land conservation for several reasons. Plants possess intrinsic interest and beauty; they also have great economic and scientific value and make an important aesthetic contribution to the landscape. Most animals depend directly or

indirectly on plants for food, and often for shelter, protection, and nesting places. Since physical features of the site - climate, topography, and soils - largely determine the native vegetation, the nature of the physical environment can often be judged by the type of vegetation present. Plants are also important in protecting soils from erosion.

Classification

The classification of the vegetation on the public land of the study area is used both as a legend for mapping and as a scheme for description. The maps, even at a scale of 1:100,000, can only depict the vegetation generally, but more detailed accounts are given in the block descriptions at the end of this report. The aim of the classification is to facilitate description of the vegetation, and to assist in land-use planning for the area. The classification of native vegetation in the study area is shown in detail on the vegetation maps (Maps 9a and 9b).

The maps were compiled from plans supplied by the Forests Commission, National Parks Service and various other sources. They used a variety of classifications, and the form of these data influenced the classification adopted here.

Structure

Structural forms are the chief means of classification of vegetation, based on

the height and crown density of the tallest stratum. The forms follow the scheme proposed by Specht (1970), but have been altered slightly to suit more closely the regional vegetation being studied. The structural forms are shown in Table 10.

Floristics

Within each category of structural form, commonly occurring combinations of

species have been defined. These groupings, although not based on detailed studies of relations between species, are readily recognizable in the field and indicate certain sets of environmental conditions. In addition to the forms defined under the Specht system of classification, several other categories, including coastal communities and softwood plantations, are used to delineate special habitats in the study area.

Table 10

STRUCTURAL FORMS OF VEGETATION (after R.L. Specht)

Form and height class of tallest stratum	Projective foliage cover of tallest stratum		
	Dense (70--100%)	Mid dense (30--70%)	Sparse (10--30%)
Trees (over 40 m)	Closed forest	Open forest 1V	Woodland
Trees (27--40 m)		Open forest 111	
Trees (15--27 m)		Open forest 11	
Trees (8--15 m)		Open forest 1	
Shrubs (2--8 m)	Closed scrub *	Open scrub *	
Shrubs (under 2 m)	Closed heath	Open heath	
Grasses (0--2 m)		Grassland	

* Vegetation found in fresh-water swamps and along drainage lines.

Open forest IV

Tall forests of mountain ash with dense understorey still grow in the Strzelecki Ranges and on Wilsons Promontory, occupying fertile soils on sheltered aspects where the annual rainfall exceeds 1,000 mm. Clearing for agriculture has greatly reduced their occurrence in the Strzeleckis, but at the beginning of settlement, reports of trees greater than 100 m in height were common. Today the tallest tree in Bulga Park is just over 71 m and has a girth at breast height of 12 m. On Wilsons Promontory, some stands have been destroyed or damaged by wildfires.

Mountain ash has been planted widely on abandoned farmland in the Strzeleckis, and many of these stands now have a dense understorey of species typical of the natural forest: tree-ferns, hazel pomaderris, blanket-leaf, and musk daisy-bush. This recolonization probably developed from pockets of gully vegetation left uncleared by the early settlers, and from seed remaining in the soil.

Open forest III

These forests are found on well-drained, moderately fertile soils in areas where the annual rainfall is between about 650 and 1,000 mm. Messmate is ubiquitous and with two exceptions predominates in this forest type within the study area.



*Tall open forest of mountain ash
at Bulga Park*

The exceptions are the pure stands of silvertop growing at Rintoul Creek, and the forest on the drier south-eastern slopes of the Strzeleckis and on parts of Wilsons Promontory, where the main species is yellow stringybark. Mountain grey gum, narrow-leaf peppermint, and blackwood are also very common in this type of open forest. Blue gum grows with yellow stringybark, white stringybark, and messmate in the Hedley Range.



Open forest of yellow stringybark at Mullungdung

Extensive areas of this forest type, burnt during the 1951 fire at Wilsons Promontory, failed to regenerate and have been replaced by dense scrub of hazel pomaderris.

Open forest II

For various environmental reasons, forests similar to open forest III, but somewhat less tall, occur widely in the

same rainfall zone, again with messmate almost always present.

Extensive areas of this type II forest were burnt in 1951 at Wilsons Promontory but failed to regenerate and so have been replaced by dense scrub of prickly moses.

Other types of open forest II are found in the study area; for instance, the chief species north-east of Woodside is frequently Gippsland grey box. Woodlands of this and other eucalypts such as rough-barked manna gum and yellow box probably grew on the now-cleared plains around Giffard. The annual rainfall in this region is about 550--700 mm.

Open forests and woodland, with yertchuk the main species, are common on the extensive and infertile outwash deposits of Haunted Hills gravels that flank the Strzeleckis. The annual rainfall in these areas is between 700 and 1,000 mm.

The plains and downs around Churchill, Morwell, and Traralgon, except for the wettest sites, were covered with low open forest and woodland of narrow-leaf peppermint, rough-barked manna gum, and but-but. Open forest of snow gum and candlebark grew on swampy sites along the Morwell River.

The annual rainfall in these areas is about 700--900 mm. As the rainfall declined from Traralgon eastwards, this vegetation type was replaced by red gum

woodlands with a grassy understorey similar in appearance to those in far western Victoria; river red gum predominates around Traralgon, with forest red gum becoming more common further east. Although most of this latter vegetation has been cleared for agriculture, remnant stands are found along many roads and railways. Woodland, including narrow-leaf peppermint, rough-barked manna gum, and but-but, also grew on the flats around Yarram.

Open forest I

A wide range of low forests and woodlands is found in the study area.

Yertchuk woodlands are fairly similar to their taller counterparts in the preceding category and are found in the Mullungdung State Forest. Narrow-leaf peppermint, rough-barked manna gum, saw banksia, and other species form a woodland alliance in the same area. Yertchuk woodland (without saw banksia) occurs at Rintoul Creek.

The woodland of rough-barked manna gum, messmate, and saw and coast banksia found on the older dunes on the islands of Corner Inlet is a superb example of coastal vegetation. Similar woodland grows on Gellions Run. The bracken understorey in many of these stands indicates that fires have been frequent.

Shining peppermint, with saw banksia and yertchuk, make up large areas of wood-

land around Giffard, Stradbroke, and Toms Cap.

Silver-leaf stringybark grows in parts of the Mullungdung State Forest, at Yallourn, and in the Tarwin valley on localized sites with poor drainage.

Bog gum woodland occurs extensively south of the South Gippsland Highway between Welshpool and Outtrim, and on Snake Island and Wilsons Promontory.



Low open forest of manna gum grows over parts of Gellions Run



Woodland of silver-leaf stringybark at Monkey Creek

This unusual species is confined to the Victorian coastline (occurring sporadically west of Welshpool to the Portland area) and since it regenerates readily, even on grazed land, it is often found on private property. On Wilsons Promontory, bog gum grows on the margins of swamps as well as on some of the rocky peaks where drainage is locally poor.

Three other types of woodland are recognized on Wilsons Promontory. Saw banksia woodlands are extensive in the drier north-eastern hills. Messmate, brown stringybark, and shining peppermint grow together over wide areas. Blue gum and drooping she-oak form a characteristic

backdrop to the rocky headlands of the coastline.

Saw banksia woodlands occur also in Boodyarn State Forest and at Traralgon South, and red box woodland grows on steep exposed sites along the Tyers River.

Closed forest

There are two types of closed forest in the study area.

The most westerly stands of lilly-pilly in Victoria occur at lower elevations on Wilsons Promontory. The presence of this warm temperate rainforest, conspicuous in the gullies of East Gippsland but absent from the Strzeleckis, suggests that the climate of coastal South Gippsland was once rather more wet and humid than it is at present. Several other species typical of the East Gippsland jungle co-exist with lilly-pilly at Wilsons Promontory; they include blue olive-berry, fragrant fern, jungle bristle-fern, and fieldia.

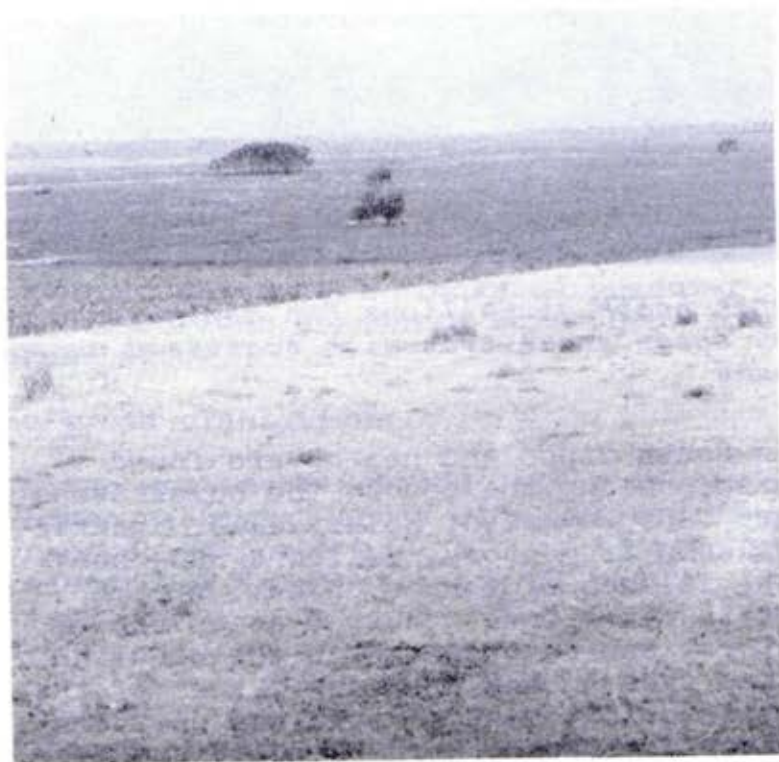
Closed forest of myrtle beech, sassafras, and blackwood grows in sheltered gullies in the eastern Strzeleckis, the best examples being in Tarra Valley and at Gunyah and Turtons Creek.

Coastal communities

The sand dunes of Recent origin, which occur along the entire coastline, carry

grasslands of hairy spinifex and the introduced sea wheat-grass and marram grass. In many areas, however, a coastal scrub of coast tea-tree, coast wattle, coast banksia, drooping she-oak, and common boobialla has now succeeded the grasslands. Point Smythe and Venus Bay offer excellent examples of these vegetational types.

Anderson Inlet, the two Shallow Inlets, and the shores and islands of Corner Inlet have large areas of salt marsh and



Salt marsh at Lake Denison



Open heath on private property at Bald Hill near Walkerville

mangroves (except that mangroves are absent from the western Shallow Inlet). The world's most southerly mangroves occur in the study area. Salt marsh is also found around Jack Smith Lake and Lake Denison.

Heath

Heath consists of low plants with small, leathery leaves and sometimes includes clumps of low trees. It is found on very infertile sites that are often waterlogged in winter and/or very dry in summer. This vegetational type is very rich in species of the genera listed in Table 11.

Table 11

 GENERA COMMON IN HEATHS

Genus *	Common name
Acacia	wattles
Astroloma	heaths
Banksia	banksias
Bauera	baueras
Baumea	twig-rushes
Boronia	boronias
Brachyloma	heaths
Calytrix	fringe-myrtles
Casuarina	she-oaks
Correa	correas
Dillwynia	parrot-peas
Drosera	sundews
Epacris	heaths
Grevillea	grevilleas
Gahnia	saw-sedges
Hakea	hakeas
Hibbertia	guinea-flowers
Hovea	hoveas
Juncus	rushes
Lepidosperma	sword-sedges
Leptorhynchus	buttons
Leptospermum	tea-trees
Leucopogon	beard-heaths
Lomandra	mat-rushes
Melaleuca	honey-myrtles/paperbarks
Patersonia	purple-flags
Platylobium	flat-peas
Pultenaea	bush-peas
Schoenus	bog-rushes
Xanthorrhoea	grass-trees

* Heathlands are also rich in orchids



Open heath at Gellions Run dominated by spear grass-tree with scattered manna gums

In South Gippsland heaths are found mainly along the coast; the chief areas are Cape Paterson, Walkerville, Yanakie, Wilsons Promontory, Gellions Run, and the islands of Corner Inlet. A rich heath flora once occurred as an understorey and in openings in the woodland that grew on the northern flanks of the Strzeleckis; most of this has now been cleared. Heaths burn readily, but have great regenerative capacity through rootstocks and seed.

Fresh-water swamps and drainage lines

Closed or open scrub with occasional emergent eucalypts occurs along streams and on the fringes of fresh-water swamps; the best examples of this vegetation are on the plains in the southern half of the study area.

Cleared land

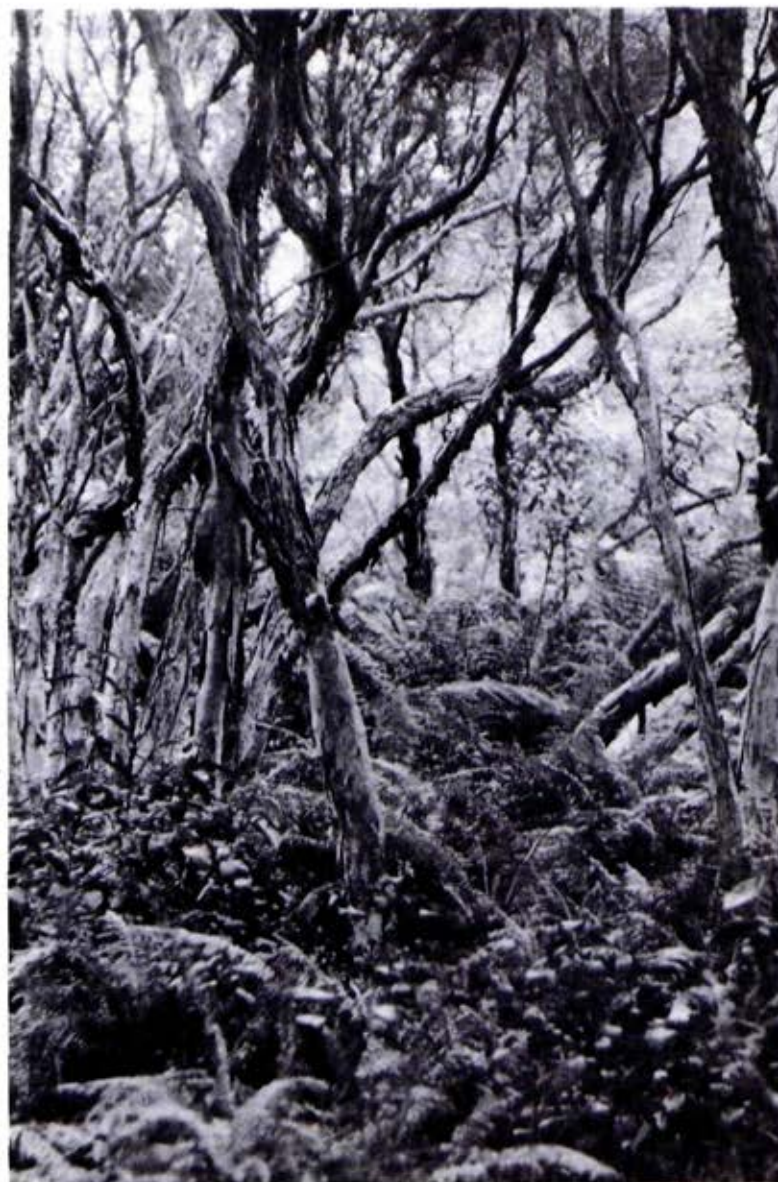
Most land delineated in this category on Maps 9A and B is land recently or currently devoted to grazing. Large areas of the Strzeleckis, however, were cleared for agriculture but eventually abandoned. This land now carries a dense scrub of silver wattle, snowy daisy-bush, common cassinia, and bracken fern, with occasional clumps of blackwood and remnant eucalypts. In some areas, for instance Dingo Creek, extensive stands occur in which tall blackwood predominates on land abandoned some 60 or more years ago.

Softwood plantations

Silver wattle, blackwood, black wattle, common cassinia, and a wide variety of grasses and herbs are able to survive as understorey in plantations of exotic softwoods.

Plant Geography

Since the study area is a temperate and maritime region of generally moderate to high rainfall, few species occur that



Closed scrub of swamp paperbark at Walkerville North

are characteristic of Australia's dry inland. It is, however, located on the axis of the former land bridge that existed between the mainland and Tasmania, and various occurrences of plants in the study area demonstrate that the two land masses were once linked. Other occurrences pose intriguing questions of plant geography.

Except for slightly lower rainfall and a few different species of plants, the Strzelecki Range can be regarded as an eastern counterpart of the Otways. The two have similar geology (and therefore topographic conformation and landscape), maximum altitude, and proximity to the sea. Even so, satinwood (which is found in the Otways, East Gippsland, Tasmania, New South Wales, and Queensland) is absent from the Strzeleckis. In contrast, the related notched phebalium grows in Tasmania and in the Grampians, Central Highlands, and Strzeleckis, but not in the Otways.

Wilsons Promontory, which has around 700 native species, best illustrates the complexities of south-eastern Australian plant geography. It shares much with the hills of South Gippsland, but also has many differences. Three Tasmanian species (oval wedge-fern, island pepper-cress, and cherry rice-flower) occur nowhere else in Victoria. Small shade nettle is found in Tasmania and New South Wales but, in Victoria, only at one locality on Cape Otway and throughout Wilsons Promontory.

The Promontory is the western limit of several species typical of the warm temperate gully vegetation in East Gippsland and coastal New South Wales. These include fragrant fern, blue olive-berry, and lilly-pilly. White kunzea and saw banksia are also absent west of the Promontory (except at Walkerville) and giant honey-myrtle, which is characteristic of the coast from East Gippsland to southern Queensland, though not on the Promontory, grows on Rodondo and Curtis Islands in Bass Strait. These species have probably survived because of the mild oceanic climate.

Coast crimson-berry, found in Tasmania and New Zealand, occurs only on the Promontory and its offshore islands and at Cape Woolamai. Promontory daisy-bush is known only from the Five Mile Road on the Promontory and from between the Wigan and Mueller Rivers in the Croajingolong National Park.

During the Pleistocene, fluctuations in sea level allowed a migration of plant species between Tasmania and the mainland. At other times, the Promontory must have been physically isolated as an island, but, in any case, the swamps and calcareous dunes of the Yanakie peninsula would have acted as barriers to the migration of some species.

Species dispersed from Australia's east coast, such as lilly-pilly, have survived on the Promontory because of the maritime climate.

Plants with their easternmost limits on Wilsons Promontory include coast ballart, paper-flower, ridged ground-berry, blotched sun-orchid, matted bog-rush, and bog gum (apart from an occurrence on Snake Island).

Brown stringybark is common in the Promontory heathlands but absent from similar vegetation elsewhere in South Gippsland. In contrast, several species occur widely in other parts of southern Gippsland but are absent from the Promontory. They include manna gum, narrow-leaf peppermint, broad-leaf peppermint, yertchuk, silvertop, white stringybark, silver wattle, and black wattle.

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11. FAUNA

The broad vegetational types described in Chapter 10 are convenient groupings to use in the description of the distribution of animals. Several additional habitats are also dealt with in this section.

The study area has a broad range of types of vegetation and consequently a diversity of vertebrates: including introduced species, there are 15 species of amphibians, about 25 reptiles, almost 40 freshwater fish, 53 land mammals (as well as seven species of whales and dolphins seen in the coastal waters), and more than 280 birds. Full lists of the species and the habitats they frequent in the study area are given in Appendix 5. This chapter does not give details of invertebrates; unfortunately these animals, despite their importance and numbers, are rarely surveyed. (One famous Gippsland invertebrate, the giant earthworm, has been reported from Boolarra South.)

Habitats

The habitats listed in this section are related to mapped vegetation formations as follows:

Habitat	Vegetation unit
Closed forest *	5
Wet open forest *	1a, 1b, 2a, 2b
Dry open forest *	3a--e
Woodland *	4a--1
Coastal communities	6a, 6b
Heathland	7
Agricultural land	9a, most rural freehold land
Wetlands	8
Softwood plantations	10
Ocean and estuary	
Towns	

* These four together make up the general forest habitat.

Note however that localized features in any environment, such as dense shrubbery, or hollow trees, may be more important to a species than the surrounding vegetation.

General forest habitat

Open forest and woodland cover most of the public land in the study area and support a diverse fauna. Many of the

animal species are widely distributed within the study area, and have no known affinity for particular types of forest. Those species with a definite preference for a particular forest type or specific plant layer in that vegetation are indicated in the following descriptions.

Closed forest. In the study area this only occurs in moist sheltered gullies in the Strzeleckis and on Wilsons Promontory. From the point of view of



Mature tall open forest at Yinnar South; excellent habitat for arboreal mammals

animal habitat it is similar to wet open forest.

Wet open forest. Open forests IV and III can be conveniently grouped as one broad animal habitat. The tall trees, dense layers of shrub and moist, often ferny, gullies provide a variety of niches that result in a diverse fauna.

Dry open forest and woodland. Open forests II and I and woodland together constitute a drier type of forest habitat, which is characterized by shorter trees, a lower and more open understorey, and a shallower litter layer than the category above.

Coastal communities

This category embraces the diversity of vegetational types that occur immediately inland from the beaches and estuaries within the study area.

Heathland

Such a habitat supports a variety of animals, some of which are adapted to the particular conditions of heath and are not found elsewhere. Its important features are the dense low ground cover, occasional clumps of trees, and frequent swampy areas, especially during winter.

Agricultural land

Management has eliminated many of the original species from the area, but some



*Closed heath on Wilsons Promontory -
habitat for the rare broad-toothed rat*

(especially birds) have been able to adapt to the environment, which is usually grassland or a very open woodland.

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

Wetlands

These areas, which are seasonally or permanently inundated by fresh or brack-

ish water, include swamps, reservoirs, lakes and streams. A number of habitat zones can be correlated with water quality, water levels, and the duration of inundation.

Settlement has considerably altered the wetland habitats in the area. Swamps have been drained for agriculture or filled for urban development, dams and reservoirs constructed, and drylands irrigated.

Softwood plantations

Pine plantations cover large areas in the Latrobe Valley and Strzelecki Ranges and, as they develop, provide a succession of habitats that animal species not fully dependent on specific types of native vegetation are able to utilize. Grassland areas that are planted continue to support herbivores for some years until the crowns of the developing pines begin to merge and so suppress the grasses. Native shrubs predominate on cleared shrubland for some years, again until the canopy of the pines closes.

The maturing pine plantation develops a characteristic structure of tall forest with sparse ground vegetation and a thick layer of litter.

The areas of native vegetation retained along streams and other sites within or between planted areas continue to provide a habitat for native animals, some of which use the adjacent plantations in

conjunction with retained native vegetation.

Ocean and estuary

This includes the coastal lands and waters that are subject to tidal influences - beaches, estuarine mudflats and sand flats, salt marshes and mangroves - as well as open oceans and bays.

Fluctuating water levels and high rates of nutrient exchange make the tidal zone very productive of marine invertebrates, which are an important food for many fish and water birds. The shallow water provides spawning and nursery grounds for many marine fish. Adjoining salt marshes and mangroves supply nutrients and prevent soil erosion, and also provide nesting sites for a number of bird species.

Towns

Some native species still find refuge in urban areas in semi-natural gardens and parks within cities and towns.

Birds

General forest habitat

Of the more than 280 native species of birds in the study area, perhaps 100 species frequent forests and woodlands. Some live in the forest exclusively, while others find shelter and breeding space there but forage elsewhere. It is

the availability of food that determines the distribution, since birds are mostly restricted to the environments in which they can efficiently harvest food.

Sources of food for birds in forests include insects in and under the canopy and on the tree-trunks; insects, worms and arthropods in the litter and soil; nectar from blossoms; seed and fruits from trees and shrubs; and, in the case of the larger predatory species, small birds, reptiles and mammals, and carrion.

Insects and invertebrates in the soil constitute the major part of the diet of



White-throated treecreeper

many species in the wetter forests. The number of species feeding on seeds and nectar increases in the drier forests and woodlands.

Most species that feed in a particular level of the forest also breed in that stratum. Some species require specific sites for breeding - for example, hollow

limbs for the boobook owl and kookaburra and dense low thickets in the case of the superb fairy-wren and rufous fantail.

Coastal communities

Two groups of birds frequent this habitat. A wide variety of land birds feed,



*Unobtrusive
tawny frogmouths
resting during
the day*

nest, and shelter in dune scrub, and a number of sea birds breed in the dunes, especially on the offshore islands.

Coast and saw banksia are particularly valuable for nectar-eating birds such as the five species of lorikeets, white-eared and New Holland honey-eaters, eastern spinebills, and red and little wattlebirds. Other species, such as yellow-tailed black cockatoos, crimson and eastern rosellas, and brush bronze-wings, forage in the coastal scrub for seeds, particularly from banksias, tea-tree, and she-oak. In addition, a variety of small insectivorous birds - including grey fantails, superb fairy-wrens, white-browed scrubwrens, brown thornbills, silvereyes (which also eat fruits), and fan-tailed cuckoos - are very common in the denser stands.

Among the sea birds using the coastal vegetation as a site for breeding are the little penguin and short-tailed shearwater, which occur in large numbers on the islands off Wilsons Promontory. The common diving-petrel is less numerous. All of these species construct nesting tunnels in the sand, usually among the roots of vegetation.

Heathland

Of the many species of birds that can be seen frequenting heathlands, only three are confined to the habitat. The ground parrot is found on Snake Island, in the northern part of Wilsons Promontory, and

on Gellions Run, and the southern emu-wren and tawny-crowned honeyeater are commonly observed in heath and in neighbouring low scrub throughout the lowlands of the southern part of the study area.

Because many heathland plants bloom in the winter, a large number of nectar-feeding species migrate there at that time. The seeds of many of these plants are also valuable sources of food.

Agricultural land

Many insectivorous and omnivorous native and introduced birds have adapted readily to this man-made habitat. Of the 40 or so species frequenting agricultural land, most require trees or shrubs for nesting sites, but some nest on the ground. Among the most common are the Australian magpie and magpie-lark, starling, goldfinch, kookaburra, straw-necked ibis, sacred ibis, stubble quail, little raven, Australian raven, common skylark, white-faced heron, welcome swallow, eastern rosella, banded lapwing, masked lapwing, Richard's pipit and willie wagtail.

Certain species migrate to or traverse the grasslands in winter, including the pink robin, flame robin, and scarlet robin. Water birds such as the Australian shelduck, maned duck, Cape Barren goose, black swan, and Latham's snipe may also feed on pasture, especially when it is partly flooded.

Wetlands

Broad shallow expanses of water have the greatest value as habitat for water birds, since they generally do not dive



White-faced herons are found on farmland throughout the study area, on freshwater swamps and along the coast

deeper than 5m. Species such as the darter, great cormorant, little pied cormorant, Australian pelican, musk duck, and little grebe fish in waters between 1 and 5 m in depth, but waters shallower than 1 m are biologically the most productive and often support an emergent flora. The Pacific black duck, Australian shelduck, grey teal, chestnut teal, black swan, and dusky moorhen feed here by dabbling. Wading birds, such as the Pacific heron, white-faced heron, great egret, and yellow-billed spoonbill take yabbies, freshwater snails, frogs, and insects from the margins of the lakes or swamps.

Many water birds use mud banks as nesting areas, and others nest and feed in the scrub and reeds that usually border swamps. The latter group includes the Australian crake, the rare Baillon's and spotless crakes, Lewin's and buff-banded rails, Eurasian coot, purple swampen, clamorous reed-warbler, little grass-bird, the rare Australasian bittern, the rufous night heron, and the golden-headed cisticola.

Predatory birds in wetlands are the marsh harrier, peregrine falcon, whistling kite, and occasionally the white-bellied sea eagle.

The most important wetlands in the study area are Jack Smith Lake, the privately owned Kangaroo Swamp, and the swamps on Wilsons Promontory, around Shallow Inlet, and in the lower Tarwin valley.

Softwood plantations

The distribution of native birds in pine plantations depends largely on the amount of remnant native vegetation. The most common species include those which, in eucalypt forest, feed and nest in the canopies and boles of trees, in the shrubby understorey, and on the ground.

Those found inhabiting canopies in pine plantations include the brown thornbill, golden whistler, and grey thrush, while those living in lower vegetation include the olive whistler, scarlet robin, southern yellow robin, white-browed scrubwren, superb fairy-wren, buff-rumped thornbill, and spotted quail-thrush. The calamanthus frequents shrubby windrows in plantations in the Strzeleckis.

Those species which only nest in hollow limbs and boles of eucalypts do not breed in softwood plantations, although they may regularly forage there.

Ocean and estuary

The diverse geomorphology of the South Gippsland coastline provides a variety of littoral habitats and, consequently, the number of ocean, strandline, estuarine and salt-marsh species in the study area is high.

Around 90 species of birds have been recorded in this habitat.



Peregrine falcon

The oceanic species include albatrosses, giant petrels, gadfly petrels, prions, diving petrels, shearwaters, storm petrels, terns, penguins, and the Australasian gannet. Among the shoreline species are sandpipers, plovers, lapwings, oystercatchers, curlews, and gulls, many of which migrate from their breeding grounds in the Northern Hemisphere to feeding areas along the Australasian coasts during our summer.

Hooded plover and red-capped plover are among the few species that occur on the most exposed sandy beaches. Sheltered



Silvereye, common in towns in the study area

mudflats attract more species in greater numbers. Corner Inlet supports very large populations of migratory waders, which feed at low tide on the extensive mudflats and gather to roost at high tide on secluded islands and beaches. The importance of the area has only recently been appreciated, when a survey in

1979 showed it to be the most important locality in Victoria for these birds.

The estuarine species include grebes, pelicans, cormorants, herons, egrets, snipe, and dabbling ducks. The various salt marshes in the study area harbour the masked lapwing, silver gull, grey teal, red-capped plover, white-fronted chat, little grassbird, and calamanthus.

Towns

Although introduced species (starling, blackbird, song thrush, European goldfinch, house sparrow, common starling, and common mynah) predominate in towns, a range of native species is still familiar to residents. The Australian magpie, Australian magpie-lark, silver-eye, kookaburra, eastern spinebill, white-eared honeyeater, noisy miner, red wattlebird, superb fairy-wren, willie wagtail, scarlet robin, White's thrush, welcome swallow, eastern rosella, and masked lapwing all occur, at least seasonally, in towns in the study area. The current interest in native gardens should attract more species to urban areas.

Mammals

General forest habitat

The forests of the Great Dividing Range, which are within the study area at Rintoul Creek, and those of the Strzeleckis have a more diverse mammalian fauna than

the forests of Wilsons Promontory. The woodlands of the Corner Inlet islands have only up to six species of native mammals.

Eight species of possum have been recorded in the study area.

The eastern pygmy possum is widespread in the forests and woodlands of the lowlands; it feeds on nectar and insects and is the only arboreal mammal native to the islands of Corner Inlet. (The koala was introduced.) The brush-tailed possum is common except in the higher



*Eastern pygmy
possums
inhabit coastal
woodlands*

parts of the Strzeleckis and the drier eastern plains, and feeds on the leaves, buds, and fruit of various trees and shrubs. The larger, darker, Tasmanian form that occurs at Wilsons Promontory could be a relic or may have resulted from introductions early this century.

Bobucks are locally common in wet open forest in the ranges and on Wilsons Promontory (possibly also through introductions). They are vegetarian and forage on the ground as well as in the understorey. The common ringtail is widespread in forest and woodland, and feeds on insects as well as the buds and blossoms of eucalypts and shrubs.

The omnivorous sugar glider is the most common glider; it is locally abundant in the foothills on either side of the Latrobe Valley and on Wilsons Promontory.

The vegetarian greater glider is widespread in wet open forests and in the dry open forests of Mullungdung, but is absent from Wilsons Promontory.

The largely insectivorous yellow-bellied glider inhabits wet open forests at Rintoul Creek; reports from the Strzeleckis are unconfirmed. Feathertail gliders feed on insects and nectar; they are fairly common in the north of the study area, but have not been recorded on the coastal plains.

Leadbeaters possum may once have inhabited the wet open forests of the

Strzeleckis, since it was recorded from the Bass valley around 1900.

The only other arboreal species is the koala. It is common in the Strzeleckis and on Wilsons Promontory, and present at Rintoul Creek. During the early 1900s the population declined greatly - for unknown reasons - but has since built up, partly through releases of animals by the Fisheries and Wildlife Division.

All arboreal species - except the koala, common ringtail, and pygmy possum - depend upon tree hollows for shelter and breeding, and are therefore most abundant in mature forests, and scarce or absent from the regrowth forests and plantations in the Strzeleckis. In contrast, koalas and common ringtails are found in these habitats as well as in mature forests.

The distribution of bats is difficult to determine.

Five bat species have been recorded in the study area and are included in this category for convenience (although some species range much more widely and are found in other types of habitat). The most common are probably the little bat, lesser long-eared bat and Gould's wattled bat. They shelter and breed in tree hollows, and bent-wing bats occasionally shelter in mines, caves, and buildings. All are insectivorous. The chocolate bat may also be present.

Two species of flying fox are occasional visitors to central and southern Gippsland. The grey-headed fruit bat has been recorded at Welshpool and Tyers, and the red flying fox at Glengarry, just outside the study area. The former migrates annually to East Gippsland. These species eat blossoms and fruit of native and exotic plants.

There are many ground mammals in the forests of the study area. The echidna, which feeds on ants, occurs throughout except on the islands. The tiger cat, once common, has only been recorded at Tyers and Ten Mile Creek in the last 20 years. Sightings of quolls on Wilsons Promontory have not been verified. Carnivorous tuans generally frequent dry forest and woodland, but, in the study area, have only been recorded in coastal woodland (at Port Albert and Seaspray).

Brown antechinus and dusky antechinus inhabit forests and woodlands. Although normally distributed coastally, the white-footed dunnart is known also from dry open forest at Traralgon South and Boola Boola. Each of these species of marsupial eats mainly insects and invertebrates.

The two species of bandicoot found in the study area, long-nosed and short-nosed, are also insectivorous. The former is apparently the more widespread and prefers swampy localities, whereas the latter inhabits open forest and woodland with a heathy understorey.

Common wombats are numerous in forests throughout the study area. These herbivorous marsupials were considered a pest when dairy farming was important in the eastern Strzeleckis.

Potoroos are locally common on Wilsons Promontory. They have been recorded on land fringing Anderson Inlet and may have occurred along the whole of the coast within the study area.

The eastern grey kangaroo is common in the lowlands and foothills of the study area, especially in the east and south in forest and woodland close to grazing country. The black wallaby is abundant, especially in forest with dense ground cover. Both the eastern grey kangaroo and black wallaby are found on Snake Island and other islands.

Red-necked wallabies are confined to the drier open forests and woodland in the north and east of the study area.

Bush rats occur in forests and woodland, being locally abundant in densely vegetated gullies. Swamp rats also inhabit this vegetation, especially patches of rushes on the edge of creeks and swamps. The house mouse is found in dry open forest and woodland. The broad-toothed rat is rare and confined to a few small colonies in the forests of the Strzeleckis (and on Wilsons Promontory in heaths). Bush and swamp rats can damage roadside plantations by stripping bark from young trees.



Hog deer move along much of the coast, but their stronghold is Snake Island

Dingoes are probably extinct in the study area although one was sighted north of Rintoul Creek in 1973.

Foxes, rabbits, black rats, and feral cats are common in most areas of forest. European fallow deer were released on Wilsons Promontory and into the Powlett valley in the 1860s. That introduction was unsuccessful, but a herd is becoming established on Sunday Island. Hog deer (from Ceylon) are common on the islands

of Corner Inlet and are seen occasionally along much of the coastline. Sambar deer, an Indian species once common in the Tarwin valley and around Corner Inlet, is apparently extinct there now. Occasionally, however, sambar deer are sighted in the Strzeleckis. Feral goats occur in the Blackwarry area and on Sunday Island.

Coastal communities

Many species frequent the tussock grasslands and scrub along the coast. The echidna, swamp antechinus, white-footed dunnart, short-nosed bandicoot, common wombat, potoroo, eastern grey kangaroo, black wallaby, rabbit, hare, bush rat, black rat, swamp rat, house mouse, fox, and feral cat have all been recorded in this vegetation type. Red-bellied pademelons, collected from South Gippsland in 1851, are now presumed extinct on the Australian mainland, although there are recent unconfirmed sightings on Wilsons Promontory and the species is common on certain Bass Strait (Tasmanian) islands. Swamp antechinus has been recorded on some of the Corner Inlet islands and on Great Glennie Island off Wilsons Promontory, which also supports a larger than normal form of bush rat. Swamp rats inhabit coastal scrub on Snake Island.

Heathland

A large group of mammals is found on heaths: the brown, swamp, and Swainson's antechinus; white-footed dunnart; short-

nosed bandicoot; wombat; potoroo; eastern grey kangaroo; black wallaby; feral cat; fox; bush, broad-toothed, swamp and black rats; house mouse; and New Holland mouse. However, only the latter is confined to this vegetation type. Found solely in regenerating heath and heathy woodland that has been burnt or partly cleared within the previous few years, it has been recorded on Hummock Island (which is south of St Margaret Island).

Agricultural land

Most of the wild mammals in agricultural areas are introduced species. They include rabbits, hares, house mice, black rats, foxes, and cats. The native ring-tailed and brush-tailed possums, eastern grey kangaroo, and a few bat species are frequently found in areas where adequate tree cover remains.

Wetlands

The platypus is common throughout most of the area, including farmland, and in fire dams in some pine plantations, but is apparently now absent from Wilsons Promontory. The animals dig burrows in soft friable riverbank soils for shelter during the day and egg-laying during the breeding season. They feed on aquatic invertebrates such as molluscs, worms, and yabbies, which they obtain by sifting through stream sediments.

The eastern water rat is not common in the study area. It is found in fresh-

water and brackish streams, estuaries, swamps, and farm dams, and eats carrion, fish, yabbies, mussels, and even birds, lizards, and small mammals.

Softwood plantations

Many species that do not have a preferred habitat, or can survive in small patches of native vegetation, have been shown to occur in plantations. Surveys of plantations in north-eastern Victoria and New England suggest the following forest-dwelling mammals would be found at least seasonally in the softwood forests of South Gippsland: echidna, brown antechinus, Swainson's antechinus, brush-tailed possum, bobuck, eastern grey kangaroo, black wallaby, house mouse, black rat, rabbit, hare, fox, and feral cat. Those absent include the species wholly dependent on native forest - for example, the gliding possums, which rely on eucalypt sap and nectar for food and on hollows for nesting.

Ocean and estuary

Four species of seals were formerly common in Bass Strait, with breeding colonies on the offshore islands. Early in the 19th century sealers exterminated the southern elephant seal, the Australian sea lion, and the New Zealand fur seal. The Australian fur seal population was reduced to a very low level. Since then seal populations have gradually increased, although only the Australian fur seal has become common,

with a breeding colony re-established on Kanowna Island. Leopard seals are occasionally seen in Bass Strait.

Today whales are infrequently observed in Victorian waters. The southern right whale was common until whaling began in the early 19th century. Observers note a gradual increase in the numbers of this species near New Zealand, and this could reflect a general increase in the populations in Australian seas. Appendix 5B lists only the species of whales and dolphins that have been washed ashore within the study area.

Towns

Most mammals common in towns are introduced. They include black rats, house mice, cats, and dogs. The two native species still found in urban areas are ring-tailed and brush-tailed possums; occasionally koalas and echidnas come into towns and also various bats.

Reptiles

All reptiles rely on external sources of heat to control their body temperature. Basking reptiles (heliotherms) utilize direct sunshine to raise their body temperature, whereas non-basking reptiles (thigmotherms) remain in suitable sheltered situations and absorb heat from their surroundings. Reptiles therefore need a suitable thermal environment that allows them to maintain normal daily activity. Other require-

ments are a suitable micro-environment in which the reptile can shelter when external conditions are unfavourable, and (for egg-laying species) a warm, dry nesting site.

General forest habitat

In its undisturbed and mature state, tall open forest is too cold and dense to support most reptiles, and only McCoy's skink is common. Reptiles proliferate if the canopy and undergrowth are disturbed by naturally falling trees or clearing, however, especially basking species such as the southern water skink, Coventry's skink, metallic skink, Spencer's skink, blotched bluetongue, copperhead snake, and tiger snake. In lower open forest there is a similar response to canopy disturbance, but fewer species are involved. These include the tree goanna, garden skink, McCoy's skink, weasel skink, eastern water skink, blotched bluetongue, and copperhead and tiger snakes.

Woodlands are similar to low open forest for reptiles. Tree goannas are prominent; other species include the delicate skink, jacky lizard, and red-bellied black snake. Brown snakes occur in the east of the study area.

Coastal communities

Several species are found in this vegetation, including the grass skink, three-lined skink, metallic skink, Bougain-



Tiger snakes frequent streamsides in the study area

ville's skink, White's skink, blotched bluetongue, tiger snake and white-lipped snake.

Heathland

A variety of species - including White's skink, the three-lined skink, garden skink, delicate skink, blotched bluetongue, and copperhead snake - occur in this vegetation. The rare mourning skink has been recorded in wet heaths at Wilsons Promontory and Walkerville.

Agricultural land

Several species are found on farmland in the area, but number and variety depend on local factors such as rainfall, altitude, the presence of remnants of native vegetation, and vehicular traffic.

Wetlands

Long-necked tortoises are found in the Latrobe River and local dams and billabongs, but not in the south of the study area.

Red-bellied black snakes and tiger snakes are common near swamps supporting large populations of frogs.

Softwood plantations

Where there is sufficient remnant native vegetation, plantations support populations of reptiles similar to those in open forest.

Ocean and estuary

The yellow-bellied sea snake and leathery turtle are occasionally recorded offshore. These reptiles are vagrants from the seas off eastern Australia. No reptiles frequent estuaries and tidal flats in the study area.

The offshore islands support unusual communities of reptiles. Eastern water skinks and metallic skinks are found on most, but on Seal Island the former is absent and White's skink and Bougainville's skink are common.

Amphibians

The only native amphibians found in Australia are frogs of the order Anura. Because frogs and toads have only a limited ability to control water loss through their skin, they need freshwater or high humidity for the development of embryos and larvae; their distribution is strongly dependent on precipitation and temperature. Further factors influencing distribution are physiological adaptations to environmental extremes and the availability of migratory paths such as streams.

Appendix 5D lists all amphibians found in the study area.

Fish

The study area contains numerous flood-prone creeks and rivers, most of which

empty into broad, shallow estuaries. The upper reaches typically carry brown trout, blackfish, tupong, galaxiids, pigmy perch, and eels. Bream, estuary perch, yellow-eye mullet, sea mullet, trevally, flathead, and luderick occur in the tidal stretches of rivers and estuaries. The various river systems in the study area are listed below.

Agnes River

Brown trout, galaxiids, and pigmy perch occur in the upper reaches, and the tidal section, which is not very suitable for spawning, supports small numbers of yellow-eye mullet and bream.

Albert River

Brown trout are numerous in the fast water above Staceys Bridge. In the slower reaches downstream blackfish, eels, and a few brown trout occur. The tidal section, which is mainly mudflats, supports a number of estuarine species.

Bruthen Creek

Above Reedy Creek brown and rainbow trout are common; below this tributary the population is mainly tupong and galaxiids.

Darby River

This stream on Wilsons Promontory has only a very small estuary. It is generally blocked by a bar, hence the

salinity in the lower reaches is slight (generally less than 500 mg/l total dissolved solids). Pigmy perch, tupong, and galaxiids are common and there are some blackfish; estuary perch and bream are occasionally caught in the estuary.

Franklin River

The upper reaches are fast-flowing and brown trout are plentiful. The tidal zone extends upstream beyond Port Franklin, so bream, flathead, trevally, and both species of mullet are common. The extensive mangrove flats are an important spawning ground and nursery for several fish species.

Latrobe River

The waters of the Latrobe within the study area are deep, fast, discoloured by silt, and warmed by discharges from the power station. European carp and eels are the main species of fish, with brown trout occasionally above Yallourn.

Merriman Creek

Above Gormandale the creek contains brown trout. Between Stradbroke and Seaspray, Australian bass and grayling occur (both are uncommon, the latter having been declared an endangered species), as well as tupong, pigmy perch, Australian smelt, galaxiids, and eels. The diversity of this population makes Merriman Creek of great environmental

importance. Dam construction, river improvement, or changes in land use in the catchment could threaten this population.

The estuary at Seaspray is small and often closed by tidal action, but it is an excellent spawning ground and nursery for bream, luderick, estuary perch, Australian bass, yellow-eye mullet, and tupong. Salmon, flathead, and trevally are also occasionally caught there.

Morwell River

This stream carries brown trout, eels, blackfish, crayfish, and European carp.

Powlett River

Upstream from the Bass Highway the river is flood-prone and provides only a poor habitat for fish, but the estuary and tidal reaches provide a good spawning ground and nursery for bream and estuary perch.

Tarra River

The upper reaches are fast-flowing, so brown trout are common. Blackfish, galaxiids and pigmy perch are also present. The estuary does not provide a good habitat for fish.

Tarwin River

The upper reaches of the Tarwin are fast-flowing, with brown trout present.

Further downstream, in slower water, tupong, pigmy perch, blackfish, eels, and European carp are also found. The lower reaches and Anderson Inlet are good habitats for estuary perch, yellow-eye and sea mullet, tupong, bream, flathead, silver and black trevally, salmon, luderick, and gummy shark. The river and estuary around Tarwin Lower are fine spawning grounds for estuary perch and bream.

Traralgon Creek

This creek contains brown trout, eels, and crayfish.

Tyers River

The short section of Tyers River within the study area carries brown trout, eels, crayfish, blackfish, and European carp.

Tidal River

Perch, bream, and luderick are common in the estuary, which is an excellent spawning ground for these species. Tupong, galaxiids, pigmy perch, and eels are found upstream; the Australian bass has been reported around the mouth of Lilly Pilly Gully.

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12. LAND SYSTEMS

Distinct environments with characteristic patterns often occur over broad tracts within a given range of climate as part of a wider pattern, and so large areas of land may be described in terms of units, each with a particular range of climate, topography, parent material, and sometimes vegetation.

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

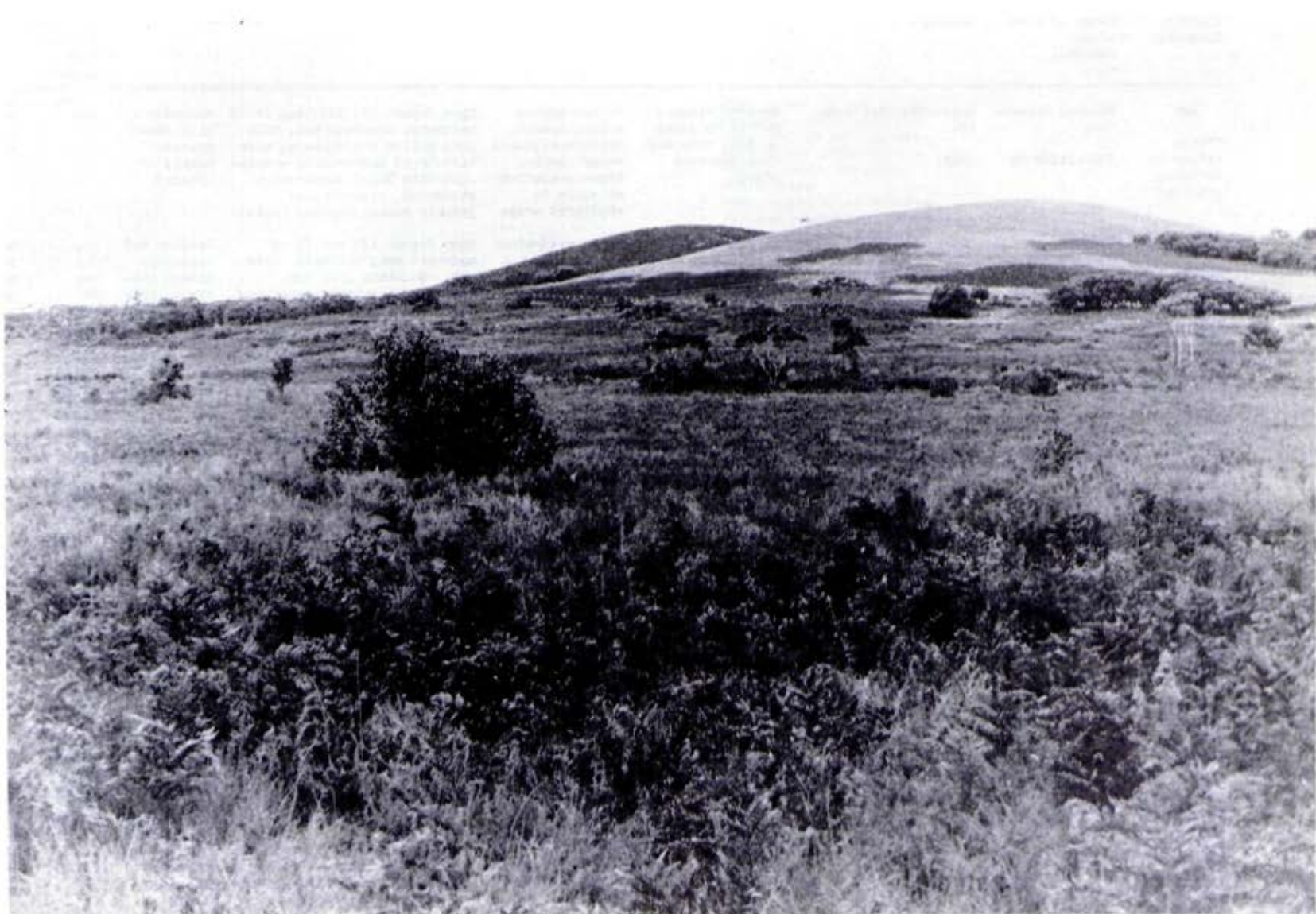
The most detailed and fundamental unit for mapping and description is the *land component*, in which the climate, parent materials, soil, and vegetation are uniform within close limits. Components usually occur in a limited number in a consistent repetitive sequence, and an area containing such a sequence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

A good illustration of a land system and its constituents is the land categorized

as 'Pd' in the Land Systems map. It consists of undulating, occasionally steep dunes of windblown sand, of varying depth, overlying estuarine or flood-plain deposits, or local country rock.

This system contains a number of components.

- a. Gentle dune slopes with acid sandy soils and iron pans at depth, usually covered with manna gum (rough-barked form) and silver banksia.
- b. Steep dune slopes with soils and vegetation similar to the above.
- c. Narrow dune crests with acid sandy soils and poorly developed coffee rock, and vegetation similar to the above.
- d. Broad flats with seasonally waterlogged acid sandy soils and poorly developed coffee rock, usually covered with grass-trees and other heathland species.
- e. Swamps with acid peaty and sandy soils, with varying plant communities, depending on the severity of waterlogging or the depth of standing water.



Public land at Bald Hill shows the typical heathy vegetation that once grew throughout the lower Tarwin valley on soils derived from Pleistocene sediments

Table 12

LAND SYSTEMS

Symbol on map 7 (Land Systems)	Localities Range of mean annual rainfall	Parent material (Symbols on map 8: Geology)	Landforms	Soils	Original vegetation	Hazards	Other systems included to limited extent	Present land use
Dgr (Steep ridges of Devonian granite)	Wilsons Promontory 750--1,500 mm	Upper Devonian granite (Dgr)	Rounded ridges; gentle to steep slopes; tors and rock outcrops common	Yellow duplex soils; coarse, uniform-textured sandy soils; brown gradational soils in sheltered areas	Open forest II, III, and IV of messmate, mountain ash, blue gum, yellow stringybark; wide variety of understorey species including hazel pomaderris, stinkwood, blanket-leaf, prickly moses, hairpin banksia	Moderate to high sheet erosion hazard if cleared	Rdb	Nature conservation
Cs (Steep land on Mesozoic and Palaeozoic rocks)	Eastern Strzeleckis 850--1,500 mm	Lower Cretaceous sandstones, mudstones, siltstones; limited outcrops of Lower Devonian, Upper Ordovician, and Silurian sandstones, mudstones, and shales (Kls; Klb; Dll; Dlt; S; Oug)	Narrow ridges; steep, deep valleys; highly dissected topography	Brown gradational soils in wetter areas; yellow duplex soils in drier areas	Open forest III and IV of mountain ash, messmate, blue gum, mountain grey gum, yellow stringybark, manna gum, narrow-leaf peppermint; understoreys of blackwood, black wattle, myrtle beech, hazel pomaderris, sweet pittosporum, blanket-leaf, tree-ferns	Erosion and landslips hazard moderate; soil creep common	Cu, Tbr, Ts, Ra	Hardwood forestry, softwood plantations, grazing
Cu (Rolling to undulating land on Mesozoic rocks)	Western Strzeleckis, Tarwin valley 750--1,000 mm	Lower Cretaceous sandstones, mudstones, siltstones; limited outcrops of Palaeozoic rocks listed above (Kls; Klb; Dll; Dlt; S; Oug)	Plateau remnants; broad, rounded ridges; moderately dissected topography	Brown gradational soils in wetter areas; yellow duplex soils in drier areas	Open forest II and III of messmate, narrow-leaf peppermint, swamp gum, blue gum; understorey of prickly moses, blackwood, common cassinia, sweet bursaria, austral bracken, forest wire-grass, tree-ferns in gullies	Erosion hazard low to moderate; landslip hazard low	Cs, Ra	Grazing
Tbr (Plateaux and downs of Early Tertiary basalt)	Strzeleckis and foothills 700--1,500 mm	Early Tertiary basalt residuals and associated sediments (Tec; Tvo)	Broad, rounded ridges; gentle to moderately steep slopes	Red gradational soils	Open forest III of messmate, mountain grey gum, manna gum, narrow-leaf peppermint, blue gum (now mostly cleared); understorey of hazel pomaderris, silver wattle, prickly moses, snowy-daisy bush, austral bracken, rough tree-fern	Moderate to high sheet and gully erosion on steep slopes when cultivated; moderate to high landslip hazard	Cs, Ts, TQu, Ra	Potato-growing, grazing
Ts (Moderately to steeply sloping foothills, downs and ridges on Tertiary sediments)	Flanks of Strzeleckis 700--1,000 mm	Late Tertiary gravels, sands, ferruginous sands, clays (Tph)	Hills and slopes of moderate steepness	Acid or neutral yellow duplex soils where parent material clayey; bleached sandy soils with iron pans where parent material sandy	A variety of communities, including: a. Open forest III and IV of mountain ash and messmate - Hallston b. Open forest III of messmate, silvertop, narrow-leaf peppermint, brown stringybark - north of Mirboo North	Moderate to high sheet erosion hazard when cleared and cultivated; moderate gully hazard	Cs, Tbr, TQu, Ra	Hardwood forestry, softwood plantations, protection forests

LAND SYSTEMS (continued)

Symbol on map 7 (Land Systems)	Localities Range of mean annual rainfall	Parent material (Symbols on map 8: Geology)	Landforms	Soils	Original vegetation	Hazards	Other systems included to limited extent	Present land use
Ts (continued)					c. Open forest II and III of messmate, white stringybark, yellow stringybark, narrow-leaf peppermint - Hedley Range, Boodyarn, Mullungdung d. Open forest II of yertchuk, shining peppermint, narrow-leaf peppermint - Gorman-dale, Traralgon South e. Open forest I of bog gum, messmate, narrow-leaf peppermint - Hoddle Range			
TQu (Undulating land on Tertiary and Quaternary sediments)	Flanks of Strzeleckis, Tarwin valley, Mullungdung, Boodyarn, Lip-trap Peninsula 600--1,000 mm	Late Tertiary gravels, sands, ferruginous sands, clays; early Quaternary marine and fluvial deposits; small areas of late Quaternary colluvium, gravel and sand; Lower Devonian sandstone, mudstone and shale (Tph; Qpa; Qrc; Dll)	Undulating terrain with gentle slopes	Acid or neutral yellow duplex soils where parent material clayey; bleached sandy soils with iron pans where parent material sandy; small areas of peaty sands	A variety of communities, including: a. Open forest I and II of bog gum, messmate, narrow-leaf peppermint - coastal plains between Toora and Inverloch b. Open forest II of messmate, yellow stringybark, white stringybark, yertchuk, but-but, Gippsland grey box, manna gum (rough-barked form) - Mullungdung c. Open forest I of mealy stringybark, silver banksia - Monkey Creek, Giffard d. Open forest II of messmate, narrow-leaf peppermint - Tarwin valley e. Open forest II of manna gum (rough-barked form), narrow-leaf peppermint, swamp gum, but-but - foothills of Latrobe Valley, Yarram area	Low to moderate sheet erosion hazard when cleared and cultivated; moderate gully hazard	Tbr Ta Ra Pd	Hardwood forestry, softwood plantations, protection forests
Qa (River terraces and flats on Quaternary deposits)	Valleys throughout study area 550--1,200 mm	Pleistocene and Recent deposits of sand, silt, clay, and gravel (Qpa; Qra)	Modern alluvial terraces subject to flooding; high-level terraces (relics of earlier river systems)	Variable - depends on nature of deposited material and length of time since deposition	Open forest II and III: manna gum, swamp gum, messmate, narrow-leaf peppermint; understorey of silver wattle, blackwood; closed scrub of swamp paperbark in wettest areas	Little erosion under natural cover; where streamside grazing is heavy or river is flood-prone, bank erosion or gully hazard may be severe		Grazing

LAND SYSTEMS (continued)

Symbol on map 7 (Land Systems)	Localities Range of mean annual rainfall	Parent material (Symbols on map 8; Geology)	Landforms	Soils	Original vegetation	Hazards	Other systems included to limited extent	Present land use
Pcf (Coastal flats on Pleistocene deposits)	Coastal plains - Inverloch, Yanakie, Hedley, Yarram Woodside 700--800 mm	Early Quaternary marine and fluvial deposits of silt, clay, and sand (Qpa)	Flats and generally undulating lowlands, often subject to seasonal water-logging	Yellow acid duplex soils and bleached sands with pan	Open forest I and II: messmate, bog gum, narrow-leaf peppermint, rough-barked manna gum	Very low erosion hazard	TQu Pd Rdb	Grazing, protection forests
Pd (Sand sheets and dunes of Pleistocene age)	Lower Tarwin, Cellions Run, Corner Inlet islands, Giffard 600--1,000 mm	Early Quaternary marine and aeolian deposits of siliceous sands, dune limestone, clay, and gravelly clay (Qrd; Qpb)	Sand sheets of varying thickness and low linear sand dunes; swamps and heathlands often occurring in depressions between the dunes	Mostly leached sands with iron pans locally overlying clays	Open forest I: manna gum (rough-barked form), messmate, saw banksia, shining peppermint, white stringybark (Giffard), bog gum (Lower Tarwin, Snake Island), coast banksia (islands); understorey of black she-oak, prickly tea-tree, austral bracken, austral grass-tree	Low to moderate wind and sheet erosion hazard if cleared and cultivated	TQu Rcf Pcf Re	Protection forests, nature conservation, grazing
Rcf (Coastal flats on Recent deposits)	Coastal plains - Lower Tarwin, Shallow Inlet, Yanakie, Port Welshpool, Jack Smith Lake, Seaspray 550--900 mm	Recent silt, clay, peat, and alluvium (Qra; Qrm)	Low-lying flats, swamps (usually now drained)	Variable - undifferentiated stratified clays, silts, and sands, sometimes covered by shallow peats or layers of wind-blown sand	Closed and open scrub: emergent swamp gum, swamp paperbark, scented paperbark, prickly tea-tree, red-fruit saw-sedge, sword sedge, wiry bauera, coral fern	Very low erosion hazard	TQu Pd Rdb Re	Grazing, potato-growing
Re (Estuarine deposits of Recent age)	Coastline, Corner Inlet islands 600--1,000 mm	Estuarine and lagoonal silt, clay and peat (Qrm)	Low-lying flat land along the coast including tidally inundated areas	Little soil development; fibrous peat on stratified clay and clayey fine sand, peaty black clays	Salt marsh: white mangrove beaded glasswort, austral seablite, selliera, sea rush, chaffy saw-sedge	Very low erosion hazard	Pd Rdb	Coastal protection
Rdb (Dunes and beach deposits of Recent age)	Coastline, Corner Inlet islands 600--1,000 mm	Recent dunes of wind-blown sand; beach and estuarine sand deposits; shell beds (Qrd)	Beaches, fore-dunes, secondary dunes; swamps often occurring in depressions between the dunes	Whitish or light brown siliceous or calcareous sands, usually with a thin dark-coloured topsoil	Open forest I: manna gum (rough-barked form), coast banksia, drooping she-oak; closed scrub: coast tea-tree, coast ballart, coast beard-heath, coast wattle; dune grassland: hairy spinifex, climbing lignum, seaberry saltbush; heathland	High wind erosion hazard when vegetation is disturbed	Re	Coastal protection

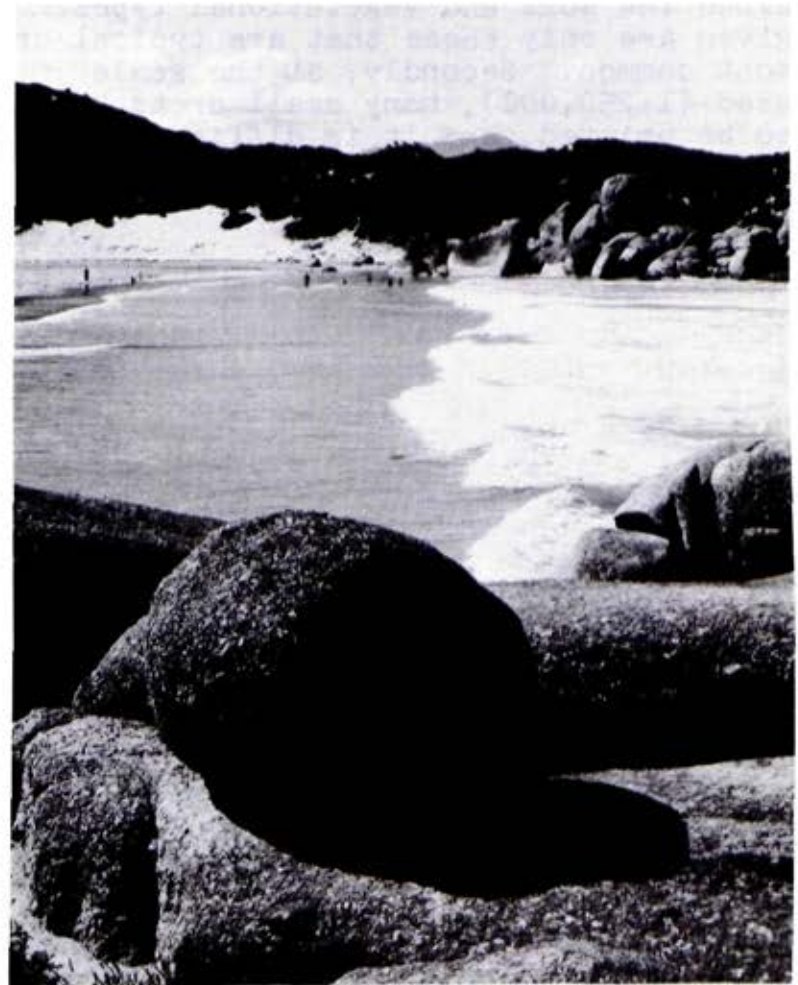
These five components occur together throughout the 'Pd' land system.

Components in any one land system may also occur in another, though usually in different proportions. One land system may also occur in areas too small to be

mapped at the scale being used. For example, in the South Gippsland area, parts of the 'Qa' land system occur as small areas in most of the other systems, while the 'Tbr' land system has minor occurrences in many parts of the 'Cs' and 'Ts' land systems.



The pole-sized regrowth of messmate and mountain grey gum at Yinnar South, in the 'Ts' land system; in contrast (right), granitic tors outcrop in many parts of the 'Rdb' land system on the Wilsons Promontory coastline



The map is only intended to give a broad-scale classification of the land within the study area and should not be used as a soil or vegetation map. There are two reasons for this. Firstly, the Land Systems map groups together areas that are most similar. There will still be variation within that land system, since the soil and vegetational types given are only those that are typical or most common. Secondly, at the scale used (1:250,000), many small areas have to be omitted, and it is difficult to transfer boundaries accurately from aerial photographs.

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PART III

LAND USE

13. LAND USE RELATIONS

The preceding chapters described the natural resources of the study area and discussed potential uses of public land. This chapter considers in turn the interactions between the principal land uses.

Uses are competitive when an increase in one leads to a decrease in another (based on the same set of resources); supplementary when the increase in one does not change the other; and complementary when one's increase benefits the other.

Depending on their relative intensities, types of land use when combined may vary between being complementary, supplementary, and competitive. Generally, the most flexible are those that complement or supplement many others over a great range of intensities.

The more obvious physical or economic aspects of such interactions form only part of land use relations; there are also such effects as social and environmental consequences. It is the sum of these factors that determines the compatibility of various land uses. These interactions, or land use relations, must therefore be considered before dec-

isions can be made regarding the uses of public land. The effects of the present or short-term use of the land must be evaluated, given that future needs may differ markedly. Activities or uses that preclude, by their operation, other forms of utilization of a given resource must also be recognized and considered.

Agriculture

Grazing is the main use of private land in the study area, but there is little grazing on the public land. Some native animals have benefitted from the increased area of grassland and forest margins resulting from agricultural development, and farm dams may have extended the range of some amphibians, reptiles, and birds. Nevertheless, agriculture is normally incompatible with most aspects of nature conservation since most species are severely reduced in number or even eliminated by the removal of their habitat and the introduction of alien plants and animals.

On the other hand, agricultural activities have in many cases added visual variety to the landscape - for example, the bare rounded hills of the western Strzeleckis. In most cases agriculture



Rural subdivision near Traralgon

affects water production; conversion from forest to grassland can alter the volume and timing of run-off, sometimes causing erosion and so affecting water quality.

The use of additional public land for agriculture would therefore compete, in particular, with timber production and most aspects of nature conservation, and to varying degrees with most other forms of land use. Forest grazing may aid fire protection, however, by reducing the accumulation of fine fuels in the forested areas.

Existing agriculture in the study area is now subject to increasing pressures from urbanization, tourism, and recreat-

ion. This relatively recent trend means that demand can force land prices and rates to rise to levels in excess of economic rural values. Farmers on viable properties are therefore placed under increasing pressure to subdivide their land for 'rural retreats' or hobby farms for people from Melbourne and local towns and cities.

Apiculture

The forests around Woodside and Darriman form the main area for beekeeping in the study area. Apiculture may complement agriculture, since the bees serve the useful function of cross-pollination.

Apiculture relies largely on the native flora and so is supplementary to timber production, recreation, water production and some aspects of nature conservation. However, bees do compete with native fauna for nectar and pollen, but the significance of this competition and its ecological effects remain unknown.

Mining and quarrying

As well as the vast open cuts of the Latrobe Valley, there are many quarries and sand and gravel pits throughout the study area.

Open-cut mining for brown coal causes great changes. Native vegetation and wildlife habitat are destroyed by the cut itself and the need to clear adjacent areas. The landscape is greatly

changed, and the regional hydrology is altered to such an extent that subsidence can occur over broad areas. Nevertheless the scale of operations - the gigantic dredges, the long uniform coal faces, the tall smokestacks and cooling towers, and the bulkily symmetrical power stations - has produced a new landscape that many find exciting. In the long term, the area will have to be rehabilitated, at the same time ensuring the conservation of the entire regional environment downstream from the coal-fields to the eastern end of the Gippsland Lakes.

Most conflicts between quarrying and landscape are localized, but they may be



Gravel pit, Calrossie

serious where values are high or the operations obvious. Other aspects that must be closely controlled are road-building, drainage, and, most importantly, rehabilitation of the site when operations have ended.

On the other hand, some quarries provide the opportunity to study the local natural history, and open sites for the collection of fossils and gemstones. Exhausted quarries and open-cut mines are often useful for water supply or rubbish disposal, or as sites for such recreation as trail-bike riding.

Most mining and quarrying is incompatible with timber production, water production, apiculture, agriculture, and nature conservation.

Nature conservation

Nature conservation is generally compatible with a wide range of uses, such as water production, apiculture, and low-intensity recreation and hardwood production. It tends to compete with any activities that radically change the natural vegetation, such as mining, agriculture, urban development or intensive forestry.

Excessive use for recreation is a problem in many areas of value for nature conservation, because these areas are often fixed in the public mind primarily as leisure resources. The other aims of parks and reserves (biological conser-



Some types of native vegetation will deteriorate with excess recreational pressure

vation, landscape preservation, research opportunities) are therefore threatened. Areas set aside specifically for reference must be managed to exclude activities other than limited scientific study. This use is complementary with nature conservation and water production only.

Recreation

Outdoor recreation encompasses a wide range of activities, and their interactions with other land uses vary according to the type of recreation and its intensity.

Some recreational activities actually depend on other land uses. For example, South Gippsland lacks natural lakes and so water storage areas are used for water-based pursuits. Other activities such as golf courses and rifle ranges need their own specialized areas. Some informal types of recreation need natural undisturbed sites, and these compete with all other land uses, except perhaps nature conservation and water production.

A single land use in a particular area may conflict with one type of recreation and yet complement another. For example, an abandoned quarry may mar a panoramic view yet provide an ideal site for gem fossicking or riding trail bikes. Similarly, forestry tracks may reduce the value of an area for nature study, but make it more accessible for picnicking and pleasure driving.

Most recreational activities are relatively flexible, however, and can be accommodated in areas managed primarily for other uses. Nevertheless, some pastimes (such as recreation fishing or the use of off-road vehicles) can become exclusive, especially at high usage rates.

Softwood timber production

Production of softwood timber in plantations is an inflexible land use. It is competitive with hardwood timber production, agriculture, nature conservation and some types of recreational activity. It can also compete with water production, as pine plantations may decrease water yields.

On the other hand, softwood plantations can add visual diversity to an area. Also, because of their relatively open understorey, they provide good opportunities for picnicking, and activities such as orienteering and camping.

Hardwood timber production

Low-intensity hardwood production is carried out in the foothill forests. When the eucalypt plantations in the Strzeleckis become merchantable however, the harvesting there will become more intensive.

Hardwood timber production is a relatively flexible land use, particularly when carried out at low intensity. It is compatible with forest grazing, honey



The relationship of timber production with other forms of land use is complex

production, and all but the strictest forms of nature conservation. It can benefit some forms of outdoor recreation by providing access tracks for walking and driving.

Harvesting operations can immediately degrade vegetation, fauna, and landscape values. Most effects are temporary, but some could be long-term. Tree felling becomes more noticeable as the size of the area increases, and when most or all

of the trees in a stand are cut. In mountainous terrain harvesting may be visible some distance from the actual operation and so, at least temporarily, affects scenic values.

Increasing the levels of hardwood production decreases its compatibility with other uses, such as nature conservation and many forms of recreation. Intensive practices may favour certain commercially valuable species, remove trees containing sites for animal nesting (as these trees are often unmerchantable), limit the size to which trees are allowed to grow, intensify harvesting activities and require the increased use of fire.

Hardwood timber production in certain parts of the study area competes with agricultural production and with recreational activities requiring solitude.

Water production

The production of water is an important use of public land. To some extent it is competitive with agriculture, hardwood timber production, mining, and recreation, depending on the intensity of these uses, the management techniques employed and the intended use for the water.

Activities such as logging, road-making, quarrying, clearing, and grazing can cause soil disturbance and reduce absorption by the soil, leading to

increases in surface run-off, stream turbidity, peak flows, siltation, and erosion.

In many cases, activities using parts of catchments away from storage areas do not pose a substantial threat to either water quality or yield. The use of the land as a catchment is therefore normally complementary with nature conservation and, to varying degrees, with other activities.

Storages, however, can have adverse effects on nature conservation. Inundation by water obviously destroys the original habitat, and the storages may alter flow regimes, affect water temperature and oxygen content, and consequently wildlife habitats downstream.

On the other hand, storages also create an aquatic habitat, supporting fish and waterfowl, and the resulting fishing and hunting. While water storages complement all water-based recreation and lakeside activities, their uncontrolled use may also cause detrimental effects, particularly if they provide domestic supplies.

Three River Improvement Trusts (Latrobe River, Shire of Alberton, and Tarwin River) have been constituted within the study area to carry out works for drainage and flood mitigation under the *River Improvement Act 1948*. Streamside clearing and the construction of channels to allow the faster passage of floodwater

(so as to raise agricultural productivity) can increase erosion and cause a decline in animal habitat (especially for fish and water-birds), affect the growth of remnant native vegetation, and alter the riparian landscape.

Public utilities and transport

Generally the provision of these services requires allocation of small areas of land only, but in most cases this represents an inflexible use.



Powerlines, Walkerville

Due to growing recreational pressures and more interest at a local level in nature conservation, there are increasing problems with waste disposal. Most disposal sites are generally regarded as unsightly, sometimes produce offensive odours, and, if not carefully managed, may have detrimental effects on other uses such as water production.

Cleared easements for transmission lines or gas or water pipes compete with vegetation and some wildlife habitats, and may be unattractive; likewise the measures taken to reduce the risk of fire along transmission lines. Again, telecommunication facilities on peaks or ridges can conflict with scenic and other values, especially when constructed in attractive or remote landscapes.

These services and most others are generally considered essential. However, measures of compatibility with other land uses can be achieved by careful

siting, location, and design to minimize the conflicts.

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14. HAZARDS

In the context of this chapter, hazards are defined as biological and physical processes that threaten the integrity of land and lower its productivity.

To retain such productivity it is imperative that actual and potential sources of environmental degradation are identified and controlled.

Soil Deterioration

Soil and vegetation in their natural condition are usually in a state of ecological balance that is easily upset by human activities. This can then lead to erosion of soil by either wind or water, toxic accumulation of salts in the surface layers, raised water tables, and alterations in soil nutrients and a consequent decline in productivity.

Soil is formed continuously but very slowly from the weathering of parent rock, so any loss of soil from productive land can be considered as permanent. As well as this, soil erosion causes silting and lowers water quality in streams and reservoirs.

In the study area certain regions have serious problems of soil degradation,

but most of these can be solved by sympathetic management.

Types of erosion

There are four principal types of soil erosion in the study area: landslips, and sheet, gully, and wind erosion.

Landslips are common on the red gradational (basaltic) and brown gradational



Old landslips in basaltic country



Gullying near Monkey Creek following clearance of the native vegetation

(sediment-derived) soils of the Strzeleckis. Presumably these areas were prone to instability even before European settlement, as many of the crescent scars and stepped hill slopes typical of this process appear to be hundreds of years old.

Clearing for agriculture has, however, produced a very significant change in their water balance, since much less water is transpired from grassland than from forests. The residual water raises

local water tables and reduces the mechanical stability of the soil, so, in wet years particularly, there is a noticeable movement ('creep') of soil down-slope. Locally - where the soil is very wet, slopes are steep, and trees are generally absent - a sudden landslide can occur.

Sheet and gully erosion are locally serious on duplex soils derived from Tertiary sediments. Some of the worst examples can be seen in the Stradbroke,

Boodyarn, and Bruthen and Bodman Creek areas, where deep sandy upper horizons overlie yellow-brown mottled clays. The sands lack cohesion and so if the native vegetation is removed the surface horizons are readily washed away to expose the similarly vulnerable clays. Some gullies formed in this way are several metres deep.

Contour ripping is practised to prevent gullies forming in young pine plantations, and adequate drainage along roads and around quarries and sandpits also reduces erosion of this type.

Sheet erosion can occur on intensively cultivated paddocks in steep country, for example where potatoes are grown on red gradational soils on the ridges of the Strzeleckis. This form of erosion is not always obvious because frequent cultivation obliterates exposed subsoil. However, sheet erosion always causes turbidity in nearby streams and silt, which includes the most fertile fraction of the soil, may be carried downstream and lost.

Wind erosion is mainly a problem on sand dunes and sheets near the coast when fire, grazing, uncontrolled recreational use, wave action, and other processes damage or destroy vegetation and expose the soil. Management practices protecting the vegetation reduce this hazard.

Isolated bank and bed erosion occurs along many streams, with severe erosion

on Bruthen and Bodman Creek and some of their tributaries.

Salting

Soil salting is localized in the drier pastoral country in the east and north-east of the study area and in low-lying parts of the coastal plains.

Flooding

The most severe general flooding in the area in recent times occurred in 1934--



Steep slopes cleared on private land, Hoddle Range.

35, due to unprecedentedly intense summer rains.

In the Latrobe Valley, flooding can be particularly severe in those areas where major tributaries converge within a short distance, allowing a synchronization of peak flows. In the coastal areas of South Gippsland, high tides and on-shore winds may also aggravate flooding by raising water levels and reducing river discharge to the sea.

The controlled development of towns, flood-plain management, and river improvements have reduced the extent and incidence of flood damage over recent years. Three river-improvement trusts (working on the Latrobe and Tarwin Rivers, and in the Shire of Alberton) try and mitigate floods by, for example, the removal of stream blockages created by fallen timber or excess growth, the widening of channels, and the drainage of river flats, but these activities can also reduce wildlife habitat and scenic values.

Wildfire

Fire risk in the study area varies markedly with elevation and aspect.

There are five zones, delineated as the high regions of the Strzeleckis, the northern slopes and foothills of the Strzeleckis, the southern slopes and foothills, the plains, and Wilsons Promontory.

Because the first zone usually receives more than 1000 mm of rain annually, fires there do not begin easily and rarely burn with a high intensity except during droughts or in extremely hot, dry and windy weather. The fire risk therefore is normally low and fires are infrequent. However, because of the large quantities of fuel on the ground, the sensitive nature of the vegetation, and the difficulty in reducing fuel by burning, an unchecked fire will cause severe damage. Many plants are killed; others are destroyed above ground and must regenerate from their resistant rootstocks. The years 1939 and 1944 were dry enough for severe wildfires to develop in this zone.

The northern slopes and foothills carry extensive softwood plantations and have a high fire risk, because the generally steep topography is exposed to hot dry northerly winds and long hours of sunshine.

The southern slopes and foothills, however, have a low fire risk during most years, since much of the land has a sheltered aspect. Large areas of softwood plantations and mixed-species eucalypt forest grow in this zone.

The plains of the Latrobe Valley carry mainly grassland, and this dries off each summer and presents a severe hazard unless grazed or harvested. The coastal plains are also prone to fire; the characteristic heathy vegetation is



Aftermath of wildfire, Gellions Run

capable of supporting a fire in any season when dry weather and windy conditions prevail.

Wilsons Promontory has a wide variety of climatic types, vegetation, and topography, so some parts are more liable to wildfires than others. The highest risk occurs on the dry heathy plains and low hills in the north, where lightning strikes often start fires. Mountainous sections of the Promontory and the

southern slopes have large areas of bare rock and a high rainfall, and therefore present less of a hazard.

The scale of fire protection required for an area is related not only to climate and vegetation, but also to land use and human activity. In the Strzeleckis proper and on their northern flanks, fire protection is complicated by the fragmented nature of the blocks of public land, the recreational usage of the region, and the increased popularity of hobby farms.

Along the coast the influx of summer visitors, especially campers, increases the risk of fire, compounded by the poor access to many localities. However, the National Parks Service considers that visitors to Wilsons Promontory are fire-conscious, few fires being caused by the public, and also that access within the park is adequate.

Fire history

Little is known of the prevalence of fire before European settlement. Early settlers, however, noted extensive regrowth forest in the Strzeleckis, certainly arising from fires, most probably started by lightning or Aborigines.

Fire was an important tool for the pioneer settlers; they felled or ringbarked trees then burnt them on very hot days. At first the surrounding belts of uncleared forest checked these fires, but

as the grassland now studded with dead trees extended, so the risks from fire intensified.

Catastrophic fires swept the Strzeleckis during the hot, dry summer of 1898.

Table 13 lists most major fires in the study area since late last century.

Over the 15-year period 1962-77, 206 fires occurred within the fire-protected area (public land with a buffer of freehold property of varying width). Of these fires, 37 (18%) were attributed to lightning, 49 (24%) to land-owners or occupiers, 36 (17%) to deliberate lighting, particularly on the coastal plains, and 15 (7%) to escapes from rubbish tips.

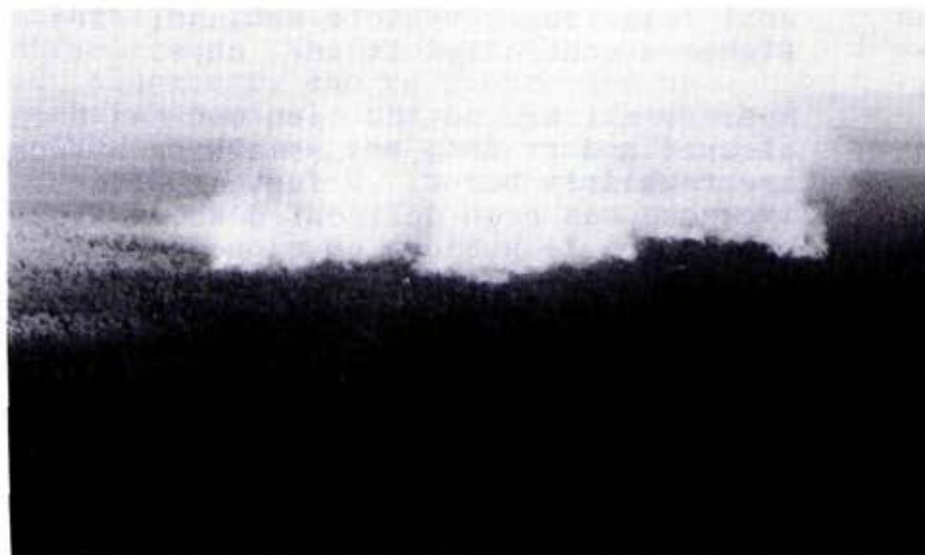
Table 13

MAJOR FIRES IN SOUTH AND CENTRAL GIPPSLAND

Year	Location and extent
1898	Extensive fires in the western Strzeleckis
1900	Yarram district
1901	Alberton West
1906	Widespread fires, particularly Foster to Binginwarri
1908	Wonyip, Gunyah, Boolarong, Hoddle Range, Wilsons Promontory
1919	Blackwarry
1926	Widespread fires - Moe, Traralgon, Yarram, Gunyah
1927	Foster, Wilsons Promontory
1939	Extensive fires throughout South Gippsland and on Wilsons Promontory
1942	Hedley to Welshpool, including Alberton West Forest
1944	Morwell to Won Wron - 13 people died; Yallourn open cut caught fire
1951	Wilsons Promontory
1962	Wilsons Promontory

No major fires have occurred in the study area since 1962 except for the fire at Morwell open cut in 1977.

Protection burning, Mullungdung



Fire protection

Rural fire-fighting bodies organized to respond to outbreaks of fire within the study area are: Forests Commission, Victoria; National Parks Service; State Electricity Commission; Country Fire Authority; and A.P.M. Forests Pty Ltd. In addition, the Department of Crown Lands and Survey has several crews equipped to fight wild-fires. Each of these organizations has the capacity to call in fire-suppression forces from elsewhere in Victoria.

Fire and land management

Fire is used as a management tool for the regeneration of native forest after

utilization, for the disposal of windrows and scrub in the establishment of plantations, and to reduce fuel in areas of natural vegetation.

Fuel-reduction burning is carried out in the mixed-species forests of the foothills to provide an effective barrier to major fires and to protect the boundaries of vulnerable settlements and rural properties, and also the valuable mountain forests and softwood plantations. It also serves to minimize the damage from wildfire within the forests.

Fire on Wilsons Promontory

Limited burning of the bush was practised by settlers on Wilsons Promontory

last century and graziers on the Yanakie isthmus. Wildfires have swept large areas of the Promontory at intervals throughout recorded history; authenticated dates this century include 1906, 1908, 1926, 1927, 1939, and 1943, but the most disastrous fire experienced on the Promontory occurred in late January 1951, when about three-quarters of the park (as it was then) was burnt.

Protective burning is carried out nowadays under close supervision, and extensive slashed fire-breaks are maintained on some of the heathlands. Since 1960 there have only been five small wildfires south of Tidal River. Since 1970, seven wildfires have originated in the north of the park.

Fire and the State Electricity Commission

The fire hazards faced by the State Electricity Commission are unique in Victoria. The open-cut coal mines, with their vast exposed faces, are vulnerable to fire during hot, dry periods, and once burning are very difficult to extinguish. Power lines are vulnerable to grass and bush fires and may be a source of fire themselves.

Two serious fires have occurred in open cuts in the past 30 years, one in February 1944 at Yallourn and the other at Morwell in 1977. The former was caused by wind-blown embers from wild-fires north-west of Yallourn on a day when fires raged throughout the Latrobe

Valley; it took 4 days to control. The latter started when burning particles of coal fell from a vehicle exhaust; fire-fighters controlled it in 2 days.

Most forest around the open cut has been cleared and grazed; any remaining stands are regularly burnt. A further extensive zone has been delineated where fire protection is subject to close consultation between the State Electricity and Forests Commissions. Each open cut also has an extensive spray-watering system.

Along the easements of power-transmission lines trees are cleared and fuel reduced. Because of the State-wide fire hazard presented by transmission lines, the S.E.C. believes that all forms of land use should make full provision for the maintenance of safe easements for power lines.

Weeds

Appendix 6 lists the declared noxious weeds found in the study area.

Noxious weeds are plants proclaimed under legislation, whose spread will lower the productivity of the land, degrade the landscape, harbour vermin, and prevent the regeneration of native species.

Weeds are generally found on farmland and disturbed areas. Undisturbed native vegetation is usually free of noxious weeds, but blackberry, furze, tutsan,

and hawthorn are sometimes found in forests. Blackberry especially is an increasing problem throughout the Strzeleckis. Where plants can be reached, blackberry can be suppressed by certain chemical sprays. Public concern about the use of the most commonly used herbicide, 2,4,5-T, is increasing, however.

Efforts to find a mechanism for biological control of blackberry started in



Outbreak of ragwort on rough pasture, Tarwin East

1977. Two organisms, a stem borer and a rust, show potential. Specificity tests to ensure that these organisms do not harm any crops and native plants will take at least 2 years to complete.

Ragwort, found in areas of higher rainfall, is poisonous to cattle, although sheep can tolerate it for a time. It will invade good pasture, and is widespread on poorer grassland, abandoned farms, and young plantations. It may eventually be suppressed by scrub on derelict land and by mature pines in plantations. The Canadian cinnabar moth and European flea beetle, which have been successfully bred in Victorian laboratories, will assist in the biological control of ragwort if they can be established in the field.

Hedge acacia, which occurs naturally in dry sclerophyll forest in the study area, is included in the list of declared noxious weeds, mainly because it forms thickets that harbour rabbits. Spear thistle, variegated thistle, shore thistle, and perennial thistle can be serious threats to pasture production. Perennial thistle is relatively resistant to weedicides, but the other species can be controlled.

Tutsan is prevalent in the Strzeleckis, and boxthorn is increasingly found in the tea-tree scrub behind beaches.

Several species that have not been proclaimed cause concern in pastoral areas.

These include austral bracken, various heron's-bills, cape weed, dock, bidgee-widgee, fireweed, yarrow, and various buttercups.

Reduction of native vegetation

The gradual clearing of native vegetation on private and some public land is a threat to honey production, as native vegetation is a very important source of food for bees.

Animals

Mammals

Feral cats, foxes, and rabbits are common throughout the study area and all require control, although their populations fluctuate greatly. In contrast, wild dogs are uncommon and hares occur only in small numbers on farms in the lowlands. Roaming domestic dogs, especially in packs, can be a local problem.

When agriculture was important in the eastern Strzeleckis, the common wombat was considered vermin and a bounty was paid on scalps. This species rarely causes problems now and its numbers are increasing.

Kangaroos and wallabies may cause local loss of fodder, compete for water, and damage fencing on properties bordering plantations and extensive areas of native vegetation. Permits to destroy these normally protected species may be



Stand killed by cinnamon root-rot, Mullungdung

granted. Rabbits and wallabies may be a problem during the establishment of hardwood and softwood plantations. Under certain circumstances the Fisheries and Wildlife Division may permit wallabies to be poisoned with the chemical 1080.

Fish

European carp is a species common in the Latrobe and Tarwin Rivers. It discol-

ours the water while feeding, thereby degrading the riparian habitat for other species of fish. Carp are caught commercially to a limited extent in the Latrobe River.

Insects

Attack by the sirex wood wasp on radiata pine in the study area was first reported in 1962. A control program was initiated and has been successful in keeping damage to softwood plantations in the area to levels that do not significantly affect timber production.

The best control techniques used are to maintain stands in a healthy condition by felling susceptible trees during thinning operations and to introduce populations of nematodes and wasps that parasitize sirex. Regular checks are made on the incidence of sirex attack in plantations throughout the study area.

Fungi

Root-rotting fungi

The root-rot fungus *Phytophthora cinnamomi* is the major pathogen known to cause dieback of eucalypts. Sites that are especially vulnerable to the disease are characterized by soils that readily become waterlogged because of poor structure or the presence of a horizon that impedes the movement of soil moisture. The risk of the disease is higher on soils that are also infertile.

P. cinnamomi has become apparent in some parts of Wilsons Promontory and in the northern section of the Mullundung Forest. The numerous pockets of dieback that appeared around 1971 in the latter area followed a summer--autumn sequence of heavier than usual rainfall and subsequent drought, and occurred on sites having poorly drained, infertile soils carrying native vegetation susceptible to the fungus. Studies at Mullundung began that year.

The occurrence of dieback at Mullundung prior to 1971 is not well documented. Examination of aerial photographs taken in 1939, however, has not revealed the presence of pockets of dieback in the forest at that date. The areas of dieback that appeared in 1971 in both Mullundung and Wilsons Promontory have been expanding slowly since then.

Although *P. cinnamomi* has been found in both of these areas, and has been positively associated with areas containing affected vegetation, it is also widespread in many other parts of the study area including farmlands and orchards. Susceptible eucalypts include yellow stringybark, messmate, and yertchuk.

Management techniques can be adopted to minimize the effect of the fungus. For example, care should be taken during logging operations to avoid excessive soil disturbance and the associated run-off, which could otherwise assist in the dispersal of the fungus. *P. cinna-*

momi can also be spread when infected gravel is used for surfacing roads. The Forests Commission tests for the presence of *Phytophthora* in gravel and other soil material on request. Gravel pits used by the Forests Commission and the National Parks Service in the area are tested to ensure that infected material is not used.

Another method of dispersal is by transport of infected soil on the tracks or chassis of heavy machines such as



Expensive measures to protect the shoreline at Foster Beach

crawler tractors. The risk of spreading the fungus can be minimized by thoroughly cleaning machines before they leave an area.

A native root-rot fungus, *Armillaria luteo-bubalina*, has recently been identified as a cause of dieback in a limited area of mountain ash plantation. Although small in extent, its incidence is being monitored.

Wood-rotting fungi

A number of fungi, including *Phellinus setulosus*, *P. badius*, *P. robustus*, and possibly others, cause rot in the heartwood of standing trees and thereby reduce their value for utilization. Mixed species eucalypt forests are mainly affected. Some tree species, including yellow stringybark, show a high degree of resistance to attack while others, such as messmate and silvertop, are more susceptible. The amount of damage is related not only to the tree species but to its age. Degradation is more likely in older trees.

The Coast

The coast consists mainly of cliffs with rocky foreshores, extensive salt marshes and mangroves (from Corner Inlet to McLoughlins Beach), and sandy beaches backed by dunes.

Most of the coastline is public land, due to the vision of early planners, but

Dune buggies at Sandy Point; drivers of recreational vehicles can cause serious erosion and sometimes endanger other people



nowadays many of the coastal areas are over-used.

Destruction of the protective ground vegetation by unrestricted traffic across dunes is the most common form of damage to dune systems. Pedestrians and off-road vehicles, when concentrated, rapidly destroy vegetation along a track, wind blows along this track and breaches the dune, and later wind-blown sand buries leeward vegetation.

Grazing by stock and rabbits will also damage coastal dunes, especially if it

is prolonged, since the natural regeneration of the vegetation is inhibited.

Other causes of disturbance to dune vegetation are wildfire, engineering works, camp sites, roads, pipelines, and the exploitation of deposits of sand. Some dune systems are, of course, naturally unstable, especially near the mouths of rivers where new sand is constantly being deposited.

Revegetation of eroded dunes, the provision of rabbit-proof fencing, or the construction of walkways across individ-



Vandalism at Refuge Cove, Wilsons Promontory

ual dunes may be necessary in popular localities.

A Coastal Management and Co-ordination Committee, comprising representatives of the Soil Conservation Authority, Department of Crown Lands and Survey, Ports and Harbours Division, and Town and Country Planning Board, plans and co-ordinates the management of public land on the coast.

Coastal roads

Scenic coastlines often generate demands for coastal roads. One long-standing proposal in the study area concerns a route from Wonthaggi to Sandy Point. Undoubtedly coastal roads allow full access to the coast, afford pleasing views, and may make possible a wide range of commercial activities and housing construction. They often, however, result in increased fires and vandalism, wind erosion of the dunes and littering; they may also intrude into the coastal scenery as a broad alien ribbon visible from most points. In addition, they generate an expensive demand for toilets, camping facilities, and car parks.

In general, it seems that the environment is better protected when roads are constructed away from the coast, with access to the shore via a series of feeder roads.

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15. NATURE CONSERVATION

Conservation is concerned with Man's relation to his environment. The need for conservation of economic resources is obvious because Man depends on these for many of the necessities of modern life. These aspects of conservation are considered in subsequent chapters under such headings as timber production, water use, and minerals and extractive industries.

Although Man is only one of many species, his dense and rapidly growing centres of population and his ability to manipulate species and environment make him a very influential force. Man has affected - either directly or indirectly - all parts of the study area. Pressure of grazing by rabbits and domestic stock, and invasion by exotic plants, have altered the original grasslands. Timber harvesting has changed the nature of the virgin forest, while the fire regime has also been drastically altered.

This chapter deals with nature conservation - the protection of native species, natural features, and landscapes - and the preservation of archaeological and historic features. Protection of these attributes is important for a num-

ber of land uses, including reference, conservation of species, recreation and education. None of them necessarily monopolizes the land; often conservation needs are compatible with each other or with commercially productive uses of land.

The natural environment has both spiritual attributes, such as inspiring landscapes and remoteness, and physical attributes such as topography, timber, and minerals. Its character comes from the combined effect of all its individual features, and so knowledge and understanding of these, and of their interactions, is essential for effective conservation. 'Naturalness' can vary considerably, being greatest in areas used for reference and less in areas requiring particular management to preserve some endangered species or the remnant of a former landscape.

Use of Conservation Areas

Reference

The solution to problems in land use, such as soil instability or falling productivity, is often helped by refer-



Shallow Inlet. near Waratah Bay

ence to an undisturbed example of that land type. Here the soils, vegetation, and fauna, and the processes linking them, can be studied under natural conditions.

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

Reference areas must be carefully chosen and managed to permit natural processes to continue without disturbance. In common with standards used in other fields, they should not be tampered with; access should be restricted, experimental manipulation should not be allowed, and they should be protected by a buffer zone.

Although all land types need to be represented in reference areas, the need is most urgent in those that have already been extensively developed for other uses. Few, if any, areas suitable for reference remain for some land types in the study area; for instance the red gum woodlands that formerly stretched from Traralgon to Bairnsdale have almost disappeared. Conscious effort must be made to retain reference areas in suitable remnants to represent each land type.

Conservation of species

Each species of plant and animal is a unique assortment of biological characteristics, evolved over millions of years, which makes a contribution to the richness and diversity of the environment. Each is part of Man's natural heritage, potentially offering an enrichment of our knowledge, and many people feel a moral responsibility to ensure that none of them should knowingly be lost or endangered.

Chemists, geneticists, physiologists and scientists in many other fields place a special value on each individual species for its potential to provide the means of solving research problems or act as the stock for breeding essential plants or animals. For example, the genetic diversity of eucalypts must be maintained because of the importance of many species within the genus, both here and abroad, as sources of fuel, timber, essential oils, and shelter.

Conservation of the existing plant and animal species and their associations in their natural habitats is therefore an important land use. The survival of some species may require certain precautions in an area because few individuals remain in existence. In other instances, particular species may be living in unusual habitats, or near the limits of their distributions, and it may be justifiable to devote the land expressly to their conservation. En-



Remnants of red gum woodland, Traralgon

dangered species, or species endemic to the study area, must also be well protected.

Special natural values

Particular areas of land are often needed to preserve such natural values as distinctive geological features. Many of these have great scientific interest, while others are valuable for education. The more accessible and spectacular

features also attract tourists, but unlike historic or archaeological sites these geological features are not protected by any specific legislation in Victoria. It is therefore important that they be satisfactorily preserved in suitable reserves.

The Register established under the *Historic Buildings Act* 1974 does not include buildings or structures on Crown land or on land vested in any Minister. The National Trust of Australia (Victoria), however, records or classifies all historic buildings, landscapes, areas, objects and sites that its expert groups consider worthy of preservation.

The study area also contains a number of Aboriginal relics, mainly along the coast. Since many of these are culturally and scientifically important, some of the more significant sites on public land may need special protection.

Recreation

Most Australians live in the artificial environment of large cities and towns, and many find that their lives are enriched by contact with the natural world. The need for natural surroundings for certain forms of outdoor recreation is discussed in Chapter 16. Bird-watching, nature study, hunting, and bushwalking all require conservation of the native plants and animals; picnicking and driving simply require a background of trees or shrubs in the



*Royal
spoonbill
and young*

recreation areas. These requirements can all be filled in the study area.

Due to the accessibility of most parts of the region, there are only a few areas that most people would regard as having any characteristics of wilderness. Smaller areas, however, can still have value by providing some degree of solitude and contact with nature, and by reducing the pressures on places more suited for conservation of particular natural features or species.

Culture

The preservation of the profound beauty and regional diversity of the natural landscape should supplement our concern for the preservation and display of Man's own finest creations - art, music, building, and writing. Thus we must preserve characteristic Australian scenery and wildlife, particularly as our economic system necessarily encourages the use of exotic plants and animals, often as monocultures.

Education

Education is another important use of land in a natural or near-natural condition. Forests, rivers, and other natural landscapes have many applications in education - from primary to post-graduate levels - giving students opportunities to see natural land forms and observe, interpret, collect, and monitor biological processes. In some cases

laboratory facilities and associated hostels are needed so that successive groups can undertake long-term studies. This may require land to be specifically set aside for education.

Productive uses

Some productive and commercial uses of land are achieved by conserving the natural ecosystems in varying degrees. The commercial product is obtained by harvesting a proportion of the population of a species or group of species, or parts of various plants, at a controlled rate that the ecosystem can sustain. Examples include apiculture, eucalyptus oil production, the sustained yield of hardwood timber, and the conservation of wetlands to produce game birds. The continued success of such uses depends on maintaining many of the natural features of the ecosystem. Land under such management can also be used for education, recreation and scientific purposes, and it may form a protective buffer around small areas specifically devoted to nature conservation.

Viability

Each natural community has evolved within its particular environment, with all the species forming a stable but slowly changing system. Undisturbed, the community represents the best combination and relative abundance of the plant and animal species that can continue to live and compete with each other in the pre-

Grass-tree plain, Gellion's Run

vailing soil, topographic, hydrological, and climatic conditions.

Different natural systems have different degrees of stability. Those containing the greatest variety are the more stable. In some of the most vulnerable, stability depends on some particular facet, such as specialized vegetation; others may have inherent topographic, soil or hydrological weaknesses.

The viability and effectiveness of conservation areas therefore depend on a number of factors, including the size of the area; the type of community, ecosystem or feature to be conserved; the degree to which the area can be managed

to control influences that will upset the natural balance; and the usage of surrounding land.

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

Small areas can nevertheless contribute

to nature conservation or the preservation of particular features. They include narrow reserves along streams, roadsides, and railways, and those originally set aside as gravel, water, cemetery, school, and camping reserves. Where these small areas retain native vegetation, and are surrounded by cleared and developed land, they can make a contribution to the regional character of the landscape. They are also often



The farming district of Allambee East - stand of blue gum on private property and along Grand Ridge Road

the only refuge for many of the remaining native animals.

Narrow strips of native vegetation are valuable for migratory and nomadic birds and as wildlife 'corridors' for small mammals. This is particularly so in those parts of the study area that are predominantly agricultural.

Careful management may enable small areas to remain viable. Management may take the form of using controlled fires to change vegetation, culling animal populations, practising silviculture, strictly controlling the number of visitors, fencing to exclude introduced animals, eradicating introduced species, and preventing rubbish being dumped in the area.

In the past, many such areas have not been properly administered nor have they been well known to the public. Because of this they have not been used as they might have been, nor have they been as secure against alienation or despoliation as they should have been.

Types of Reserves

Many of the uses discussed above are complementary, and this is reflected in the types of reserves into which natural land is placed.

In reference areas, where the emphasis is on the retention of natural conditions, conservation of species and water

production are the only other compatible uses.

Parks, however, encompass a wider range of uses - conservation of plants, animals, and land forms; differing forms of recreation; education; and other uses such as the preservation of important landscapes and historical sites. There are different types of parks, and individual parks are zoned to reduce conflict between uses.

In wildlife reserves, the conservation of species of animals and their habitats is the main aim, and this may sometimes be compatible with recreation.

Education areas may need to be set aside where alterations to the environment for experimental purposes, not permitted in parks, can be carried out. Other types of reserves that may be proclaimed include flora reserves, bushland reserves, streamside reserves, recreation reserves, scenic reserves, and geological reserves.

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16. RECREATION

Outdoor recreation is an important use of public land and a compelling reason for the retention of natural areas.

Besides Wilsons Promontory, the areas that are most popular for recreation are the reserves along the coastline on the shores of Andersons Inlet, Venus Bay, Waratah Bay, Shallow Inlet, Corner Inlet and Ninety Mile Beach.

Traversed by two highways (the major one - the Princes Highway - is an important link between Melbourne and Sydney), the study area also has a frequent rail and bus service to Melbourne. A portion of the study area is close enough for day trips from the capital and the remainder has many popular venues for weekend and longer visits.

Map 11 shows the main natural and historic features of the study area, and the locations of various recreational facilities.

Recreational Resources

Wilsons Promontory

One of Victoria's earliest national parks (it was proclaimed in 1898),

Wilsons Promontory is the most important single recreational resource in the study area. The park totals 49,000 ha, including a portion of the Yanakie isthmus, and all but one of the 15 granitic offshore islands surrounding the Promontory. It preserves some of Victoria's best coastal and mountain scenery, as well as a wide range of plants and animals.

Recreation in the park takes place predominantly around Tidal River, a small settlement on Norman Bay, which has a store, a number of lodges and cabins, and around 500 camp sites suitable for families or groups. Most visitors occupy themselves with swimming, fishing, diving, photography, and walking. Some people camp away from Tidal River for several days, and Sealers and Refuge Coves and Waterloo Bay on the eastern shore of the Promontory are popular destinations. The number of parties is regulated to ensure that these localities are not overcrowded; another area in which numbers are limited (in this instance for safety in case of wildfire) is the north-eastern part of the park. Organized nature study, particularly for children, is becoming increasingly popular.

Apart from the main road into Tidal River, and the road from there to Mount Oberon saddle, vehicular access is limited in the park.

The National Parks Service employs around 60 people at Wilsons Promontory. In 1978--79 there were 102,000 day visitors, and campers spent a total of 256,600 nights in the park.

Islands of Corner Inlet

A group of islands (including Snake, Clonmel, and St. Margaret Islands, but not the privately owned Dog, Little Dog, and Sunday Islands) forms the Nooramunga State Faunal Reserve. While primarily managed for the conservation of mammals (especially hog deer), the reserve is open to visitors with a permit from the Fisheries and Wildlife Division. In addition, fishing parties sometimes land on the islands.

The views from the islands are a particular attraction, as are the superb woodlands of manna gum, messmate, and banksia; the great variety of birds; and the opportunity to observe kangaroos, emu, and hog deer.

Sunday Island is owned by a private group, Para Park Game Reserve Co-operative Ltd, which breeds both hog and fallow deer, and allows controlled shooting of hog deer during the open season. Several houses and a long jetty have been built on the island.



Characteristic rounded hills of the western Strzeleckis

The waters of Corner Inlet are very important for commercial and recreational fishing, and for sea and wading birds. Recreational water craft using Corner Inlet generally put out from Duck Point, Foster, Port Franklin, Port Welshpool, Port Albert, Robertsons Beach, Manns Beach, and McLoughlins Beach.

The remainder of the coast

Apart from Wilsons Promontory and Corner Inlet, the coastline of the study area

consists of long sandy beaches broken in places by estuaries and stretches of bluffs and cliffs. The various towns and settlements are especially popular for summer vacations although the majority of holidaymakers use caravans or tents. Many camping grounds are on public land, usually Crown land designated as coastal reserves under the control of local committees of management: this is often the appropriate Shire Council.

Fishing, swimming, surfing, boating, picnicking, walking and hang-gliding are favoured activities, but ease of access to the coast varies. Along some lengthy sections there are no public roads or tracks to the shoreline.

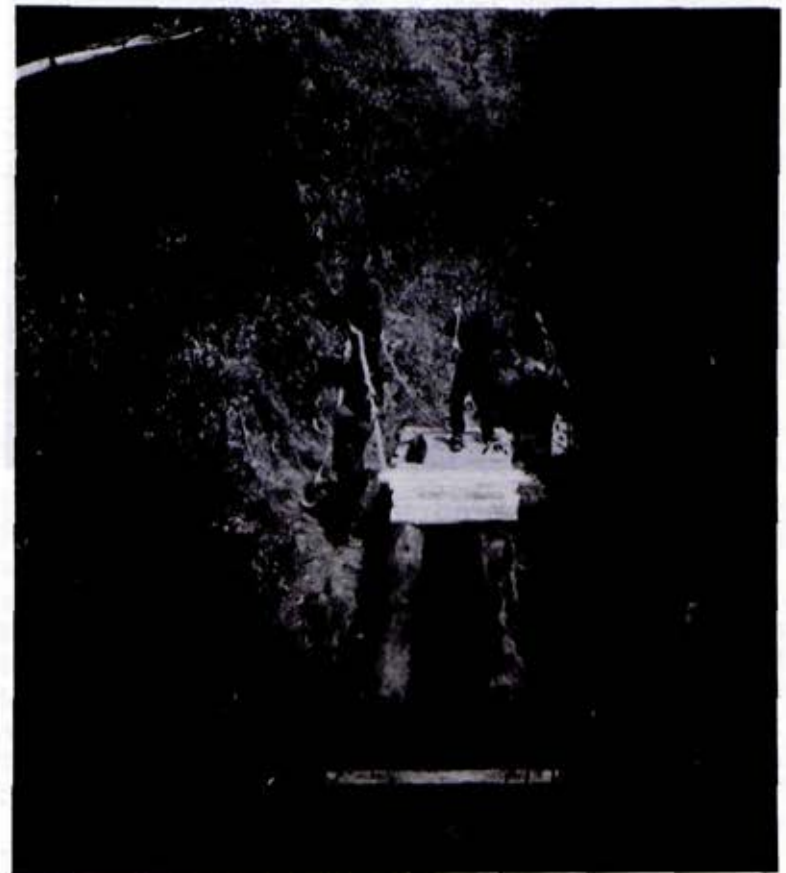
The Strzeleckis

The most popular activities in the Strzeleckis are pleasure driving and fishing in the rivers and creeks; others are picnicking, swimming, blackberrying, nature study, pony riding, and prospecting. Some of the streams attract canoeists.

There are three small national parks in that part of the Strzeleckis within the study area - Bulga (80 ha), Morwell (140 ha), and Tarra Valley (140 ha). Morwell National Park conserves an interesting tract of foothill forest notable for its gully vegetation and birdlife. The other two parks contain examples of the magnificent forest that grew throughout the eastern Strzeleckis before the land

clearing of 70--90 years ago. The abortive settlement of the eastern Strzeleckis for farming did, however, leave a network of roads and tracks that are in general use today.

Four other scenic reserves are popular. Dickies Hill preserves a 20-ha gully of



Bridge construction, Morwell National Park



Tarra Valley, a popular national park in the Strzeleckis

mountain ash in reserved forest near Mirboo North, and the nearby Lyrebird Walk meanders through messmate and gum forest along the Little Morwell River. Roadside reserves at Gunyah Gunyah and Turtons Creek both carry fine ash forest.

Holidays are offered by various farmers in the Strzeleckis; these enable city people to experience rural life.

Latrobe Valley

Various areas of land vested in the State Electricity Commission are used for recreation. The storages at Yallourn and Morwell are venues for boating and fishing; various organizations, including golf clubs, pistol clubs, a scouting group, and an astronomical society lease sites. Witts Gully and Sayers Trig are forested areas used for picnicking, nature study, fishing, and swimming.

The Commission also organizes tours at Morwell and Yallourn for visitors wishing to learn about power generation in the Latrobe Valley. In 1978 some 60,000 people visited the Commission's works areas. There are two special centres for visitors at Morwell and Yallourn and another is planned for Loy Yang. The facility at Morwell has modern audio-visual and other informative displays.

Activities

Pleasure driving

Motoring has increased greatly in popularity as a recreation over the past 20 years, and the Strzeleckis are particularly popular because of their views, wildlife, picnic spots and climate. In addition, the comprehensive roads are well maintained, but most are very winding.

The principal east-west route is the Grand Ridge Road (130 km), which was

constructed during the 1920s and 1930s. The 1925 annual report of the Country Roads Board stated, 'The construction of this road with laterals towards the main Gippsland and South Gippsland railway lines, it is confidently anticipated, will do much to solve the problem of resettling the hill country of South Gippsland'. In the long term, the completion of the road did not halt the decline of agriculture in the eastern Strzeleckis, and it has proved of minor commercial importance. On the other hand, it is a superb drive and affords pleasing views for its entire length.

Various other thoroughfares away from the Strzeleckis are popular with motorists - the South Gippsland Highway, Fish Creek--Walkerville road, Foster--Yanakie road, Inverloch--Cape Paterson road, and the tracks through the Boola Boola State Forest are enjoyed by many.

Little use is made of any public land in the study area for four-wheel-drive touring, but trail-bikes are ridden fairly widely on public land and in private pine plantations. Although they may create a noise nuisance, land managers report that soil erosion is quite localized. The main danger is from accidents; riders have died after collisions on forest tracks in the Latrobe Valley.

Trail-bike 'enduros', motorcross events, and car rallies are occasionally conducted on roads in the Strzeleckis,

including tracks through the forests and plantations.

Camping

Although some camping takes place casually on public land throughout the study area, most is done on special developed sites along the coast. This type of camping is seasonally intensive and closely regulated; it requires the construction of substantial facilities and, during the 3 summer months and over Easter, the employment of staff for supervision and maintenance. Most camping reserves are little used for the rest of the year.

Table 14 gives a complete listing of the various coastal areas used for camping and other activities.

Shooting

Except for Jack Smith Lake State Game Reserve, the study area does not contain any swamps or marshes of State-wide significance for duck-shooting. Often, however, local concentrations of game birds occur on rivers, swamps, billabongs, and dams. Less commonly, snipe are found in these areas, and quail on the Woodside--Giffard plains and in the drier parts of the Latrobe Valley.

Foxes and rabbits are hunted throughout the study area; hares are rare, being confined generally to the drier pastoral country. Hog deer are found along the

Table 14

COASTAL CAMPING AND OTHER ACTIVITIES

Locality	No. of camp sites	Recreational facilities	Comments
Cape Paterson	300	Surf club, toilets, kiosk, parking	Hang gliding, casual camping
Anderson Inlet Inverloch	600	18 toilet blocks, youth hostel, anglers club, yacht club, lifesaving club, boat ramp, parking, jetty	Water supply inadequate to western end of foreshore
Mahers Landing		Boat ramp, parking	To be improved by Shire of Woorayl
Venus Bay		Surf club, toilets	Limited camping
Lower Tarwin	20	Toilets, boat ramp, parking	Badly located between river and road
Walkerville-- Cape Liptrap	154	Boat launching, parking, toilet blocks	Lack of parking for boat ramp
Waratah Bay	180	Boat launching, parking, toilet blocks	Facilities being improved by Shire of South Gippsland
Shallow Inlet	40		Rubbish collection
Corner Inlet (Foley's Road)	20	Toilet block, boat launching	Facilities being improved by Shire of South Gippsland

Table 14 (continued)

Locality	No. of camp sites	Recreational facilities	Comments
Stockyard Creek		Boat moorings	
Port Franklin (Franklin River)		Boat moorings	
Port Welshpool	80	Toilet block, jetty, boat ramp, museum	Facilities being improved by Shire of South Gippsland
Port Albert		Toilets, jetty, museum, boat launching	Caravan park
Manns Beach		Amenities for day trippers - no camping	
McLoughlins Beach		Store, shelter, jetty, boat ramp, amenities for day trippers - no camping	
Wilsons Promontory - Tidal River	500	Store, interpretation centre, showers, toilets, boat ramps, parking	Nature trails, bush walking, swimming, fishing
Sealers Cove	30	All remote camping areas	
Refuge Cove	30	have toilets and	
Waterloo Bay	10	water supplies	
Woodside Beach	50--80	Surf club, toilets, parking	Power connected to some sites

coast wherever patches of scrub are substantial enough to provide cover. They were introduced at Cape Liptrap in 1866, and are fully protected in Nooramunga Faunal Reserve but may be shot elsewhere under the provisions of the *Game Act* 1958 and the *Wildlife Act* 1975. It is likely that a small number of sambar deer live in the eastern Strzeleckis.

School holiday camps

There are a number of holiday camps within the study area or nearby. Some are operated commercially and others are run by school and private groups. The commercial camps are at Mirboo North, Moondarra, Rumbug (Dollar), and Inverloch. Five groups of schools run camps at the sites of former State schools throughout the study area, and another (the Warragul Inspectorate) has a camp overlooking Lake Narracan. Other groups (such as churches and youth clubs) have camps in the study area. Few of these are on public land.

Parties use these camps as a base for recreation and often for educational excursions throughout the Latrobe Valley and South Gippsland, and, in most cases, they also make use of nearby public land for walking, nature study, swimming and orienteering.

Fishing

Map 11 shows the fresh-water, estuarine, and marine recreational fisheries in

the study area. Fresh-water fishing has been assisted by the construction of various dams for water supply, but degraded by the introduction of European carp, which have spread widely from a private liberation at Boolarra in the late 1950s. A further source of concern are the severe infestations of blackberries along many streams, which restrict or prevent access.

With the greater opportunities for anglers to purchase power boats, fishing in the estuaries, inlets, and bays has become much more popular. In addition, charter boats are also available at some ports.

Boating

The use of inland waters in the study area by recreational craft is confined to canoeing on a few of the streams, and a variety of boating activities on Lake Narracan and the Hazelwood Cooling Pondage.

Few watercourses are suitable for canoeing; most are too shallow and lack navigable rapids, but sections of the Latrobe River are picturesque and an annual race is conducted on the lower Tarra River.

The two storages in the Latrobe Valley are popular for sailing, water-skiing and power-boat racing. Because the pondage contains heated water discharged from Hazelwood Power Station it has be-



Chartered cruiser anchored in Refuge Cove, Wilsons Promontory

come a venue for winter racing, the most notable being the annual 'Sauna-sail'.

Nature study

Various tracts of public land in the study area offer interesting opportunities for the study of natural history. Besides the four national parks, there are three special reserves in State Forest, the State Electricity Commission

leases land near Yallourn to a field naturalists club, the Lands Department has reserved a number of areas to protect wildflowers and roadside scenery, and both the Nooramunga and Jack Smith Lake wildlife reserves have a rich fauna. The latter two are less frequented by visitors.

A list of other localities in the study area with diverse natural features includes Point Smythe, Walkerville, Sandy Point, Wilsons Promontory, Corner Inlet and its islands, Jack Smith Lake, Mullungdung State Forest, Hallston Bush, the heads of Traralgon and Turtons Creeks, and areas around Gunyah and Balook.

Orienteering

An orienteering group in the Latrobe Valley holds occasional competitions on public land.

Bushwalking

Apart from Wilsons Promontory and the various reserves in the Strzeleckis there are few parts of the study area popular for bushwalking.

Horse-riding

Horse-riding is a popular hobby for children throughout the study area. Various groups conduct trail rides through the Strzeleckis, and the Forests Commission has marked a pony trail through the Morwell River plantations.

Walkerville combines scenery and history - these lime kilns have been classified by the National Trust



Surfing

The best surf beaches in the study area are on and west of Wilsons Promontory - unfortunately sharks are more common here than in other coastal waters. The Ninety Mile Beach, although popular for swimming and fishing, is too open for good surf and only occasionally has suitable waves. Surf clubhouses are sometimes located in the seaward dunes, a situation that can lead to erosion.

Hang gliding

Hang gliding is mainly practised off the cliffs between Cape Paterson and Inver-

loch. Enthusiasts tend to concentrate in certain favourable locations and so cliff-top vegetation is often damaged.

Fossicking

Gold fossicking takes place on a small scale at Foster and Turtons Creek and gemstones are sought at Walkerville. Some prospectors have damaged gully vegetation by excessive clearing; others are very careful to protect plants.

Historic buildings

Table 15 lists the landscapes, buildings and structures recorded or classified

Table 15

CLASSIFIED LANDSCAPES AND STRUCTURES IN THE STUDY AREA

Name	Classi- ficat- ion	Date of origin	Name	Classi- ficat- ion	Date of origin
<u>Alberton</u>			<u>Port Welshpool</u>		
'Hawthorn Bank', Pound Road	CNH	1850	'Crescent', Turnbull Street	CN	1873
<u>Ninety Mile Beach</u>			<u>Tarraville</u>		
Marilyns Beach (between Reeves Beach and Woodside Beach)	N		Christ Church	CN	1856
Vicinity Jack Smith Lake	N		<u>Traralgon</u>		
<u>Port Albert</u>			'Hollydale' (homestead)	C	1898
House (former Bond Store)	CN	1845?	Traralgon Hotel	CN	1914
Immigration Depot, South Street	CN	1857--58	Court House and Post Office	R	1886
Post Office	CN	1864	'Fernhill' (homestead)	R	1871
Store (formerly Derwent Hotel), corner Wharf and Victoria Streets	CN	1858	<u>Waratah Bay</u>		
Maritime Museum (form- erly Bank of Victoria)	R	1861	Lime kilns	C	1870--
			Landscape of Waratah Bay	C	
			<u>Wonthaggi</u>		
			Landscape of Powlett River and estuary	C	

C Classified by National Trust

R Recorded by National Trust

N Included in Register of the
National EstateH Listed by Historic Buildings
Preservation Council

by the National Trust of Australia (Victoria).

Although European settlement of South Gippsland dates from the 1840s, the region has a limited heritage of Victorian-style architecture. Port Albert, the general area of the earliest habitation, has the oldest standing buildings and retains some of the atmosphere it had when almost all of Gippsland's trade passed across its docks. The nearby



Yarram's fine Federation-style courthouse

Tarraville church, and the later hotel at Alberton built in 1890, indicate early civic cohesiveness and a gradually acquired prosperity during the rest of the century - the affluence of the 1880s is also reflected in the substantial farmhouses around Yarram.

In the Latrobe Valley grazing flourished on the red gum plains east of Traralgon, and pastoralists built handsome Victorian homesteads around Flynn and Rose-dale. Towns like Moe, Morwell, and Traralgon remained small and dormant, although the latter's striking post office and courthouse must have conferred municipal prestige.

Local timber was widely used on farms - a few barns and sheds, and many lengths of post and rail fencing, remain from this period. Early buildings in the Strzeleckis were also wooden and of slab construction. Due to subsequent bushfires and a low natural durability of the local timbers, almost none have survived.

Construction of the Great Southern Railway brought the fine Korumburra station and monumental rock cuttings and timber bridges (especially the one over the East Tarwin River near Koonawarra).

By the 1900s the best hill dairy farms had reached a high level of productivity. The resulting prosperity is reflected by the sturdy Federation (*Art Nouveau*) hotels and public buildings in towns

like Foster, Leongatha, and Yarram, and numerous houses of late Victorian or Federation style on farms located on the belts of fertile soil.

More broadly, dairy farming had imposed a characteristic landscape on much of the study area - rolling green hills studded with huge dead stags and sporadic clumps of blue gum, remnants of the primeval forest gradually being replaced by straight shelterbelts of radiata pine and cypress; hills subdivided into 100-acre allotments, each with its cottage, orchard, and galvanized iron cowshed alongside the road; a butter factory at the centre of each hamlet.

The 1920s and 1930s brought a few new schools in the Art Deco style throughout the study area, the pleasant new town of Yallourn, and the first tall industrial smokestacks to the Latrobe Valley.

After World War II, the Latrobe Valley towns started to sprawl, first by means of peripheral Housing Commission estates, the beginnings of a process of physical and social fusion that is gradually reducing parochial differences and uniting the separate communities.

Along the coast and in the Strzeleckis the towns have changed little, except for expanding Inverloch and Cape Paterson and their associated outlying clusters of holiday houses.

A new element in many rural districts is

the hobby farm, often comprising a substantial suburban or countrified dwelling with concrete water tank and native garden, set in 5, 10, or 20 ha of former farmland.

Museums

In South and Central Gippsland there are two well-established and popular outdoor folk museums. Coal Creek at Korumburra has as its theme the black coal mining of late last century, while the Gippsland Folk Museum at Moe includes a variety of exhibits on provincial activities and industries. There is also a proposal for an outdoor museum at Wonthaggi to preserve relics of the town's black coal mines. Other towns in the study area with museums are Foster, Port Albert, and Port Welshpool.

Tourism and the Economy

Government initiatives

The Department of State Development has a Division of Tourism that assists tourist projects, and the promotion of travel generally within Victoria. It allocates subsidies and loans to various governmental bodies, including municipalities. In addition, the Division has fostered a number of Regional Tourist Authorities, which link State and local government with companies in the travel industry. These authorities produce literature, provide local information to visitors, and generally encourage the de-



The Forests Commission has constructed many roadside picnic areas

velopment and maintenance of facilities and attractions.

The State Government provides annual grants to cover part of the authorities' running costs and may also make available money for the promotion of regional tourism. Each authority is run by a committee of six to eight persons; half are from local councils and half are from the travel industry.

The study area lies within the zone of responsibility of the Gippsland Regional Tourist Authority, which is based at Drouin.

Recent statistics

Table 16 gives statistics relating to tourist attractions in Central and South Gippsland.

Future demands

The increasing cost of fuel in Australia is likely to reduce the use of motor vehicles for recreation. The extent of this reduction is hard to predict, as is the time span involved.

European observations suggest that, no matter what the cost of fuel, private motorists are likely to continue to take their cars on their annual holidays, even if they are compelled to reduce their mileage during the rest of the year.

It appears that, in future, recreational use of land within and close to cities and towns (especially land handy to public transport) will increase greatly, and that visits to many of the large, distant national parks and other natural areas at present prized for their recreational quality may not be substantially diminished.

On the other hand, venues of intermediate distance (perhaps 2 to 3 hours

Table 16

STATISTICS OF TOURISM

<u>Coal Creek</u>	1977 & 78	155,000 visits in 2 years	<u>C.R.B. road counts, Princes Highway (iv)</u> (12-hour periods)		
			Drouin	March 1977	4,438
<u>Gippsland</u>				March 1978	5,731
<u>Folk Museum</u> (i)	1977	45,770 visits	Rosedale	March 1976	2,536
	1978	38,347 visits		March 1977	2,626
				March 1978	2,889
<u>S.E.C. Works</u>	1977	54,288 visits	<u>Accommodation</u> 1977 September (i) (bed-nights quarter 33,477 in G.R.T.A. December area) quarter 39,197		
<u>Areas</u> (ii)	1978	59,705 visits			
<u>Wilsons</u>	1976--77	340,977 visits (12 months)		1978 March	49,900
<u>Promontory</u>				quarter	
<u>National</u>	1977--78	351,400 visits (12 months)		1979 June	41,864
<u>Park</u> (iii)	1979--80	226,615 visits (8 months)		quarter	

Sources: (i) Gippsland Regional Tourist Authority; (ii) S.E.C.V.; (iii) National Parks Service; (iv) C.R.B.

drive) from centres of population (which are often visited by motorists at present) may become much less important for leisure.

This is the view of S.M. Gold, writing on recreation. He notes that in the United States about 30% of all private vehicular mileage is related to recreation, much of which is to allow people to leave their neighbourhood and travel to a regional park or other facility. Whether his speculations are relevant to Australia is difficult to say.

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17. WATER UTILIZATION

Domestic, Industrial, and Rural Demand Resources - a summary

The Latrobe and Tyers Rivers run through the northern part of the study area.

The other important streams can be collected into two groups. The first comprises those that drain the northern slopes of the Strzelecki Ranges and flow into the Latrobe River. This group includes the Morwell River and Traralgon and Flynn Creeks, and has a total average annual flow of some 180,000 ML. The second group comprises those running coastwards from the southern slopes of the Strzelecki Ranges and from the mountains of Wilsons Promontory. They include, from east to west, Merriman Creek; Tarra, Albert, Agnes, and Franklin Rivers; and the largest southern stream by far, the Tarwin River. The average aggregate yearly flow is 430,000 ML (as measured at existing gauging stations, some of which are well upstream in the catchments).

Water quality is excellent and salinities are low in the higher parts of all catchments. Pollution reduces the quality of the water in the lower reaches of

most streams, especially the Latrobe River.

The plains and foothills surrounding the Strzelecki Ranges have large reserves of groundwater of varying quality. In some localities, this groundwater is suitable for domestic use.

Large storages

In the past there has been little demand for large water storages within the study area. The only storages are those that have been constructed in the Latrobe Valley, primarily to serve the power stations at Morwell and Yallourn, but also to supply local industries and towns.

In 1964 a basin came into service at Morwell, adjacent to Hazelwood power station. The pondage holds 31,000 ML, which is required continuously for cooling during power generation, and is kept filled from local creeks and aquifers, as well as from Moondarra Reservoir outside the study area.

In 1962, the Latrobe River was dammed upstream from Yallourn to form the 8,000-ML Lake Narracan, the waters of



*Site of Blue Rock dam on
Tanjil River*

which are used by the Yallourn power stations.

Elsewhere in the study area the construction of large storages has not been necessary. Because of the reliable rainfall, many towns have been able to draw water directly from nearby streams,

and irrigation has been practised locally on a small scale only, again drawing from streams.

In 1968--69, due to an increased demand for water for stock, domestic, and irrigation purposes, the State Rivers and Water Supply Commission carried out an

investigation into the possibility of constructing a storage on the Tarwin River. This project has not proceeded, as it is not economically feasible at this stage.

Map 5 shows the utilization of water throughout the study area.

Latrobe Valley water supply

The Latrobe Valley Water and Sewerage Board built Moondarra Reservoir in 1962 on the Tyers River below Gould township, which is now submerged. Lying outside the study area, it is the main water storage for the Latrobe Valley and holds 30,000 ML.

Construction has commenced of the 75-m-high wall for a 200,000-ML reservoir on the Tanjil River at Blue Rock near Willow Grove to augment water supplies to the Latrobe Valley. The State Rivers and Water Supply Commission will bear half the cost and oversee the project; the State Electricity Commission will pay the remainder.

Half of the water released from the dam will be available to the State Electricity Commission, diversion taking place from either the Tanjil River or the Latrobe. The balance of the yield will be allocated for river freshening and maintaining minimum flows in the Latrobe River, and also for domestic, irrigation, and industrial uses. Moe Waterworks Trust has been allocated 1,000 ML

annually, and a further 10,000 ML have been allocated to consolidate and expand irrigation by private diversion within the river basin.

The State Rivers and Water Supply Commission will formulate policy on the management of this water and the Latrobe Valley Water and Sewerage Board will operate the reservoir and distribution network.

Latrobe Valley Water and Sewerage Board

Besides taking responsibility for supplying much of the Latrobe Valley with water, this board provides disposal facilities for sewage and industrial waste, and acts as an agent for the Environment Protection Authority in the control of all forms of pollution throughout central and eastern Gippsland.

Originally, it was established to deal only with industrial effluents. From 1956 to 1970, before the advent of natural gas as a domestic fuel, town gas was generated from brown coal at Morwell by means of the Lurgi process. The Latrobe Valley Drainage Board was set up in 1952 to construct disposal works to prevent streams being polluted by wastes from the gas plant and other nearby industries.

In 1953 the *Latrobe Valley Drainage Act* 1951 was amended to make the Board responsible for water supply also. The organization was constituted in its

present form, and with its present title, in mid 1954 and at the moment has a staff of 140.

Urban domestic supplies

Most towns within the study area are served by waterworks trusts - statutory bodies composed of local commissioners - which operate their own storages and distribution networks. Wonthaggi, Cape Paterson, and Inverloch, however, are served from a State Rivers and Water Supply Commission reservoir at Lance Creek; Churchill, Morwell, Traralgon, and Tyers draw water from Moondarra; and the State Electricity Commission supplies water to Yallourn, Newborough, and Hernes Oak. Excluding Wonthaggi and Cape Paterson, where the State Rivers and Water Supply Commission controls the entire system, and Yallourn, in all of the above towns local trusts distribute water. Table 17 details all urban water supplies.

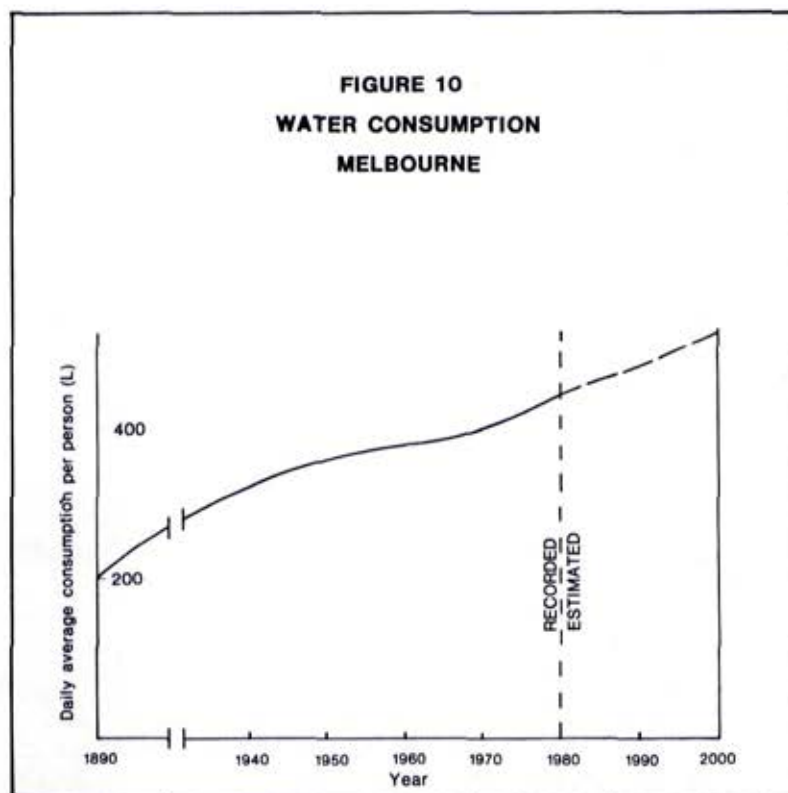
The two urban centres using the most water annually are Morwell--Churchill--Yinnar (3,356 ML) and Traralgon (2,404 ML).

Most town water supplies within the study area are chlorinated for domestic consumption.

Future domestic demand

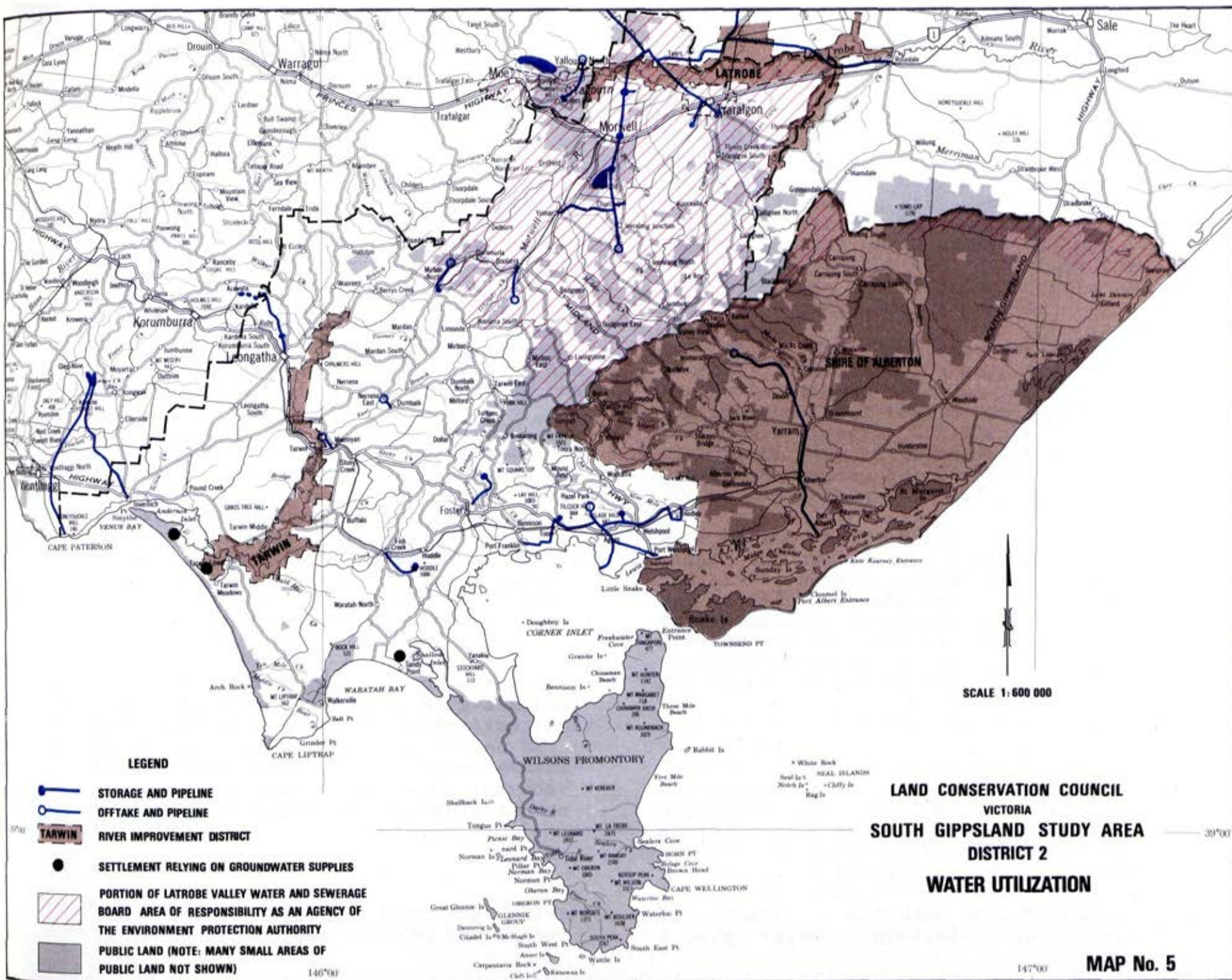
The urban population of the Latrobe Valley (that is, the cities and towns

FIGURE 10
WATER CONSUMPTION
MELBOURNE



between Warragul and Traralgon) is now roughly 65,000 (estimated from Australian Bureau of Statistics data for 1976 based on local government areas). Forecasts of regional population growth over the next decade vary, but it is expected that expansion by the State Electricity Commission and Australian Paper Manufacturers Ltd will create around 2,500 new jobs during that period.

Figure 10 shows recorded past and estimated future average daily consumption of water *per capita* for Melbourne. It is



possibly a guide to the situation in the Latrobe Valley.

Industrial supplies

By far the largest user of water within the study area is the State Electricity Commission. It needs high-quality water for boilers and for general operations, and large volumes of low-quality water for power-house cooling systems, cleaning, sluicing and disposing of ash, and fire prevention (including spraying coal faces).

The high-quality water is supplied from Moondarra Reservoir, and the lower-quality water is drawn from the Latrobe River, aquifers under the Morwell open cut, and local creeks at Hazelwood and Morwell. In 1978 the State Electricity Commission took the following volumes daily: Moondarra Reservoir 78 ML/day; Latrobe River 84 ML/day; and groundwater 104 ML/day.

The next largest consumer of water in the Latrobe Valley is the Maryvale pulp and paper mill owned by Australian Paper Manufacturers Ltd, drawing around 82 ML/day from Moondarra. Planned expansion over the next decade will increase the daily requirement from this source to 91 ML.

Future industrial demand

Plans for expansion by both Australian Paper Manufacturers Ltd and the State

Electricity Commission mean an increased industrial demand for water in the Latrobe Valley. The Loy Yang development alone will require 208--246 ML/day when fully operational, but the State Electricity Commission is confident that its consumption in 1992 will be met by drawing water from the existing sources as well as the Blue Rock reservoir.

Australian Paper Manufacturers Ltd proposes to augment its supplies from Moondarra with water drawn directly from the Latrobe River (below the junction with Tyers River). It is expected that some 45 ML will be drawn daily when the operation begins, but by 1990 this figure should increase to 250 ML/day.

Most of the water, minus the losses within the system, would be returned to the river, however, studies are under way to determine whether this proposal is feasible in the light of temperature limitations that may be imposed in a State Environment Protection Policy for the waters of the Latrobe River.

Beyond the year 2000, new power stations (on at least the same scale as Loy Yang) could be under construction, and a plant converting brown coal to fuel oil may be operating also. Both these industries would require large volumes of water, but meeting this additional demand may not be such a problem as it would seem. Even though part of the water taken in by industry is consumed or evaporated, a large volume (especially that required

Table 17

LOCAL WATER SUPPLIES

Controlling body	Towns supplied	Total population served	Source of water	Headworks capacity (ML)	Local storage Type	Capacity (ML)	Annual usage (ML)	Remarks
Alberton--Port Albert Waterworks Trust	Alberton, Port Albert	400	Obtained from Yarram Trust - forested catchment	-	Elevated concrete tank .	0.1	100	Chlorination
Boolarra Waterworks Trust	Boolarra	500	Two weirs on O'Grady Creek - catchment mainly pastoral	-	Service basin	2.3	58	Chlorination
Dumbalk Waterworks Trust	Dumbalk	250	Pumped from Tarwin River - pastoral catchment	-	Concrete tank	0.2	40	Chlorination
Fish Creek Waterworks Trust	Fish Creek	820	Battery Creek - catchment pastoral and forested	30	Excavated concrete-lined basin	1.4	100	Sedimentation
Foster Waterworks Trust	Foster	1,040	Reservoir on Deep Creek - catchment pastoral and forested	52	Three excavated service basins	3.2 27.3 45.3	191	Water purification plant proposed
Hernes Oak Waterworks Trust	Hernes Oak	100	SEC pump from Latrobe River, treat, and sell to Trust	-	Excavated service basin	1.1	11	Operations of Trust being wound up
Inverloch Waterworks Trust	Inverloch	5,000 *	SRWSC Lance Creek Reservoir (built 1911 to supply Won-thaggi) - pastoral catchment	1,909	Excavated service basin	13.6	455	Untreated. New 227-ML storage recently constructed near Inverloch
Leongatha Waterworks Trust	Leongatha	3,600	Ruby Creek - three reservoirs, the largest Hyland Dam - pastoral catchment	34 136 750	Concrete basins	9.1	1,425	Gravity supply from three reservoirs. Coagulation, filtration and chlorination
Meeniyah Waterworks Trust	Meeniyah	540	Pumped from Tarwin River - pastoral catchment	-	Excavated basin	1.1	85	Chlorination
Mirboo North Waterworks Trust	Mirboo North	1,000	Pumped supply from Little Morwell River - forested catchment	-	Concrete-lined basin	1.1	152	Sedimentation and chlorination

* Includes summer visitors

Table 17 (Continued)

Controlling body	Towns supplied	Total population served	Source of water	Headworks capacity (ML)	Local storage		Annual usage (ML)	Remarks
					Type	Capacity (ML)		
Morwell Waterworks Trust	Morwell, Churchill	24,000	Obtained from LVWSB Moondarra Reservoir - catchment mainly forested	-	Buckleys Hill basins (LVWSB) Churchill Northways	241.0 22.5 6.0	2,064	Low-level zone supplied directly from Buckleys Hill. Higher parts of Morwell serviced from concrete tank. Sedimentation and chlorination
	Hazelwood, Yinnar		Separate reticulation from Billy Creek to augment supply - catchment mainly forested		Excavated concrete-lined tank	1.4		
					Concrete elevated tank, various small tanks	0.9		
State Electricity Commission	Yallourn Works Area		Pumped from Latrobe River					Yallourn township being vacated; population and water usage declining. Chlorination
Toora Waterworks Trust	Toora, Welshpool, Port Welshpool, Port Franklin, Agnes	850	Offtake weir on Agnes River above falls - catchment mainly pastoral	-	Three excavated basins, one concrete-lined tank	5.7 0.9	430	Sedimentation and chlorination
					Elevated steel tank	0.1		
Traralgon Waterworks Trust	Traralgon	16,500	Obtained from LVWSB Moondarra Reservoir	-	Excavated basin	68	2,132	Sedimentation and chlorination
					Reservoir	45		
					Concrete tank	0.5		
Tyers--Glen-garry Waterworks Trust	Tyers, Glengarry, Toongabbie	1,200	Obtained from LVWSB Moondarra Reservoir	-	Service basin Tyers	1.1	390	Untreated
Yarram Waterworks Trust	Yarram	3,000	Gravity supply from Tarra River - forested catchment	-	Excavated basin and tank	5.2	623	Chlorination
Yallourn North Waterworks Trust	Yallourn North	1,850	SEC pump from Latrobe River, treat, and sell to Trust	-	Concrete basin	4.1	185	Sedimentation and chlorination
					Elevated tank	0.02		

for cooling) is either recycled or returned to the Latrobe River to flow seawards through the Gippsland Lakes.

Saline water - an additional problem

Large quantities of ash remain after the combustion of coal in power stations. The best way of handling this at the moment is to mix it into a slurry with water and collect it into settling ponds. When the ash precipitates, the



Hazelwood power station and cooling pond

water (known as 'saline waste water') can be drawn off and reused.

The waste water is saline because brown coal ash contains soluble salts that accumulate in the water during the recycling process. If the water becomes too saline the salts build up deposits that eventually block the system. So, to avoid this, part of the waste water is discharged and the volume made up with fresh water, but the waste water still has to be disposed of.

At present, Yallourn, Hazelwood, and Morwell power stations have separate means of waste-water disposal. The Yallourn stations pump the saline water into the Yallourn and Yallourn North open cuts. Waste from Hazelwood is discharged into the cooling pondage, which overflows to the Morwell River. Saline water from Morwell is released after dilution into the Morwell River.

Other methods have been explored to allow disposal of the high volumes of waste water that will be produced when the Loy Yang power station starts operating. Evaporation, or desalination followed by re-use, would not be feasible; the first process would require a vast evaporating basin of 7,000 ha, which is clearly impracticable, and it is not technically possible yet to desalinate water on the scale required. Land disposal is also unsuitable since it would cause deterioration at Dutson Downs. Direct disposal into the Latrobe River system or

into Lake Reeve would contaminate fresh water and cause environmental problems. And so it has been decided that saline waste water will be discharged into Bass Strait.

The State Electricity Commission is now developing a common disposal scheme whereby saline waste water from all power stations will be piped to Loy Yang. This water, together with that from Loy Yang, will be piped to an ocean outfall on the Ninety Mile Beach. This scheme, now under construction, will be operated by the Latrobe Valley Water and Sewerage Board. It comprises an underground pipeline of 610 mm in diameter. The first 12 km is a pressure pipeline to a balancing storage on high ground near Hiamdale; from there, waste water will flow by gravity some 42 km to an outfall about 500 m offshore at McGaurans Beach.

A licence for this discharge has been issued by the Environment Protection Agency. The project is scheduled to start operating before June 1982.

Stream diversion

Part of the Morwell River has been shifted westwards to allow expansion of the Morwell open cut. The normal flow of the stream has been directed into pipes and a broad floodway above the pipeline copes with excess flow. A further diversion is planned downstream adjacent to the Yallourn open cut.



Construction of saline waste-water pipeline from Latrobe Valley coalfields to Ninety Mile Beach

Farm supplies and irrigation

The reliable summer and autumn rainfall in the study area obviates the need for large-scale irrigation schemes; nevertheless, many landholders divert water from local streams for household use and

AUTHORIZED DIVERSIONS FROM STREAMS

Stream	Number of permits								No. of ha irrigated (approx.)
	Irrigation	Domestic & dairy	Domestic	Domestic & stock	Industrial	Domestic, stock & dairy	Dairy	Total	
Ruby Creek	2	-	-	-	-	3	2	7	14
Coalition Creek	2	-	-	1	-	6	3	12	15
Tarwin River (West Branch) and lower Tarwin River	26	-	1	28	-	54	3	112	190
Tarwin River (East Branch)	7	-	1	7	1	37	4	57	45
Fish Creek	-	-	-	4	-	-	-	4	-
Franklin River	5	-	-	7	-	1	1	14	45
Agnes River	6	1	-	1	-	3	-	11	64
Albert River	11	1	3	5	1	4	9	34	76
Jack River	12	-	4	6	-	5	5	32	90
Tarra River	12	-	3	5	-	-	1	21	80
Bruthen Creek	5	-	1	-	-	-	1	7	15
Little Morwell River	10	-	1	-	-	1	-	12	45
O'Grady Creek	7	-	-	-	-	-	1	8	35
Middle Creek	9	-	1	1	-	3	3	17	55
Billy Creek	1	-	-	7	-	2	-	10	6
Morwell River	32	-	-	10	2	6	5	55	170

irrigation of small areas of pasture and crops, especially potatoes. Even though irrigation is practised on less than 1% of the agricultural land in the study area, the withdrawals utilize all of the available summer flows in certain water-courses. Consequently no new irrigation permits will be issued in the study area to divert water during the summer. In many cases, more winter permits will be issued if the land-owner constructs storages to conserve excess streamflows.

Table 18 lists the authorized diversions in the study area. Most are for the irrigation of small areas of farmland,

generally less than 12 ha in area. Sprays are used commonly, and pumps draw water directly from the stream or from separate storages. Table 19 summarizes the total areas under irrigation from shire to shire.

Future agricultural demand

This depends on the directions taken by the farming community in the next decades. Over the last 20 years the emphasis on intensive production has encouraged farmers to irrigate - within the study area this has mainly occurred among potato-growers. The extent to

Table 19

SUMMARY OF IRRIGATION AREAS, 1977

Local government authority	Area (ha)	Area occupied by rural holdings (ha)*	Area irrigated (ha)
Woorayl Shire	124,600	101,397	312
Mirboo Shire	25,400	20,164	238
Morwell Shire	66,900	34,654	444
Traralgon Shire	46,700	27,148	644
Alberton Shire	186,700	133,124	972
South Gippsland Shire	143,200	85,990	125
Total	593,500	382,477	2,735

* Land occupied in growing pasture and occasional crops, but including small areas of steep country and forest in many localities.

which this trend persists will depend on the availability of water in the future.

The Future - A Broad View

Demand for water in the study area will grow.

At present, 12% of the mean flow of the Latrobe River at Rosedale (a yearly average of 910,000 ML) is utilized for domestic, industrial, and agricultural use. By 1990, increasing requirements of industry will mean that 20% of the present flow will have been committed.

As part of its plans to meet this increase, the Latrobe Valley Water and Sewerage Board commissioned the Snowy Mountains Engineering Corporation to report on ways in which the regional water resources could be more efficiently exploited. The Corporation subsequently outlined construction works that would increase the capacity of the Moon-darra storage from its present 30,000 ML. One option is the erection of spillway gates to raise the water level of the reservoir.

The Corporation also devised operating rules for the release of water from the reservoir into the Latrobe Valley distribution system. These programs designate the maximum volumes of water to be drawn from the storage during normal seasons, but still ensure that restrictions are kept to a minimum during severe droughts. These measures are

still under consideration by the Latrobe Valley Water and Sewerage Board.

In the long term some of the water to be impounded by the Upper Thomson dam (under construction by the Melbourne and Metropolitan Board of Works at present) may become available for use in the Latrobe Valley. Some of the streams draining the northern slopes of the Strzeleckis may also be dammed in the future.

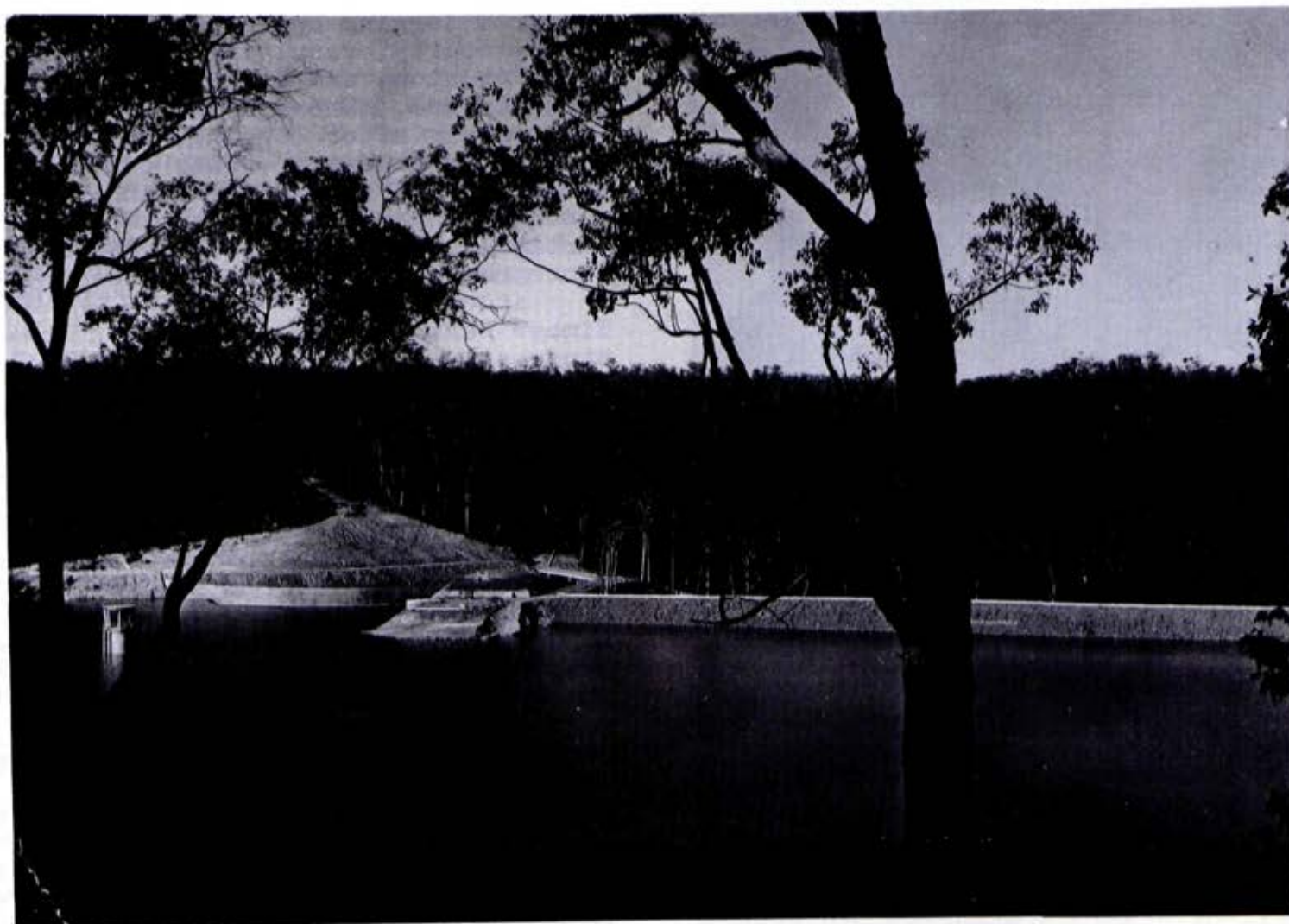
This discussion has centred largely on the utilization of water in the industrial areas of the Latrobe Valley. Clearly the demand for water from this region is so great that all of the resources of the Latrobe basin, including groundwater, must be skilfully developed and managed. In contrast, the water resources of the southern half of the study area have had little exploitation, except perhaps for some local summer irrigation. Domestic supplies are generally adequate, and the lack of industrialization means that no large reservoirs have been required so far.

Catchment Management

The chapter on Water Utilization in the report on the South-western area, District 2, includes a lengthy discussion on catchment management. The processes operating in the forested mountainous catchments of the study area should conform to the general outline given in that report. Many streams discharge

water from mountainous catchments onto the plains surrounding the Strzeleckis, and some of the flow of these streams is

absorbed by the thick alluvial sediments of these areas to become part of the regional groundwater.



Moondarra Reservoir on Tyers River, shortly after construction

Water quality

The main influences on water quality are turbidity and sediment load, colour, chemical quality, and biological contamination.

Storage is quite an effective means of purifying water, and a supply system with a considerable period of storage is less subject to quality changes than one that simply diverts water into supply mains. Storage of water permits breakdown of pollutants and settling of suspended solids. Alternatively, deterioration in water quality can be rectified by treatment, but at considerable cost.

The importance of changes in water quality also depends to some extent on the uses to which the water is to be put.

Land use and water production

The relations between the various forms of land use that may take place on a catchment, and the quantity, quality, and timing of water that flows from the catchment, are imperfectly understood. Although research into catchment management in Australia has increased greatly in recent years, many aspects have not been investigated, and the results of overseas studies must be taken as guides. No detailed research has been carried out in the catchments on public land in the study area.

Forest harvesting

Most forest soils have very high permeabilities to water. Disturbance arising from logging operations can reduce this property, resulting in overland flow, erosion, and transport of sediment into streams. These effects can be seen immediately after logging, but rapidly decline in severity. They can be reduced greatly by careful planning and control of harvesting operations. It is particularly important to avoid disturbance near streams, and on steep slopes.

Timber harvesting operations in the study area are usually confined to relatively small areas, but must still conform with detailed prescriptions designed to protect the water supply and its quality. The prescriptions cover the period during which logging and carting operations are permitted; the location, design, and construction of roads, snig tracks, log landings, and dumps; the retention of protective strips along streams and around storages; and other operations in, and uses of, the forest. The rehabilitation work that is also required after harvesting (such as ripping log landings and barring snig tracks) also reduces the deleterious effects of harvesting on water quality.

The burning associated with regeneration treatments following logging may affect, temporarily, the chemical quality of stream-flow. This is discussed later. The dense young regeneration that foll-

ows harvesting may use more water than the mature forest it replaces, and thus reduce catchment yield.

Phytophthora

Work in Western Australia has shown that on certain areas, following the death of trees through the effects of the root-rotting fungus *Phytophthora cinnamomi*, saline groundwater rises and may lead to increased stream salinities. In the study area the fungus at present is confined to areas where the salinity of the underlying groundwater is low.

Road construction

Roads are an important source of turbidity in water, especially in the year after their construction. Stream crossings and roads across steep side slopes, particularly those requiring extensive earthworks, can generate the highest sediment loads. Turbidity arising from roads can be reduced by careful design, stabilization of exposed cut and fill slopes, and attention to the disposal of drainage water, which should be directed into undisturbed forest. There it can infiltrate the litter and soil, rather than flow directly into stream channels.

Recreation

The effect of recreation on water quality in catchments has long been debated. Evidence from overseas indicates that recreation on water storages - swimming,



Lake Hyland, one of Leongatha's storages

fishing, and boating - usually results in some contamination of water. As described previously, however, the design of the system, the time in storage, the monitoring and treatment facilities available, and the end use of the water must all be considered in assessing what forms of recreation, if any, should be permitted on a particular storage.

Most studies show that controlled recreational use of catchments (as opposed to storages) does not lead to great increases in bacterial counts, turbidity, or chemical pollution, provided the use of roads by recreational vehicles is controlled, especially in wet weather. In the study area, virtually no restrictions are placed on access to water catchments.

Clearing for agriculture

The differences between cleared, settled catchments and forested ones have been briefly described earlier in this section. Conversion of a forested catchment to grassland for farming can be expected to lead to generally poorer quality water in the stream, and to higher peak flows following storms. Water yield from the catchment may increase because evapotranspiration is less for grassland than for forest.

Gravel extraction

Exposure and compaction of soils in gravel pits can lead to locally high

sediment loads. These can be greatly reduced by proper attention to drainage, retention of topsoil, and by ensuring rapid revegetation of disturbed areas.

Grazing

Grazing could affect catchment values if the soil is bared - heavy rain would then produce high sediment loads in streams. Heavy grazing could also lead to localized soil compaction and disturbance, especially around watering points and alongside streams, which would also generate excessive surface run-off. It is unlikely that stock make a substantial contribution to levels of bacteria and other pathogens in streams and storages, although very little work has been done on this aspect.

Fertilizers and pesticides

Overseas experience indicates that the most important mechanism for entry of chemicals into water supplies is direct application or drift of spray chemicals onto the surface of streams or storages. The designation of buffer strips, the choice of chemicals that break down quickly, and selection of suitable weather to prevent drift can greatly reduce the risk of water pollution.

'Phoschek' (di-ammonium phosphate) is mixed with water to make a slurry that is used in 'bombing' fire outbreaks. The compound is soluble in water, but the amounts used each year in the study

area (there is a mixing unit at Yanakie airstrip) are very small and any phosphate enrichment of streams and storages would be negligible.

Pine plantations

Investigations into the hydrology of *Pinus radiata* plantations in Australia have shown that stream flow from catchments carrying dense pine plantations is much less than that from similar areas carrying native eucalypt forest. The differences in stream flow are attributed to the greater interception of rainfall by the dense canopy of the pines. In thinned pine stands interception is less and stream flow is greater, in some cases higher than from a similar catchment under eucalypts.

Similar results have been reported in overseas work on the effects on stream flow of conversion of native vegetation to pine plantations. A reduction in stream flow was also recorded when grassland (in Ohio) was converted to a mixed hardwood--softwood plantation. Australian work has shown that water use by pine plantations is greater than that by grassland.

Fire

When high-intensity storms follow severe fire, surface run-off and sediment loads can be very high. Loads decrease as the forest regenerates. Light rain

after fire may result in little erosion, especially if revegetation is rapid.

Fire may adversely affect the structure and permeability of soils, but this varies with soil type. The effects of low-intensity, prescribed (fuel reduction) burns are not clear. Any adverse effects, however, are probably preferable to those that would follow a high-intensity wildfire burning in the same fuel.

Burning following clear felling may result in increased amounts of nitrogen and phosphorus being released into streams. This effect is countered by the increased water yield, which dilutes the additional nutrients.

Legislation

Current legislation provides for the proclamation of water catchments by the Governor in Council. The Soil Conservation Authority can then designate (by the issue of a Land Use Determination) the most suitable uses (in the public interest) of all land in that catchment. Prescriptions covering forest operations are complementary to any land use determination.

In the study area, the catchments of Billy Creek, Little Morwell River, and Tarra River - all sources of town water supplies - have Land Use Determinations. No other catchments have yet been proclaimed.

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18. PRIMARY PRODUCTION

Agriculture

The main forms of agriculture in the study area are dairying and the production of beef cattle. Various areas of fertile soil produce around one-twentieth of the State's potatoes, but other forms of cropping are not significant.

The use of fertilizers has raised pasture and crop production and allowed increased stocking, and the consequent steady growth in agricultural output over the last three decades has been one of the outstanding aspects of farming in South Gippsland. Another factor making agriculture successful in the area is the high productivity of labour that has been reached in almost every type of farming.

An earlier chapter detailed the broad history of agriculture in the study area. Since World War II large tracts of sandy coastal country have been cleared between Inverloch and Yanakie. The Yanakie isthmus itself was subdivided into 46 farms by the Soldier Settlement Commission and its successor, the Rural Finance and Settlement Commission. The estate was originally Crown land totalling 4,800 ha. In addition,

freehold properties in the study area comprising about 3,600 ha were acquired after the war by the Soldier Settlement Commission. Sixty smaller farms were created on this land and in general the soldier settlers have been quite successful.

Map 12 depicts the distribution of farming enterprises in the study area.

Livestock numbers

The numbers of beef and dairy cattle and of sheep in the study area are shown in Table 20.

Dairying

Production of milk and cream is the main agricultural industry in the study area, and South Gippsland as a whole is the most important dairying region in Victoria.

In 1978 the study area had 1,403 dairy farms; typically 60--80 ha in area and highly productive, they carried 11.7% of the State's dairy cattle. The average herd of 97 milking cows produced an annual total of around 11.5 tonnes of butterfat and 25,000 L of whole milk.

The industry is concentrated in the wetter parts of the study area, where the climate suits dairying with its long growing season of up to 10 months, high annual rainfall (that is, more than 800 mm), and relatively mild summers. Irrigation is rarely practised. Dairy cattle graze improved pasture and their feed is supplemented when necessary with hay or silage. Fodder crops are not normally grown.

Until recently Jerseys were the favoured breed in South Gippsland, but Friesians and Jersey--Friesian crosses are now becoming more popular. The study area also contains a few Ayrshire, Dairy Shorthorn, Guernsey, and Red Poll breeders.

The main calving period usually begins in June and lasts 3 months, but on some farms it starts earlier, in late autumn or early winter. Natural mating and artificial insemination are both practised.

Two dairy companies operate in the study area. Murray Goulburn Co-operative Coy Ltd has factories at Leongatha, Yarram, and Archies Creek. Unigate (Australia) Pty Ltd has plants at Toora and Poowong. Both firms make a variety of products, including butter, casein, and powdered milk, as well as supplying bulk milk to the Melbourne market.

During the 1880s and 1890s, changes in technology reduced labour in the dairy industry and enabled new markets to be exploited. These developments were the invention of the mechanical cream separator (by De Laval), the formation of local dairy co-operatives (which built small factories throughout the dairying districts), and the introduction of refrigeration to the shipping industry, which allowed the export of surplus dairy products to Europe.

Milking machines became available from 1895; their use increased greatly from the 1930s onwards as rural areas were

Table 20

STOCK NUMBERS IN THE STUDY AREA

	1973	1974	1975	1976	1977
Beef cattle	219,776	238,923	262,600	247,016	212,603
Dairy cattle	223,733	212,380	220,513	210,416	182,737
Sheep	349,961	373,124	387,907	391,217	391,860

connected to the State power grid. Government supervision of dairies began in 1905 and herd testing in 1912. Artificial insemination was introduced in 1953. The gradual improvement of country roads helped the industry immeasurably, as did the development of larger trucks.

Further technical changes over the last two decades have also improved output. Herringbone cowsheds decrease milking time - about half the farms in the study area now have this facility. Only a few of the more elaborate rotary sheds operate.

Other advances have been in pasture management, in fodder conservation, and in animal health. Bulk handling of milk is universal; refrigerated milk vats and tankers have banished the once-familiar ten-gallon milk can. A law enacted in 1970 requires all fittings in a dairy in contact with milk to be of stainless steel or other inert material - this has improved milk quality by ensuring more effective cleaning.

The consolidation of dairy factories has eliminated all of the smaller local enterprises, but has allowed greater mechanization and efficiency through a concentration of investment.

The Department of Agriculture, which began special dairy management research and extension services in the early 1950s, has assisted in the development



Cattle sale, Tarwin Lower

and publicity of these technical advances.

In contrast many other changes have been less easy to accept. They reflect recent alterations in Australia's internal economy and in export markets. Farmers have been leaving the Victorian dairying industry - the annual exodus for several years has been three farmers out of each hundred, but some of their enterprises were always marginal. For instance, in the eastern Strzeleckis the isolation, steepness, winter cold, and abundance of weeds prevented any real increases in productivity.

The departing farmers have either left agriculture entirely or directed their efforts to other rural enterprises. Many of the remaining milk-producers have enlarged their properties and purchased more modern machinery. Family labour, a traditional part of the industry, is now even more important since profits are generally too low to pay employees.

Before 1960 many farms sold cream only to the local factory. This was collected every few days, or even weekly, and the separated skim (residual) milk was fed to pigs. Improved transport helped to end this practice, but the advent of large-scale, automated piggeries elsewhere in the State probably also contributed. Today no farms supply cream, and the small number producing pigs within the study area feed their animals with grain.

Beef cattle

Farmers in the study area run just over 5% of Victoria's beef cattle, and South Gippsland is one of the most important areas for the production of fat bulls. Consequently, breeding animals form a lower proportion of the cattle in the study area than elsewhere. Producers purchase store beasts, hold them for varying periods of time, and sell them fattened at 2 or 3 years of age.

Breeding herds in the study area produce calves, which, after 10--12 months, are

sold for slaughter for veal or weaned and marketed for fattening. Dairy farms also sometimes produce vealers - milking or dairy-cross cows are joined with a beef sire.

Herefords predominate in the study area, especially on properties devoted to fattening. Farmers also raise small numbers of Angus, Murray Greys, Short-horns, and some of the recently introduced European breeds. Cattle properties average 160 ha.

Sheep

The study area supports only 1--2% of Victoria's flock. In the drier eastern portions the sheep are run solely for wool production, and elsewhere the graziers produce fat lambs.

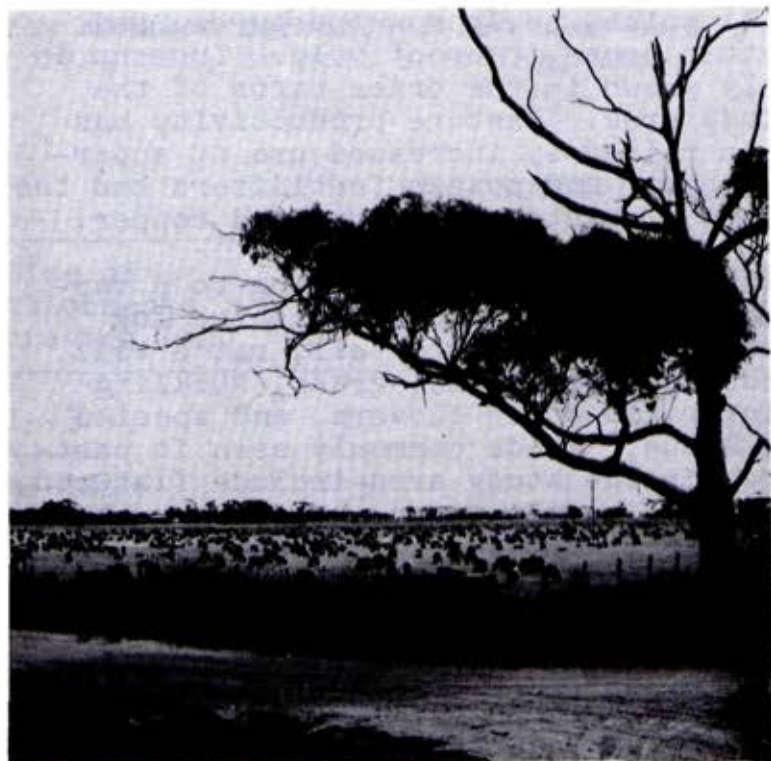
Fat lambs are usually bred from first-cross ewes (Border Leicester x Merino) mated to Dorset Horn or Southdown rams. Some farmers import weaners from other parts of the State for fattening and sale between late spring and autumn when prices are highest.

Potatoes

About 800 ha in the study area are sown annually to potatoes in three main areas. The deep, well-drained red and grey clay loams formed on the Older Volcanic lava flows around Boolarra South, Mirboo North, and Leongatha account for around 600--650 ha of the annual plant-

ings. The remainder is grown mostly on the grey sandy clay loams at Fish Creek and Stony Creek, and the sands and peats at Yanakie and Hedley.

Small crops are harvested elsewhere, including around Anderson Inlet, Hallston, and Mount Eccles. Some years ago Carrajung and Blackwarry farmers grew potatoes extensively; most have since sold their land for reforestation and almost no potatoes are produced there today.



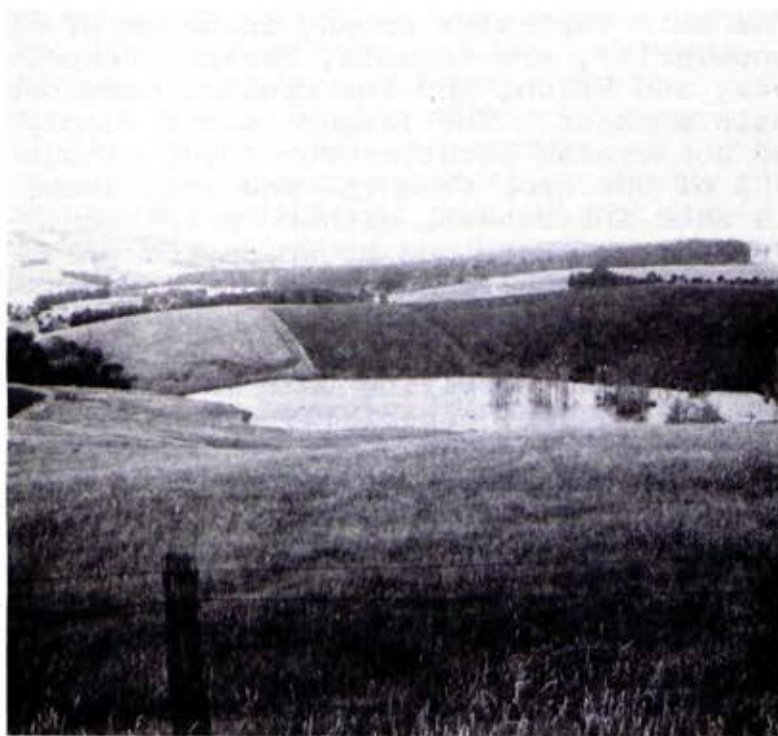
Fine wool is produced from the plains around Woodside

The main varieties grown, in order of popularity, are Sequoia, Sebago, Kennebec, and Exton, and the growers have two main markets. The larger is the supply of commercial potatoes for food. About 60% of the crop from the red soil areas is sold interstate, either in Brisbane or Sydney. Potatoes grown on the grey soils are usually excellent for processing into chips and crisps.

Most farmers supplying this market now use irrigation, especially around Mirboo North and Leongatha. Yields range from 25 to 50 tonnes per ha. Many large farm dams have been constructed during the last decade to supply water for potato crops.

The second important product is seed potatoes, produced at Hedley and in the Fish Creek--Stony Creek district from a total area of 60--70 ha, and around Thorpdale (in the Melbourne study area, 12 km north of Mirboo North) from some 220 ha. Together these districts are recognized as among Australia's most important producers in one of the world's best seed-distribution schemes. They supply buyers throughout eastern Australia (from Atherton, Queensland, to Virginia, South Australia), and an increasing export trade with several Pacific, south-east Asian, and African countries.

Seed crops are usually grown without irrigation and yields range from 12 to 30 tonnes per ha.



Farm dam in dairying and potato-growing country near Mirboo North

Most potato-growers have beef cattle also; others are dairy farmers supplementing their income from milk.

Potato-growing once involved intensive labour, especially when the crop was dug and bagged by hand. Suitable workers are harder to find today and growers are turning to mechanical planters, cultivators, and harvesters. This precludes the tillage of steeper country and demands the use of irrigation to give the highest possible yields.

If this trend continues, potato-growing may shift away from the hills to the gentler country, such as the Leongatha district.

Pasture production

Unimproved pastures are rare. The most common species used for pasture improvement are the introduced perennial ryegrass, white clover, and subterranean clover. Cocksfoot, red clover, and strawberry clover are common on friable hill soils, newly sown pastures, and wetter areas, respectively. Lucerne is only grown in the drier parts of the study area. Pasture productivity has been raised by increased use of superphosphate and potash fertilizers and the trace elements molybdenum and copper.

Volunteer species, occurring to a variable extent, include Yorkshire fog grass, crested dog's tail, rat's tail fescue, sweet vernal-grass, suckling clover and other clovers, and species of lotus. Weeds commonly seen in pastures in the study area include flatweed, ribwort, common daisy, bracken, rushes, thistles, capeweed, wild radish, dock, and sheep sorrel. Botanical names of these various species are listed in Appendices 6 and 7.

About 75% of the farmland in the study area is sown to pasture. Usually some two-thirds of pasture growth is produced during the 3 months from mid October to mid December.

Fodder conservation

Hay is the most common fodder stored, but some dairy farmers also make silage from excess spring pasture.

Hobby farming

Like many other parts of the State, the study area has had a considerable amount of rural subdivision. Table 21 shows its extent between 1970 and 1977. Although some of the allotments formed are now managed for activities such as horse, dog, or goat breeding, many,

especially the larger allotments, remain devoted to the traditional types of livestock production.

Public land

In general, public land in the study-area has little potential at present for agriculture. This is especially so for the main consolidated areas: Wilsons Promontory, the eastern Strzeleckis, and the Mullungdung--Stradbroke forest. Certain of the smaller allotments of public land scattered through the study area have some agricultural potential,

Table 21

LAND SUBDIVISION IN THE STUDY AREA (1970-1977)

Size of allotments created (ha)	Alberton Shire	Mirboo Shire	Morwell Shire	South Gippsland Shire	Traralgon Shire *	Woorayl Shire	Total
1--3	15	1	120	12	476	28	652
4--5	2	3	114	54	155	59	387
6--10	5	4	21	19	35	38	122
11--15	1	-	4	9	11	11	36
16--20	32	11	37	38	7	84	209
21--40	24	16	59	54	30	115	298
41+	31	7	29	66	26	91	250
	110	42	384	252	740	426	1954

* Important coal reserves lie under much of this subdivided land

(Source: Town and Country Planning Board, unpublished data (1978).)

however, although many also have value for other uses such as the conservation of flora and fauna, gravel extraction, and recreation.

Grazing on public land

Public land is important for grazing in two localities in the south of the study area. (See Map 12.) Few other areas of public land are used for this purpose.

Wilsons Promontory was grazed until all licences were revoked in 1959. The public land on the Yanakie isthmus, which was not then part of the national park, had been opened from 1909 to the hill farmers of South Gippsland for winter agistment of dry cows. When the Yanakie run was added to the park in 1969 it was agreed that cattle grazing could continue on a proclaimed portion of that land.

Currently the National Parks Service controls grazing on the isthmus in consultation with the Yanakie Agisters Association. Up to 2,000 cattle are agisted there for as many as 16 weeks over winter, and a maximum of 300 beasts admitted between October and February. Numbers are set according to the condition of the run. Fees collected go towards the cost of managing the park.

Except for the northern boundary the area is unfenced, so cattle have access to all parts of the isthmus, including the easily eroded foredunes along War-

atah Bay. Occasionally some find their way into the southern part of the park despite the fact that the Darby River and the swamps west of Millers Landing form a natural barrier. On the other hand agistment assists with fire protection by lowering fuel quantities in a broad belt on the northern flank of the park.

Snake and Little Snake Islands are part of the Nooramunga State Faunal Reserve, which is managed by the Fisheries and Wildlife Division. This organization allows the Snake Island Agisters Association to graze not more than 1,000 cattle altogether on the two islands each winter, and up to 150 beasts during summer. The stocking, however, may be reduced according to the condition of the run. Grazing began on the islands at least 70 years ago. Cattle can only be moved across the inlet at very low tides; the majority are dry dairy cows.

The future

The 1978--79 season saw a marked improvement in agricultural prospects as a result of good seasonal conditions and higher prices.

While the current situation for farmers is a significant improvement on the past several years of below-average returns, there is nothing to suggest that the fundamental trends that have always been a feature of agriculture will change dramatically.

In the long term, prospects for the main export industries - namely wheat, beef, live sheep, sheep meat, and wool - are sound. The dairy industry, however, has limited export prospects, and this industry is likely to increase its orientation towards the protected domestic market. Broadly, while many of the rural industries have sound prospects, fluctuations and uncertainty can also be expected.

Operating costs (particularly the cost of fuel) will continue to increase. While the rate of inflation had, until recently, been decreasing (and is now below that of many of our trading partners), it is still above the level of the 1960s. Farmers' terms of trade are expected to continue to decline at more than 2% a year and farmers can expect to face continuing economic pressures.

As a result, the ability to adjust to change and to raise productivity, which have been features of producers' responses to the difficulties of the past few years, will remain important. The historical trend in the numbers of farmers leaving agriculture can be expected to continue.

Apiculture

Beekeeping is practised on a small scale in the study area. The main areas of value are the Boodyarn and Mullungdung State Forests, Gellions Run, and the coastal vegetation between Cape Paterson

and Yanakie. The Strzeleckis are occasionally worked in summer. There are a dozen or so designated bee sites on the Promontory.

Table 22 gives notes on the apicultural significance of a number of species found in the study area based on information supplied by local apiarists.

Commercial Fishing

Anderson, Corner, and Shallow Inlets all support important inshore fisheries, and large tonnages of offshore species are landed at Port Albert and Port Welshpool. Eels are harvested commercially on a small scale inland, and reefs off Capes Liptrap and Paterson, and Wilsons Promontory, yield abalone and lobsters.

Corner Inlet

Corner Inlet has been managed as a restricted fishery since 1970 to protect the fish resources from over-exploitation. There are, currently, around 45 fishermen licensed to fish in Corner Inlet. Most are engaged in mesh and seine netting, but some troll or use long-lines.

In 1973--74 some 290 tonnes of fish were landed; the annual catch has been of this order for three or four decades. The main species taken are King George whiting, rock flathead, flounder, Australian salmon, pike, and yellow-eye mullet. The Corner Inlet catches of the

Table 22

NOTES ON REGIONAL HONEY FLORA

Various coastal banksias	Sought-after honey increasing in popularity; saw banksia flowers January; up to 50 kg of honey per hive; areas have been reduced by clearing
Blackwood	Source of pollen
Blue gum	Moderate to good yields
Clover	Very important - flowers late spring to mid summer, and again in autumn
Gippsland grey box	Moderate yields but unreliable
Heath species	Some of the Wilsons Promontory heaths are worked
Manna gum	Used for building up hives; flowering not reliable
Messmate	Fairly reliable; yields pollen and nectar for breeding as well as honey
Mountain ash	Sometimes worked
Mountain grey gum	Sometimes worked
Narrow-leaf peppermint	Useful during breeding season but not as source of honey
Paperbark	Good yields
Silver-leaf stringybark	Light yields
Silvertop	Rarely yields honey but good for building up hives
Swamp gum	Fair yields
Tea-tree	Some manufacturing-grade black honey produced
Wattles	Spring feeding for bees - abundant pollen
Yellow box	Good yielder - localized in study area
Yellow stringybark	Less reliable than messmate - worked some years

first three species are of premium quality and eagerly sought in the markets.

Shallow and Anderson Inlets

These two smaller inlets have a combined annual catch of about 23 tonnes, mainly Australian salmon, ruff, and yellow-eye mullet. Both areas are managed as restricted commercial fisheries.

Abalone

Six or seven divers work along the coast throughout the year and a similar number move in to operate in summer during the best weather.

Rock lobster

A total of around ten boats from Inverloch, Newhaven, Port Welshpool, and San Remo fish the rockier sections of the coastline.

Shark

Port Albert and Port Welshpool are important ports for shark fishermen. Around ten boats operate regularly - they are joined often by boats from elsewhere. Table 23 lists catches for the period 1970--78.

Potential

All commercial fisheries in this area are considered to be very stable and should be able to sustain the present

yield in the future. Port Welshpool should become more important, as it is the only reasonable 'deep-water' harbour between Western Port and Eden. There is considerable potential for the development of a scallop fishery and for an expansion in trawling. The recent introduction of the 200-mile declared fishing zone may lead to the use of the port as a base for joint fishing ventures between Australian and foreign companies. Squid fishing, deep and mid



Fishermen's jetty at Port Albert

Table 23

OFFSHORE SHARK FISHING (1970--78)(tonnes)

Year	Port Albert			Port Welshpool		
	School and gummy shark	Saw shark	Elephant shark	School and gummy shark	Saw shark	Elephant shark
1970	215			116		
1971	214			216		
1972	223			236		
1973	175			226		
1974	67			245		
1975	139			269		
1976	77			201		
1977	58	17	12	134	19	14
1978	147	31	20	170	18	17

water trawling, and purse-seining could all eventuate under these terms.

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19. HARDWOOD PRODUCTION

History

Originally more than half the study area carried forest that was potentially commercially productive (see Figure 11). During the first three decades of settlement timber-cutting and sawmilling were important industries in the coastal and foothill forests around Corner Inlet when large quantities of hewn and sawn material were shipped to Melbourne and foreign markets. The main species utilized were messmate, blue gum, and yellow stringybark for general construction and blackwood for furniture and internal panelling.

During the gold rushes, Sealers Cove, Port Franklin, Toora, and Hedley produced timber. Stands of red gum in the Latrobe Valley were also an important early source of timber. They yielded large quantities of paving blocks, which were used in Melbourne streets and in foreign cities.

During the construction of the Great Southern Railway (1887--92), sleepers and construction timber were cut from local forests. Blue gum and yellow stringybark were especially prized for these purposes.

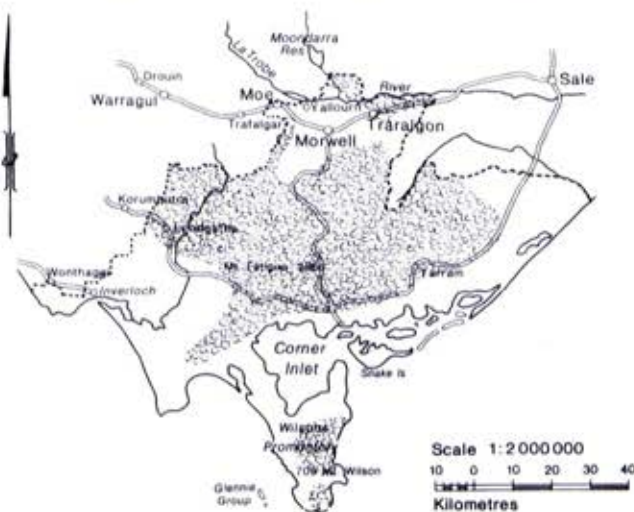
By the 1880s, settlers in the higher parts of the Strzeleckis had started to clear the great forests of blue gum and messmate in the west of the range, and mountain ash in the east. Most of the timber was burnt, but small quantities were used by settlers for housing, fencing, bridging, corduroy roads (dirt tracks with saplings laid across them), and fuel. A few mills in the foothills sawed timber, and there was a large trade in split palings for fences.

The Alberton West Forest, in the Hedley Range, was reserved in 1885; reportedly at that time many pit-saws operated there. These could be easily moved, whereas the bigger (and hence more permanent) steam-powered mills required large volumes of sawlogs to be accessible by tramway from the mill.

The Mullungdung Forest was logged last century, and especially after 1909 when the Goodwood Timber and Tramway Company opened its sawmill at Goodwood, about 11 km north of Woodside.

It sawed up to 18,000 cubic metres of logs each year (mainly yellow stringybark) until it closed in 1920, when the surrounding stands had been cut out.

SOUTH GIPPSLAND AREA, DISTRICT 2



LEGEND

- Swamps, heath, or low woodland
- Forest suitable for production of sawn timber

FIG.11: EXTENT OF FORESTS IN STUDY AREA
BEFORE EUROPEAN SETTLEMENT

The opening of the State coal mine at Wonthaggi in 1909 created a market for mining timbers cut in local forests.

Waggon-loads of split palings were regularly transported to the Boolarra and Toora railheads from Gunyah in the early 1920s. In 1923 a commercial mill began operating at Balook. By that time, however, most of the virgin forests had been cleared and there were relatively few stands suitable for milling, given the logging techniques then available.

In the 1920s and 1930s large quantities of yellow stringybark sleepers and beams were hewn in the Mullungdung Forest. During the depression, unemployed workers thinned the Mullungdung, Won Wron, and Alberton West forests, and defective or moribund trees were ringbarked to improve the quality of the stands.

Little firewood has been produced for use outside the study area, but in 1854 several shiploads were taken from Corner Inlet to Melbourne. From 1940 to 1945, firewood was cut in the mixed-species foothill forests of Won Wron, Boodyarn, and Mullungdung and sent to Melbourne by railway; charcoal was also produced locally.

After World War II, the strong demand for timber led to several small sawmills being granted allocations of sawlogs from public land. These mills, and others, also drew logs from freehold property.

*Logging at Mullungdung
in 1912 by Goodwood
Timber and Tramway
Company Limited*



Australian Paper Manufacturers Pty Ltd (A.P.M.) entered into an agreement with the Victorian government in 1936 to draw supplies of hardwood pulpwood from State forests. Prior to this, pulp fibre was obtained from imports and recycled paper. The Maryvale mill was completed in 1939 and the first intake of pulpwood was in 1940. In 1961 and 1966, the company obtained leases for plantation purposes over about 8,600 ha of public land in the study area to supplement the

plantations it had started in Gippsland. A.P.M. also operated a hardwood sawmill at Tyers for some years, drawing logs from Boola Boola State Forest.

Hardwood logging in the study area today is on a small scale. Removal of poorer trees, for example in Boodyarn and Mullungdung forests, provides a source of pulpwood and low-quality sawlogs, while allowing the remaining superior trees to grow with more vigour. Hardwood sawlogs

and pulpwood are also obtained when derelict forests and abandoned farm land, purchased for reforestation, are cleared.

Distribution of Hardwood Forest

The main areas of forest in the study area that have remained unalienated are those on Wilsons Promontory and on the lowlands and foothills around Darlimurla, Traralgon South, Carrajung South, Won Wron, Darriman, and Alberton. Only a few parts of the Strzeleckis were never alienated. Apart from scattered small reserves, these comprised Gunyah and Callignee Timber Reserves, the Agricultural College Reserve north of

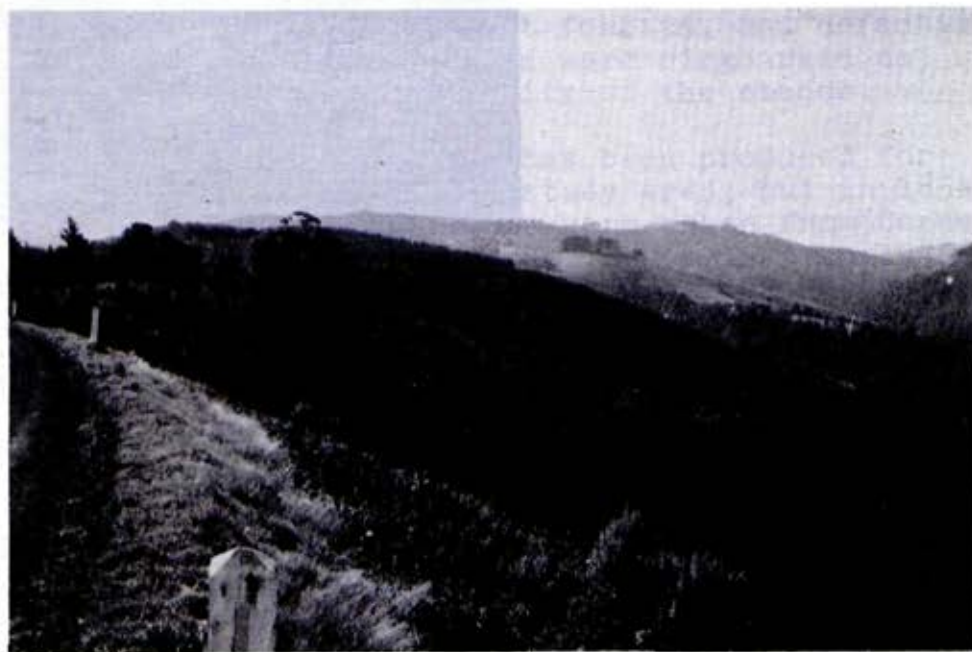
English Corner, and parts of the present national parks and Hallston Bush.

Forest Types

Table 24 shows the productivity of the various forest types in the study area.

Mountain forest

These stands comprise mountain ash or mixed species of eucalypts where the potential height of the mature stand exceeds 40 m. Stands and plantations of pure mountain ash predominate; mixtures of mountain ash, messmate, blue gum, and mountain grey gum are limited. Dense luxuriant understoreys are typical, with



Photograph taken in 1980 of the scene shown on page 22

Table 24

PRODUCTIVITY OF HARDWOOD FORESTS

Main timber species	Predominant soils	Potential productivity * (M.A.I., cubic metres per ha per year) **
Open forest IV		
Mountain ash Messmate Mountain grey gum	Friable brown and red gradational soils	M.A.I. range is 7--21 depending on site; suitable for sawlogs and pulpwood
Open forest III		
Messmate Blue gum Yellow stringybark Mountain grey gum Silvertop	Friable brown and yellow gradational soils; duplex soils	M.A.I. range is 3--6; suitable for sawlogs and pulpwood
Open forest II		
Messmate Yellow stringybark Brown stringybark Yertchuk White stringybark	Duplex soils	M.A.I. range is 1--3; suitable for sawlogs, pulpwood, and minor products
Open forest I		
Gippsland grey box Yellow box Yertchuk	Duplex soils, leached sands	M.A.I. is very low; mainly suitable only for fencing materials and firewood

* The potential productivity is that expected with improved utilization, adequate stocking, and intensive management of forests.

** M.A.I. stands for mean annual increment and represents the total volume production of logs up to a small-end diameter of 10 cm under bark, divided by the age of the stand in years.

blackwood, myrtle beech, and ferns lining the gullies.

Such forests usually occur above 300 m on friable red or brown gradational soils, where rainfall exceeds 1,200 mm per year.

The mountain forests on public land are shown on Maps 9a and 9b as open forest IV. More than half of this area comprises plantations established on purchased farmland formerly carrying tall open forest. Much of the remaining mountain forest, apart from the mature or overmature stands represented in national parks or other reserves, consists of small pockets of regrowth or open stands of scattered mature to overmature trees overtopping a dense understorey of ferns, scrub, and low trees.

Foothill forests

These forests have a potential mature stand height of between 15 and 40 m and can produce an economic crop of sawlogs. They generally consist of a mixture of eucalypt species although pure stands do occur. Messmate, mountain grey gum, silvertop, yellow stringybark, brown stringybark, and blue gum are most important for sawlog production. Selective logging in the past has produced stands with a high proportion of defective or unmerchantable trees.

The forests receive an annual rainfall of 700--1,200 mm and grow on yellow to

brown gradational soils or duplex soils. These are less fertile than those on which the mountain forests occur.

Foothill forests on public land are shown as open forest II and III on Maps 9a and 9b. For the most part these forests occupy land that has never been alienated.

Low forests

These forests have a potential mature stand height of less than 15 m and include a number of eucalypt species. The most common are brown stringybark, messmate, white stringybark, yertchuk, narrow-leaf peppermint, and various types of box.

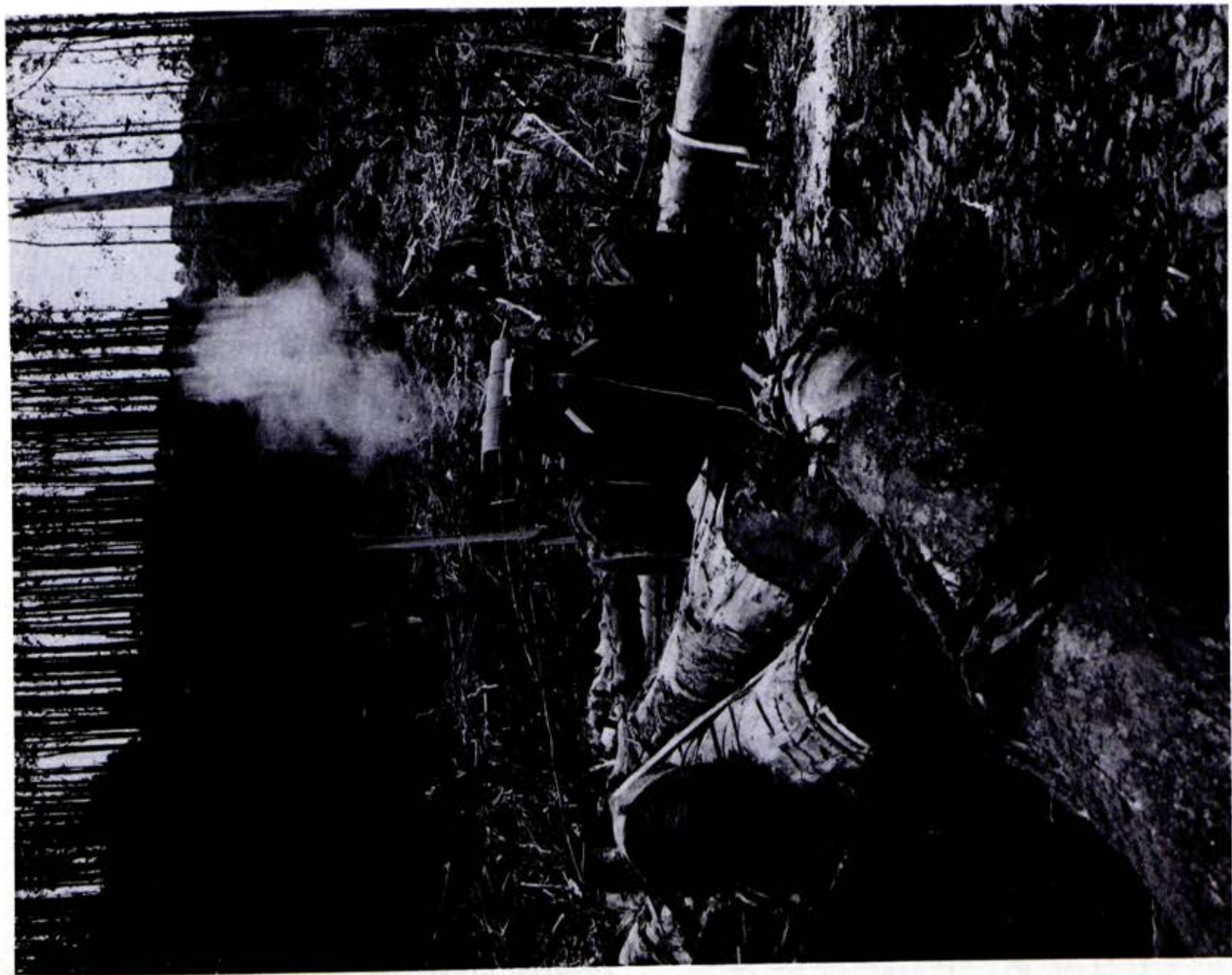
The low forests on public land are shown as open forest I and woodland on Maps 9a and 9b. They occupy areas in the eastern and southern parts of the study area where rainfall is less than about 700 mm, or on sites with shallow, rocky, or poorly drained soils.

Utilization

Sawmills utilizing logs from public land in the study area are located at Boolarra, Drouin South, Foster, Leon-gatha, Morwell, Traralgon, and Yarram.

Mountain forests

The mountain forests are very productive because of their fast growth rates and



Logging in mountain ash forests in the Strzeleckis

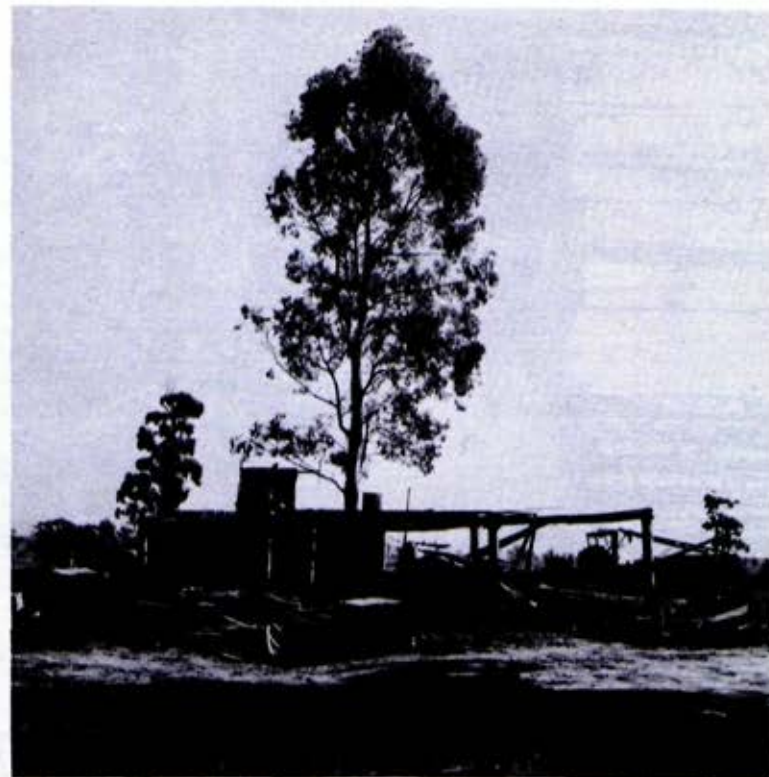
resulting high yield. The timber is valuable because of its moderate density, attractive appearance, and relative absence of defect in young to mature trees. Major products include quality seasoned timber for joinery, panelling, and flooring, and structural timber for house frames. Currently about 9,000 cubic metres of sawlogs are obtained annually from these forests, mostly from mountain ash trees felled prior to reforestation.

The wood is also excellent for paper pulp. The comparatively long, pale fibres of mountain ash require relatively little bleaching and produce strong, tear-resistant paper.

At present about 30,000 cubic metres of eucalypt pulpwood are cut annually from mountain forests in the study area for the Maryvale mill. This is far below the capability of these forests, and substantial future increases will be possible when plantations mature.

Foothill forests

Integrated operations, whereby sawlogs and pulpwood are harvested concurrently, remove about 5,000 cubic metres of sawlogs and 12,000 cubic metres of pulpwood annually from foothill forests on public land. The operation involves the felling of generally large trees whose trunks are suitable for sawlogs and heads for pulpwood. Pulpwood is also obtained from large defective stems un-



Sawmill at Budgeree utilizing stands on private property

suitable for sawlogs. The smaller trees of good form are left as stock for future sawlogs.

The sawlogs are converted into timber for house framing and other general construction. The pulpwood yields fibres that are shorter than those of ash, so the paper produced has a high resistance to bursting. However, the pulp does require bleaching.

About 5,000 cubic metres of sawlogs per year are harvested from public land.

Other products from foothill forests include poles, fence posts, strainers, rails, and firewood. Although produced in small quantities, these are still important, particularly to local farming communities.

Low forests and woodlands

Low forests and woodlands grow very slowly and are generally unsuitable for the sustained production of sawlogs or pulpwood. However, they can produce small but locally important quantities of minor timber products such as fencing timbers and firewood.

Freehold Land

Private hardwood forests within the study area supply pulpwood to Australian Paper Manufacturers (A.P.M.), sawlogs to the milling industry, round timbers to preservation treatment plants, and fencing materials to the local community. Production is quite small and will diminish further as areas of privately owned forests are converted to farmland.

Forest Industries

About 55 people are employed in harvesting and converting hardwood sawlogs from public land in the study area. In the smaller centres particularly, sawmills are important suppliers of local markets

and sources of employment. The four small sawmills now operating on log supplies from private land employ perhaps 10 people.

Forested public land is an important source of hardwood pulpwood for A.P.M. Its mill at Maryvale produces industrial and packaging paper from mixtures of hardwood and softwood pulp and recycled waste paper, and in recent years about 210,000 tonnes of pulp have been produced annually.

A.P.M. is the second biggest private employer of labour in manufacturing in Victoria, outside Melbourne, and provides jobs for about 1,200 people in the Latrobe Valley. Its subsidiary, A.P.M. Forests Pty Ltd, provides work for about 110 people engaged in forest management, research, and wood supply, and contractors employ some 70 persons to cut and transport pulpwood from hardwood forests on public land in the study area.

The Forests Commission, under the *Forests (Wood Pulp Agreements) Act 1974*, must supply annual volumes of hardwood pulpwood to A.P.M. In 1979--80 this was 590,000 cubic metres, but by 1982--83 this must rise to 765,000 cubic metres and stay at that level until 2004 unless the Agreement is modified by government. Map 14 shows the portion of the study area included in the area of supply specified in the *Act*. This land is particularly valuable as a source of pulpwood because of its proximity to



Scrub-covered former farmland near Gunyah Junction, January 1979: reforestation is under way but many gullies and steep slopes remain uncleared

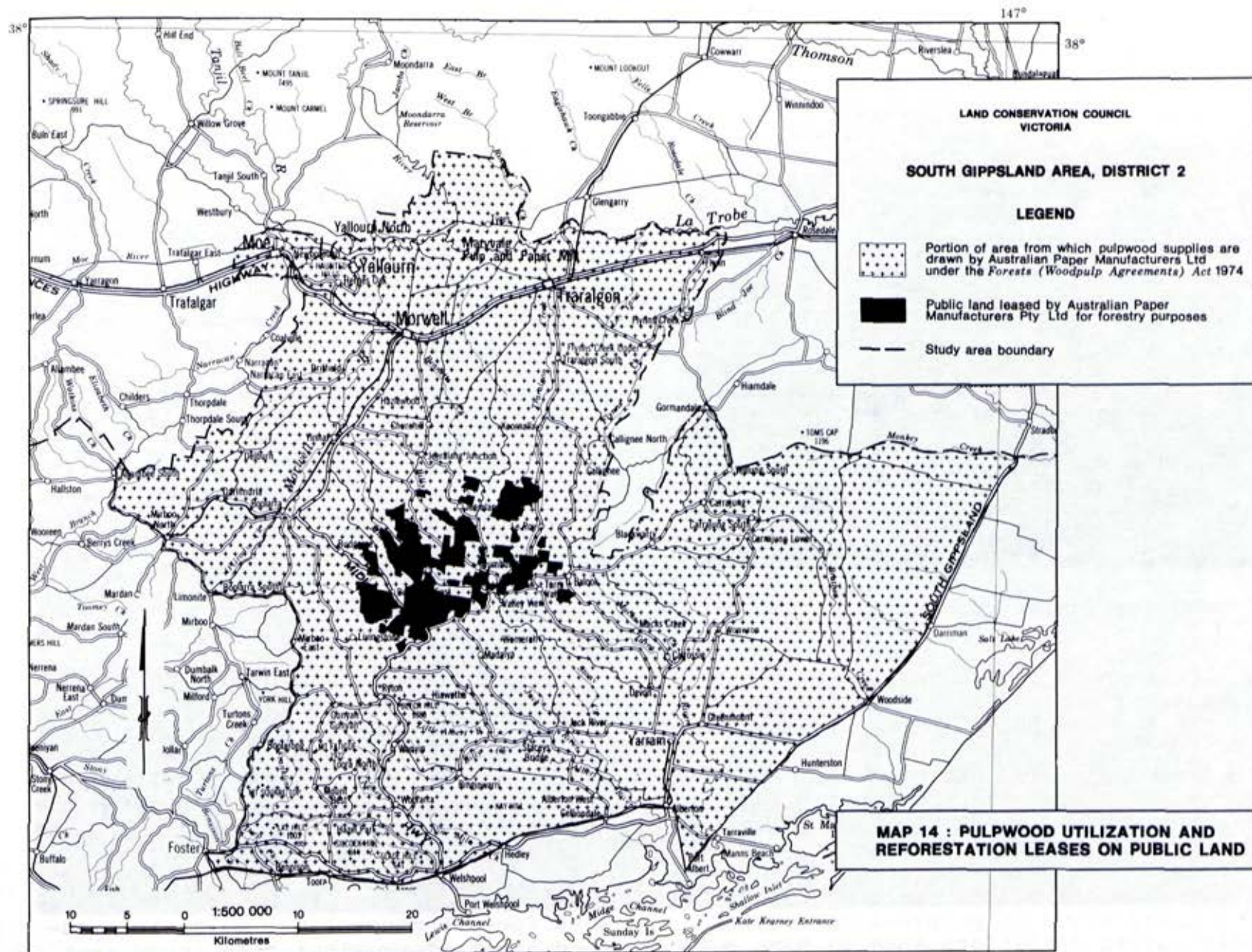
Maryvale. The company also draws pulpwood from its own forests in Gippsland.

Reforestation

In the 1930s the government authorized the Forests Commission to begin a reforestation program in the Strzeleckis to restore to productivity some of the land that had originally been cleared for settlement, and to provide resources for the development of local wood-based industries. Land that had reverted to Crown ownership was dedicated as reserved forest and other land procured.

Purchases by the Commission reached a maximum during the late 1940s and early 1950s, and declined later that decade when high prices for agricultural products made hill-farming briefly profitable and encouraged farmers to withhold their properties from sale. Land acquisition increased again in the 1960s and 1970s, and to date more than 300 properties with an area of about 25,000 ha have been sold voluntarily to the government. Some purchases have been made under the auspices of the Rural Finance Commission, principally through the Rural Reconstruction and Rural Adjustment Schemes, and as part of the State-wide reorganization of the dairy industry. A.P.M. Forests Pty Ltd have also bought land for reforestation in the Strzeleckis.

The planting program involves development of adequate road access, the clear-





Mountain ash plantation around 20 years old

ing of remnant forest and scrub where necessary, and the planting of appropriate tree species.

In clearing operations, pockets of eucalypts that have reasonable potential for timber production are retained while sawlogs and pulpwood in other accessible stands are salvaged and transported to local sawmills and Maryvale pulpmill. The integration of pulpwood harvesting with sawlog operations enables more com-

plete use of the wood resource. Subsequent clearing and planting operations are facilitated by the removal of logging debris by bulldozers or by burning. All but the steeper slopes can be treated, as the soils do not readily erode.

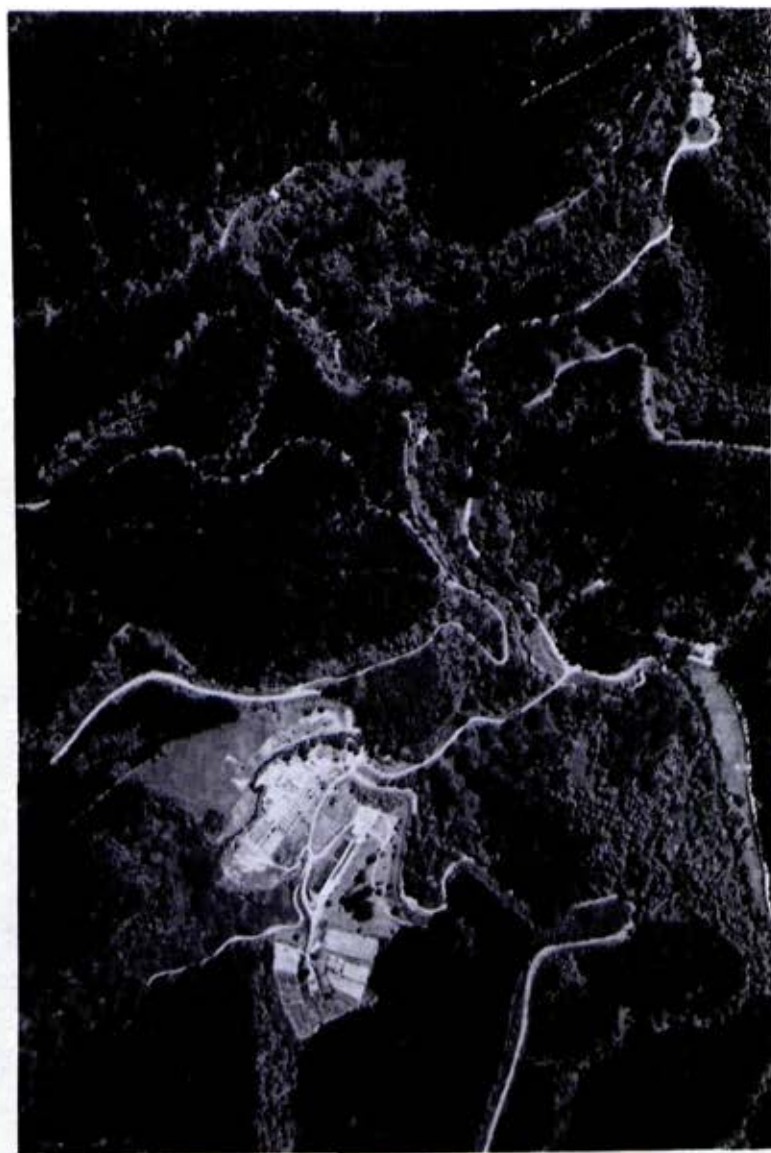
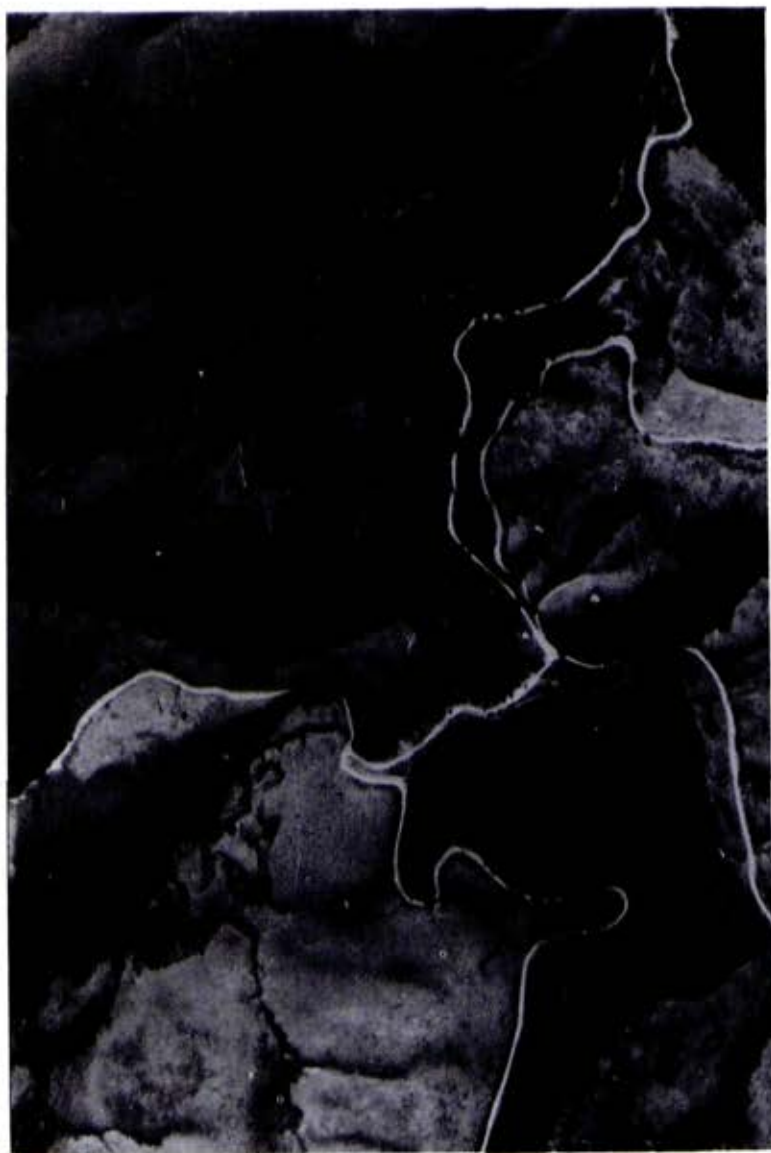
The choice of species, by both the Forests Commission and A.P.M. Forests Pty Ltd, depends primarily on site conditions. Generally mountain ash, and occasionally other eucalypts such as blue gum, are planted on areas that previously carried these species and are not too exposed or weed infested. Eucalypt seedlings for planting are grown at nurseries at Olsens Bridge and Won Wron. Radiata pine is generally grown on areas that originally carried foothill forest and on sites where exposure, weed infestation, or competition from pasture grasses limits the growth of mountain ash.

Planting activities began in 1946 with the establishment of mountain ash and radiata pine plantations by the Forests Commission on abandoned farmland at Childers and Allambee (Melbourne study area). Planting of both species commenced in 1949 in the upper Morwell River valley and has continued virtually uninterrupted. The Forests Commission now has a total area of 4,660 ha of hardwood plantation.

A.P.M. Forests Pty Ltd has planted hardwood forests since 1954, so their hardwood plantations within the study area



Watering eucalypt seedlings, Olsens Bridge



These aerial photos, both at a scale of 1:10,000, show the Olsens Bridge area. The left one was taken in 1937, before the establishment of hardwood and softwood plantations. The other, taken in 1979, includes the Morwell River Reforestation Prison.

now total 6,000 ha, of which 3,140 ha have been developed on leased public lands since 1964.

Under the *Forests (Wood Pulp Agreement) Acts* of 1961 and 1966, A.P.M. Forests Pty Ltd lease a total of 8,600 ha of public land, comprising several blocks located around Budgeree East, Balook, and Jeeralang (see Map 14). Most of this land had been cleared for agriculture and subsequently acquired by the Commission.

The first lease was obtained in 1962 and an additional area was leased in 1967. The leases run concurrently and are renewable after 60 years. They require A.P.M. Forests to reforest the area, and give the company sole rights to obtain pulpwood and sawlogs from the land. In return, the *Act* stipulates that the company must pay rent (which is reviewed regularly) on the leased area, pay royalties on any sawlogs and pulpwood removed in preparing the land for reforestation, and ensure that all areas suitable for forestry are adequately reforested within 16 years of the commencement of the lease and thereafter maintained.

Generally, the efforts have been very successful. Large areas have become fully productive in the process, providing wood for a major decentralized industry and for local sawmills. The new forests will eventually yield much larger quantities of wood, enabling substantial expansion of these industries.

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20. SOFTWOOD PRODUCTION

Softwood forestry has become a significant feature of the use of public and freehold land in the study area during the last 35 years. Plantations are located in the eastern Strzeleckis and in the Latrobe Valley, and form part of an extensive softwood resource located within 100 km of Maryvale pulp mill.

Plantations on State forest in the study area form the major part of the Latrobe Plantation Development Zone, one of eight such zones in Victoria that are the basis of Forests Commission plans to provide wood resources sufficient to support large permanent industries at suitable centres. Such plantings will supplement wood supplies from plantations already established by A.P.M. Forests Pty Ltd and the extensive hardwood resource on State forest.

Radiata pine is the major softwood species grown in Victorian plantations and requires:

- a minimum annual rainfall of about 760 mm
- an acid soil of at least moderate fertility
- good drainage

- an optimum of 0.75 m and a minimum of 0.5 m of soil over any root- or water-impeding layer
- freedom from heavy falls of snow

Surveys to determine the suitability of land for the establishment of plantations have been carried out by the Forests Commission over much of the public land in the study area, mapping slope, aspect, exposure, soils, rainfall, vegetation, adjacent land use, environmental constraints, and scenic quality.

Although radiata pine generally grows quite rapidly in the study area, variations in growth rates occur due to differing site factors. Growth rates can be expressed in terms of site quality (S.Q.), which is a measure of the total volume of timber a site can produce.

Seven classes have been defined: S.Q.I. to S.Q.V. covers healthy productive stands, S.Q.VI stands are marginally productive, and S.Q.VII ranges from marginal to unproductive stands.

Sites in the Strzelecki Ranges, on average, approximate to S.Q.III. Sites on

Table 25

SITE QUALITY FOR RADIATA PINE

Site quality	Site index (height in metres at age 20 years)	Total volume yielded over 30 years (cubic metres per ha)*	Mean annual increment (cubic metres per ha per year)**
I	31	955	32
II	29	850	28
III	27	745	25
IV	26	645	22
V	24	535	18
VI	21	380	13
VII	18	235	8

* Volumes shown are underbark to 10 cm small-end diameter

** M.A.I. (mean annual increment) = total volume divided by the number of years in the rotation (usually taken as 30 years)

the foothills and plains have classes varying from S.Q.IV to S.Q.VI. By applying fertilizers, especially phosphates, and by site preparation, the productivity of most of these latter sites can be raised by at least one site quality class. Table 25 details the productivity of each class.

Commercial plantations of douglas fir have similar requirements to those of radiata pine except that they prefer a cooler climate, an annual rainfall of 1,000--1,500 mm, and sheltered southerly or easterly aspects. Sites carrying mountain ash are therefore also suitable for douglas fir, but the native hardwood

grows much faster than the conifer. Within the study area, just over 220 ha in the Strzeleckis have been planted with douglas fir.

Establishment of softwood plantations

Most softwood plantations have been established on former farmland purchased by the government or by private interests. The Forests Commission began in 1949 with small-scale plantings in the Morwell River valley, which continued at a comparatively low level until extended in the mid 1960s with the aid of funds received under the Commonwealth--States Softwood Forestry Agreement. Until 1978



Radiata pine planted on former farmland, south-eastern Strzeleckis

this agreement enabled about 450 ha to be established yearly in the study area. The area planted now includes 1,500 ha at Macks Creek and south of Womerah, established and maintained under a 1974 Commonwealth grant under the Export Incentives Grants Scheme.

A.P.M. Forests began its land purchase program in the 1950s. Its first substantial softwood plantings began in 1955. Later, in 1962, plantation development began on the leased public land shown on Map 14.

A significant and increasing number of individuals and small companies have also planted softwoods on private property, especially since the Victorian

government introduced a loan scheme in 1966. This scheme is designed to encourage and assist land-owners to establish farm woodlots as a source of wood for local forest industries.

In general, softwoods are planted on sites formerly occupied by mixed-species forests and on exposed and blackberry-infested sites at higher elevations. The characteristic soils of the Strzeleckis are not prone to erosion; this allows mechanical site preparation of steep slopes prior to planting.

The location of softwood plantations on public land is shown on the vegetation map. Radiata pine comprises more than 95% of the area planted. On the remain-

ing area, much of which is at high altitudes, douglas fir is the main species.

Planted areas in the Strzeleckis generally have irregular boundaries and are interspersed with a network of gullies and steep slopes on which the native vegetation has been retained. Plantations are more regular on the gentler lowland topography.

Areas of softwood plantation

Plantations on State forest in the study area are located mainly south of the Grand Ridge Road; on several blocks scattered around the northern and eastern foothills from Mirboo North to Koor-nalla; and at Carrajung South and Won Wron. The total area planted up to 1979 was 7,600 ha. A.P.M. Forests have 12,400 ha of plantations on freehold land on the lowlands and foothills south of Traralgon, east of Thorpdale (Silver Creek Tree Farm), and surrounding Maryvale (Maryvale and Boola Tree Farms). A further 1,250 ha have been planted on leased public land. Some 95% of all of these plantings have been radiata pine.

Stands of softwood owned by individuals or small companies are, in many cases, located adjacent to Forests Commission or A.P.M. Forests plantings. They total about 800 ha, half of which has been established with the aid of government loans. In addition, many school plantations are scattered throughout the study area on public land and land owned by



Photograph taken at time of plantation establishment - extensive stands of native forest have been retained on public land near Binginwarri (Scale 1:12,000)

A.P.M. Forests. Virtually all are less than 10 ha in area, and together total about 100 ha.

Table 26 lists the areas of softwood plantation in the study area.

Table 26

SOFTWOOD PLANTATIONS IN THE STUDY AREA
(1979)

F.C.V. on public land (part of Latrobe Plantation Development Zone)	7,600 ha net
A.P.M. on public land	1,250 ha net
A.P.M. on freehold land	12,400 ha
Private on freehold land	800 ha
School plantations on freehold and public land	100 ha

Note: The Latrobe Plantation Development Zone will eventually contain 28,000 ha of softwoods. Some 11,800 ha have already been planted. The Forests Commission plans to establish 690 ha of softwoods annually within the zone (600 ha within the study area) over the next 24 years to meet this target, giving ultimately 22,000 ha of State-owned plantation in the study area.

Industrial Requirements

Production of woodpulp is the main industrial use for softwood grown within the study area, employing about 25

people in supplying pulpwood from State-owned plantations to the A.P.M. mill at Maryvale.

In 1979--80 the government commitment to A.P.M. for softwood pulpwood was 30,000 cubic metres. By the year 2000 the annual commitment will increase to 100,000 cubic metres and stay at that level until 2004. The company also has a large softwood sawmill at Morwell with



Clear felling in radiata pine, Albert River

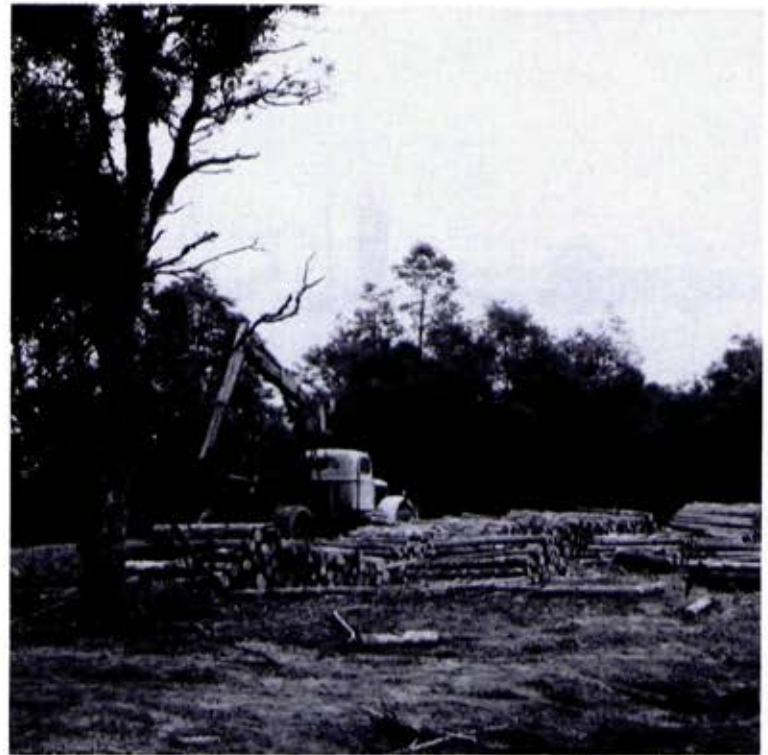
an annual intake of about 80,000 cubic metres; an allocation of 30,000 cubic metres is available from State-owned plantations. Up to 1980, no sawlogs had been obtained from public land within the study area, but substantial quantities will be supplied as they grow to merchantable size. More than 100 people are employed in the mill.

A number of plants preserving round softwood timbers are located in and adjacent to the study area. Again it is likely that supplies will be sought from the study area as appropriate material becomes available.

Future plantation development

The annual output from State softwood plantations in the Latrobe Plantation Development Zone is planned to rise from the present 51,000 cubic metres of sawlogs and 27,000 cubic metres of pulpwood to more than 300,000 cubic metres of pulpwood and sawlogs by the year 2000. Plantations in the study area will contribute about three-quarters of the output, based on the achievement of plans to establish 28,000 ha of softwood plantations on State forest in the zone.

The Forests Commission plans to maintain the current annual rate of expansion of 690 ha, of which about 600 ha is located in the study area. Most of the available land in the area is located to the east of the Midland Highway and south of



Pulpwood harvesting, Jack River

Grand Ridge Road. In the Strzeleckis this is all former farmland. Other possible areas consist of forested public land near Carrajung and Boodyarn. Further purchase of private land will be necessary if the target is to be met.

Outputs of wood from the zone will be used by the Forests Commission to meet its commitment to supply pulpwood to A.P.M., and other wood-processing industries will also be provided with an increasing level of raw material.



A.P.M. Wood Products Pty Ltd sawmill at Morwell cuts softwood sawlogs from throughout Central Gippsland

Estimates of the future yields from A.P.M. Forests' plantations in Gippsland are not available, but as these areas currently total about 40,000 ha and are being continually expanded, their yields will be considerably greater than the output from State forest.

The existing 800 ha of woodlots owned by other private interests produce, in most cases, mainly round timbers and fencing materials. By the year 2000, however, they are expected to produce more than 20,000 cubic metres of sawlogs and pulpwood per year.

Reference

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21. MINING AND QUARRYING

This chapter should be read in conjunction with Map 13 (Mining and Quarrying).

Minerals from the study area are crucial to Victoria's economy - the brown coals of the Latrobe Valley and the offshore deposits of oil and gas in the Gippsland Basin are the State's main sources of fossilized fuels. This aspect is discussed in detail in chapter 22, Energy. The brown coals are also described in the Geology chapter, and the Utilities chapter lists the ways in which oil and gas production affects public land.

Minerals

There is little active interest in non-fuel minerals within the study area. One mining lease for gold is current on public land in the catchment of the Franklin River, and three mineral leases for bauxite affect private land in the Boolarra--Mirboo North area.

Bauxite

Deposits of bauxite are known from about 40 localities around Boolarra and Mirboo North, mostly on private land. The largest deposits are Napiers No. 1, situated 3 km north-east of Mirboo North,

which had estimated reserves of 170,000 tonnes initially, and Watkins, 6 km north of Mirboo North, which originally contained more than 200,000 tonnes.

The total alumina content is usually 50--53%, compared with an average of 55%



Worked-out bauxite mine, Mirboo North

at Weipa, Queensland. Bauxite from the Strzeleckis has been used in firebrick, cement, and chemical manufacture. Production in 1975--76 was 2,366 tonnes.

The bauxite is weathered from basalt flows of the Older Volcanics. One view is that it is of lateritic origin, but it has since been suggested that the formation of bauxite is due to a relation between basalt, overlying sands, and faulting. The younger sands, when down-faulted against the basalt, provide ready drainage for leaching groundwater across the buried fault edge of the basalt, which then decomposes the basalt to form bauxite.

Such geological situations are numerous north of Boolarra South on both private and public land, and it is probable that many other small deposits of bauxite exist.

Copper

In 1916 copper, in the form of native crystals enclosed in quartzose nodules, was found in decomposed basalt at Carrabung South. The discovery proved of no commercial value.

Gemstones

Pebbles of jasper, serpentinite, and green nickel-bearing quartz occur in the sandy coves of Cape Liptrap and Walkerville. Granite at Yanakie contains small specimens of garnet, zircon, green

and blue sapphire, topaz, and almandine ruby. At Wilsons Promontory, tourmaline is found as both masses and veins in granite, and in quartz reefs as masses and large well-formed crystals.

Gold

Within the study area, gold occurs in Palaeozoic rocks and in sediments derived from Palaeozoic material. The latter include the granitic sands of Wilsons Promontory and the Haunted Hills Gravels. Only in rare instances, however, has gold been found sufficiently concentrated in these latter two groups of rocks to allow profitable mining to proceed. Gold is unlikely to be present in Mesozoic sediments.

During last century the rich gold deposits of Ballarat and Bendigo stimulated prospecting in other parts of the State, including South Gippsland, but the finds were generally small. Several rushes occurred in the study area in the 1860s and 70s.

Shallow alluvial gold was found at Stockyard Creek (near Foster) and Turtons Creek, and beach sands at Waratah Bay yielded small quantities. Minor leads were worked at Foster - these were gravels from an earlier stream system capping New Zealand Hill, Dalton Hill, and parts of Kaffir Hill. Reef mining also took place at Foster. The host rock is a granitic dyke cutting sandstones and mudstones of Devonian age.

The most successful mine, the Victory, operated below Kaffir Hill until the early 1900s; other productive claims included Ophir Reef, Granite Bar, and Jubilee.

The Lower Palaeozoic sediments at Waratah Bay contain variable concentrations of gold, none of which are economically significant. It is probable that the gold recorded in the Digger Island Limestone is of detrital origin.

The very localized deposits of alluvial gold at Turtons Creek are probably derived from conglomerates of the Liptrap Formation, which outcrop in Yankee Tom Gully at the head of the creek. Gold has been found downstream from the Devonian beds (which contain less than 0.15 g per tonne), but not above. It therefore seems likely that gold has been eroded from the conglomerate and concentrated in the younger sediments down the valley.

Sampling of the Palaeozoic sediments in the Foster--Mt Hoddle area yielded lower values, commonly less than 0.10 g per tonne.

Reports of gold discoveries during the latter half of the 19th century in the foothills south of Moe and Morwell are difficult now to substantiate. An additional source of conjecture is the Blackwarry field. Gold was allegedly discovered there in the 1890s and a tunnel was driven to work the deposit.



Stockyard Creek (Foster) diggings, 1871

In 1911 a second tunnel, known as the New Comet, was excavated nearby. It apparently proved unprofitable.

Iron

Minor occurrences of iron ores are recorded from a number of places in the study area.

An outcrop of highly ferruginous Tertiary gravel and clay situated 5 km north of Mirboo North contains 77% iron oxide, and a small deposit of limonite derived from basalt at Alberton West contains 44% iron. Both deposits are on private property bordering public land. Bog

iron ore on private land south of Leon-gatha contains 11% iron.

Nickel

Sulphide mineralization has been detected on the foreshore at Bell Point, where the contact between the intrusive serpentized gabbro and the Digger Island Limestone is exposed. A drilling program revealed non-commercial nickel concentrations along the contact zone, and limited investigation of the serpentized bodies revealed low nickel mineralization of the order of 0.01--0.33%.



Toora tin-fields, scene of mining from around 1880 to 1939

Phosphate rock

Phosphate-bearing rocks occur in Upper Ordovician sediments in the Hoddle Range, and at Bald Hill to the west, but the grade is usually low and quantities are small.

Platinum and osmiridium

These elements are found in small amounts with the alluvial gold at Turtons Creek and Foster, and in the beach sands of Waratah Bay.

Silver

Veins of pyrite in the Waratah Limestone at its faulted contact with Cambrian greenstone contain minor amounts of silver and traces of gold. No production has been recorded.

Tin

Tin is found as cassiterite (tin oxide) at Toora, Yanakie, and Wilsons Promontory. The Toora field lies in Tertiary gravels deposited at the foot of the up-lifted Gelliondale Block. The earliest investigations of these tin deposits took place in the 1870s. The field was worked by several companies up to 1939 and produced in excess of 400 tonnes of tin concentrate; it was, however, only marginally profitable. Recent drilling by the Department of Minerals and Energy showed a maximum cassiterite grade of 76 g per cubic metre, and it was concluded

Table 27

STONE AND MINERAL EXTRACTION (1977/78)

Material	Amount extracted (tonnes)
Bauxite	2,136
Brick, clay, and shale	25,244
Brown coal	29,382,229
Crushed and broken basalt	212,700
Crushed and broken shale/sandstone	36,296
Earth, soil filling	23,744
Limestone (agricultural)	8,130
Salamander	4,500
Sand and gravel*	304,000

* Excludes non-commercial (municipal) operations.

that reopening of the field would not be economically feasible.

A venture to mine alluvial tin from Mount Hunter on Wilsons Promontory in 1920--34 closed because of the low grade of the ore.

Exploration

Work is continuing, by both government and industry, in delineating and proving the massive brown coal deposits underlying the northern and south-eastern parts of the study area.

Since the introduction of the present licensing system during the mid 1960s,

four Exploration Licences have been granted in the study area. One remains current (for brown coal at Gelliondale).

Other exploration has been for phosphate rocks and base metals (such as nickel and gold) in the Lower Palaeozoic rocks of the Liptrap Peninsula, Mount Hoddle--Foster area, and Turtens Creek.

Stone

The study area is self-sufficient in supplies of sand and gravel for road construction and building, including the requirements for the various large-scale projects. However, half the supply of aggregate comes from elsewhere.

Large-scale extractive industries are concentrated close to the main centres of population in the Latrobe Valley. Several large quarries situated on the northern side of the valley have their main markets within the study area. There is a lesser concentration of quarries around the Leongatha--Koonwarra area, and the remainder are scattered throughout the study area meeting local demands.

In all, 28 quarries operating under the *Extractive Industries Act* 1966 are located within the study area; five are on public land. The total annual stone production from these quarries is approximately 570,000 tonnes.

A substantial amount of the gravel used in the study area is extracted from a large number of relatively small pits. These operate under any one of a number of different *Acts* that include provision for stone extraction. Many of these pits are on public land.

The shires as a group, and the Country Roads Board, require the largest volumes of sand and gravel annually for maintenance and surfacing of roads. Construction works at Loy Yang are expected, however, to utilize around 1 million tonnes of sand and aggregate over the next decade.

Table 27 shows the quantity of stone and minerals extracted during 1977/78 in the study area.

Basalt

Basalt aggregate is used in road-making, building, and for concrete, the demand being particularly high in the Latrobe Valley.

More than 300,000 tonnes of crushed basalt is produced annually from seven quarries on private land within the study area, and around the same tonnage is imported each year from quarries on the northern slopes of the Latrobe Valley, outside the study area.

Clay

Clay for brickmaking at Traralgon is extracted from Cainozoic sediment on private land at Tyers, and from weathered Lower Palaeozoic sediment in the Boola State Forest under licence from the Forests Commission.

Limestone

Limestones of three ages occur within the study area, and each has been or is being exploited.

Palaeozoic limestone. Palaeozoic limestone bodies are located at Waratah Bay. Quarrying took place in the Kiln and the Bluff members of the Lower Devonian Waratah Limestone, and the stone was burnt for lime in the kilns that remain as ruins at Walkerville. Although in places the stone may be clayey or dolomitic, or contain a fair proportion of

sand, the purer limestone sections contain up to 95% calcium carbonate.

Estimated reserves are about 500,000 tonnes. The remaining calcareous formations along the western shore of Waratah Bay have not been quarried: the basal Bird Rock member of the Waratah Bay Limestone is very dolomitic, the Lower Devonian Bell Point Limestone is clayey, and the Ordovician Digger Island Limestone is siliceous. (See also Chapter 4 - History.)

Tertiary limestone. Gippsland Limestone is quarried at Darriman on private land, and at Merriman Creek just outside the study area. The limestone at Darriman is clayey and is sold as agricultural lime within the study area and as far north-east as Sale. The higher-quality limestone at Merriman Creek is used by the Traralgon cement factory.

Quaternary limestone. Pleistocene calcareous dunes at Yanakie in the northern part of the Wilsons Promontory National Park are used as a source of agricultural lime. The limestone has 67% calcium carbonate and production in 1975/76 was 6,106 tonnes.

Sand and gravel

Gravels and sands contained within Cainozoic sediments are widespread in the study area on both public and private land. The two main units exploited are the Haunted Hills Gravels and equivalent

ents, of Late Tertiary age, and younger Quaternary alluvial deposits.

In the northern part of the study area the demand is high for sized sand and gravel for the building and concrete industries. Eight quarries in this area, one of which is on public land, produce washed sand and gravel from Tertiary or Quaternary sediments.

In the southern part of the study area, in the Shires of South Gippsland and Woorayl, coarse quartz gravels occur on top of, or surrounding, Lower Palaeozoic and Mesozoic sediments. Large deposits



Municipal employees loading gravel, Toora

remain on public land at Toora that was formerly worked for alluvial tin. Further east in the Shire of Alberton there are extensive areas of public land situated on outcrops of Haunted Hills Gravels.

Table 28 shows the amounts of gravel extracted during 1978/79 by the various municipalities. It underlines the importance of public land to several councils for the supply of material for road maintenance and construction.

Excessive quantities of clay in the gravels often limit their usefulness for road maintenance. Several private operators at Hallston, Leongatha, Maryvale,

and Toora, however, upgrade clayey gravels by washing, and in the future the Shires may also follow this practice.

The Country Roads Board extracts or obtains material from some 37 sites within the study area. Those on public land are generally small in scale.

Other main users of road gravel are A.P.M. Forests Pty Ltd, the Forests Commission, and the State Electricity Commission. A.P.M. Forests takes gravel from its own areas of freehold land, and the Forests Commission takes it from public land under its control. In addition, the latter issues licences for gravel extraction according to the pro-

Table 28

MUNICIPAL GRAVEL EXTRACTION (JULY 1978 - JUNE 1979)

Municipality	Quantity (cubic metres)	Percentage from public land
Alberton	55,000	99
Mirboo	27,000	0
Morwell	60,000	24
South Gippsland	34,000	0
Traralgon - Shire	30,000	100
- City	23,000	100
Woorayl	44,000	0
Total:	273,000	44% of total municipal requirements were taken from public land

visions of the *Forests Act* 1958. During 1975/76 licensed extraction on the study area of this type totalled approximately 17,000 cubic metres, 97% of which came from Yarram Forest District.

Restoration of worked-out sites on both public and private land in the study area has largely been neglected. Examples of unrehabilitated public land include the quarries at Calrossie, where abandoned sections are eroding badly and show minimal regrowth of vegetation. An example on private land is Grasstree Hill just north of Lower Tarwin.

In some cases restoration has been carried out, as along Harvey Road in the Mullungdung State Forest, and on private land near Koonwarra and Leongatha South.

Future consumption of gravel is likely to grow slowly, as most of the Shires expect either no change or only a slight increase in their present consumption. The Country Roads Board requirements will decrease in the short term, following completion of the four-lane highway between Morwell and Traralgon, but will rise sharply when future freeways, such as the Morwell and Traralgon by-passes, are constructed. In most parts of the study area, gravel deposits on private

land will supply the demand, but, for works within the Shire of Alberton, both the municipality and the Country Roads Board stress their reliance on deposits on public land.

Sandstone

Sandstone of the Strzelecki Group is quarried from private land adjoining Shady Creek north of Welshpool. The stone is used by the Ports and Harbors Division at Port Welshpool. The Country Roads Board extracts sandstone from a pine plantation near Jeeralang Junction.



Unrehabilitated gravel pit

Glossary

Aggregate - various-sized fragments of hard construction material

Almandine ruby - almandine is the iron--aluminium end-member of the garnet group; it

- is found in regionally metamorphosed rocks; ruby is a deep red, transparent variety of almandine
- Bog iron ore - a low-grade ore of impure hydrous iron oxides formed in swampy areas by precipitation from iron-bearing waters
- Cassiterite - tin oxide; a brown or black mineral and the principal ore of tin. In addition to the lode and alluvial fine deposits, cassiterite occurs in igneous rocks such as granite
- Jasper - a variety of dense, crypto-crystalline silica containing iron oxide impurities that give the rock various colours, generally reds and greens
- Lime - calcium oxide, specifically quicklime
- Osmiridium - a white to grey native alloy containing 25--40% osmium and 50--60% iridium, often found with platinum. Iridium is used in the dental, electrical, and jewellery trades; osmium is of little commercial importance
- Platinum - a highly corrosion-resistant, ductile, and malleable metal used in jewellery, surgical instruments, chemical and electrical equipment, and thermocouples
- Pyrite - iron sulphide
- Sapphire - blue transparent variety of the mineral corundum (an oxide of aluminium)
- Salamander - mixture of coarse crushed rock and clay used for base courses and foundations
- Stone - as defined under the *Extractive Industries Act* 1966: building stone, basalt, granite, limestone, or rock of any kind, non-crystalline quartz, slate, gravel, clay, sand, earth, and soil
- Topaz - a fluoro-silicate of aluminium occurring in acid igneous rocks and used as a gemstone. Colours vary from white, yellow, and pink to blue
- Tourmaline - a complex boro-silicate of aluminium together with alkali metals or iron and magnesium, it is a black mineral often occurring in acid igneous (especially granite, pegmatite) and metamorphic rocks
- Zircon - a gemstone formed from zirconium silicate and found in various colours. Zirconium oxide (zirconia) is refined from zircon and used as a refractory, and in the manufacture of abrasives and enamels

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22. ENERGY

The Importance of Brown Coal

Australia is well endowed with energy reserves compared with many other countries and Victoria possesses about a quarter of the Australian total. Brown coal comprises 95% of Victoria's natural energy reserves, with oil and gas making up the other 5%. Known resources of brown coal total 123,000 million tonnes, 109,000 million tonnes of which occur in the Latrobe Valley, predominantly in the study area but extending east into the South Gippsland, District 1, and Stradbroke study areas. A further 5,600 million tonnes exist in the Alberton and South Gippsland Shires.

The main coal deposits stretch 50 km in an almost continuous belt eastwards from Yallourn in a zone varying from 8 to 16 km wide. Coal seams range from 10 to 140 m in thickness and, as a result of geological movements, overburden thickness ranges from as little as 15 m to more than 100 m.

Recognizing that brown coal was vital to Victoria, the State government, in June 1975, issued Statement of Planning Policy No. 9 directed primarily to the

planning of land use in areas overlying the Central Gippsland brown coal deposits.

In 1977, 35,000 million tonnes of brown coal in the Central Gippsland region was classed as economically winnable. These deposits covered 80,000 ha outside township planning scheme boundaries and the Australian Paper Manufacturers' mill at Maryvale. Interim Development Orders were promulgated in April 1978, allowing the Town and Country Planning Board to regulate subdivision, housing, and other developments on this area.

Amendments to the Orders in December 1978 grouped the coal-fields into two areas. One - of 30,000 ha near Morwell and Traralgon, provisionally identified for electricity production by the State Electricity Commission - contains about half of the economical coal. The second area was provisionally assigned to other or 'non-S.E.C.' uses.

Restrictions on housing on existing subdivisions in the 'non-S.E.C.' areas were relaxed, but new housing on existing subdivisions within the 'S.E.C.' areas was generally prohibited, compensation

being offered on some 150 small lots. These planning controls are being incorporated into local planning schemes.

Figure 12 shows the locations of the planning control areas in Central Gippsland and Figure 13 geological cross-sections of the Latrobe Valley coalfield.

History

Brown coal was first mined in the Latrobe Valley in 1889 at Yallourn North by the Great Morwell Coal Mining Co. Technical problems, a bushfire, and competition from imported black coal caused the company to close in 1899.

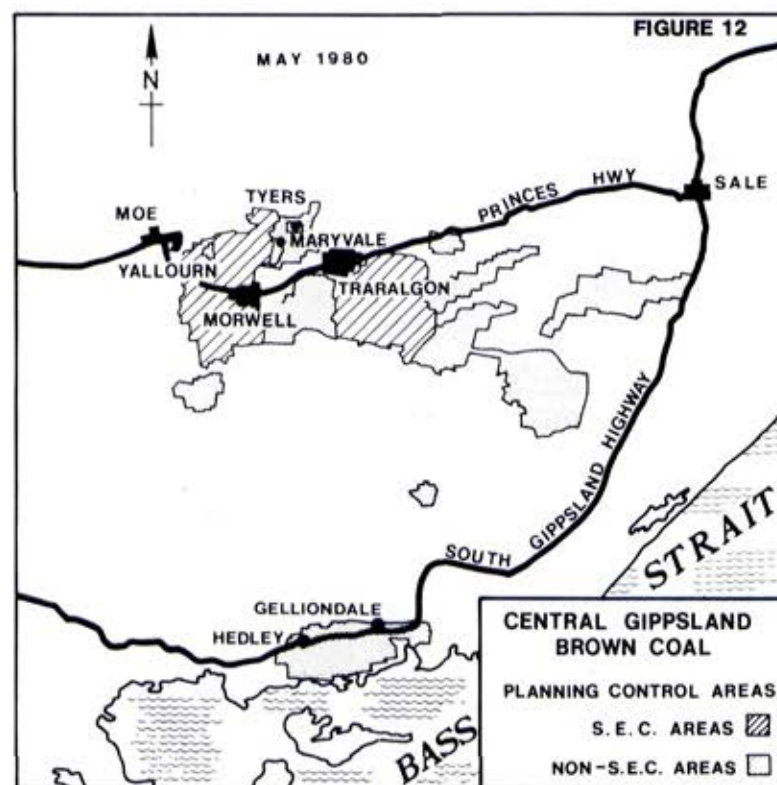
Shortages of fuel (especially imported black coal) during World War 1 led to the formation of a Brown Coal Advisory Committee in 1917, which advised the State Government to establish the State Electricity Commission of Victoria. This was done; funds were provided for the construction of a power station at Yallourn, and in June 1924 the first generator was supplying power to Melbourne.

The Commission also produced briquettes from brown coal. By 1939, 3.7 million tonnes of coal were being mined annually and the Latrobe Valley power stations were the largest in Victoria.

Further serious fuel shortages during World War II were partly overcome by us-

ing briquettes in the metropolitan power stations.

Power generation commenced at Morwell in 1958 and at Hazelwood in 1971, when more than 80% of Victoria's electricity was being generated in the Latrobe Valley. Commissioning the first stage of Yallourn 'W' power station commenced in 1974. Meanwhile, electricity became available to virtually every settlement in the State.



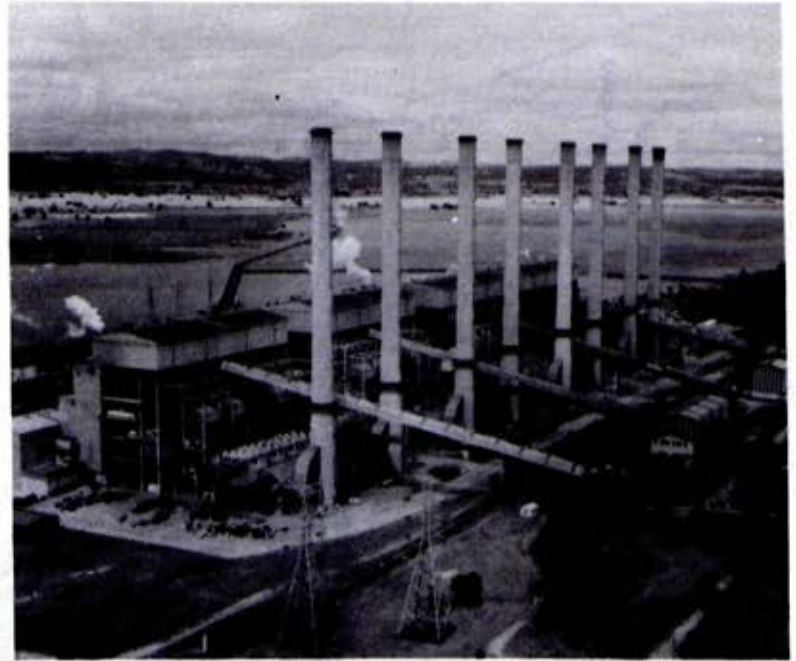
Victorian requirements

During 1978--79, brown coal was produced at an annual rate of 31 million tonnes, predominantly for electricity generation and briquette production, with minor quantities for private sales for char production and other purposes. Brown coal output is increasing and, for electrical generation alone, is expected to double by the time the Loy Yang Project south of Traralgon is completed. The production rate would also increase markedly if other processes such as coal-to-oil conversion came into operation.

The government's energy policy for Victoria, issued in 1979, predicted that the use of electricity would grow by from 4.5--7.1% per year in the early 1980s, this rate reducing to from 2.5--5.5% by the year 2000. If mid-range figures for growth are assumed, starting from the present 5% and declining to 3% next century, then all of the coal presently classed as economically winnable in the provisional S.E.C. areas will be fully utilized in about 100 years.

Commitment of 'non-S.E.C.' coal areas (the balance of the coal-fields - some 50,000 ha) would depend on coal usage for other purposes such as coal-to-oil conversion plant.

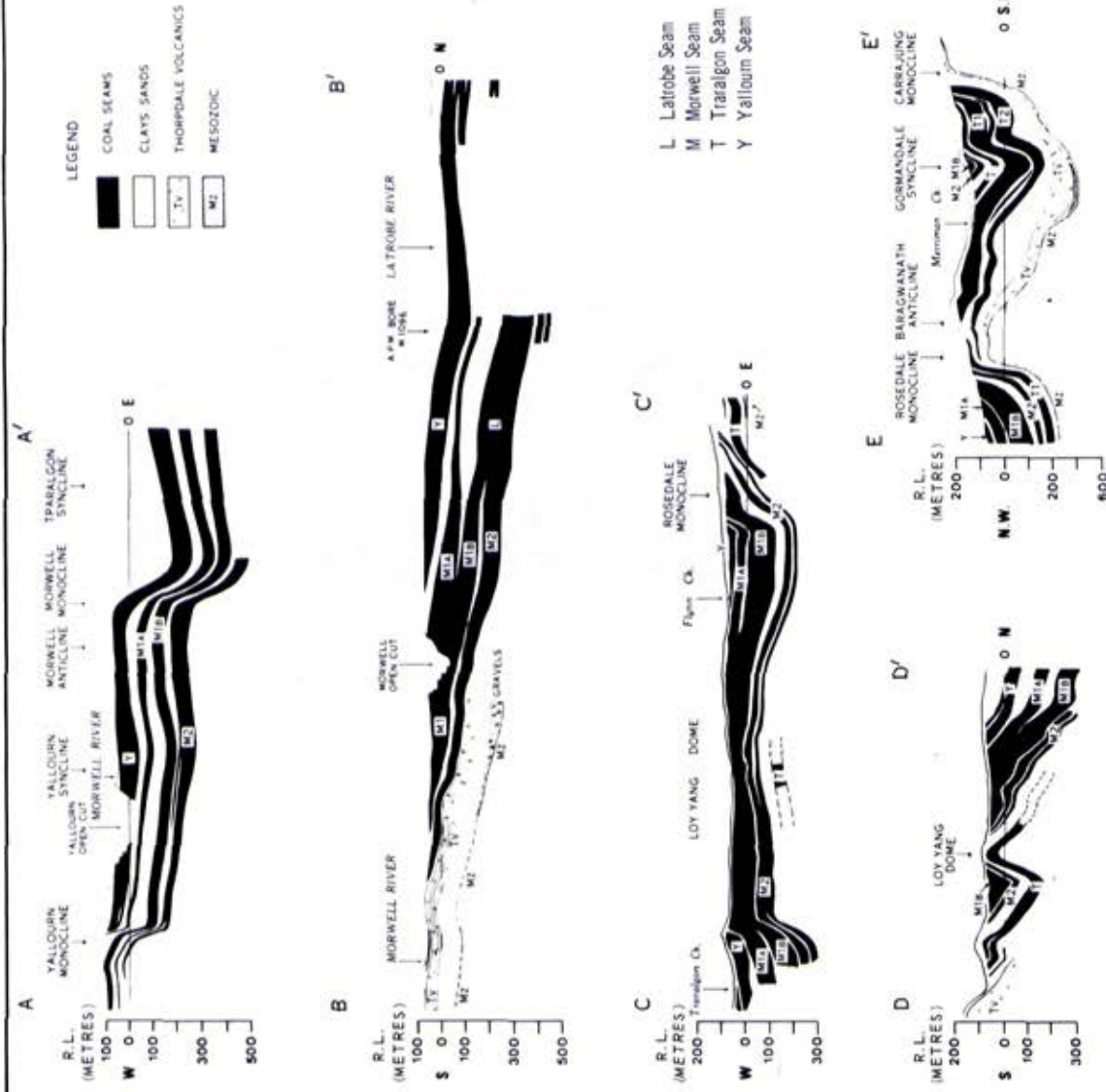
With the predicted future demand for liquid fuels, such commitments could be expected within the next 20 years.



*Hazelwood power station south of Morwell
- with a capacity of 1,600 MW*

Supporting resources, such as air, water, and land on and off the coal-fields, are essential for the effective utilization of brown coal, including the generation of electricity, and limitations on these resources (in terms of both quality and quantity) in the Latrobe Valley could moderate the rate of utilization of brown coal. This in turn could result in energy resources outside the Latrobe Valley being brought into

continued on page 250



**FIG.13 Cross-sections;
Latrobe Valley coalfield**

FIGURE 13

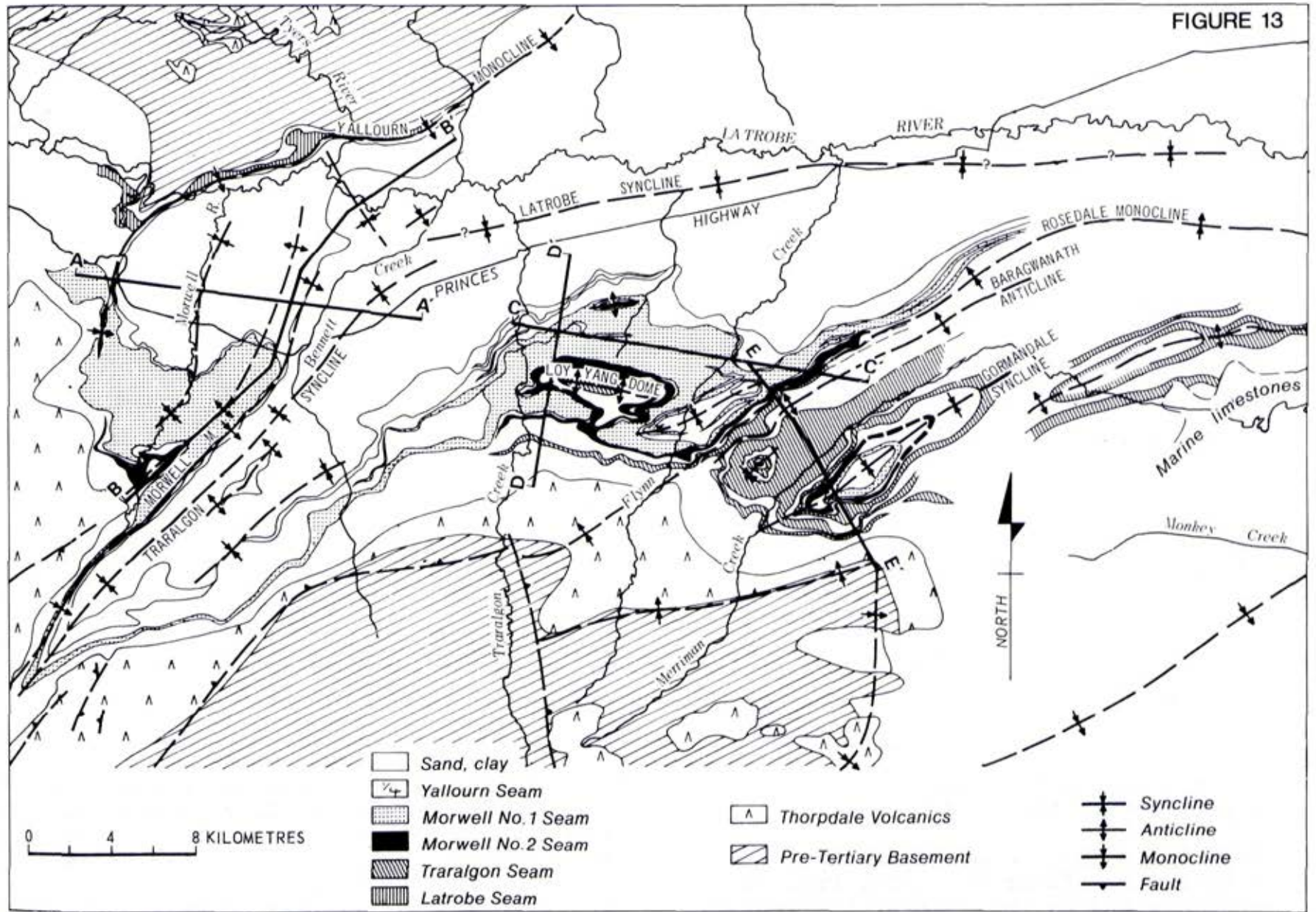


Table 29

LATROBE VALLEY POWER STATIONS

(A) Existing Latrobe Valley Power Stations (1978/79)

	Installed capacity MW(1)	Electricity production GWh(2)	Fuel	Percentage of total Victorian elec- tricity production
Yallourn Power Station	521	2,939	Brown coal	13.7
Yallourn 'W' Power Station	700	3,526	Brown coal	16.8
Morwell Power Station (3)	170	1,178	Brown coal	5.5
Hazelwood Power Station	1,600	9,406	Brown coal	44.0
Jeeralang 'A'	225	478	Natural gas	2.0
	<u>3,216</u>	<u>17,527</u>		<u>82.0</u>

(1) 1 MW = 1,000 kilowatts

(2) 1 GWh = 1 million kilowatt-hours

(3) Morwell Power Station also supplies process steam for the Morwell Briquette Factory

use, and reduce the industrial and urban development of the study area.

Electricity meets about a quarter of the State's non--transport energy requirements now and by the turn of the century could be supplying around 40%. To meet

the existing demand, plant with a capacity of 3,861 megawatts has been brought into service in Victoria, mainly in the Latrobe Valley. Brown-coal-fired plant in the study area supplies 80% of the State's electricity. The major brown coal power stations in the study area

(B) Planned power stations

Year ending June	Power station component	Capacity added MW	Total capacity MW	Fuel
1980	Jeeralang 'B'	240	240	Natural gas
1981	Yallourn 'W' *	375	1,075	Brown coal
1982	Yallourn 'W' *	375	1,450	Brown coal
1983	Loy Yang 'A' (Unit 1)	500	500	Brown coal
1984	Loy Yang 'A' (Unit 2)	500	1,000	Brown coal
1985	Loy Yang 'A' (Unit 3)	500	1,500	Brown coal
1987	Loy Yang 'A' (Unit 4)	500	2,000	Brown coal
1988	Loy Yang 'B' ** (Unit 1)	500	500	Brown coal

* These components form the second stage of Yallourn 'W' project

** The eventual planned capacity of Loy Yang 'B' is 2,000 MW

include the Yallourn and Yallourn 'W' power stations using Yallourn open-cut coal, and the Morwell and Hazelwood power stations based on the Morwell open cut. Capacities and outputs of the stations for 1978/79 are given in the first part of Table 29.

To meet expected electricity demands through to the early 1990s, the Commission has under construction in the study area the Yallourn 'W' (Stage 2) 750-MW power station, currently scheduled for completion in 1982, and the 4,000-MW Loy Yang project scheduled for completion



Gas turbine generators with a capacity of 225 MW located north of Jeeralang

in 1991. Both of these are described later.

Gas turbines are being installed in the study area at the Jeeralang power station, located near the Hazelwood terminal station, to meet an expected shortage following the decision to reduce the size of the gas-fired Newport 'D' Power Station from 1,000- to 500-MW capacity. (Gas turbine generators do not require water for cooling.)

Planned future development of generating plant in the Latrobe Valley to 1988 is shown in the second part of Table 29.

Briquette and char production

A significant amount of brown coal is used to produce briquettes, which are made by compressing pulverized, dried brown coal into small blocks. They are used widely for industrial and domestic purposes, and are manufactured at the Morwell briquette factory from Yallourn open-cut coal. In 1978/79 this factory turned out just over 1 million tonnes of briquettes.

Briquettes are also used in the manufacture of brown coal char. They are carbonized to give a high-grade carbon, which can be used either as a source of pure carbon or as a reducing agent in the chemical and metallurgical industries.

Char production in Victoria is undertaken in two privately owned plants at Morwell and Traralgon, which use briquettes and small quantities of brown coal purchased from the S.E.C.

Between 1955 and 1969, a significant proportion of Melbourne's town gas was supplied from the high-pressure gasification of briquettes in the Gas and Fuel Corporation's Lurgi plant located east of the Morwell open cut. The plant was shut down after the introduction of natural gas to Victoria, but brown coal

could again be the source of Victorian gas supplies when the Bass Strait natural gas fields are exhausted.

Utilization of brown coal

The high moisture content of brown coal (typically 2 tonnes of water for every tonne of dry coal) means that the coal is relatively expensive to transport on the basis of thermal value, compared with other fuels or feedstocks. Usually, therefore, it is upgraded or used close to its source. Accordingly, power stations, briquette factories, and facilities have been located close to open cuts, creating substantial industrial activity in the Latrobe Valley.

Mining of brown coal

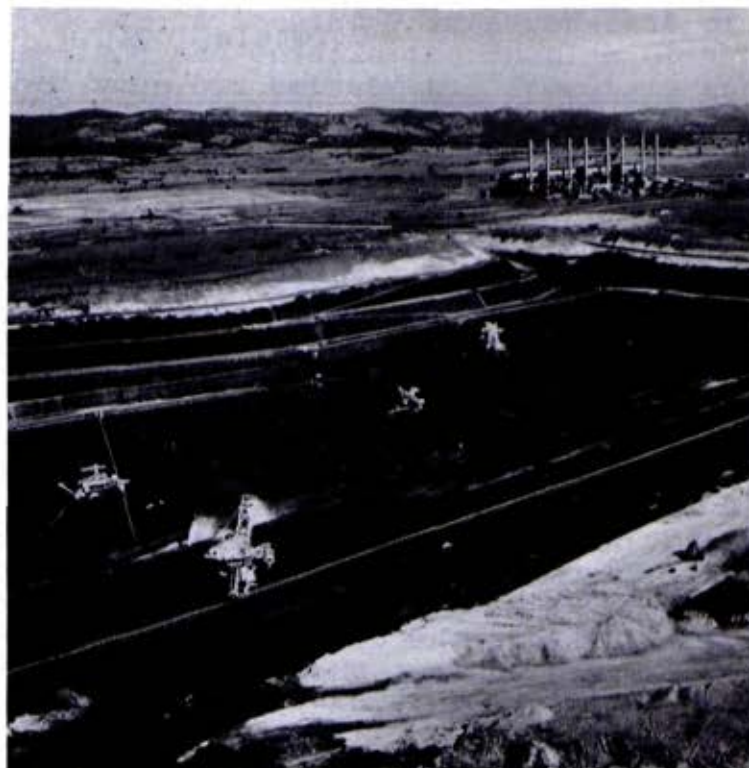
Two major open cuts, at Yallourn and Morwell, and two small open cuts, at Yallourn North and Tyers West, have been developed in the Latrobe Valley.

The Yallourn open cut was established in 1921 on the southern side of the Latrobe River to use coal from the Yallourn seam to supply the Yallourn power station and the now demolished briquette factory. In June 1979 the excavation covered an area of 980 ha. It still supplies coal to the Yallourn power stations and now also to the Morwell briquette factory.

The Morwell open cut was established in 1955--56 immediately south of Morwell township, and supplies the Morwell and

Hazelwood power stations. In June 1979, the excavation occupied 348 ha.

The Yallourn North Extension open cut, which is much smaller than those at Yallourn and Morwell, was established by the S.E.C. in 1956 to supply local industry from a small deposit of the better quality Latrobe seam coal following the exhaustion of the Yallourn North open cut. Most of its output is supplied to the Maryvale paper mill.



Winning brown coal from Morwell open cut

Table 30

LATROBE VALLEY OPEN CUTS

Utilization	Yallourn	Morwell	Yallourn North	Total
	(Values expressed in millions of tonnes of coal)			
Electricity generation	12.0	15.7	-	27.7
Briquette production	3.0	-	-	3.0
A.P.M. and other Gippsland industries	-	-	0.2	0.2
Totals	15.0	15.7	0.2	30.9
Overburden removed (million cubic metres)	6.5	3.5	Not available	

Outside the Latrobe Valley limited quantities of brown coal were mined by private companies from the Gelliondale field from a small open cut, which was worked from 1934--44 and from a mine at Won Wron during the 1960s. Brown coal is also produced from open cuts to the west of Melbourne at Anglesea and Bacchus Marsh. Production from these areas in 1977--78 totalled 2.06 million tonnes.

Table 30 shows the coal output and overburden removed from the Latrobe Valley open cuts during 1978--79.

Up to June 1979, 400 million tonnes of coal had been won from the Yallourn open cut and 130 million cubic metres of

overburden removed, and for the Morwell open cut to the same time, 200 million tonnes of coal had been won, and 48 million cubic metres of overburden removed.

Future Development of the Resource for Power Generation

Yallourn area

The annual coal supply from the Yallourn open cut will be progressively increased to 23 million tonnes by 1983 to supply the existing power stations and the 750-MW Yallourn 'W' Stage 2 station approved by Parliament in 1972. This, together with briquette production, has required



Site of open cut at Gelliondale, worked 1934--44

the commitment of the brown coal resources of the East Field and those under Yallourn itself. Consequently the removal of the township is now well advanced. All the houses in the township are owned by the S.E.C., and tenants are moving progressively into the surrounding towns.

Coal operations will be completed in the township area in the 1990s and operations will be progressively transferred

to the East Field coal areas to the east of the present Morwell River channel, near its junction with the Latrobe River. Overburden removal is expected to start about 1990, and this will necessitate a diversion in the mid 1980s of a portion of the Morwell River to the east of its present course.

Loy Yang project

The Loy Yang project, approved by Parliament in 1976 and occupying an area of 4,700 ha, is located 7 km south-east of Traralgon and entails the opening of a major open cut between the Traralgon and Loy Yang Creeks, and the construction of two power stations, each containing four 500-MW generating units. The project will also involve the construction of new 500-kV transmission lines to Hazelwood terminal station south-east of Morwell, several water supply pipelines, and a pipeline carrying waste water from the Latrobe Valley power stations to the sea at McGaurans Beach. At 1979 prices, the project is estimated to cost \$2,800 million.

The open cut will eventually yield 1,000 million tonnes of coal, sufficient to operate 4,000 MW of generating plant for 30 years. Additional coal could be won by extending the planned open cut boundaries.

The four generating units in the Loy Yang 'A' station are planned to go into service progressively between 1983 and

1987, and the second station (Loy Yang 'B') will follow.

The project will bring other substantial new developments to the Latrobe Valley - for example, housing for the 2,000 workers and their families expected to move to the area.

Power projects to follow Loy Yang

It is expected that further new projects will be required after Loy Yang is

completed, and the Commission is giving consideration to proposals for more base-load generating facilities with a capacity of up to 6,000 MW to cover electricity demands to around the turn of the century.

Other Possible Developments

On current projections of future demands for energy, it must be assumed for long-term planning purposes that the whole of the designated coal areas will be required.

Brown coal can be used as a feedstock for various processes, including the production of synthetic fuels and solvent-refined coal. Plants converting brown coal to synthetic oil or other fuels could be major future users of brown coal, depending in part on the future price of crude oil.

Interest in solid solvent-refined coal has been aroused because of its reported value as a blending component in coke manufacture and as a substitute for petroleum coke in electrode carbon manufacture.

The installation of a solvent-extraction plant based on Victorian brown coal could be a logical interim step in the development of a local coal-liquefaction industry. Further hydrogenation of solvent-refined coals to liquid fuels suitable for transport requirements is an avenue that may be investigated.



Loy Yang project, early 1980

Information on potential methods for the production of synthetic fuels is given in Appendix 9.

Other Resources Required for Energy Production

Coal production and power generation make an immense demand on the resources of the Latrobe Valley.

Water

Power stations require reliable supplies of water in large quantities, especially for condensing steam. The sources of this water, and present and future daily requirements, are described in the Water Utilization chapter.

In the case of the Hazelwood power station, the 500-ha Hazelwood pondage dissipates the waste heat in the cooling water, mainly by evaporation and radiation to the surrounding air as the cooling water circulates around the pond, each cycle taking about 2 weeks.

At the Yallourn 'W' stations and for the future Loy Yang stations, natural-draught cooling towers perform this function, each tower acting as a chimney to draw cooling air through a spray of cooling water from the condenser in the lower part of the tower so that the water is cooled prior to recycling.

Since it does not need large volumes of condenser-cooling water, the older power

station at Yallourn can take cooling water directly from the river storage and discharge it back to the river. Water cooling facilities are used where necessary, to ensure that the discharge-water temperatures do not have an adverse effect on the stream environment.

Future users of brown coal would also require water in varying quantities.

Air

Discharges from plants using brown coal consist largely of water vapour, but the particulate matter and gases inevitably produced must be controlled to preserve air quality. This will necessitate rigid monitoring of air composition. Studies have commenced on these aspects. The most important is the Latrobe Valley Air Shed Study by the State Electricity Commission, Environment Protection Authority, Latrobe Valley Water and Sewerage Board, and the Commonwealth Scientific and Industrial Research Organization. It will monitor present Latrobe Valley air quality and dispersion of emissions, predict dispersion patterns for future emissions, and consider possible future emission controls that may be necessary. Eighteen monitoring stations for the study area will be completed in 1980, at a cost of around \$2 million.

Land

Land will be required to site coal-handling installations and supporting

facilities such as roads, water, or drainage pipelines, power lines, and overburden dumps.

The full development of the Latrobe Valley brown coal resources will require the maximum possible utilization of water within a reasonable distance of the area, and land use planning must take into account requirements for associated water storages, regulating dams, retarding basins, pipelines, and pondages.

Some streams will need to be relocated to allow for future coal winning. Proposals have been put forward for a major diversion of the Morwell River to the east of Morwell, for example, to allow full utilization of coal lying south of the Princes Highway and west of Morwell. Land will be required for overburden dumps, power station or coal-to-oil conversion plant sites. As far as possible these facilities must be sited off the coal, to allow development of open cuts.

Land will be needed for the urban expansion associated with the development of the coal reserves and eventually for reorganization of transport routes over the coal-field areas.

Statement of Planning Policy No. 9 provides for the protection of economically winnable brown coal and prohibits developments of a permanent nature that would interfere with its extraction and utilization. The statement also provides for the planning and management of the

catchments of the river systems and groundwater, to ensure an adequate water supply for development in the area.

Post-Operational Treatment for Brown Coal Excavations

Statement of Planning Policy No. 9 requires brown coal excavations and overburden dumps in Central Gippsland to be planned and rehabilitated to the highest practicable degree consistent with their potential future use.

The size and scale of the Latrobe Valley open cuts, together with their long working period, require post-operational treatment broader than the best current practice in black coal open-cut operations in the United States and the United Kingdom, or in brown coal operations in Germany.

Treatment of open cuts

In the Latrobe Valley 3.3 tonnes of coal are removed on average for every cubic metre of overburden displaced. As the cut develops, the overburden can be replaced but will never fill the excavation. Thus, even though it is not possible to restore the working area to its original topography, the object is to leave the worked-out area in a form suitable for other useful purposes after operations have been concluded.

In view of the time involved (the Yallourn open cut has already been worked

for 59 years), post-operational plans must be able to take account of the community's changing land use requirements.

The floors of the deeper open cuts in the Latrobe Valley are below the natural drainage level of the surrounding land, and so will naturally fill with water and form artificial lakes when pumping stops. Only shallow elevated open cuts, such as the Yallourn North Extension, can be drained naturally. The lakes thus created may be used for recreation and water storage, but it may be necessary to remove the water to provide for safe working of adjoining or nearby coal-fields, and possibly to permit the establishment of vegetation, including crops, on the sides of the cut.

Treatment of overburden dumps

In new developments a large external dump may be required to accommodate overburden until the bottom of the coal seam is reached and sufficient space is established for internal dumping. When seams exist below the first cut, external dumping may have to continue to allow utilization of the lower seams at some later stage.

External dumps can be progressively contoured to match the existing topography and treated to suit the local environment, but they remain an operational area until disposal operations are completed and vegetation is established on the final surface.

Continuing use of open cuts and overburden dumps

The floor of the worked-out Yallourn North open cut is now serving as an ash-disposal pond for the Yallourn group of power stations, and settling ponds for power station and general effluent have been constructed on an old overburden dump lying between the Yallourn and the worked-out Yallourn North open cuts.

Extensive rehabilitation - to stabilize exposed faces of open cuts, prevent erosion, control run-off, and provide aesthetic improvement - is being carried out. Pines and other trees have been planted in a number of areas.

Treatment of coal-utilizing plant

These structures can be progressively removed as they reach the end of their operational lives, and the plant sites made available for other purposes.

Energy Conservation

The assumption of an annual growth in electricity consumption of around 5% until the end of this century is challenged by certain community groups on the basis that alternative energy sources may eventually have to be substituted for coal-fired generators. They also believe that other sources will contribute increasingly to satisfying the community's demand for energy. These will include solar heating which will

be supplemented by better design and insulation.

The groups claim that the introduction of new appliances - such as refrigerators, air-conditioners, and colour television sets - contributed to the past high growth in electricity use. When the market for these goods is saturated, their effect on electricity demand will decline.

Many believe that we should plan for local renewable sources of energy to ultimately provide most of our needs, rather than complex centralized generators utilizing non-renewable resources.

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23. UTILITIES

Utilities and services essential to the welfare of the community are often located on public land. These include facilities for the disposal of industrial and domestic waste, for road and aerial transport, for communications and survey, for the distribution of fuel and electricity, for military training, and for the provision of navigational aids. This chapter describes the current use of public land for these purposes, and attempts to assess future requirements in certain fields. Maps 4a and 4b show the locations of utilities and services within the study area.

Electricity Supply

The Victorian power grid

The State Electricity Commission utilizes large areas of public land in the Latrobe Valley for the mining of brown coal and for electric power generation, briquette production, and associated activities. These works are described further in the chapters on Energy and Water Utilization.

The distribution of electrical energy is an important consideration in land use planning.

The Commission distributes electricity throughout Victoria via a three-stage system of power lines. The main transmission grid conducts high-voltage power (at 220 kV and above) from the generating stations, via associated terminal stations, to terminal stations in the regions where the electricity will be used. In the study area, terminal stations are located at Hazelwood and Morwell, and a site is available at Tyers if required. The high-voltage power lines are typically mounted on steel towers, and several of these lines emanate from the power stations in the Latrobe Valley and pass out of the study area towards Melbourne. Figure 14 shows some types of tower used in the main transmission grid.

The sub-transmission grid then conducts medium-voltage power (at 66 kV) to zone sub-stations, and the distribution grid, operating at 22kV and lower voltages, links these with individual users of power. Both sub-transmission and distribution lines are carried on poles or may be buried if the additional expense can be justified.

Table 31 lists general easement widths for each type of power line.

Table 31

AVERAGE EASEMENT WIDTHS FOR POWER LINES

Main transmission lines	40--70 m*
Sub-transmission lines	15--25 m
Distribution lines	10--25 m

* Single line

Future construction in the study area

Lines are also to be constructed within the Latrobe Valley between Loy Yang power station and Hazelwood terminal station, and a third line in the existing northern easement between Hazelwood and Coldstream will be built during the 1980s. In addition an easement will be required for a 220-kV power line running from Morwell to Montgomery, near Sale. Other new transmission lines running out of the study area may be necessary in the future.

Sub-transmission and distribution-line networks may be continually expanded, as required by the growth of population and industry.

Power lines and the rural environment

Main transmission lines are generally constructed along the most direct and practical route between terminal stations, across both public and private land, to minimize costs and power losses

in the line. The route may be varied, however, to take advantage of high features that offer the opportunity to lengthen cable spans, thereby using fewer towers, or to avoid areas where construction difficulties may arise. It may also be altered to minimize the effects on the environment and to preserve the amenity of an area.

In recent years, landscape architects and design engineers have worked togeth-



Several major power and pipeline easements traverse the Latrobe Valley

LAND CONSERVATION COUNCIL
VICTORIA
SOUTH GIPPSLAND STUDY AREA
DISTRICT 2
UTILITIES

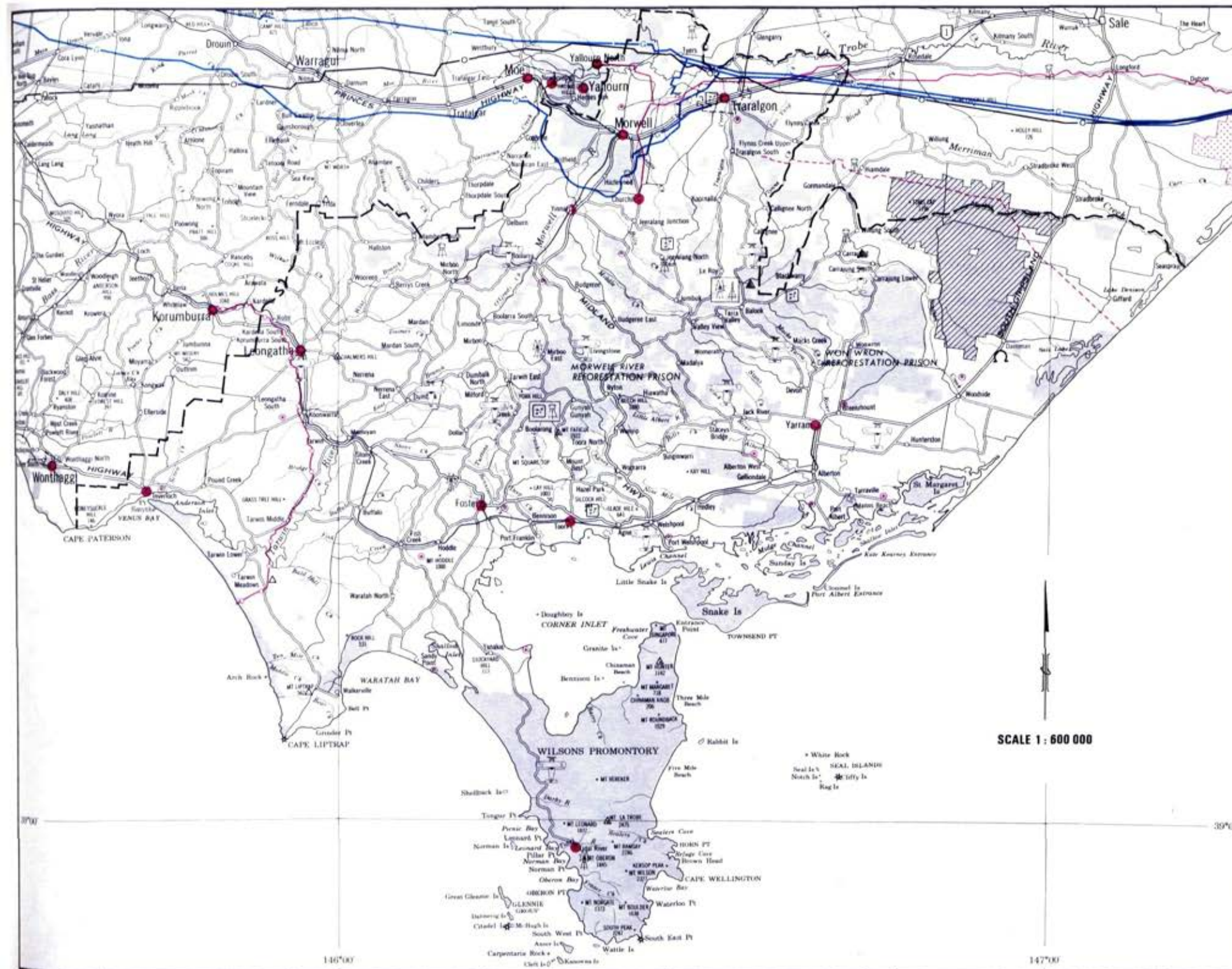
LEGEND

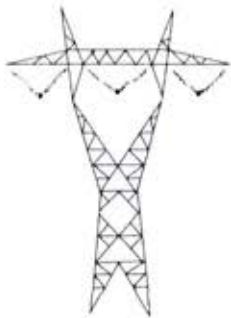
- Sewered towns and settlements
- Sewerage scheme under construction
- Outson downs disposal area
- Latrobe Valley outfall pipeline and channel
- Proposed saline wastewater outfall
- Korumburra—Leongatha ocean outfall
- Natural gas pipeline
- Oil and gas liquids pipelines
- ✈ Airstrip
- ▲ Air navigational aid
- Site of Omega station
- ★ Lighthouse
- ⋈ Television tower
- ⋈ Telecommunications tower
- ⋈ Other radio and telecommunications installations (operating or proposed)
- ⋈ Fire lookout
- △ First order trigonometrical stations
- Mullungdung training area (Australian Army)
- Tips on public land
- Tips on freehold land
- Public land *Note: Many small areas of public land are not shown at this scale.*
- Study area boundary

* See map No.4B for pipeline & easement detail.

SCALE 1 : 600 000

MAP No.4A





Typical 500 KV Single Circuit Tower



Typical 220 KV Double Circuit Tower

FIGURE : 14
TOWERS IN THE MAIN TRANSMISSION GRID
Not to Scale

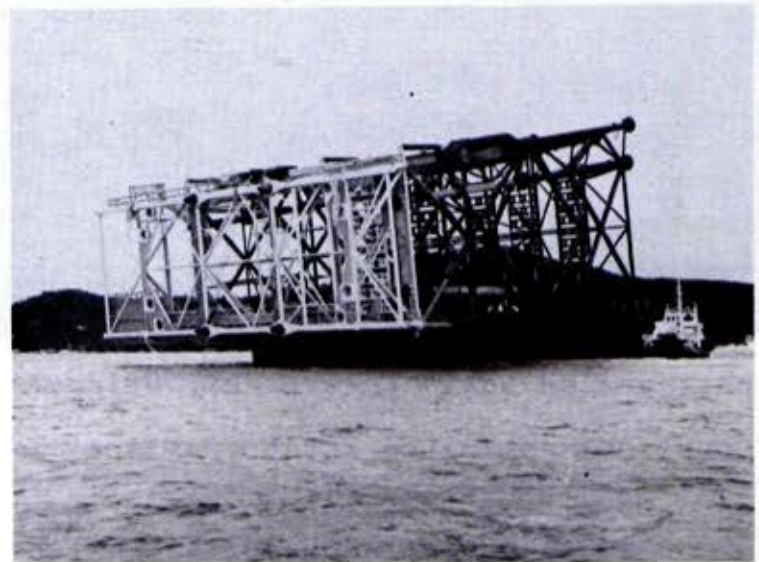
er to design and locate main transmission lines in Victoria, in order to minimize their impact on the landscape.

Most sub-transmission and distribution lines have been constructed along road reserves. The remainder, including most of the 12.7-kV single wire-earth return lines, are in easements, usually through private land.

The use of road reserves with functioning thoroughfares ensures year-round access for maintenance vehicles, but may require the destruction of some roadside vegetation during the period of construction. Fire-protection measures such as tree-pruning and the subsequent burning of branches can be unattractive and may damage ground flora, at least temporarily.

Oil and Gas Distribution

The natural gas and oil pipelines between the Bass Strait oilfields and Melbourne and Westernport all pass through the Latrobe Valley. Small areas



Oil platform under tow to Bass Strait fields from Barry Beach



Lighthouse on South East Point, Wilsons Promontory

of public land in the study area are traversed by these easements.

The 450-mm-diameter gas pipeline, which linked the Lurgi plant at Hazelwood with Melbourne, is now used to transport natural gas.

Minor pipelines, such as the Morwell--Traralgon connection, are often located along road and railway reserves.

Provided rehabilitation, in the form of contour ploughing and re-sowing, is carried out very soon after the con-

struction of pipelines through grassland, little erosion of the soil should result. Where pipelines pass through forests, easements must be kept clear of regrowth for maintenance purposes and this could lead to erosion.

Other Services

Telecommunications

Telecom Australia operates four radio-telephone repeaters in the study area - on Austins Hill at Mirboo East, at Foster North, at Mount Tassie near Balook, and on public land at Mount Oberon. Another station is likely to be constructed during 1980--81 at Mount Fatigue, near Foster. This site is also on public land.

Radio-telephone repeaters must be accessible by vehicle. They commonly occupy sites of around half a hectare, and comprise a single-storey building, a tower 15--40 m high, and limited space for parking. The installation at Mount Tassie, however, is mounted on the transmitter of Gippsland's national television station. Radio repeaters are located at various places in the study area. None are on public land, but the S.E.C. plans to construct stations at Mount Fatigue and Jeeralang.

Air navigation

There are two air-navigational installations in the study area. The Depart-

ment of Transport operates an air--ground--air communications station at Mount Tassie. This facility is located on public land and greatly increases the operating range eastwards of the Melbourne Flight Service Centre.

The Omega navigational aid is being built at Darriman, and a monitoring station associated with this project will be established in the Strzeleckis at Carrajung. The main Omega tower will be 427 m high and the largest such structure in the Southern Hemisphere.

Marine navigation

The Department of Transport maintains lighthouses at Cape Liptrap, South East Point (Wilsons Promontory), Citadel Island, and Clifffy Island. Both the latter islands are owned by the Australian government. Only the lighthouse at South East Point is manned.

Airstrips

Appendix 8 lists the airstrips located on public land in the study area.

Fire look-outs

There are numerous look-outs in the Latrobe Valley and the Strzeleckis, and these are manned by the State Electricity Commission, Forest Commission, or A.P.M. Forests Pty Ltd. They are complemented by towers outside the study area and so this comprehensive system

ensures that fires are rapidly detected. Table 32 lists these fire look-outs.

Military training

Military training in the study area is almost entirely confined to the Mullungdung State Forest north-east of Yarram (which extends into the neighbouring Stradbroke study area and covers about 28,000 ha). This land has been proclaimed as the Mullungdung Training Area



Fire tower at Dickies Hill



Rubbish tip on public land at Boolarra

and is used about three times a year for sub-unit training in infantry tactics (involving around 50 soldiers for a week or so at a time) and occasionally for weekend activities. Tracked vehicles do not train in the area; all supporting vehicles are wheeled and do not leave roads.

Waste disposal

Waste disposal often presents problems to municipalities. Solid waste from towns in the study area is usually dumped as land-fill, often on public land

Table 32
FIRE LOOK-OUTS

Organization	Tower	Details
A.P.M. Forests Pty Ltd	Boola (Tyers)	Located on private property
	Coalville	Located on public land
	Flynn Creek	Outside study area
	Longford	Outside study area
	Mount Hooghly	Public land on lease
	Stockdale	Outside study area
Forests Commission	Dickies Hill	Manned only when necessary
	Mount Fatigue	Manned only when necessary
	Mount Moornappa	North-east of Briagolong
	Mount Tanjil	Willow Grove area
	Mount Toorong	North-east of Noojee
	Mount Useful	Great Dividing Range
	Carrajung	Cabin on public land
State Electricity Commission	Hazelwood	Located on S.E.C. land
	Yallourn	Located on S.E.C. land

reserved for garbage disposal, or in old quarries or other areas, including freehold land. This usually destroys the value of the land, at least temporarily, for most other forms of occupation. In

some situations, pollution of streams or groundwater is also a problem.

Careful choice of locations for rubbish tips, day-to-day control of dumping, and

attention to rehabilitation can reduce the impact of this form of land use.

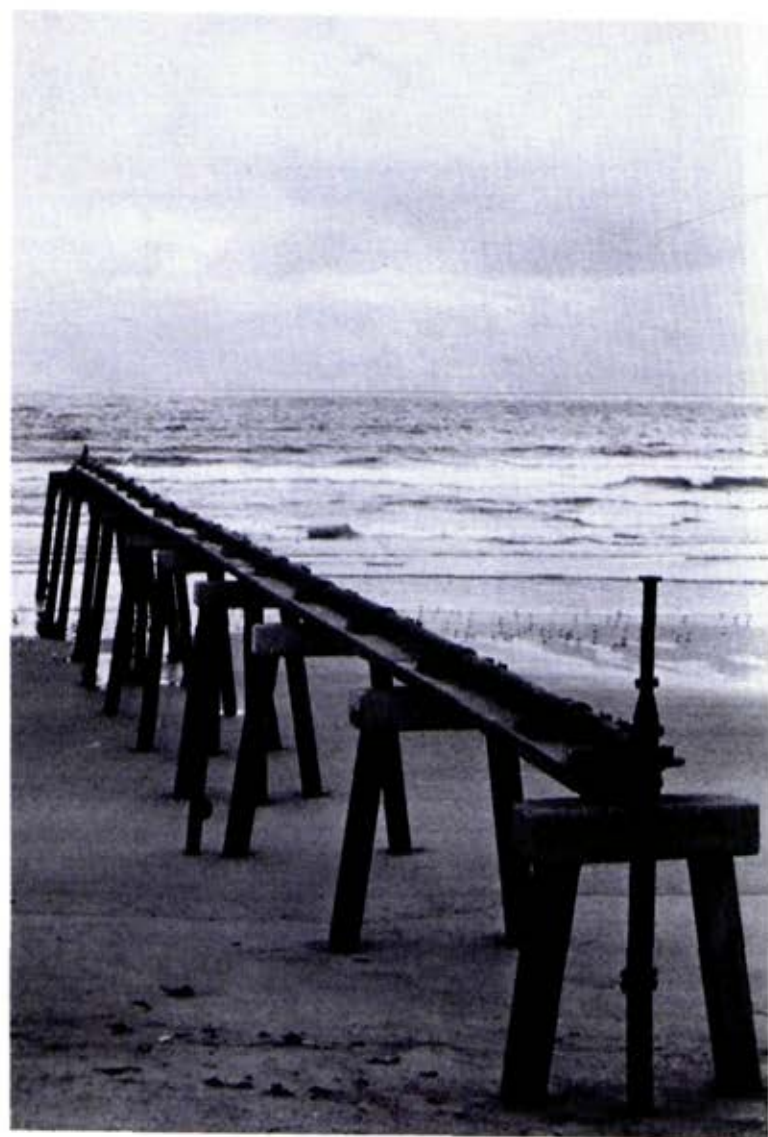
Selection of new sites for tips, when the existing ones are close to being filled, can be difficult, as there is often little public land near towns. Resentment commonly arises among established local residents, and people interested in recreation and conservation of landscapes.

Various methods are used for the disposal of liquid waste. Most towns are sewered; no sewerage authorities use public land for the disposal of effluent except as part of easements for pipelines to treatment works and outlets.

Two schemes have been adopted to dispose of industrial waste.

The Latrobe Valley Outfall Sewer carries industrial and domestic waste from the Latrobe Valley to Dutson Downs. The trunk sewer incorporates some 45 km of pipeline and 40 km of open channel.

Liquid waste is moved slowly around the 9,500-ha disposal area (South Gippsland study area, District 1) through a series of settling ponds and holding basins. In the process (over at least 9 months) it is continually aerated and used several times for the irrigation of pasture and plantation; eventually it evaporates, or soaks into the soil, or is discharged under licence into Lake Coleman.



Ocean outfall of pipeline conveying effluent from Leongatha and Korumburra to Venus Bay

The Korumburra--Leongatha ocean outfall was constructed between the two towns in the western Strzeleckis southwards to Venus Bay. This pipeline is used for the disposal of raw waste from the Leongatha butter factory, and a small quantity of abattoir effluent and domestic sewage, and enters the sea at a point south-east of Tarwin Meadows.

The saline waste-water outfall from the Latrobe Valley power stations to the Ninety Mile Beach, now under construction, is discussed in the chapter on Water Utilization.

Port and harbours

The provision of maritime services is an important use of the shoreline and various areas of public land in South Gippsland have been reserved for this purpose.

Apart from Wilsons Promontory, management of coastal public land in the study area is generally the responsibility of the Department of Crown Lands and Survey. However the Ports and Harbours Division of the Public Works Department carries out engineering works, when they are necessary, and undertakes the construction, operation, and maintenance of port facilities and associated works such as local navigational aids.

General policies for the coast are drafted by a Coastal Management Committee comprising representatives of the

Lands Department, Ports and Harbours Division, Soil Conservation Authority, and the Town and Country Planning Board.

Within the study area there are several small ports. While some are mainly used for recreation, Barry Beach and Port Welshpool have commercial importance while Port Albert and Port Franklin support small fishing fleets and charter operations for tourists.

Port Welshpool particularly plays an important role in coastal trade between the Bass Strait islands and Victoria. The Corner Inlet approach channel is 5 m in depth, with Lewis Channel to Port Welshpool 4 m, so the port is physically suitable (besides being ideally located) for the Flinders Island traders bringing cattle and sheep to the mainland.

The Toora channel has a depth of 5 m and is used by oil drilling and production vessels from Barry Beach. Broadly speaking, Corner Inlet is the only safe harbour for small coastal vessels between Westernport and Eden, N.S.W.

Table 33 lists the ports in the study area.

The main restrictions on navigation into Corner Inlet and Port Albert are the limitations on draught due to the presence of shoals, particularly at the entrances. The entrance at Port Albert varies in depth due to the movement of sand, and its use requires considerable

Table 33
PORT FACILITIES

Port	Facilities	Remarks
Inverloch	jetty, launching ramp	a few commercial fishermen, otherwise recreational use
Walkerville	private moorings	had a long (possibly 320 m) pier when lime kilns were operating
Port Franklin	two wharfs, slipway, private jetties	small fishing fleet, two charter services, recreational use
Barry Beach	Esso Standard Oil (Aust.) Ltd construction site and wharf	servicing and construction of off-shore gas and oil structures and associated facilities; not used by general shipping
Port Welshpool	shipping pier, fishermen's pier, unloading wharfs, slipway, depot	reclamation of waterfront land in progress for port and associated facilities and fishing fleet base
Port Albert	wharf with fish-processing works, slipway, several mooring jetties for fishing and private vessels, unloading jetty	fishing fleet; charter service
Manns Beach	jetty	recreational use only
McLoughlins Beach	jetty	recreational use only
local knowledge. The depth of the channel up to Port Albert is as little as 1.5 m at low water.		and gas commence in Bass Strait, more coastal land could be required for the construction of platforms and the re-supplying of vessels. In addition, the utilization of the Gelliondale coal-
If further offshore operations for oil		

field may also require the provision of new marine facilities.

Railways and roads

Railway easements were reserved decades ago and often contain significant remnants of the original vegetation, particularly where they pass through agricultural country.

Of the State railway lines constructed within the study area, four have since been dismantled. In some instances, portions of easements have been sold to private land-owners; normally, where disused railway easements abut public land, they have been taken over by the authority managing that public land.

The State Electricity Commission also has its own 90-cm-gauge railway for transporting coal between Yallourn and Morwell.

Road reserves throughout the study area also contain remnants of the original vegetation, many of which are of conservation interest. Roadside vegetation often makes a valuable contribution to the local landscape. The use of road reservations for power transmission and telephone lines, and also the construction required in upgrading roads to take faster and heavier traffic more safely, can reduce these stands and their viability.

Cuttings on both road and railway re-

serves may be important for displaying aspects of the regional geology.

With respect to access to public land, most roads are maintained by either the Country Roads Board or local municipalities. The Forests Commission has an extensive network of tracks through its forests and plantations, which are open to the public and used to a moderate degree by recreational drivers. Some roads maintained by the National Parks Service and State Electricity Commission are only available for departmental use.

Miscellaneous

In many places public land is used for cemeteries, schools, public buildings, sportsgrounds, and service basins.

Another frequent use is for the provision of trigonometric stations for surveys - the study area contains eight primary stations, 33 of secondary importance, and a further 284 minor installations, many of which are, however, on freehold land.

The Community Welfare Services Department runs two institutions in the study area. Established in 1961, the Morwell River Reforestation Prison is an open gaol with up to 70 inmates, some 40 of whom would work in the forest. The Wron Reforestation Prison is a medium-security gaol with a similar capacity. In both gaols, prisoners are engaged in nursery work, planting, scrub clearance,

and general forestry, under the supervision of warders and local staff of the Forests Commission.

The Mental Health Division of the Health Department has a large hospital on Crown land with the City of Traralgon.

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PART IV
BLOCK DESCRIPTIONS

BLOCK DESCRIPTIONS

For this part of the report, the study area has been divided into six blocks, areas in which the public land has broadly similar climate, soils and topography. Map 6 shows these blocks; they facilitate the description and assessment of natural resources and have no significance for making recommendations on land use.

The present tenure, nature of the land, uses and capability for various purposes are listed for each block. Hazards are also assessed. The sections dealing with uses refer only to the public land except where explicit reference is made to private land. A consistent format of headings and sub-headings is used to help readers compare specific details between blocks.

Capability

The capability of land means the degree to which it can be used to produce specific goods or services. It depends on the inherent characteristics of the land, such as rainfall, soil fertility, slope, and so on, but is also affected by other factors including hazards (such as erosion and exposure to disease) arising from forms of land use, con-

straints such as costs of development, distance from markets, and access, and susceptibility to wildfires. In most cases capabilities are given in general terms, as the information available varies from block to block, and some values are difficult to quantify.

The capability of land is relative, in that it depends on the size and nature of the area being considered. For many forms of use, land may have a high capability on the local scale but low or moderate capability when considered in the state or national context. In this report capabilities are given in the context of the study area, except where comparison with some other part of the State is specifically made.

The extent of the land under discussion may also influence consideration of its usefulness - for example, a very large area of a land type that has low to moderate capability may be more important for a particular use than a small area with a high capability.

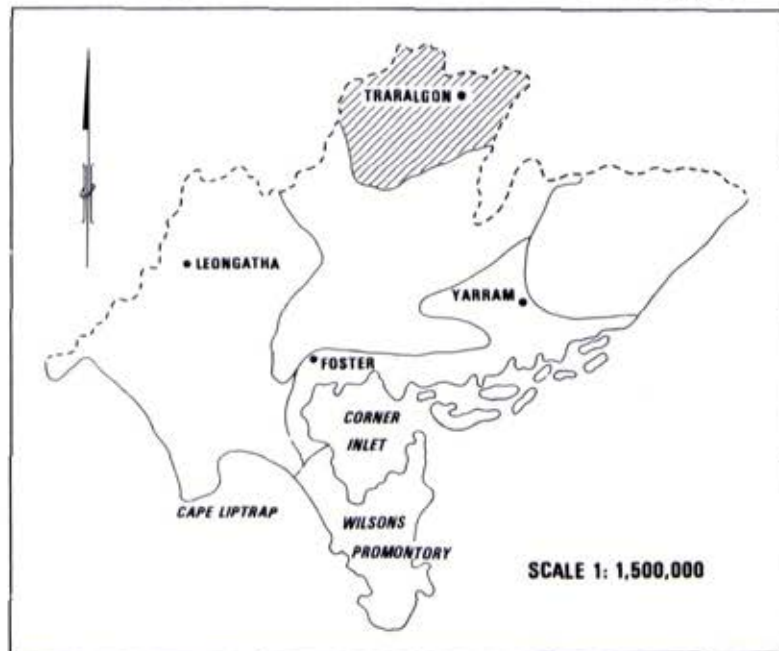
In many cases the current uses on each land type, including those on private land, give a good indication of capability.

1. LATROBE VALLEY

A. Tenure and Nature of the Land

1. Present tenure

The total area of public land in this block is around 14,300 ha, 10,000 of which are used for coal production, power generation and associated activities by the State Electricity Commission. This land is located around Morwell and Yallourn, and south-east of Traralgon.



1. LATROBE VALLEY

As a result of the Land Conservation Council's recommendations for the Melbourne Study Area, a 630-ha section of land along the Tyers River, which is now vested in the S.E.C., will eventually be designated as part of Tyers Regional Park and managed by the National Parks Service.

The remaining public land comprises 900 ha of reserved forest north of Tyers (part of the extensive Boola Boola State Forest), about 50 ha of unoccupied Crown land in small blocks on the plains between Morwell and Flynn, some 75 ha reserved for purposes such as education, recreation, gravel production and water supply, and areas reserved for public use along many of the local streams.

2. Climate

The Latrobe Valley is marginally influenced by the east coast depressions which bring rain to East Gippsland throughout the year, therefore the percentage of summer rainfall in the annual average tends to be higher in the valley than in the regions to the west. Nevertheless rainfall varies considerably from year to year with droughts more likely on the plains east of Traralgon

than in most other parts of the study area.

The average annual rainfall declines eastwards, from around 950 mm at Moe and in the foothills to about 700 mm at Flynn.

Temperatures over 38°C occur on average three times yearly in the Latrobe Valley. Mean minimum temperature for January in the block is between 11 and 13°C ; the absolute January minimum at Yallourn is 4°C . Mean minimum temperature for July is $3-5^{\circ}\text{C}$; the absolute minimum recorded at Yallourn is -3.8°C . During the year the Latrobe Valley is likely to have the greatest daily range of temperature in the study area.

Fogs are relatively common on the plains of the Latrobe Valley. Snow falls very rarely in the block. The Latrobe River is prone to flooding.

3. Geology and geomorphology

Geomorphically the block consists of the flattish plains of the Latrobe Depression flanked by piedmont downs, with the dissected Fumina plateau to the north and the rounded hills of the Strzeleckis to the south.

The area is covered almost entirely by thin Tertiary to Quarternary alluvial sediments, beneath which lie the Tertiary Latrobe Valley Group of sediments that contain the brown coal measures.



Thickets of swamp paperbark on public land along Loy Yang Creek

Basalts of Oligocene age outcrop in the Yinnar area and Palaeozoic and Mesozoic rocks outcrop on the northern boundary of the block.

The main streams in the block are the Latrobe River and its tributaries Tyers River, Morwell River, Traralgon Creek and Flynn Creek.

4. Soils

The main soils in the block are the neutral, mottled yellow duplex soils found on the plains and downs of the Latrobe Valley. Their major agricultur-



Boolarra, situated on the Morwell River

al use is for the production of pasture - cropping is rare. Similar but acidic soils occur on public land in the foothills at Rintoul Creek and on the northern slopes of the Strzeleckis. Most of these areas carry pine plantations or native forest.

5. Vegetation

The largest area of natural vegetation in the block is in the foothills between the Tyers River and Rintoul Creek. Tall open forest of messmate, mountain grey gum and silvertop, with associated lower open forest of but-but, scent-bark, white stringybark, yellow box and narrow-leaf peppermint, grows on sheltered aspects and on the ridges. The

drier, usually steep, northerly aspects along Tyers River carry low open woodland of red box.

6. Fauna

The natural vegetation found in Rintoul Creek and along Tyers River supports the varied mammalian fauna typical of the tall open forests of the Great Dividing Range; the koala and eight species of possums and gliders, a variety of native rodents, two species of bandicoot and two species of antechinus, black wallaby, common wombat, echidna and several introduced species. In addition a recent survey by the Forests Commission recorded 102 species of birds in Boola Boola State Forest.

The majority of the block is occupied by farmland, industrial and urban areas, and privately owned pine plantations, where the only common native mammals are brush-tailed possums, common ringtails and various species of bat. Introduced species such as the rabbit, house mouse, black rat and fox are widespread. In contrast, around 130 species of native birds have been recorded from the Latrobe Valley - remnant stands of natural vegetation and the billabongs and swamps along the Latrobe River are especially important for these animals.

Populations of native fish in the local streams have been reduced by industrial pollution, flood-mitigation works, urban settlement, agricultural activities,



Tall open forest in the catchment of Rintoul Creek

and the introduction of trout and European carp; the Tyers River is probably the least affected watercourse in the block.

B. Present Uses and Capabilities

1. Nature conservation

The most suitable land in the block for nature conservation, a portion of the forest and woodland west of the Tyers River below Moondarra Reservoir, has

already been recommended by the Land Conservation Council for reservation as a regional park. It contains interesting scenery where the Tyers River flows through several gorges, there are a number of attractive plant species, and the local rocks yield fine fossils. Similar woodland located on the eastern side of the Tyers River is made the more interesting by the remains of a now defunct lime-burning operation on a cliff above the river.

Forest abutting the woodland east of Tyers River has been utilized for sawlogs and pulp and has a moderate value for nature conservation.

The various Crown reserves and areas of unoccupied Crown land have a low capability for nature conservation as most have been entirely cleared. Some river and creek frontages carry remnant native vegetation, which has a moderate conservation capability but can make a great contribution to the agricultural landscape.

Most land managed by the S.E.C. is grassland, with a low capability for nature conservation, but certain remnants of native forest, especially the 20-ha Sayers Trig near Coalville, have a moderate capability.

2. Recreation

Parts of the public land in the Rintoul Creek--Tyers River area have a moderate

capability for walking, picnicking and nature study.

With the exception of the Sandbank Reserve on the Latrobe River near Tyers, which is a picnic ground managed by a local committee, none of the unoccupied Crown land or Crown reserves in the block have a very high capability for recreation.

In contrast, some of the S.E.C. holdings are locally important for recreation. Over 60,000 people annually visit the Commission's open cuts and power stations. Some 174 ha in the Morwell and Yallourn areas is leased to such groups as golf, pistol and boating clubs, and the Scouts. In addition, the Hazelwood Cooling Pond is very popular for water sports, and the Witts Gully reservoir is used for fishing and swimming.

3. Agriculture

There are no large areas of public land in the block suitable for alienation for farming, but most of the S.E.C. grassland is leased to local graziers until it is required for coal production or the expansion of generating facilities.

4. Apiculture

The red box woodlands along the Tyers River have a moderate capability for honey production. Few other areas of public land in the block have great importance for this purpose.



Great egret, sometimes observed along the Latrobe River

5. Timber production

Apart from the stands of silvertop, messmate and mountain grey gum in that portion of the Boola Boola State Forest which protrudes into this block, no areas of public land have any capability for sawlog production. The red box woodlands along the Tyers have limited capability for firewood production. The establishment of pine plantations may be permitted on certain areas of S.E.C. land that are now designated as buffer zones to protect the open cuts from wildfire.

6. Water production

Areas of the S.E.C. land are managed for water production and large water storages are required for power generation. The Moondarra--Lalorbe Valley pipeline runs along the Tyers River. Water is not harvested from any other area of public land in the block at present although future developments may necessitate this.

7. Mining and quarrying

A large proportion of the land held by the S.E.C. at Yallourn, Morwell and Loy Yang will be mined for brown coal by open-cut methods over the next 50 years. Apart from a number of gravel pits, some of which are on S.E.C. land, and the limestone deposits once worked along the Tyers River, other areas of public land in the block have a low capability for



Inside the generating room of a power station

the production of stone or minerals. Several gravel pits, stone quarries and a clay pit operate on freehold land.

8. Utilities

Some of the many oil and gas pipelines, sewerage and wastewater outfalls, electricity transmission lines, and water mains which service or traverse the Lalorbe Valley also cross public land. Both the Morwell and Traralgon rubbish tips are on public land.

9. Grazing

Large areas of S.E.C. land are leased for grazing by local landowners. Grazing of areas adjacent to open cuts is an

important aid in protecting the cuts from fire.

C. Hazards and Conflicts

The hazard of soil erosion in this block is low to moderate on the plains and low in the Boola Boola forests, provided that logging follows the catchment prescriptions designed to prevent silting of streams.

Flooding is a hazard on the plains although it has been partly overcome by mitigation works carried out by the Latrobe River Improvement Trust.

Vermin and weeds offer a low to moderate hazard to users of public land. Rabbits are controlled by poisoning, fumigation, myxomatosis, rabbit fleas and local shooters. Foxes mainly eat carrion and are widely hunted for sport and for their fur. Most noxious weeds in the block can be controlled by spraying or cultivation. The main exception is blackberry, which grows densely in gullies in the Boola Boola Forest where it is inaccessible to sprays.

The main hazard in the Latrobe Valley block is wildfire. The S.E.C., Forests

Commission and Country Fire Authority are responsible for the protection of various parts of the area from fire - they are assisted by the fire-fighting organization of A.P.M. Forests Pty. Ltd. The 1944 and 1977 fires were a reminder of the vulnerability of the coalfields to fire.

The large scale coal-winning in the area has required many practices to protect the regional environment. Any waste-water must be disposed of without increasing the salinity or temperature of local streams; the erosion of mined faces must be prevented; particulate matter must be removed from smoke; power stations and other facilities may need to be landscaped; transmission lines must be sited to minimize social and scenic disruption; aquifers must be monitored to determine if any damage results from regional subsidence; coal faces must be sprayed to eliminate dust and minimize the chance of a fire; local streams must be regulated and diverted to prevent flooding and enable economical coal-winning; overburden must be shifted to fill old workings; and open cuts must be rehabilitated when mining has ceased so that they are productive and, within limits, attractive.

2. EASTERN STRZELECKIS

A. Tenure and Nature of the Land

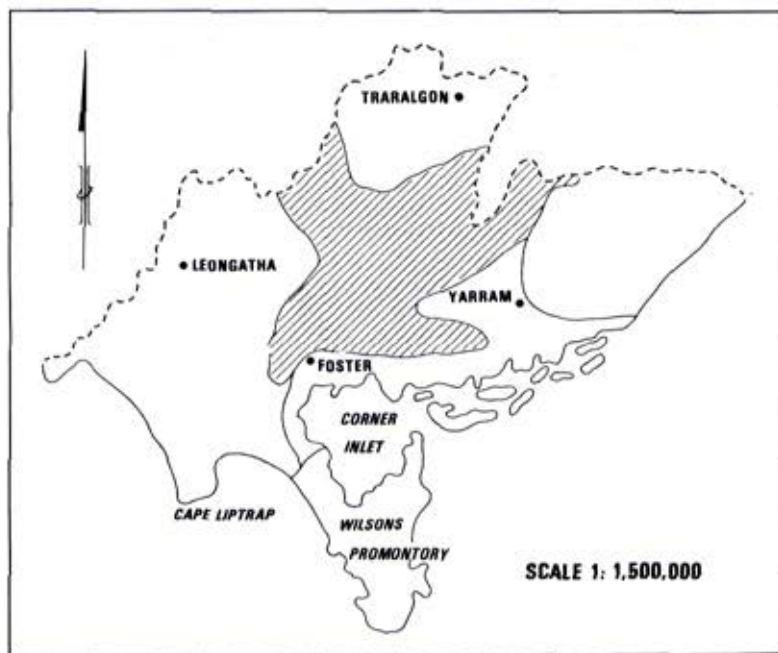
1. Present tenure

The total area of public land in this block is around 47,000 ha, of which 44,000 ha are reserved forest. This includes 4,600 ha of hardwood plantation; 7,600 ha of softwood plantation; extensive stands of mixed species foot-

hills forest and regrowth mountain ash; large areas of former farmland purchased for reforestation; around 8,600 ha in the Balook, LeRoy and Jumbuk areas which are leased by A.P.M. Forests for forestry; and a large area of former farmland that has been purchased for reforestation. The remainder of the public land comprises some 2,300 ha of unoccupied Crown land, the largest area of which (950 ha) lies between Koornalla and Callignee South; about 380 ha of Crown reserves (not counting many streamside reserves); and three small national parks (Bulga, Tarra Valley and Morwell) totalling 360 ha.

2. Climate

The average annual rainfall increases with altitude and westerly and south-westerly winds bring rain to the higher parts of the Strzeleckis throughout the year. Budgeree East, at 380 m, has an annual average of 1113 mm, whereas Balook and Blackwarry, at 600 m, have annual averages of 1455 mm and 1410 mm respectively - these are among the wettest parts of the ranges. Annual rainfall declines rapidly between the Madalya area and the plains around Yarram, and minor droughts do occur.



2. EASTERN STRZELECKIS

Days over 38°C occur on average about once a year in the Strzeleckis. The mean minimum temperature for January in the block is 9.5°C ; the absolute summer minimum at Olsens Bridge is -0.8°C . Mean winter (July) minimum temperature in the block is 1.8°C ; the absolute minimum recorded at Olsens Bridge is -6.1°C .

Some snow settles on the higher parts of the Strzeleckis two or three times annually. Brief floods are common.

3. Geology and geomorphology

Geomorphically the block forms the eastern half of the South Gippsland Highlands. The north-west corner (the upper valley of the Morwell River) is down-thrown relative to the country to the south-east and has a more subdued topography.

The principal rocks outcropping in the highlands are Mesozoic sandstones and siltstones, while early to middle Tertiary basalts occur around the margins. North-east of the Budgeree Fault, where the topography is more subdued, the surface outcrops consist of a patchwork of late Tertiary to Quarternary alluvial sediments overlying middle Tertiary basalt. Lying beneath this relatively thin cover of material in the Boolarra area are sediments of the Latrobe Valley Group containing economically winnable brown coal. Late Tertiary sediments in the Gormandale, Traralgon South and Won



Some ferns grow under radiata pine

Wron areas also overlies such coal reserves.

The main streams are the Morwell River and Traralgon Creek on the northern fall of the range, and the Tarwin, Franklin, Agnes, Jack, Albert and Tarra Rivers to the south.

4. Soils

The main soils in the block are the brown gradational soils found on the

Mesozoic sediments. These well structured, deep, yellow to brown, acid, clayey soils commonly change from fertile clay loam on the surface to medium to heavy clay below the 2 m level. Forest vegetation typically utilizes nutrients derived from weathered rock, but fertilizers are usually required when shallow-rooted pasture is established.

Red gradational soils have developed on the weathered lava residuals, and almost all of this country has been alienated for agriculture. They are deep, well-structured acid soils changing from red clay loam on the surface to a red clay at a depth of 2-4 m or more. These soils fix phosphorus; therefore this element must be added regularly by farmers.

5. Vegetation

The Strzeleckis were heavily forested (and supported some of the world's tallest trees) before the advent of European settlers. Settlement eliminated most of this vegetation, however there were two large reservations of mountain ash forest in the higher eastern Strzeleckis; the Gunyah Timber Reserve and the Agricultural College Reserve in the parish of Jumbuk. In addition a few waterfalls and their surrounds were set aside. Belts of dry sclerophyll forest between Boolarra and Mirboo North and around Yarram were also retained. Virtually every other part of

the ranges was alienated, including parts of the present Bulga and Tarra Valley National Parks.

Settlers felled and burnt the timber on their selections and, in the process, neighbouring stands were destroyed. Wildfires swept the reserves at Gunyah and Jumbuk early in the century, the present stands being regrowth from those fires.

As described in the chapters on Hardwood and Softwood Production, large areas of scrub, the legacy of unsuccessful agricultural endeavour, are now being reforested mainly with mountain ash and radiata pine.

6. Fauna

Two-thirds of the block is forested or scrub-covered public land and one-third is agricultural.

The Strzeleckis forests support a slightly less varied mammalian fauna than the forests in the foothills of the Great Dividing Range. Echidna are common and the platypus apparently is widening its range. Koalas and wombats are widespread, but the tiger cat, reportedly common early this century, is believed close to extinction. Brown and Swainson's antechinus inhabit most forest types, as do the black wallaby and two species of bandicoot. Of the gliders and possums, the yellow-bellied glider has not been confirmed as present in the

Strzeleckis. The bush rat, black rat, house mouse, broad-toothed rat, and water rat are all known from the Strzeleckis. Several bats, and the rabbit, fox, feral cat, feral goat and sambar deer complete the list of mammals.

Some 80 species of birds are recorded from the Strzeleckis; most are species favouring forested or aerial habitats.

Fourteen species of lizards and snakes have been listed for the block.

Populations of native fish in most streams have been affected by the introduction of trout, and probably also by local increases in siltation and water temperature through the clearance of streamside vegetation. European carp, though prevalent in the Latrobe River, and reported from the Tarwin system, are unlikely to be found in the faster, cleaner waters of streams in the block.

B. Present Uses and Capabilities

1. Nature Conservation

This block has a high capability for nature conservation. Despite the extensive destruction of forest by selectors, some areas have regenerated. In addition, the vegetation under hardwood plantations (and, in some cases, below pines) retains part of the character of the original understorey.

No areas of the eastern Strzeleckis



Felling a blue gum tree at Budgeree in 1913

could be classed as entirely natural, but near-natural stands totalling several hundred hectares occur at Bulga Park, Tarra Valley and Gunyah, and there are small pockets of similar vegetation at Turtons Creek, upper Traralgon Creek,

along the Grand Ridge Road, and elsewhere. On the southern fall of the range there are also extensive areas of tall scrub of blackwood, silver wattle, black wattle, hickory wattle and many other species, which also contain scattered pockets of very old mountain ash. Vegetation of this type may have existed locally before European settlement, in areas where fires had been more frequent than normal and had prevented regeneration of mountain ash, but the present examples result from land clearance early this century. Undoubtedly these areas also have value for nature conservation, but reports of various species of rare birds and mammals from places like Dingo Creek and Macks Creek have not been verified.

The areas of softwood plantation have a low capability for nature conservation although various ground-feeding and shrub-frequenting birds are commonly seen, and mammals, such as the echidna, brown antechinus, Swainson's antechinus, brush-tailed possum, common ringtail and black wallaby, plus at least six introduced species, frequent stands of pine.

2. Recreation

The Strzeleckis have a moderately high capability for motorized recreation, fishing and shooting, and a high capability for nature study. Bushwalking is not especially popular, except along walking tracks in parks and other reserves, because of the density of the



Mountain ash forest in Bulga National Park

vegetation, the cool wet climate, and probably also the proximity of the Victorian Alps and Wilsons Promontory. On the other hand, horse riding is locally popular on roads and tracks in the range. Another occasional activity is gold prospecting in the two auriferous zones in the block.

Table 34 shows details of the recreational use of Bulga and Tarra Valley National Parks.

Table 34

VISITORS TO NATIONAL PARKS
IN THE STRZELECKIS

	<u>Visitor Days</u>	
	1977-78	1978-79
Tarra Valley	24,000	27,000
Bulga	24,000	36,500
Morwell	3,500	7,500

Of visitors interviewed, 42% came from Melbourne, 44% from Central and South Gippsland and 4% came from East Gippsland.

3. Agriculture

There are no large areas of public land in this block suitable for agricultural development under present economic conditions.

4. Apiculture

Beekeepers occasionally place hives in stands of mountain ash, and in foothill forests such as those at Alberton West.

5. Timber production

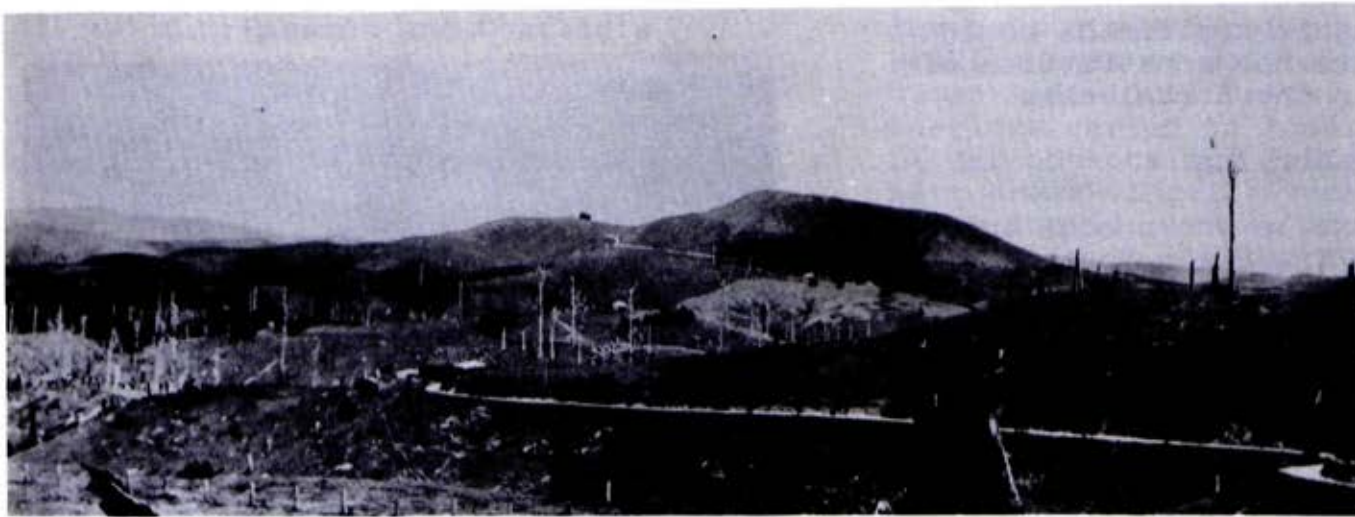
The block has a high capability for forestry for several reasons. The abortive settlement of the Strzeleckis showed that trees make better use of this type of land than pasture, and growth rates



Mt Square Top from Elphicks Hill, 1913

in the area are among the highest in Victoria. The species that grow best there are important commercially. As long as the nearby Maryvale pulp mill operates, stands of softwood and most local hardwoods can be economically thinned. The block is well roaded. Sufficient resources are available to control wildfires. Melbourne is close enough to provide an excellent market for timber sawn from the Strzeleckis forests. In addition, if logging takes place in accordance with catchment prescriptions, then land under forest erodes only little.

Among the areas of special interest is the Alberton West State Forest. Reserved in 1885, it was swept by a severe wildfire in 1942, when all but a few sheltered gullies were razed. The ensuing regrowth has been protected from fire



*The same view
in 1938*

and now consists of superb stands of pole-sized messmate, blue gum, yellow stringybark, and white stringybark which are utilized on a small scale for firewood, posts, and light poles.

6. Water production

Several catchments in the Strzeleckis yield water for local communities; these are Deep Creek (Foster), Agnes River (Toora, Welshpool, Port Welshpool and Hedley), Tarra River (Yarram, Alberton and Port Albert), Billy Creek (Yinnar), O'Grady Creek (Boolarra), Little Morwell River (Mirboo North), and Tarwin River (Dumbalk and Meeniyan). Recreational activities and forestry in these catchments may need to be restricted to protect water supplies.

Development of the Latrobe Valley, Won



Mt Square Top in 1980

Wron and Gelliondale coalfields could eventually require the construction of water storages in the Strzeleckis.

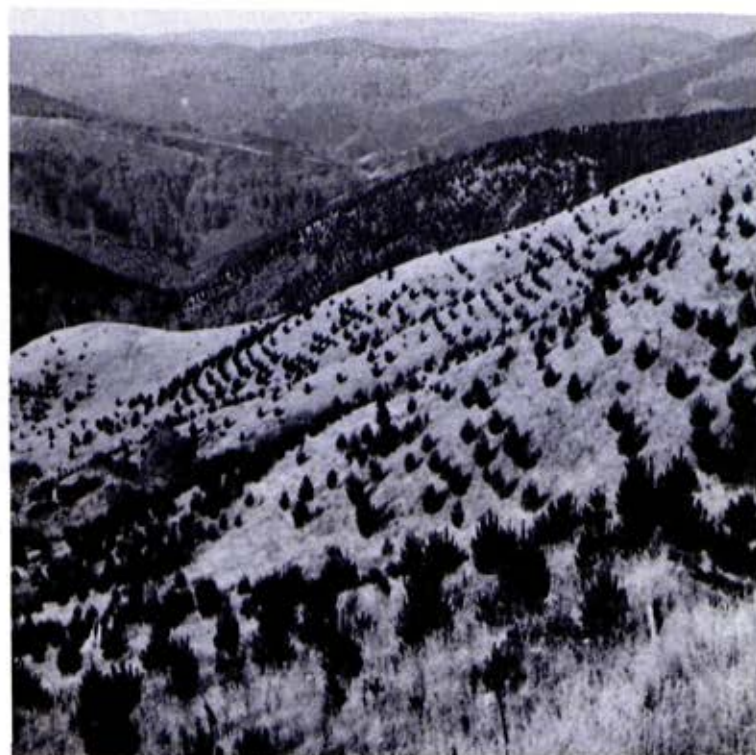
7. Mining and quarrying

Economically winnable brown coal occurs in the Boolarra, Traralgon South, Gormandale and Won Wron areas. The Strzeleckis otherwise have a low capability for mining. The only possible activities, on the basis of present knowledge, are bauxite production from basaltic areas and exploration for gold around Turtons Creek. None of the seams of black coal have been worked in the block except briefly at Boolarra; thin coal beds are common in roadside cuttings. Surveys of the Toora tin field have shown it to be uneconomic.

The block has a moderately high capability for the production of stone and gravel. Several quarries on private property yield basalt for construction, and two pits produce crushed sandstone. Deposits of Pliocene sands and gravels are locally important for municipal purposes.

8. Utilities

An air-navigational installation, several fire lookouts and an official tip (at Mirboo North) are located on public land in the Eastern Strzeleckis block. Public land is also used on a small scale for cemeteries, schools, halls, service basins and recreation reserves.



*Privately owned pine plantations,
Callignee-Balook road*

9. Grazing

Some properties purchased for reforestation are leased for grazing until planting commences. Otherwise there are seven leases (totalling less than 15 ha) on reserved forest and five leases (totalling around 25 ha) on unoccupied Crown land and Crown reserves in the Eastern Strzeleckis block.

C. Hazards and Conflicts

The most prominent hazards to land use in the block are soil erosion, mainly through landslips and sheet erosion, both of which are associated with inappropriate land use on certain susceptible areas; wildfire; weeds, especially blackberry, ragwort and tutsan; and animal pests, especially rabbits. Hazards from flooding and from the spread of cinnamon root-rot are fairly low; in the latter case the climate appears to be too cool and the soil too free draining for the organism to survive.

The main conflict is over reforestation. Public and private forestry organizations are rehabilitating scrub-covered land, wrongly cleared decades ago, and restoring it practically and economically so that it can produce timber, protect water catchments and provide opportunities for recreation. A well established, small-scale hardwood-milling industry with few mature stands to utilize depends on replanting operations for the bulk of its sawlogs. When the

scrub is cleared prior to planting, any small stands of mountain ash, and sometimes individual trees, are felled and the logs carted to local sawmills. Larger pockets are left, as are extensive areas of gully vegetation (which often include large, over-mature trees, especially in steeper country), so sites are never completely cleared.

Opponents of this activity believe, however, that the removal of the large overmature eucalypts and the clearance of scrub in general, causes an unacceptable decline in the amount of faunal habitat, especially conditions suitable for arboreal mammals such as gliders and large birds such as owls which nest in hollow trees. In addition, they fear that management of forests in the Strzeleckis on a short rotation for the production of pulpwood would also cause a decline in the amount of habitat for wildlife.

The areas of economically winnable brown coal will affect overlying or adjacent lands if developed in the future.

3. WOODSIDE

A. Tenure and Nature of the Land

1. Present tenure

The total area of public land in this block is about 34,300 ha.

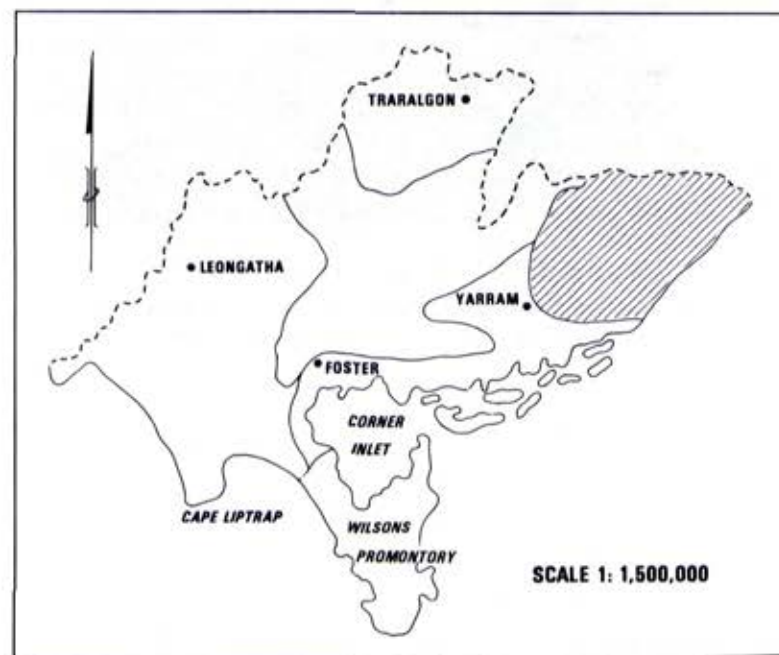
The Boodyarn and Mullungdung Forests are reserved and occupy 6,700 and 13,800 ha. This land is located between Greenmount and Hunterston in the south and Toms Cap and Stradbroke in the north, and is bisected by a belt of freehold land along Bruthen Creek. Boodyarn State Forest lies to the west of Bruthen Creek and Mullungdung State Forest to the east.

Around 10,000 ha are unoccupied Crown land, and 5000 ha of this total is contiguous with the Boodyarn State Forest. Some 4,000 ha abut Mullungdung State Forest. The next largest tract of unoccupied Crown land is a 500 ha block north of Giffard. The remainder consists of small areas of bushland around Darriman, Giffard, Woodside, Won Wron and Yarram, and a strip of coastal country between Jack Smith Lake and Ninety Mile Beach.

Various small Crown reserves are scattered throughout the block at Bruthen

Creek, Giffard, Lake Denison, Morris Creek, Reeves Beach, Seaspray, Woodside, Woodside Beach, Won Wron and Yarram, and there are about 1,000 ha of shoreline reserved for public purposes as a strip generally 30 m wide but sometimes greater along the Ninety Mile Beach.

The only other area of public land in this block is Jack Smith Lake State Game



3. WOODSIDE

Reserve, of some 2500 ha, which lies east of Darriman at the mouth of Warrigal and Morris Creek and is managed by the Fisheries and Wildlife Division.

2. Climate

The plains and downs between Yarram and Stradbroke are marginally influenced by the east coast depressions that bring rain to East Gippsland throughout the year, therefore summer rainfall in this area tends to equal that in winter (in contrast to the country further west where most rain falls in winter).

The average annual rainfall declines to the north-east from Yarram, which has 755 mm, to Giffard, Seaspray and Stradbroke which have 558, 585 and 620 mm. The block is therefore the driest part of the study area and has the greatest likelihood of drought.

No long-term data are available on local temperatures.

3. Geology and geomorphology

The Woodside block consists of three distinct geomorphic units. Much of the northern part of the block is a raised plain of Tertiary alluvial sediments (the Stradbroke Block), which has since been dissected. This is flanked to the north-west by a portion of the South Gippsland Highlands, and to the south-east by broad coastal plains with a seaward belt of sand dunes, coastal swamps



Lagoons and coastal plains north-east of Jack Smith Lake

and non-perennial estuarine basins like Jack Smith Lake.

The rocks outcropping are principally Tertiary and Quaternary alluvial, lacustrine and aeolian sediments. Along the north-western margin of the block early Tertiary basalts and sediments, and Mesozoic sediments, flank the South Gippsland Highlands.

The Latrobe Valley Group, which contains brown coal, underlies much of the Woodside block. The Stradbroke coalfield in the northern part of the block is almost entirely overlain by public land. To date 2,800 million tonnes of economically winnable coal have been proven in this area. To the east the coal seams

pass under middle Tertiary marine limestone.

The block is drained by Bodman Creek (which joins Tarra River), Bruthen Creek (which enters Corner Inlet near McLoughlins Beach), Morris Creek and Warrigal Creek (which intermittently fill Jack Smith Lake), and Merriman Creek with its tributaries Monkey and Little Monkey Creeks.

4. Soils

These are five main types of soils found in the Woodside block.

Duplex soils:

- a. Sandy neutral and acidic yellow mottled soils - found in the lower Boodyarn and Mullungdung Forests and on the coastal plains between Yarram and Seaspray
- b. Hard acidic yellow mottled soils - these hard-setting loamy soils are found in the upper portions of Boodyarn and Mullungdung Forests and around Corner and Shallow Inlets
- c. Sandy acidic yellow mottled soils with bleached upper horizons - found around Yarram and in the lower Boodyarn Forest

Uniform soils:

- a. Siliceous sands with minimal devel-

opment of profile - found in a narrow zone behind Ninety Mile Beach rarely more than a kilometre or so wide

- b. Leached sands with a compact or pan-like layer below the bleach - found in the northern part of the Mullungdung Forest and along Monkey Creek

In addition, dark plastic clays with uniform profiles are found on flood plains along some of the watercourses. With the exception of the latter minor group of soils, all of the above have a low fertility.

5. Vegetation

About 40% of the block (including most of the public land) is uncleared.

The Boodyarn and Mullungdung Forests comprise mostly low and medium open forest of yellow stringybark and messmate, with blue gum and mountain grey gum in the wetter gullies, and woodlands of yertchuk and shining peppermint on different classes of sandy soils in the drier parts of the area. Low open forest of white stringybark occurs in the north of Mullungdung Forest and there are extensive woodlands of silver-leaf stringybark on the swampy flats that typically border the watercourses. Yellow box and Gippsland grey box are common around Darriman and Woodside; swamp gum and thickets of swamp paperbark occur widely in swamps and along streams in various areas. Narrow-leaf



Banksia woodland in the Mullungdung Forest; shining peppermint is present

peppermint and but-but are widespread, as is the rough-barked form of manna gum; saw banksia and black she-oak often occur as understorey species. Silvertop is limited to a couple of stands.

Both Boodyarn and Mullungdung Forests have a wide variety of understorey vegetation. Surveys by the Latrobe Valley Field Naturalists Club list over 240 species of native ground and understorey vegetation.

Elsewhere on public land there are few areas with intact native vegetation; the best is a 500-ha tract of unoccupied Crown Land at Giffard which has extensive stands of white stringybark open forest and shining peppermint - saw banksia woodland. The coastal strip has been grazed and burnt and certain reserves have been quarried, but Jack Smiths Lake is being revegetated progressively with local species, after a large proportion of this game reserve was purchased from local farmers.

Fauna

Mullungdung and Boodyarn State Forests support a range of native mammals.

Echidnas are common but the platypus is not. Tuan are recorded from woodland at Seaspray and are likely to be widespread. Wombats, koalas, and brown and Swainson's antechinus, are common. The long-nosed bandicoot is recorded from Mullungdung, as are several possums and gliders - the brush-tailed possum, common ringtail, sugar glider, greater glider, feathertail glider and eastern pigmy possum. The larger marsupials are represented by the eastern grey kangaroo and the smaller black wallaby which are common, and the red-necked wallaby which is uncommon. At least three species of bats are widespread, as are the bush rat and swamp rat. In contrast the eastern water rat, swamp rat, broad-toothed rat and New Holland mouse are all uncommon to rare.

Of the exotic mammals, rabbits, the house mouse, black rat, feral cat, and fox are common. Hog deer are moderately common, apparently moving along the coast between Corner Inlet and the Gippsland Lakes; hare are uncommon.

Over 160 species of birds, including maritime species, have been recorded for the block. The number is likely to be larger because of the attraction of the coastal marshes and lakes for waterbirds and waders.

Seventeen species of lizards and snakes have been listed for the block.

The lower reaches of Merriman Creek have a population of Australian bass and grayling; both are rare native fish in Victoria, and the grayling is considered endangered throughout Australia. Associated native species are tupong, pygmy perch, Australian smelt, galaxiids and eels.

The other streams in the block need to be surveyed to determine their importance for the preservation of native fish species.

B. Present Uses and Capabilities

1. Nature conservation

Although open to shooters during the duck season, Jack Smith Lake State Game Reserve has a high capability for nature conservation.

It has extensive areas of habitat for waterbirds and waders. Its level and salinity fluctuate, but it is being managed to maintain water levels in the estuary (however a regulator keeps levels below a certain maximum determined in consultation with neighbouring farmers to minimize flooding of freehold land). In addition, the reserve is gradually being revegetated with original species and it is being protected from fire, grazing by stock and vandalism.

The Mullungdung and Boodyarn State Forests have a moderately high capability for nature conservation. Despite having



Kangaroo Swamp, on private land within Mullungdung State Forest

been logged for many years, they are attractive forests supporting a large variety of birds and mammals, and have many veteran trees suitable for wildlife habitat. The unoccupied Crown land at Giffard has a similar capability.

Lake Denison, a saltmarsh 4 km south-east of Seaspray, has a high capability for nature conservation in wet years, and the coastal reserve has a moderate capability if dune vegetation is not burnt or overgrazed. In addition, this area has important Aboriginal sites.

The various Crown reserves and other areas of unoccupied Crown land generally have a low capability for nature conservation. Some have been stripped of gravel.

2. Recreation

The major recreational resource in the block is Ninety Mile Beach, which although not often suitable for surfing is very popular for surf fishing. The main access to the beach is via roads to Reeves Beach, Woodside Beach, McGauran Beach and Seaspray. There are life-saving clubs at Woodside and Seaspray.

Jack Smith Lake has an especially high recreational value for duckshooters although the fluctuating water levels make shooting variable from year to year. Other people use the lake for birdwatching and access to an isolated section of Ninety Mile Beach.



A typical stretch of Ninety Mile Beach

The Mullungdung and Boodyarn State Forests have a moderate capability for recreation. The chief forms of leisure activity are motoring, picnicking and nature study, but both areas afford interesting bushwalking. The Forests Commission has provided recreational facilities in many areas of State forest, especially at "The Gums" and White Womans Waterhole.

3. Agriculture

Parts of Mullungdung and Boodyarn State Forests are suitable for development for agriculture, although costs would be very high.

4. Apiculture

Beekeepers regularly use the Boodyarn and Mullungdung State Forests as a

source of nectar; the favoured species are yellow box, saw banksia, messmate, paperbarks, silvertop (for building up hives), yellow stringybark and blue gum.

5. Timber production

Parts of the Woodside block have a moderately high capability for timber production.

The commercially significant parts of the Mullungdung State Forest lie south

of Froud Road and those in the Boodyarn Forest south of Boodyarn Road. Both were reserved in 1885 and are made up of slow-growing eucalypt species. Mullungdung State Forest has been logged for over 100 years and Boodyarn State Forest for an even longer period, perhaps 120 years. Both areas have at various times supported small hardwood sawmills and large numbers of beam and sleeper cutters. Considerable quantities of charcoal were obtained during World War II from both areas.



*Sawn timber leaving the
Goodwood Company's mill in
the Mullungdung Forest,
1912*

The main product today is fencing material - around 50,000 posts are cut during some years. Two sawmills, one at Traralgon and one at Yarram, each have an annual sawlog allocation of 3,000 m³ from these forests - the usual combined annual output is some 5,000 m³. Firewood production is of minor importance.

Some 310 ha of radiata pine have been established in the Woodside block on public land.

6. Water production

No communities depend on streams on public land in Woodside block as a source of domestic water, but a few farmers pump from creeks to irrigate pasture. Some stream regulation may be required in the future to supply water for future coal production and power generation.

7. Mining and quarrying

Brown coal was mined briefly at Won Wron. Seams also occur under shallow overburden in the north of Mullungdung State Forest forming part of the Stradbroke coalfield. Both deposits have been covered by Interim Development Orders and Statement of Planning Policy No. 9 issued by the Town and Country Planning Board.

The area has some potential for oil and gas discoveries. An occurrence of native copper in decomposed basalt at Carrajung South discovered in 1916

proved to be of no value for mining.

Limestone has been quarried for agriculture at Darriman on private land and from a Crown reserve west of Woodside.

The block has a moderately high capability for the production of sand and gravel, and both the Mullungdung and Boodyarn State Forests yield large quantities of gravel for municipal road construction and maintenance. Some worked-out pits have been rehabilitated by the Forests Commission and Department of Crown Lands and Survey.

8. Utilities

The Omega navigational aid is being constructed by the Australian Government on land purchased at Darriman.

Mullungdung State Forest is a proclaimed military training area used by the Army to train soldiers in navigation, infantry drills and tactics. Vehicles do not move off the roads and strict rules are laid down for fire prevention.

The Woodside and Yarram tips are on public land and two schools have pine plantations on a small area of public land near Yarram.

9. Grazing

Local landowners graze five leases totalling less than 35 ha of public land in the Woodside and Giffard areas.

C. Hazards and Conflicts

Wildfire is an annual problem in Boodyarn and Mullungdung Forests, and on farms; controlled burning is practised during autumn and spring on public land to minimize this danger.

Cinnamon root-rot, which is common in the Mullungdung Forest is a prominent hazard. Machines leaving the area must be thoroughly cleaned of soil to ensure that the fungus is not transferred to other locations; the fungus has killed some stands of yellow stringybark forest in areas with high watertables.

Soil erosion is in progress, in some areas, mainly through gullying along watercourses where riparian vegetation has been grazed or native forest cleared, but also from the action of wind on sandy soils after fire and overgrazing and along the shoreline when seas are high. Uncontrolled gravel stripping has also cleared areas of native vegetation and hence exposed them to erosion.

Stream improvement works could affect the habitat of Merriman Creek (and possibly other streams) and the populations of native fish.

The incursion of weeds and rabbits is a significant hazard.

Construction works along the coast could cause damage. Archaeological surveys were necessary at McGaurans Beach before the saline wastewater outlet could be located.

The main conflict is the importance of State forest in the area in providing local building timber and fencing, measured against the value of Mullungdung and Boodyarn Forests for nature conservation and landscape protection. Another source of conflict could eventuate if further large areas of hardwood forest were to be converted to softwood plantation. On the other hand, big tracts of this block will be required eventually for the production of brown coal by open-cut mining.

4. CORNER INLET

A. Tenure and Nature of the Land

1. Present tenure

The total area of public land is around 15,000 ha, and the largest single area is the Nooramunga State Faunal Reserve. This consists of all the islands, banks and shoals between the eastern side of Corner Inlet and McLoughlins Beach (except for the bulk of Sunday Island which is privately owned). The reserve totals 10,000 ha and is managed by the Fisheries and Wildlife Division.

The next largest area is Gellions Run which is 2,600 ha of unoccupied Crown land.

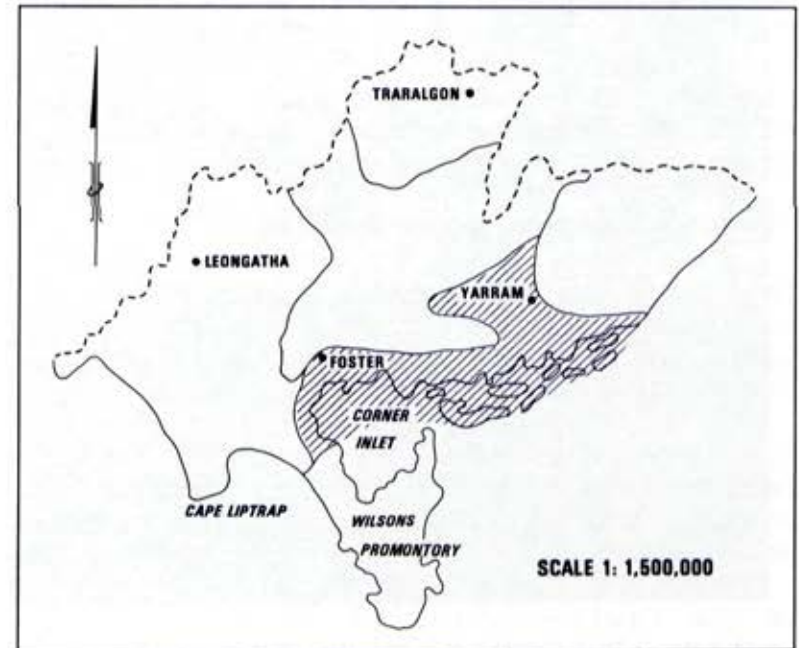
There are 240 ha of reserved forest at Tooloonook and various small parcels of unoccupied Crown land at Bennison, Manns Beach, Calrossie, Foster, Mangrove Island, McLoughlins Beach, Port Albert, Port Welshpool, Tarraville and Toora, and along the coast of Corner Inlet, which total about 1,700 ha.

Other small Crown reserves scattered throughout the block at Alberton, Alberton West, Bennison, Binginwarri, Devon, Foster, Gelliondale, Hedley,

Manns Beach, Port Albert, Tarraville, Port Welshpool, and Toora total around 470 ha.

2. Climate

Sheltered by the Strzeleckis and the Hoddle Range and close to the sea, the Corner Inlet block has a mild climate. Annual rainfall is 1137 mm at Foster,



4. CORNER INLET

808 mm at Yanakie, and 899 mm at Agnes River in the west of the block, and 687 mm at Alberton and 755 mm at Yarram in the east. There are no rainfall records for the islands of Corner Inlet.

Average minimum temperatures throughout the year would be among the highest in the study area and the average daily range of temperatures would be among the least variable. In summer it may be about 6°C ; in winter it is around 4°C . Relative humidity along the coast shows little variability as it is commonly 70-80%. Floods are frequent on the coastal plains in the block because the numerous streams have short, steep catchments that are located in a zone of high rainfall. Consequently swollen streams leaving the hills spill out over the plains. The floods are worst when high tides and onshore winds cause the waters to back up from the estuaries.

3. Geology and geomorphology

The block consists principally of coastal plains and the offshore islands of Corner Inlet laid down in the Alberton Depression of the Gippsland Basin.

Surface outcrops are principally late Tertiary to Recent alluvial, lacustrine, aeolian and shallow-water marine sediments.

On the fault-controlled northern and western boundaries, where the plains abut the South Gippsland Highlands, and



Manns Beach, with a portion of Shallow Inlet visible in the foreground

in the Yanakie area, there are various outcrops of Lower Tertiary basalts, Mesozoic and Lower Palaeozoic sediments.

The Latrobe Valley Group of sediments, which include economically winnable brown coals, underlie much of the block.

The main streams in the block from west to east are Stockyard Creek, Deep Creek, Franklin River, Agnes River, Nine Mile Creek, Billy Creek, Albert River, Jack River and Tarra River. They drain into a coastline of mudflats, low islands and protected water behind a partially developed barrier system.

4. Soils

Soils in the block are mainly duplex. The commonest are the hard, acidic, yellow mottled soils with bleached upper horizons occurring on the coastal plains and the islands. Siliceous sands are found on many of the barrier deposits and there are patches of peaty soils at Yanakie, Hedley and on the Albert - Tarra deltas. These were formed in swamps which were subsequently drained by farmers. Heavy alluvial soils are extensive in the Alberton West-Tooloonook-Yarram area.

5. Vegetation

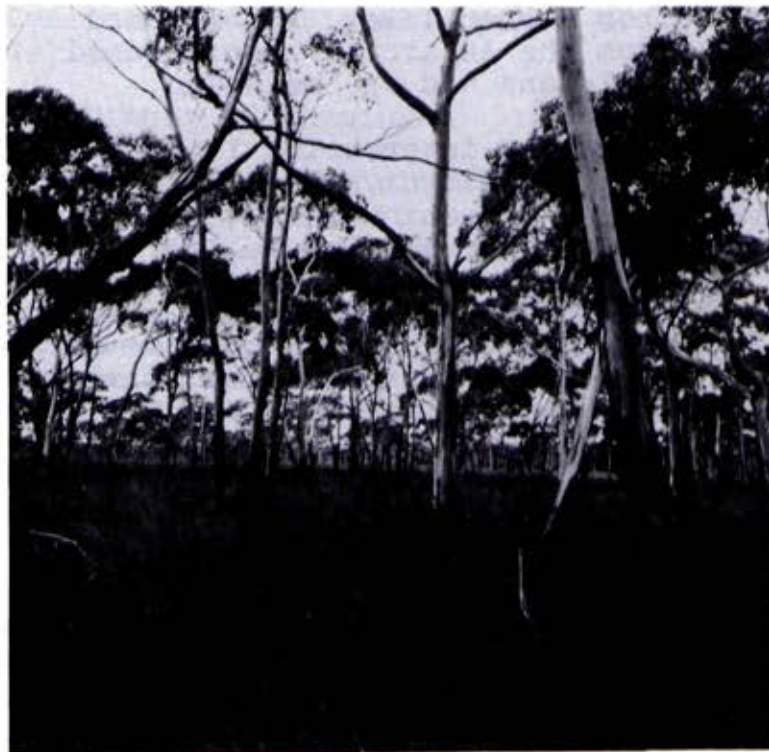
A large proportion of the mainland natural vegetation has been cleared for agriculture but an area remains essentially unchanged today on Gellions Run. Also relatively unchanged is the coastline, which is lined with mangroves, salt-marsh, and for much of its length above the tides, low woodlands of messmate and manna gum.

The islands of Corner Inlet and Shallow Inlet (not to be confused with the Shallow Inlet on Waratah Bay) are probably little changed - the main vegetation types are woodlands of manna gum, messmate, coast banksia and saw banksia (with stands of bog gum on Snake Island) interspersed with wet heaths, and with extensive saltmarsh and mangroves on the mud flats within the inlets. Compared with Western Port, the other main Vic-

torian area for these vegetation types, the coastline of Corner Inlet is in a very natural condition.

6. Fauna

As a consequence of the clearing of the mainland vegetation, the fauna in the block has been reduced. Echidna, koalas and common wombats are widespread, platypus are probably common, and the tuarag may be present on Gellions Run. Brown



Manna gum woodland on Gellions Run with spear grass-tree understory

and swamp antechinus, brush-tailed possums, common ringtails, sugar and greater gliders, and eastern pigmy possum are all recorded from the block. Of the macropods, only the eastern grey kangaroo and black wallaby are present, although the red-bellied pademelon and potoroo were probably once resident. Several species of bat inhabit the block. The swamp rat, bush rat, New Holland mouse, and eastern water rat are the only native rodents known from the region. Australian fur seals are recorded from Corner Inlet, and leopard seals from the Antarctic have beached on Snake Island and the mainland.

The islands are interesting in that only four small mammals have been observed there: swamp antechinus, eastern pygmy possum, swamp rat and New Holland mouse. A report of an echidna has not been verified. Eastern grey kangaroos and black wallabies are common on some of the islands. Of the introduced mammals, the house mouse, black rat, rabbit, fox, hog deer and feral cat are widespread but the hare is uncommon.

Around 160 species of birds are recorded from the block, but the number is likely to be higher because of the inaccessibility of the islands and the fact that the richness of the inlets as a habitat for waders has only recently been recognized. Surveys have shown that a large proportion of the migratory waders in Victoria congregate on the mudflats of Corner Inlet and Shallow Inlet.



Typical saltmarsh and mangroves bordering Corner Inlet; Sunday Island is beyond

Eleven species of lizards and snakes have been listed for the block.

The freshwater reaches of local streams support populations of the introduced rainbow and brown trout, and the native blackfish, galaxiids, short-finned eel and freshwater crayfish. Flathead, trevally, luderick, mullet and estuary perch occur in the estuaries.

B. Present Uses and Capabilities

1. Nature conservation

Public land in the Corner Inlet block has a very high capability for nature conservation.

Parts of the shoreline of Corner Inlet are important Aboriginal sites.

Gellions Run is known widely for its range of wildflowers and its birdlife. The saltmarshes and mudflats around the coast of Corner Inlet and Shallow Inlet are believed to be among the best areas for waders in Australia, but smaller areas are also valuable. The Port Albert racecourse has a central swamp frequented by many species of waterbird, reserves along Nine Mile Creek above Hedley and at Binginwarri carry attractive remnants of the yellow stringybark forests which once covered the valleys, and the heathy woodlands around Foster have many interesting plant species and attract a range of nectar-feeding birds.

The finest areas, however, are the offshore islands, especially Snake Island, the largest, with its tall woodlands, undulating dunes, broad heaths, fringe of saltmarsh and mangroves and views across to Wilsons Promontory.

Corner Inlet also provides excellent examples of evolving geologic processes, with natural land formation in sheltered parts of the inlet in contrast with marked and rapid changes associated with the developing barrier system and tidal channels.

2. Recreation

The main recreational pursuits on public land in the block are estuarine fishing, motoring, boating and nature study. Public access is restricted and hunting is prohibited on the Nooramunga State

Faunal Reserve, although ingenious poachers occasionally attempt to shoot deer there.

3. Agriculture

No large areas of public land in the block are suitable for farming in the present economic climate. Gellions Run could be developed but at great cost.

4. Apiculture

Beekeepers occasionally place hives on Gellions Run.

5. Timber production

Public land in the block generally has a low capability for timber production. Few stands could produce anything but posts, fuel or some very small sawlogs. Exceptions are a few limited Crown reserves which carry tall open forest, and Mays Bush at Tooloonook which is a small parcel of reserved forest.

6. Water production

All towns in the block draw water supplies from sites upstream in the Eastern Strzeleckis block. Local streams may eventually be regulated to provide water for coal production at Gelliondale.

7. Mining and quarrying

Brown coal may be mined from Gelliondale and Won Wron.

Total coal reserves at Gelliondale are estimated to be 5,600 million tonnes. This includes 750 million tonnes offshore from Gelliondale and under the township of Alberton. The more closely drilled area holds 900 million tonnes beneath 400 million cubic metres of overburden.

The Gelliondale field was exploited sporadically between 1929 and 1944. In



*Tidal stretch of Poor Fellow Me Creek,
south - west of Foster*

1975 the private company International Oil Ltd published a proposal to mine the coal and produce electrocarbon while piping the effluent into Bass Strait.

The Won Wron field was mined briefly during the 1960s. It is a small deposit of good quality coal in two seams, one up to 73 m thick, which is estimated to contain about 2 million tonnes.

Public land in the Corner Inlet block has a moderate capability to supply sand and gravel.

The only other possible mining activity could be renewed explorations of the Foster goldfields, which were worked by companies until about 1914.

8. Utilities

The Foster, Port Albert, Port Welshpool and Yarram tips are all on public land.

9. Grazing

Licensees graze Gellions Run and various small areas of unoccupied Crown land at Alberton, Bennison, Devon, Foster, Hedley, Port Albert, Port Welshpool Tarraville and Yarram. None of the latter areas are over 60 ha in area and most are less than 5 ha.

Snake and Little Snake Islands (part of Nooramunga State Faunal Reserve) carry up to 1,000 cattle each winter and up to 50 beasts in summer. Numbers are de-

creased if management considers this necessary to protect the vegetation. Cattle are driven out to the islands at very low tides.

C. Hazards and Conflicts

The existing hazards of noxious weeds

and animals, wildfire and soil erosion are overshadowed by the effects that large-scale mining for brown coal at Gelliondale could have on the hydrology of Corner Inlet and the coastal environment. Mining would also destroy most of the attractive native vegetation on Gellions Run.

5. WILSONS PROMONTORY

A. Tenure and Nature of the land

1. Present tenure

Public land occupies a total of about 49,400 ha; besides the 49,000-ha Wilsons Promontory National Park, there is a 350-ha coastal reserve running along the shoreline of Corner Inlet in the vicinity of Duck Point, and 30-ha of

unoccupied Crown land in the Seal Islands.

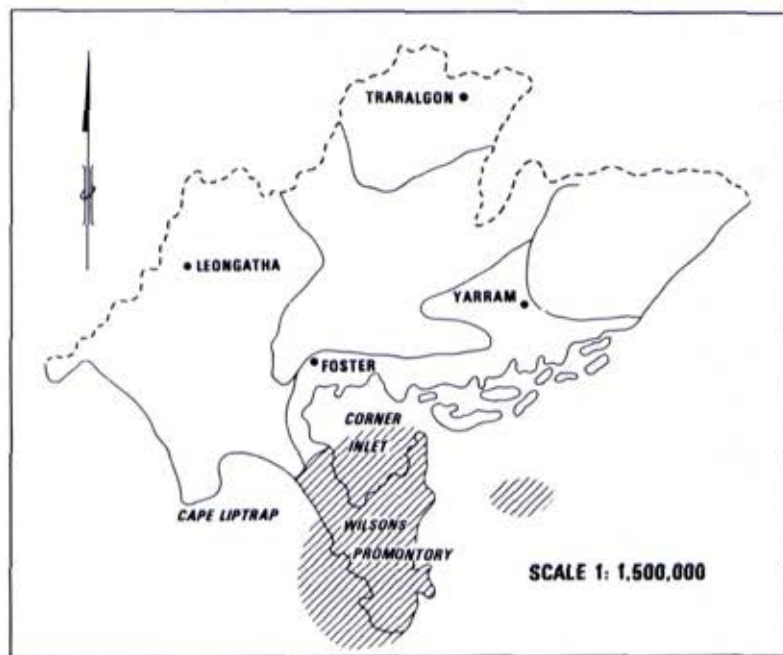
Both Citadel and Cliffy Islands are owned by the Commonwealth of Australia for the purpose of maintaining automatic lighthouses, and a manned lighthouse is situated on a 30-ha Commonwealth Reserve on South East Point.

2. Climate

Average annual rainfalls at South East Point, Tidal River and Yanakie are 1,050, 1,083 and 808 mm. Annual rainfall along the east coast could be up to 1,500 mm. The block has a low likelihood of drought.

Temperatures over 38°C occur on average once every five years at sea level. The average daily range of temperatures fluctuates throughout the year between 4.0 and 6.5°C . The absolute minima for January and July on Wilsons Promontory are 5.5°C and -1.0°C , with the average minimum temperatures for the same months 14.0°C and 8.0°C .

Frosts are very rare at lower elevations and snow, if it falls, lies only briefly on the peaks.



5. WILSONS PROMONTORY

Winds are predominantly south-westerly; when they do occur, easterlies bring bad weather. Streams flood occasionally, especially after summer storms which have brought up to 75-100 mm of rain in a day.

3. Geology and geomorphology

Wilsons Promontory consists of a rugged granitic peninsula extending into Bass Strait and joined to the mainland by a relatively thin isthmus of sediment and dune. It is by far the largest granitic mass along the Victorian coast and the exposed shoreline accentuates the impressive tors that have developed through the weathering of the Devonian granite. A series of granite islands occur around the Promontory and at least 10 varieties of granite have been identified and mapped.



Rabbit Island, offshore from Five Mile Beach

Overlying the granite are superficial Quaternary swamp deposits, colluvial fans, sand ridges, dunes and sandy beaches at the heads of embayments, all of which add to the diversity of the landscape.

Cemented dunes form cliffs at Darby Bay, and outcrop on Shellback Island where they extend underwater to depths of 20m. They are quarried for agricultural lime on Yanakie isthmus.

Middens left by Aborigines are commonly buried in sand dunes around the Promontory. The oldest have been dated at around 6,500 years B.P.

4. Soils

There are three main soils on Wilsons Promontory: calcareous sands on the Yanakie isthmus and on sand ridges and flats in the lower valleys; the leached sand soils with a compact or pan-like layer at depth found in swamps; and skeletal sandy soils on the ranges.

5. Vegetation

Over 740 species of native vascular plants have been recorded; the area has a wide range of plant habitats, and many affinities with the flora of Tasmania.

Tall open forests of blue gum, messmate and its hybrids, yellow stringybark, and mountain ash cover many of the upper slopes and shade luxuriant fern gullies

and myrtle beech groves. Lilly-pilly and blackwood grow in sheltered lowland gullies. Drier slopes carry woodlands of brown stringybark, shining peppermint, banksia and drooping she-oak, changing on poorer soils to stunted scrub and open heaths. Swamp paperbark grows in swamps with wet heath on infertile soils with restricted drainage. Coastal dunes and much of Yanakie isthmus carry dune grassland and coast tea-tree scrub with occasional marshes. Mangroves and salt-marsh fringe Corner Inlet. Large areas of closed scrub result from the 1951

fire. High saddles are grass-covered. The open heaths have over 170 species of plants; 76 species of orchids are recorded. Of 117 alien species almost all are confined to settled areas like Tidal River and around the lighthouse.

The first part of the park, gazetted in 1898, covered 24,280 ha. Earlier, parts had been logged and often grazed and burnt, particularly around the sawmilling and fishing settlements. The vegetation has largely recovered since then, despite the 1951 fire.



*Sealers Cove, after
the 1951 fire*

6. Fauna

Liberations of native mammals on Wilsons Promontory between about 1900 and 1941 cause confusion to students of the local fauna, even though few species would have survived and bred. Table 35 lists these introductions, as far as is known.

There are no recent records of platypus, tiger cat, quoll, dingo, or the red-bellied pademelon on the Promontory. The echidna, brown antechinus and Swainson's antechinus are common and the rarer swamp antechinus is locally abundant on Great Glennie Island. White-footed dunnarts are uncommon, and common wombats, koalas and both species of bandicoot are widespread. The koala may have been introduced.

Of the arboreal mammals found in the study area, the greater glider and yellow-bellied glider are absent from Wilsons Promontory. The feathertail glider although previously unrecorded was found there in 1980. Eastern grey kangaroos are common on the Yanakie isthmus and black wallabies are abundant. At least three species of bats occur, as do bush and swamp rats, and the uncommon broad-toothed rat and New Holland mouse. Australian and New Zealand fur seals, leopard seals and several species of whales are recorded in the waters off Wilsons Promontory; Australian fur seals come ashore to rest on several of the islands and breed on Kanowna Island.

Table 35

KNOWN LIBERATIONS OF NATIVE MAMMALS ON WILSONS PROMONTORY

Echidna - several in 1911
 Eastern grey kangaroo - several 1910-12
 Red kangaroo - three in 1914
 Euro - unknown number before 1914
 Red-necked wallaby - number 1911-14
 Black-striped wallaby - number before 1914
 Red-bellied pademelon - number 1911-14
 Brush-tailed rock wallaby - number before 1915
 Rufous rat-kangaroo - two in 1923
 Nail-tailed wallaby - two in 1924
 Bennett's tree kangaroo - numbers and dates are not known
 Brush-tailed possum (Tasmanian race) - several 1911-14
 Bobuck - numbers and dates not known
 Common ring-tail - numbers and dates not known
 Sugar glider - four in 1934
 Greater glider - one in 1929; one in 1934
 Western pigmy possum - unknown number in 1934
 Koala - Various liberations
 Wombat - Several (including King Island wombats) in 1910
 Long-nosed bandicoot - six 1911-23
 Barred bandicoot - unknown number 1923
 Tiger cat - unknown number in 1941
 Fat-tailed dunnart - unknown number 1933

(Information from National Museum of Victoria, 1977.)



Emus

Hog deer are moderately common on the Yanakie isthmus, and the rabbit, black rat, house mouse, fox and feral cat are widespread.

Some 182 species of birds have been recorded for the area, including maritime species since the Promontory is an important route for birds migrating across Bass Strait. Carcasses of Antarctic birds are often washed up on the beaches. Other significant species include the Cape Barren goose (which breeds on Anser and Glennie Groups), ground parrot, an unidentified bristlebird, peregrine falcon, orange-bellied parrot and Australasian gannet. Lyrebirds introduced to the Promontory did not survive.

Fifteen species of lizards and snakes are recorded.

Darby River has blackfish in its upper reaches, and tupong, galaxiids and pigmy perch downstream near the mouth, which is often silted up. Australian bass are reported from Tidal River, a stream important in the spawning and development of estuary perch, luderick and bream. There are no introduced species of fish in local streams, a situation that is very unusual in Victoria.

B. Present Uses and Capabilities

1. Nature conservation

Wilsons Promontory is of national importance for nature conservation. It has a large variety of vegetational types that support a correspondingly diverse fauna, it is well protected geographically and relatively unaffected by European settlement, it is extensive enough to include areas for concentrated recreation as well as conservation, it is scenically superb with one of the most impressive granitic landscapes in Australia, and the aims of management are widely identified and appreciated by the public.

The Promontory forms a boundary for the distribution of many plants and animals, and so is an important area for studies in this field as it provides evidence of links between Tasmanian and Victorian species and lies on the main pathway for migratory birds across Bass Strait.

Wilsons Promontory and Yanakie isthmus especially are of great archaeological

interest, with many Aboriginal middens along the shoreline.

2. Recreation

Wilsons Promontory has a high capability for recreation - surfing, fishing, sight-seeing, photography, boating, bushwalking, camping and nature study are popular activities with the many visitors. These activities can be carried out with a low impact on natural values because of the size of the park. Table 36 details the number of visitors each month between 1977 and early 1980.

3. Agriculture

There are no large areas of public land in this block suitable for alienation for farming.

4. Apiculture

There are eight designated sites for beekeepers to occupy in the north of the park - saw banksia and sweet bursaria are the most useful species.

5. Timber production

Commercial stands of timber occur only on the east coast. A sawmill operated at Sealers Cove in the 1850s and afterwards between 1903 and 1906. Future logging is unlikely and would be expensive because of the need to construct a large road system through difficult country.

Table 36

VISITORS TO WILSONS PROMONTORY NATIONAL PARK

VISITOR DAYS*

Month	1977-78	1978-79	1979-80
July	5437	6444	5686
August	16965	13807	12658
September	43691	20628	17718
October	40488	50362	22844
November	43479	54846	44683
December	36107	40422	35794
January	48622	49163	47542
February	35939	36873**	39690**
March	35690	37069	
April	19651	24037	
May	19199	18527	
June	7038	10240	
TOTAL	351400	358600	

*Visitor Days = day visitors + (number of campers x number of nights spent in park)

Monthly figures include bookings made for future camping - people who have booked are not recounted on arrival at the park.

** Progressive total for 1979-80 is down 17 per cent on the equivalent figure for 1978-79.



The Easter influx of campers to Wilsons Promontory in 1979

6. Water production

Wilsons Promontory is not important regionally for water production.

7. Mining and quarrying

A tin mine operated near Mount Hunter between 1920 and 1936 but proved uneconomical. Drilling in Corner Inlet in 1967 near Bennison Island failed to encounter submarine deposits of gravels containing tin oxide. The potential for discoveries of economic deposits is low.

A granite quarry functioned briefly at Refuge Cove in 1859. Gravel utilization

has ceased in the park and, if local limestone is unsuitable for particular road maintenance tasks, supplies are carted in from outside.

Three syndicates quarry limestone from pits on the Yanakie isthmus. The Department of Minerals and Energy, in consultation with the National Parks Service, sets an annual limit of 5,000 tonnes of stone from each pit; this material may only be used in the Shires of South Gippsland and Woorayl.

8. Utilities

Lighthouses operate on South East Point (manned), Citadel Island (automatic) and

Cliffy Island (automatic, manned until 1971), and the Ports and Harbours Division maintains various minor coastal beacons. A radio-telephone and television repeater station are located on Mount Oberon. Power is generated by the National Parks Service at Tidal River for the settlement there, which also has a water supply, sewerage and a rubbish destructor. The store and cafe at Tidal River are owned by the Service and leased to a private company.

9. Grazing

Wilsons Promontory was grazed more or less continuously by cattle until all licences were revoked in 1959.

The Yanakie isthmus, connecting the Promontory to the mainland, had been under pastoral licence from the 1850s until late in the nineteenth century, when the licences were surrendered. In 1905 the Government proposed to include it in Wilsons Promontory National Park, but did not implement this decision. In 1909 the Minister of Lands made the "Yanakie Run" available for the agistment of dairy cattle over the winter months. In 1954, the northern part was taken over for soldier settlement, and the southern part set aside for ultimate inclusion in Wilsons Promontory National Park, subject to the agreement of the then National Parks Authority to continue agistment. Provision for proclamation of an agistment area was inserted in the National Parks Act.



Staff at Wilsons Promontory help visitors to the park to appreciate the various types of habitat

Currently, the National Parks Service controls grazing on the section of the isthmus within Wilsons Promontory National Park, an area of 7,000 ha, in consultation with the Yanakie Agisters Association and through a ranger-herdsman on the Service's staff. Only dry dairy cattle are agisted; up to 2,000 graze there for as many as 16 weeks over winter, and a maximum of 300 may be admitted between October and February, according to the condition of the land.

Fees collected partly defray the cost of this management operation. Darby River and the swamps west of Millers Landing form natural barriers to cattle, which, together with the arrangement of watering facilities, effectively confine cattle to the isthmus.

C. Hazards and Conflicts

Wildfire is an important hazard.

The Forests Commission is legally responsible for the suppression of wildfires in State Forest and National Parks, and Crown land designated as "protected public land". The National Parks Service, however, maintains a firefighting force for initial attacks on fires. Fire protection is carried out in accordance with a plan prepared

by the Forests Commission and the National Parks Service. Fire protection works include track construction, fuel reduction burning and slashing.

Popular areas may be over used. Concentration of visitors in a locality can cause destruction of vegetation, soil erosion and littering, disturb wildlife, and require the construction of expensive roads, car parks and other facilities.

Cinnamon root-rot, which is present in parts of the park, was apparently spread when local gravel was used widely for road maintenance.

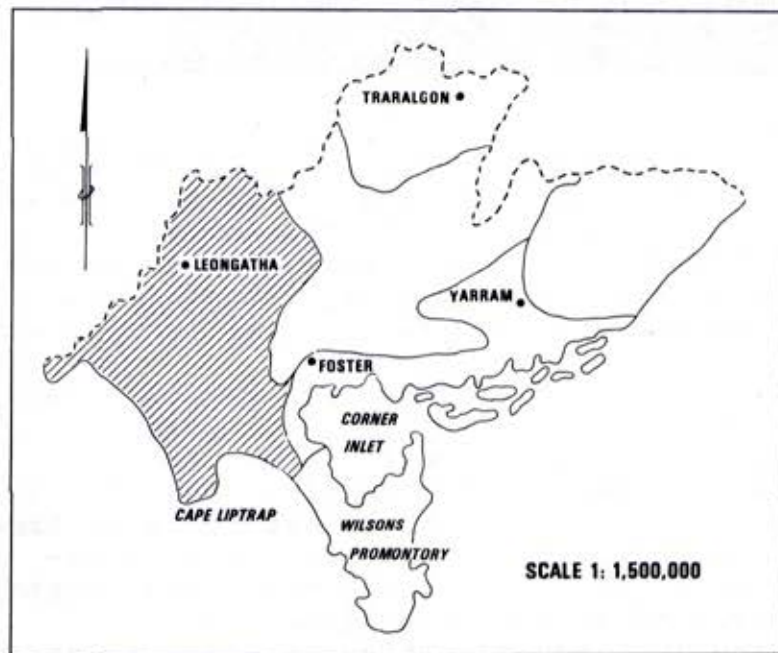
Noxious animals, particularly rabbits, and weeds have to be controlled on Wilsons Promontory.

6. TARWIN - WARATAH

A. Tenure and Nature of the Land

1. Present tenure

The total area of public land in this block is around 5,900 ha. There are 890 ha of reserved forest at Hallston and Waratah Bay, with 360 ha of unoccupied Crown land at Bald Hill, Grass Tree Hill, Inverloch, Lower Tarwin,



6. TARWIN-WARATAH

Pound Creek and Waratah Bay. The largest area embraces 4,350 ha of coastal reserves between Cape Paterson and Sandy Point, and various other reserves, each less than about 50 ha and totalling 300 ha, are scattered throughout the block.

2. Climate

Annual rainfall across the Tarwin - Waratah block varies from 929 mm and 983 mm on the coast at Wonthaggi and Lower Tarwin to 1,025 mm and 1,209 mm at Fish Creek and Ferndale at higher elevations. Rainfall commonly is greatest in the months May to September but all stations in the block show average monthly totals of at least 40-60 mm during December and January.

Floods are fairly frequent in the Tarwin River system.

Temperature data are limited, but Wonthaggi has average maxima and minima for January of 24.1°C and 12.6°C, and for July, 13.5°C and 5.9°C.

3. Geology and Geomorphology

Faulting and rock type have played an important role in the evolution of the

*Cliffs of dune limestone on
the coast near Arch Rock*



landscape that can be seen in the block nowadays.

Running north-east from Cape Liptrap is a ridge of Lower Palaeozoic rock passing into Mesozoic sediment. North from Fish Creek the land rises into the South Gippsland Highlands proper, which cover the northern part of the block. The highlands in this area comprise Mesozoic sediment, Tertiary basalt and Late Tertiary sediment.

South of the highlands, and on either side of the Liptrap Peninsula, are lowlying areas, in part fault-controlled, abutting Venus and Waratah Bays. The larger area, west of the peninsula,

called the Tarwin Sunkland contains a mixture of Late Tertiary and Quaternary alluvial and aeolian deposits and Mesozoic felspathic sandstones. West of Inverloch the Tarwin Sunkland is bounded by an area of undulating Mesozoic and Quaternary sediments.

The coastline of the block exhibits many examples of coastal geomorphology. Inlets with narrow mouths back the Venus Bay and Sandy Point barrier systems. The cliffs and shore platforms from Cape Paterson to Inverloch provide good exposures of Mesozoic sediments and those revealed around Cape Liptrap are excellent for the study of Early Palaeozoic geology.



Eagles Nest between Inverloch and Cape Paterson - a stack formed from Mesozoic sandstone

The main stream in the block is the Tarwin River. Of its two branches, the eastern drains the south-western Strzeleckis and the western rises in the Allambee-Childers area. The Powlett River runs along the Kongwak Fault and drains the plains north-east of Wonthaggi.

4. Soils

The main soils found on the Tarwin - Waratah block are as follows:

Uniform soils

- a. Calcareous and siliceous sands, developed on coastal dunes

- b. Leached sands with a compact or pan-like layer below the bleach, found on the flats throughout the Tarwin valley

Gradational soils

- a. Red and brown gradational soils, developed on Older Volcanics and Cretaceous sandstones, respectively, in the wetter parts of the block

Duplex soils

- a. Hard-setting loamy soils with acidic yellow-mottled subsoils developed on the outwash deposits flanking the Tarwin valley and Waratah Bay
- b. Sandy, acidic, yellow-mottled soils, occurring on the plains north-west of Inverloch

Organic soils

- a. Peaty soils, developed in various lowland swamps

In addition, there are occurrences of plastic clay soils on alluvium on some of the river and creek flats.

5. Vegetation

Almost all of the block has been cleared for agriculture. There are a few large areas of public land, and most of the stands of native vegetation on private land have been grazed continually and often burnt.

The only sizable remnant of the natural vegetation of the higher parts of the block on public land is at Hallston, where tall open forests of messmate, mountain grey gum, narrow-leaf peppermint and silvertop, with mountain ash in sheltered gullies, grow on Tertiary sediments and Older Volcanics lavas.

The sole allotment of public land in the Hoddle Range consists of closed scrub of common cassinia and austral bracken, with old stags (identified by C.S.I.R.O. as messmate) overlooking a ferny gully lined with blackwood and hazel pomaderris. Mountain ash grows on private land south of Fish Creek.

Besides the Hallston forests, the only large areas of relatively unmodified native vegetation are on the coastal reserve between Point Smythe and Cape Liptrap, and at Sandy Point, and also the heaths and open forest of messmate and narrow-leaf peppermint found on the slopes above Walkerville and Waratah Bay, and the low heathy woodland at Bald Hill.

6. Fauna

Because of the general lack of native vegetation in the block many once-common mammals have been greatly reduced in number.

Echidna, koalas and common wombats are still widespread, and platypus inhabit the Tarwin system. The three species of



Dry heath at Walkerville

antechinus, two species of bandicoot and the white-footed dunnart are present. Records show the brush-tailed possum, bobuck, common ringtail, sugar glider, greater glider, feathertail glider, and eastern pygmy possum inhabit parts of the block. The gliders are probably all uncommon, except for the sugar glider. Two tiger cats were trapped at Ten Mile Creek several years ago. Potoroos occurred on the coastal plains. Eastern grey kangaroos and black-tailed wallabies remain common, as do bush and swamp rats. Among the rodents, the eastern water rat, broad-toothed rat, and New Holland mouse are restricted in distribution. Several species of bats are known from the block.

Seals are occasionally seen in Anderson Inlet and one swam up the Tarwin River to Leongatha in 1965.

Of the alien mammals the rabbit, fox, black rat, house mouse, and feral cat are common, and the hare and hog deer uncommon.

About 155 species of native birds are recorded from the Tarwin-Waratah block. The coastline is particularly important for waders. A survey in the summer of 1979 showed that around 7% of migratory waders spending the summer in Victoria were on Anderson Inlet. Shallow Inlet was also important but birds fed there in conjunction with nearby Corner Inlet. Cape Barren geese have been observed on agricultural land between Sandy Point and Tarwin Lower.

Twelve species of lizards and snakes are recorded from the block but this figure is probably low.

The Tarwin River has blackfish in some of its upper tributaries; brown trout, eels and tupong are in most parts of the system above the estuary. European carp have been reported from Wilkur Creek near Leongatha. Mullet, Australian salmon, estuarine perch, trevally and silver bream are present in Anderson Inlet and the tidal part of the river, as well as in Shallow Inlet.

B. Present Uses and Capabilities

1. Nature conservation

Six areas of public land in the Tarwin - Waratah block have high importance for

nature conservation, because they represent the bulk of the surviving natural land.

Parts of Hallston Bush were cleared for settlement decades ago but have regenerated. The area offers an example of the tall open forests that grew on basalt residuals in the Strzeleckis, and also has stands growing on Plio-Pleistocene sediments.

In the Hoddle Range a 45-ha block with steep, fern-lined, scrubby gullies and cleared ridges, which formerly grew tall open forest of messmate, offers an



Cooks Creek, running into the sea near Waratah Bay township



Camping on public land on the east side of Shallow Inlet

opportunity for re-establishment of the original vegetation.

At Walkerville, steep cliffs and ferny gullies overlooking Waratah Bay carry open forest of messmate with dry and wet heaths on the ridge behind. The area has rich flora and fauna, is scenically interesting, and its lime kilns are a reminder of the industry and associated settlement which flourished at Walkerville between 1878 and 1924. The cliffs and shore platforms from Morgan Beach to Walkerville provide perhaps the best exposures of complex Lower Palaeozoic geology in the State. The stratigraphic and structural features are important educationally and for scientific research, as well as for general interest.

Shallow Inlet is a broad estuary with an agricultural hinterland, sheltered from Waratah Bay.

The Venus Bay coastal reserve is a narrow strip of generally undisturbed coastal scrub and grassland with limited access, running from Point Smythe to Cape Liptrap, and backing a broad and lonely beach, with low sandstone cliffs and rock stacks south-east of Ten Mile Creek.

Bald Hill is a flattish area of open forest, heathy woodland and wet heath that covers 120 ha and has considerable value for wildlife.

None of these areas is very large; parts of the coast are subject to great pressure from visitors, and Hallston Bush is logged on occasions.

2. Recreation

The coastal public land has the greatest capability for recreation. The cliffs east of Cape Paterson attract hang gliders, sightseers, surfers, picnickers, beachcombers and rock fishermen. Inverloch is popular with campers, and yachtsmen, anglers and boating enthusiasts enjoy Anderson Inlet. Surfers and surf fishermen frequent the beaches along Venus Bay. Campgrounds at Walkerville and Waratah Bay are well patronized by holidaymakers attracted to the local scenery, swimming beaches and opportunities for fishing, surfing and boating.

Sandy Point abuts a large subdivision and so fishing in the inlet and surfing and fishing along the ocean beach are popular.

The main recreational uses of other public land are pleasure driving, picnicking and nature study, and there are several town recreational reserves used for sports.

3. Agriculture

Some areas of public land could be developed for agriculture.



A view along Clear Creek Road near Mirboo taken in 1913 in June and showing the difficulties settlers faced daily

4. Apiculture

Beekeepers value the coastal belt as a source of banksia honey and are troubled by the great reduction of native vegetation on private land which has taken place throughout the block.

5. Timber production

Apart from Hallston Bush, and very limited stands in steep, wet, coastal gullies at Walkerville, all the areas of the public land in this block have a low capability for the production of timber.

Sawmills operated in the Hallston Bush early this century. In recent years the forest has been utilized by local farmers for limited quantities of fence posts and firewood. Mining timbers were probably cut from many areas of public and freehold land during the life of the Wonthaggi coal mines.

6. Water production

Areas of public land are so limited in the block that they play little part in regional water production, except along the coast at Sandy Point and Venus Bay, where household supplies are drawn from bores.

7. Mining and quarrying

Public land has little potential for mining in this block.

Mining activity could include development of bauxite deposits around Mirboo North and exploration for black coal in Mesozoic sediments at Wonthaggi and for gold, nickel and other metals at Cape Liptrap and in the Hoddle Range.

Small quantities of gravel and sand are available from public land. Each of the three Shire councils relies on pits on private land and a lime pit is on private land at Ten Mile Creek.

8. Utilities

Tips at Inverloch, Mirboo North and Sandy Point are located on public land, as is Cape Liptrap lighthouse.



Typical landscape of pasture, scrub and forest in the Mount Eccles area

9. Grazing

Several blocks of unoccupied Crown land carrying coastal heath, woodland and grassland in the Venus Bay - Tarwin South - Walkerville area are grazed. These range from 10 to 50 ha with two larger areas at Tarwin Meadows and Bald Hill around 220 ha and 120 ha. In almost every case the licensees are neighbouring landowners. Various other small blocks around Buffalo, Fish Creek, Leon-gatha, Mirboo South, Stony Creek and Tarwin are grazed; none is over 10 ha.

C. Hazards and Conflicts

The most pressing hazard on public land in the block is the effect of increasing numbers of people on the environment. Other hazards include wildfire, flooding along the Tarwin River, coastal erosion and noxious animals and plants.

The coastline of the block is very popular with tourists. This often leads to extensive recreational and residential developments of freehold land, which may lead to the deterioration of nearby natural land (usually publicly owned) from pedestrian and vehicular traffic, wildfire (accidentally or deliberately lit), roaming cats and dogs, and illegal dumping of rubbish.

A second occasional problem is the effect of grazing, both illegal and legal, on the integrity of remnant areas of native vegetation on public land.

APPENDICES

Appendix 1

METRIC CONVERSION FACTORS

Quantity	Metric unit	Imperial unit	Metric to Imperial	Imperial to Metric
Length	millimetre (mm)	inch (in)	1 mm = 0.039 ⁴ inch	1 inch = 25.4 mm
	centimetre (cm)		1 cm = 0.3937 inch	1 inch = 2.54 cm
	metre (m)	foot (ft)	1 m = 3.281 feet	1 foot = 0.30 m (30.5 cm)
	kilometre (km)	mile	1 km = 0.621 ⁴ mile	1 mile = 1.61 km
Area	hectare (ha)(= 10,000 m ²)	acre (ac)	1 ha = 2.47 acres	1 acre = 0.405 ha
	square kilometre (sq km) (= 100 ha)	square mile (sq mile)	1 sq km = 0.3861 sq mile (2 ⁴ / ₇ ac)	1 sq mile = 2.592 sq km
Mass	kilogram (kg)	pound (lb)	1 kg = 2.20 lb	1 lb = 0.45 ⁴ kg
	tonne (t)(= 1,000 kg)	ton	1 t = 0.98 ⁴	1 ton = 1.02 t
Volume	cubic metre (m ³)	cubic foot (ft ³)	1 m ³ = 35.31 ft ³	1 ft ³ = 0.0283 m ³
		super foot (timber)	= 423.7 super feet true = 332.6 super feet (Hoppus log volume)	1 super foot true = 0.00283 m ³ 1 super foot HLV = 0.003 m ³
	megalitre (ML) (= 1,000,000 litres)	acre-foot (ac ft)	1 ML = 0.8098 ac ft	1 ac ft = 1.235 ML
Temperature	degree Celsius (°C)	degree Fahrenheit (°F)	1°C = 5/9 (°F - 32)	1°F = 9/5 (°C + 32)
Compound units	milligrams per litre (mg/L)	parts per million (ppm)	1 mg/L = 1.000 ppm	1 ppm = 1.000 mg/L
	litres per second (L/s)	gallons per hour (gph)	1 L/s = 791.7 gph	1 gph = 0.00126 L/s
	megalitres per day (ML/day)	cubic feet per second (cusecs)	1 ML/day = .4083 cusecs	1 cusec = 2.4493 ML/day

Appendix 2A
RAILWAY HISTORY

Line	Completed	Closed	Details
Melbourne--Sale	1879		205 km; Richmond--South Yarra 1859, Sale--Dandenong 1877, Dandenong--South Yarra 1879
Moe--Walhalla	1910	1954	Narrow gauge (2ft 6in.) 42 km; Platina--Walhalla closed 1944, Erica--Platina closed 1952, Erica--Walhalla closed 1954
Moe--Thorpdale	1888	1958	17 km
Morwell--Mirboo North	1886	1974	32 km
Traralgon--Heyfield	1883		35 km; extended to Stratford 1887; branch line Maffra--Briagolong 1889, closed 1952
Melbourne--Port Albert	1892	*	219 km; Melbourne--Korumburra 1891; Korumburra--Leongatha 1891; Leongatha--Port Albert 1892 * (Alberton--Port Albert 6 km closed 1949)
Koo Wee Rup--Strzelecki	1922	1959	49 km; Triholm--Strzelecki closed 1930; Yannathan--Triholm closed 1941; Bayles--Yannathan closed 1950; Koo Wee Rup--Bayles closed 1959
Nyora--Wonthaggi	1910	1977	47 km

Line	Completed	Closed	Details
Korumburra--Jumbunna	1894	1953	6 km Lines also ran from Korumburra to mines at Coal Creek and Silkstone
Jumbunna--Outtrim	1896	1951	4 km
Welshpool--Welshpool Jetty	1905	1941	Narrow gauge (2ft 6in.) horse-drawn tramway 5 km
Alberton--Yarram	1921		6 km
Yarram--Won Wron	1921	1953	13 km
Won Wron--Woodside	1923	1953	15 km

In addition to the above State-owned lines, a private broad-gauge tramway operated between Port Franklin (Bowen) and Bennison. This 2-km tramway was built in 1889 by Andrew O'Keefe, contractor for the Korumburra--Toora section of the Great Southern Railway, and afterwards was operated by local fishermen for the carriage of goods and passengers until the late 1930s. When the line was demolished the rails were sold to sawmills at Erica.

Appendix 2B

ORIGIN OF PLACE NAMES

Anderson Inlet	after Samuel Anderson, early settler
Buffalo	named after local creek where many wild cattle had been found - possibly they descended from cattle left behind by the Corinella settlers in 1828
Callignee	Aboriginal 'water'
Darlimurla	Aboriginal 'tall trees'
Dollar	presumably after Dollar, town in central Scotland
Flynn	after Flinn, policeman at Alberton, 1848
Foster	after H.W. Foster, early mining warden
Franklin River	named by Latrobe after Sir John Franklin, Governor of Tasmania
Gelliondale	presumably after J. Gellion, early settler in Alberton district in 1840s
Inverloch	after Loch Inver in Scotland
Koornalla	Aboriginal 'running water'
Le Roy	after Roy Lee, early settler
Mardan	allegedly Aboriginal 'misery' or scene of calamity'
Maryvale	after Mary Ville, early run
Morwell	after Morwell Rocks in the River Tamar, Devon

Mount Eccles	presumably after early settler of that name who lived locally
Point Smythe	after G.D. Smythe, contract surveyor to government in Gippsland and Otways (or his brother Henry, early squatter)
Powlett River	after F.A. Powlett, appointed Commissioner, Western Port Squatting District, 1840
Rintoul Creek	after J. Rintoul, early settler and one-time occupier of Loy Yang run
Traralgon	Aboriginal 'river of little fish'
Turtons Creek	after Turton, early surveyor, whose party first found gold there
Tyers	after C.J. Tyers, early Gippsland land commissioner
Walkerville	presumably after W.F. Walker, part-owner of limeworks around 1880
Waratah Bay	after S.S. <i>Waratah</i> , a vessel forced to shelter there in 1858
Wilsons Promontory	named by Bass and Flinders after one of Flinders' London friends

Appendix 3A

RAINFALL IN THE STUDY AREA

A = Mean rainfall in mm.

B = Median rainfall in mm - the rainfall that is not reached in half the years under study and is exceeded in the other half of the years. The median for the year usually differs from the sum of the monthly medians because it is obtained from all of the available yearly values and not by summation of the monthly median values. The more variable the climate, the greater is the divergence of the median from the mean.

C = Average number of days on which there was .2 mm or more of precipitation other than frost, dew, or mist. It is taken as the 24 hours between 0900 hours on consecutive days.

BUREAU OF METEOROLOGY
STATION IDENTIFICATION NUMBER

Agnes River	085001	Moe	085059
Alberton	085003	Mount Best	085063
Balook	085008	Outtrim	086194
Budgerree East	085015	Port Albert	085070
Callignee South	085017	Rosedale	085071
Cape Liptrap	085175	Seaspray	085073
Carrajung	085018	Stradbroke	085077
Erica	085026	Tarwin Lower	085137
Ferndale	085114	Thorpdale	085081
Fish Creek	085028	Tidal River	085082
Foster	085029	Traralgon	085086
Giffard	085033	Wilsons Promontory Lighthouse	085096
Gormandale East	085036	Wonthaggi	086127
Leongatha	085048	Yanakie	085244
Madalya	085053	Yarram	085099
Mardan South	085056	Yinnar	085100

RAINFALL IN THE STUDY AREA

Station; span of records for mean rainfall; elevation		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Agnes River	A	52	57	72	78	79	84	76	85	87	85	75	69	899
71 years	B	45	46	66	68	71	80	70	77	83	82	72	59	911
8 m	C	7	7	10	12	14	15	15	16	14	14	12	10	146
Alborton	A	46	47	62	56	58	62	57	62	65	68	59	55	697
73 years	B	35	32	48	50	51	56	52	55	58	63	48	45	688
10 m	C	6	6	8	9	11	12	11	12	11	11	9	8	114
Balook	A	90	101	112	133	128	156	131	128	137	132	104	103	1455
39 years	B	68	55	88	107	117	131	123	117	123	127	92	100	1459
630 m	C	9	8	10	13	14	15	15	15	15	15	12	11	152
Budgerie East	A	61	64	74	87	112	109	107	113	106	106	91	83	1113
67 years	B	64	53	65	81	99	104	104	105	106	101	83	77	1114
442 m	C	9	8	11	13	16	16	17	18	16	16	14	11	165
Callignee South	A	70	79	84	112	124	137	117	141	110	113	111	97	1295
43 years	B	62	50	63	100	104	113	109	134	110	104	111	89	1277
c. 600 m	C	11	12	14	16	18	19	20	21	18	18	16	14	197
Cape Liptrap	A	146	26	51	93	123	68	90	66	121	34	-	42	860
2 years	B	146	26	51	93	123	68	90	66	121	34	-	42	860
122 m	C													
Carrajung	A	74	79	80	87	103	125	98	119	102	101	92	84	1144
81 years	B	67	60	59	66	87	108	89	109	93	100	79	72	1106
549 m	C	8	8	8	10	13	14	13	14	13	12	11	9	132
Erica	A	79	78	79	101	96	95	80	104	98	118	115	110	1153
43 years	B	62	61	68	85	83	83	70	96	98	113	110	99	1170
403 m	C	11	11	12	15	16	16	17	18	16	17	15	14	178

RAINFALL IN THE STUDY AREA

Station; span of records for mean rainfall; elevation		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Ferndale	A	67	67	85	106	108	122	115	134	126	118	82	79	1209
31 years	B	58	62	77	90	98	118	105	134	116	120	73	69	1239
335 m	C	7	6	8	11	12	16	15	16	14	12	9	7	133
Fish Creek	A	54	60	69	95	102	104	99	114	90	97	86	69	1039
47 years	B	42	52	62	83	95	95	94	111	89	88	85	64	1025
60 m	C	9	10	11	15	18	18	18	20	16	17	15	12	179
Poster	A	62	61	79	102	107	117	106	119	111	108	86	97	1137
90 years	B	52	48	65	88	97	106	100	114	103	101	76	73	1131
38 m	C	8	8	10	12	14	16	16	17	16	15	12	10	154
Giffard	A	40	40	50	42	45	48	43	46	45	55	55	49	558
67 years	B	38	27	29	33	36	43	37	42	42	49	49	45	557
c. 15 m	C	5	5	6	7	9	10	9	10	8	9	8	6	92
Gormandale East	A	49	51	73	73	70	89	81	88	73	77	76	60	850
42 years	B	41	37	61	51	58	81	69	75	72	78	54	55	835
120 m	C	8	6	8	9	12	14	14	13	13	12	10	8	127
Leongatha	A	59	61	71	88	85	95	83	95	88	96	81	68	970
42 years	B	46	49	72	70	80	92	79	94	87	92	71	60	957
88 m	C	10	9	11	15	17	18	18	20	17	16	14	11	176
Madalya	A	78	81	87	111	109	125	113	121	121	120	101	88	1255
58 years	B	65	60	76	88	89	109	104	121	111	112	89	72	1268
457 m	C	8	9	10	12	14	15	15	16	15	14	12	10	150
Mardan South	A	59	58	74	86	99	94	92	102	99	100	85	77	1025
75 years	B	52	46	64	82	84	91	88	100	96	97	77	72	1011
213 m	C	8	7	9	11	14	14	14	15	14	13	12	10	141

RAINFALL IN THE STUDY AREA

Station; span of records for mean rainfall; elevation		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Noe	A	58	57	67	76	92	90	89	97	92	100	80	71	969
77 years	B	50	45	53	65	80	82	87	97	90	96	80	68	974
67 m	C	8	7	9	11	14	15	16	16	15	14	12	10	147
Mount Best	A	67	73	86	97	112	115	111	122	116	112	99	86	1196
68 years	B	59	56	69	84	100	107	108	113	107	96	88	82	1174
351 m	C	8	8	9	11	13	14	15	15	13	13	11	10	140
Outtrim	A	68	50	77	84	102	104	93	100	105	92	75	73	1023
50 years	B	46	37	65	74	99	95	79	98	103	88	72	69	1053
c. 70 m	C	7	5	8	10	13	13	14	14	14	12	10	8	128
Port Albert	A	47	44	58	59	65	66	59	61	66	68	61	55	709
110 years	B	39	35	45	49	57	61	51	55	61	64	55	50	706
3 m	C	8	7	9	11	13	14	13	14	13	13	11	9	135
Rosedale	A	44	46	56	50	55	56	47	57	58	69	62	59	659
96 years	B	43	38	40	40	50	49	41	54	54	65	56	53	654
18 m	C	7	6	7	9	11	12	12	13	12	12	10	9	120
Seaspray	A	43	41	55	48	49	50	42	46	47	55	55	54	585
74 years	B	41	29	40	41	45	45	37	41	45	52	46	43	578
6 m	C	6	6	7	8	10	11	11	12	10	11	9	7	108
Stradbroke	A	43	47	53	55	50	58	47	49	52	62	52	52	620
81 years	B	37	31	42	38	40	55	44	41	51	58	46	42	623
47 m	C	5	5	6	8	9	10	9	10	9	10	8	7	96
Tarwin Lower	A	54	44	72	94	93	106	93	95	104	91	67	70	983
32 years	B	44	27	57	90	95	110	71	89	101	81	65	59	994
4m	C	9	7	11	14	16	18	18	18	18	15	13	11	168

RAINFALL IN THE STUDY AREA

Station; span of records for mean rainfall; elevation		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Thorpdale	A	58	60	75	80	91	112	99	114	107	113	87	81	1077
56 years	B	51	54	59	71	87	104	90	116	92	109	81	76	1090
244 m	C	7	7	9	11	12	14	14	15	14	13	10	9	135
Tidal River	A	46	55	60	97	134	115	116	125	95	100	85	55	1083
28 years	B	32	41	51	95	151	102	107	111	88	84	73	48	1041
	C													
Traralgon	A	48	52	55	56	64	67	62	71	71	79	67	63	755
62 years	B	38	37	43	46	56	63	57	68	67	77	58	58	762
43 m	C	7	6	8	10	12	14	13	14	13	12	11	8	128
Wilsons Promontory Lighthouse	A	49	48	70	89	112	120	116	117	97	94	74	64	1050
102 years	B	44	38	55	85	98	116	106	108	97	85	70	54	1060
89 m	C	9	9	11	15	18	19	19	19	17	16	13	11	176
Wonthaggi	A	47	49	63	82	100	94	96	100	86	84	68	60	929
63 years	B	37	40	55	80	93	84	91	100	89	80	65	57	911
40 m	C	7	7	9	12	15	15	16	16	14	13	11	9	144
Yanakie	A	48	33	75	81	74	93	87	76	79	65	46	51	808
24 years	B	31	30	75	73	72	92	96	78	77	61	46	50	795
35 m	C													
Yarram	A	52	52	62	63	64	71	59	68	68	70	66	60	755
82 years	B	42	38	46	51	55	66	50	63	63	63	57	51	752
20 m	C	8	8	10	11	13	15	14	15	14	14	11	10	143
Yinnar	A	44	47	62	66	73	80	75	87	80	91	73	65	843
60 years	B	38	40	50	55	61	77	66	84	79	79	64	64	824
53 m	C	6	6	8	10	12	13	13	14	12	13	10	8	125

Appendix 3B REPRESENTATIVE TEMPERATURES

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean for year
<u>EAST SALE</u> Latitude 38°06' S Longitude 147°08' E Elevation 5 m													
9 a.m. Mean temperature (°C) and mean relative humidity (%)													
Dry bulb	19.7	19.3	16.7	13.1	9.6	7.2	6.5	8.2	11.0	14.0	16.3	18.3	13.3
Humidity	64	71	76	83	87	88	86	85	78	73	67	65	77
3 p.m. Mean temperature (°C) and mean relative humidity (%)													
Dry bulb	23.6	23.8	22.1	19.7	15.5	13.6	12.7	13.7	15.4	17.5	19.4	20.9	18.2
Humidity	51	53	53	53	62	64	64	61	58	58	55	56	57
Daily maximum temperature (°C)													
Mean	25.4	25.3	23.4	20.6	16.3	14.3	13.5	14.6	16.6	19.0	21.1	23.0	19.4
Daily minimum temperature (°C)													
Mean	12.5	13.3	11.5	8.5	6.1	4.1	3.3	4.3	5.6	7.8	9.4	11.4	8.2
<u>OLSENS BRIDGE</u> Latitude 38°29' S Longitude 146°19' E Elevation 183 m													
9 a.m. Mean temperature (°C) and mean relative humidity (%)													
Dry bulb	17.9	17.9	15.0	10.9	7.5	5.4	4.8	6.2	9.5	12.7	14.6	16.4	11.6
Humidity	65	70	80	86	96	97	92	92	84	73	67	68	81
3 p.m. Mean temperature (°C) and mean relative humidity (%)													
Dry bulb	21.8	22.7	20.7	17.4	13.0	10.9	10.4	11.7	13.5	15.8	17.4	19.3	16.2
Humidity	53	51	54	62	73	80	72	69	62	60	57	57	63
Daily maximum temperature (°C)													
Mean	23.5	23.9	21.7	18.3	13.9	11.8	11.3	12.6	14.7	17.2	19.3	21.1	17.4
Daily minimum temperature (°C)													
Mean	9.5	9.9	7.9	5.9	4.4	2.6	1.8	2.6	3.7	5.6	7.1	8.5	5.8

Appendix 3B (continued)

	Jan	Feb	Mar	Apr	May	Jun.	Jul	Aug	Sep	Oct	Nov	Dec	Mean for year
<u>WILSONS PROMONTORY LIGHTHOUSE</u>	Latitude 39°8' S		Longitude 146°25' E		Elevation 89 m								
9 a.m. Mean temperature (°C) and mean relative humidity (%)													
Dry bulb	17.7	18.0	16.9	15.1	12.6	11.3	10.1	10.3	11.4	13.0	14.2	16.0	13.9
Humidity	75	76	77	76	79	79	78	80	78	77	77	75	77
3 p.m. Mean temperature (°C) and mean relative humidity (%)													
Dry bulb	18.3	18.7	17.6	15.7	13.3	11.9	10.8	11.1	12.0	13.5	15.0	16.4	14.5
Humidity	75	*73	74	77	78	80	79	79	77	76	74	76	77
Daily maximum temperature (°C)													
Mean	20.7	20.6	19.4	17.4	14.4	12.9	11.8	12.2	13.5	15.5	17.0	18.7	16.2
Daily minimum temperature (°C)													
Mean	14.0	14.7	14.2	12.6	10.6	9.3	8.0	8.0	8.6	9.8	10.8	12.0	11.1
<u>YALLOURN (S.E.C.)</u>	Latitude 38°11' S		Longitude 146°22' E		Elevation 153 m								
9 a.m. Mean temperature (°C) and mean relative humidity (%)													
Dry bulb	17.8	17.1	14.8	12.0	9.2	7.5	6.6	7.4	9.4	12.0	14.3	16.4	12.0
Humidity	68	76	80	82	85	84	85	84	80	77	73	69	79
3 p.m. Mean temperature (°C) and mean relative humidity (%)													
Dry bulb	23.7	23.1	21.1	18.1	13.8	11.9	11.0	12.1	13.9	16.4	18.6	20.8	17.0
Humidity	45	48	51	56	66	68	68	64	60	57	55	50	57
Daily maximum temperature (°C)													
Mean	24.9	24.2	22.1	18.9	14.6	12.7	11.8	13.0	15.0	17.6	19.9	22.3	18.1
Daily minimum temperature (°C)													
Mean	12.9	13.2	11.9	9.5	7.3	5.8	4.8	5.4	6.6	8.3	9.7	11.4	8.9

Appendix 4A

PLANT NAMES IN REPORT

Common name	Botanical name	Common name	Botanical name
Austral bracken	<i>Pteridium esculentum</i>	Erect guinea-flower	<i>Hibbertia stricta</i>
Austral grass-tree	<i>Xanthorrhoea australis</i>	Fieldia	<i>Fieldia australis</i>
Austral mulberry	<i>Hedyocarya angustifolia</i>	Forest clematis	<i>Clematis glycinoides</i>
Austral seablite	<i>Suaeda australis</i>	Forest red gum	<i>Eucalyptus tereticornis</i>
Banyalla	<i>Pittosporum bicolor</i>	Forest wire-grass	<i>Tetrarrhena juncea</i>
Beaded glasswort	<i>Salicornia quinqueflora</i>	Fragrant fern	<i>Microsorium scandens</i>
Bidgee-widgee	<i>Acaena anserinifolia</i>	Furze hakea	<i>Hakea ulicina</i>
Black she-oak	<i>Casuarina littoralis</i>	Gippsland grey box	<i>Eucalyptus bosistoana</i>
Black wattle	<i>Acacia mearnsii</i>	Golden bush-pea	<i>Pultenaea gromii</i>
Blackwood	<i>Acacia melanoxylon</i>	Hairpin banksia	<i>Banksia spinulosa</i>
Blanket-leaf	<i>Bedfordia salicina</i>	Hairy spinifex	<i>Spinifex hirsutus</i>
Blotched sun-orchid	<i>Thelymitra fusco-lutea</i>	Hazel pomaderris	<i>Pomaderris aspera</i>
Blue gum	<i>Eucalyptus globulus</i>	Heath tea-tree	<i>Leptospermum myrsinoides</i>
Blue oliveberry	<i>Elaeocarpus reticulatus</i>	Holly lomatia	<i>Lomatia ilicifolia</i>
Bog gum	<i>Eucalyptus kitsoniana</i>	Hop bitter-pea	<i>Daviesia latifolia</i>
Broad-leaved peppermint	<i>Eucalyptus dives</i>	Hop goodenia	<i>Goodenia ovata</i>
Broom spurge	<i>Amperea rhiphiolada</i>	Horny cone-bush	<i>Isopogon ceratophyllus</i>
Brown stringybark	<i>Eucalyptus baxteri</i>	Island pepper-cress	<i>Lepidium praetervisum</i>
Bulrush	<i>Scirpus fluviatilis</i>	Jungle bristle-fern	<i>Macrogloma caudata</i>
Burgan	<i>Leptospermum phylloides</i>	Kangaroo apple	<i>Solanum</i> spp.
Bushy club-moss	<i>Lycopodium deuterodensum</i>	Karkalla	<i>Carpobrotus rossii</i>
Bushy needlewood	<i>Hakea sericea</i>	Kidney weed	<i>Dichondra repens</i>
But-but	<i>Eucalyptus bridgesiana</i>	Knobby club-rush	<i>Scirpus nodosus</i>
Button-grass	<i>Gymnoschoenus sphaerocephalus</i>	Large-leaf bush-pea	<i>Pultenaea daphnoides</i>
Chaffy saw-sedge	<i>Gahnia filum</i>	Lemon bottle-brush	<i>Callistemon pallidus</i>
Cherry ballart	<i>Exocarpos cupressiformis</i>	Lilly-pilly	<i>Acmena smithii</i>
Cherry rice-flower	<i>Pimelea drupacea</i>	Love-creeper	<i>Comesperma volubile</i>
Climbing lignum	<i>Muehlenbeckia adpressa</i>	Manna gum	<i>Eucalyptus viminalis</i>
Coast ballart	<i>Exocarpos myrticola</i>	Marram grass	<i>Ammophila arenaria</i>
Coast banksia	<i>Banksia integrifolia</i>	Matted bog rush	<i>Schoenus brevicaulis</i>
Coast beard-heath	<i>Leucopogon laevigatus</i>	Messmate	<i>Eucalyptus obliqua</i>
Coast crimson-berry	<i>Cyathodes juniperina</i>	Mountain ash	<i>Eucalyptus regnans</i>
Coast everlasting	<i>Helichrysum paraliun</i>	Mountain grey gum	<i>Eucalyptus cypellocarpa</i>
Coast saw-sedge	<i>Gahnia trifida</i>	Musk daisy bush	<i>Olearia argophylla</i>
Coast swainson-pea	<i>Swainsona lessertiifolia</i>	Myrtle beech	<i>Nothofagus cunninghamii</i>
Coast tea-tree	<i>Leptospermum laevigatum</i>	Narrow-leaf peppermint	<i>Eucalyptus radiata</i>
Coast wattle	<i>Acacia longifolia</i> var. <i>sophoras</i>	Narrow-leaf wattle	<i>Acacia mucronata</i>
Common beard-heath	<i>Leucopogon virgatus</i>	Notched phebalium	<i>Phebalium bilobum</i>
Common boobialla	<i>Myoporum insulare</i>	Oval wedge-fern	<i>Lindsaea cuneata</i>
Common cassinia	<i>Cassinia aculeata</i>	Paper flower	<i>Thomasia petalocalyx</i>
Common correa	<i>Correa reflexa</i>	Pink-bells	<i>Tetraloaea ciliata</i>
Common flat-pea	<i>Platylobium obtusangulum</i>	Pink swamp-heath	<i>Sprengelia incarnata</i>
Common heath	<i>Epacris impressa</i>	Prickly broom-heath	<i>Monotoca scoparia</i>
Common raspwort	<i>Haloragis tetragyna</i>	Prickly geebung	<i>Persoonia juniperina</i>
Common scale-rush	<i>Lepyrodia muelleri</i>	Prickly moses	<i>Acacia verticillata</i>
Coral-fern	<i>Gleichenia</i> spp.	Prickly tea-tree	<i>Leptospermum juniperinum</i>
Cranberry heath	<i>Astroloma humifusum</i>	Privet mock-olive	<i>Notolaea ligustrina</i>
Creeping brookweed	<i>Samolus repens</i>	Promontory daisy-bush	<i>Olearia allenderae</i>
Creeping raspwort	<i>Haloragis micrantha</i>	Radiata pine	<i>Pinus radiata</i>
Douglas fir	<i>Pseudotsuga menziesii</i>	Red box	<i>Eucalyptus polyanthemus</i>
Drooping she-oak	<i>Casuarina stricta</i>	Red-fruit saw-sedge	<i>Gahnia sieberiana</i>
Dwarf she-oak	<i>Casuarina pusilla</i>	Ridged ground-berry	<i>Acortriche affinis</i>

Appendix 4A (continued)

Common name	Botanical name	Common name	Botanical name
River red gum	<i>Eucalyptus camaldulensis</i>	Spike wattle	<i>Acacia oxycedrus</i>
Rosy baeckea	<i>Baeckea ramosissima</i>	Spreading rope-rush	<i>Calorophus lateriflorus</i>
Rough tree-fern	<i>Cyathea australis</i>	Spreading wattle	<i>Acacia diffusa</i>
Sandhill sword-sedge	<i>Lepidosperma conoava</i>	Sticky wattle	<i>Acacia howittii</i>
Saw banksia	<i>Banksia serrata</i>	Stinkwood	<i>Zieria smithii</i>
Scent-bark	<i>Eucalyptus aromaphloia</i>	Sunshine wattle	<i>Acacia botrycephala</i>
Scented paperbark	<i>Melaleuca decussata</i>	Swamp paperbark	<i>Melaleuca ericifolia</i>
Scrub she-oak	<i>Casuarina paludosa</i>	Swamp gum	<i>Eucalyptus ovata</i>
Sea wheat grass	<i>Agropyron junceum</i>	Sweet bursaria	<i>Bursaria spinosa</i>
Sea rush	<i>Juncus maritima</i>	Sweet pittosporum	<i>Pittosporum undulatum</i>
Seaberry saltbush	<i>Rhagodia baccata</i>	Sweet wattle	<i>Acacia suaveolens</i>
Selliera	<i>Selliera radicans</i>	Tall yellow-eye	<i>Xyris operculata</i>
Shade nettle	<i>Australina muelleri</i>	Thatch saw-sedge	<i>Gahnia radula</i>
Shining cassinia	<i>Cassinia longifolia</i>	Thick twist-rush	<i>Caustis pentandra</i>
Shining coprosma	<i>Coprosma nitida</i>	Tree everlasting	<i>Helichrysum dendroideum</i>
Shining peppermint	<i>Eucalyptus nitida</i>	Varnish wattle	<i>Acacia verniciflua</i>
Showy bossiaea	<i>Bossiaea cinerea</i>	Victorian Christmas-bush	<i>Prostanthera lasiantha</i>
Silver banksia	<i>Banksia marginata</i>	Water-buttons	<i>Cotula coronopifolia</i>
Silky hakea	<i>Hakea sericea</i>	White correa	<i>Correa alba</i>
Silver wattle	<i>Acacia dealbata</i>	White kunzea	<i>Kunzea ambigua</i>
Silver-leaf stringybark	<i>Eucalyptus cephalocarpa</i>	White mangrove	<i>Avicennia marina</i>
Silvertop	<i>Eucalyptus sieberi</i>	White stringybark	<i>Eucalyptus globoides</i>
Slender tree-fern	<i>Cyathea cunninghamii</i>	Wiry bauera	<i>Bauera rubioides</i>
Slender twine-rush	<i>Leptocarpus tenax</i>	Wonga vine	<i>Pandorea pandorana</i>
Small grass-tree	<i>Xanthorrhoea minor</i>	Yellow box	<i>Eucalyptus melliodora</i>
Smooth parrot-pea	<i>Dillwynia glaberrima</i>	Yellow hakea	<i>Hakea nodosa</i>
Snowy daisy-bush	<i>Olearia lirata</i>	Yellow stringybark	<i>Eucalyptus muelleriana</i>
Southern sassafras	<i>Atherosperma moschatum</i>	Yertchuk	<i>Eucalyptus consideniana</i>
Spike beard-heath	<i>Leucopogon australis</i>	Zig-zag bog-rush	<i>Schoenus brevifolius</i>

Appendix 4B

VASCULAR PLANTS ENDEMIC TO VICTORIA AND FOUND IN THE STUDY AREA

Based on information supplied by Mr. A.C. Beauglehole, Dr. J.H. Willis,
and Mr. N. Scarlett

Species	Distribution
<i>Acacia howittii</i>	Yarram area; also Glenfalloch, Mount Useful
<i>Acrotriche prostrata</i>	Widely distributed in Victoria
<i>Asterotricha parvifolia</i>	Eastern Victoria
<i>Banksia</i> sp.	Grampians, Wilsons Promontory
<i>Eucalyptus kitsoniana</i>	Coastal - west of Welshpool
<i>E. yarraensis</i>	Southern Victoria
<i>Grevillea chrysophaea</i>	Eastern Victoria
<i>Olearia allenderae</i>	Wingan River, Wilsons Promontory
<i>O. rugosa</i>	Otways, Gippsland
<i>Prasophyllum parviflorum</i>	Southern Victoria
<i>Prostanthera melissifolia</i>	Otways, South Gippsland
<i>Pultenaea prolifera</i>	South-western Victoria, Otways, South Gippsland

Appendix 4C

TASMANIAN PLANTS FOUND ON THE MAINLAND IN THE STUDY AREA ONLY

<i>Pimelea drupacea</i>	Wilsons Promontory
<i>Lepidium praetervisum</i>	Wilsons Promontory
<i>Cyathodes juniperina</i> var. <i>oxycedrus</i>	Wilsons Promontory

Appendix 4D

RARE, LOCALIZED, OR ENDANGERED PLANTS

Species	Distribution
(V) <i>Asplenium obtusatum</i>	Snake Island, Wilsons Promontory
(V) <i>Australina pusilla</i>	Wilsons Promontory
(A) <i>Burnettia cuneata</i>	Foster, Hedley, Wilsons Promontory, Wonthaggi
(V) <i>Caladenia leptochila</i>	Wilsons Promontory
(V) <i>Corybas fordhami</i>	Yanakie
(A) <i>Cyathea cunninghamii</i>	Bulga, Gunyah, Tarra Valley, Turtons Creek, Wilsons Promontory
(V) <i>C. marcescens</i> *	Tarra Valley
(V) <i>Cyathodes juniperina</i>	Townsend and Tongue Points; Rabbit and Doughboy Islands
(V) <i>Exocarpos syrticola</i>	Wilsons Promontory
(A) <i>Lepidium praetervisum</i>	Norman and Oberon Bays
(V) <i>Lindsaya microphylla</i>	Welshpool
(V) <i>L. trichomanoides</i>	Chinaman Creek
(V) <i>Lycopodium myrtifolium</i>	Sealers Creek
(V) <i>Microtis orbicularis</i>	Wonthaggi
(V) <i>Pimelea drupacea</i>	Sealers Cove
(V) <i>Pterostylis alveata</i>	Little Snake Island
(V) <i>P. crypta</i>	Waratah Bay
(V) <i>Tetrarrhena acuminata</i>	Wilsons Promontory
(A) <i>Thelmymitra epipactoides</i>	Hedley, Yarram
(A) <i>T. matthewsii</i>	Mullungdung
(V) <i>T. murdochae</i>	Inverloch
(A) <i>Tmesipteris elongata</i>	Morwell National Park
(A) Assessed as rare throughout Australia	(V) Assessed as rare in Victoria, but may be more common elsewhere

* Hybrid between *C. cunninghamii* and *C. australis*

Appendix 4E

PRINCIPAL NATIVE TREE SPECIES FOUND IN SOUTH GIPPSLAND AREA, DISTRICT 2

Botanical name	Common name	Notes
<i>Acacia dealbata</i>	Silver wattle	Widespread (absent Wilsons Promontory)
<i>A. mearnsii</i>	Black wattle	Widespread (absent Wilsons Promontory)
<i>A. melanoxylon</i>	Blackwood	Widespread
<i>A. verniciflua</i>	Varnish wattle	Northern foothills of Strzeleckis; southern foothills west of Jack River
<i>Acmena smithii</i>	Lilly-pilly	Wilsons Promontory
<i>Atherosperma moschatum</i>	Southern sassafras	Strzeleckis, Wilsons Promontory
<i>Banksia integrifolia</i>	Coast banksia	Coastal zone
<i>B. serrata</i>	Saw banksia	Coastal zone east of Walkerville, south-eastern and eastern foothills of Strzeleckis
<i>Casuarina littoralis</i>	Black she-oak	Latrobe Valley, Mullungdung, Wilsons Promontory
<i>C. stricta</i>	Drooping she-oak	Waratah Bay, Wilsons Promontory
<i>Eucalyptus aromaphloia</i>	Scent-bark	Mullungdung, Yinnar, Moe, Rintoul Creek
<i>E. baxteri</i>	Brown stringybark	Wilsons Promontory, Mirboo North
<i>E. bosistoana</i>	Gippsland grey box	East of Woodside, Stradbroke
<i>E. bridgesiana</i>	But-but	Widespread north and east of study area
<i>E. camaldulensis</i>	River red gum	Traralgon, Flynn, Giffard
<i>E. cephalocarpa</i>	Silver-leaf stringybark	Mullungdung, Stradbroke, Yallourn, Won Wron, Meeniyan
<i>E. considaniana</i>	Yertchuk	Tyers, eastern foothills of Strzeleckis, Mullungdung, Dickies Hill (absent Wilsons Promontory)
<i>E. cypellocarpa</i>	Mountain grey gum	Widespread, occasionally at Wilsons Promontory
<i>E. globoidea</i>	White stringybark	Monkey Creek, Tyers, Gormandale area, Alberton West, Agnes River
<i>E. globulus</i>	Blue gum	Strzeleckis, Wilsons Promontory, Mullungdung, Won Wron, Traralgon South
<i>E. kitsoniana</i>	Bog gum	Hedley to Outtrim, Wilsons Promontory, Snake Island
<i>E. melliodora</i>	Yellow box	Leongatha, Mullungdung, Traralgon, Tyers
<i>E. muelleriana</i>	Yellow stringybark	East of Welshpool on coastal plain and foothills, Wilsons Promontory
<i>E. nitida</i>	Shining peppermint	Wilsons Promontory and coastal plains to the east, Monkey Creek
<i>E. obliqua</i>	Messmate	Widespread and variable (due locally, perhaps, to hybridization with mountain ash and brown stringybark) - among these distinct forms: so-called 'mountain form' on ridges in eastern Strzeleckis; var. <i>disocarpa</i> on Wilsons Promontory
<i>E. ovata</i>	Swamp gum	Widespread (uncommon Wilsons Promontory)
<i>E. pauciflora</i>	Snow gum	Morwell, Yanakie, Yinnar (rare)
<i>E. polyanthemosa</i>	Red box	Traralgon, Tyers, Boodyarn, Won Wron
<i>E. radiata</i>	Narrow-leaf peppermint	Widespread (absent Wilsons Promontory)
<i>E. regnans</i>	Mountain ash	Strzeleckis, Wilsons Promontory, south of Fish Creek
<i>E. rubida</i>	Candlebark	Morwell Bridge, Yinnar
<i>E. sieberi</i>	Silvertop	Rintoul Creek, northern slopes of Strzeleckis, Mullungdung, Calrossie
<i>E. tereticornis</i>	Forest red gum	Flynn, Traralgon, Loy Yang
<i>E. viminalis</i>	Manna gum	Rough-barked form: plains of Latrobe Valley coastal plains, Corner Inlet islands, Yanakie; Smooth-barked form: Strzeleckis, Rintoul Creek
<i>E. yarraensis</i>	No common name	Morwell, Flynn Creek Upper, Loy Yang, Tyers
<i>Excoarpos cupressiformis</i>	Cherry ballart	Widespread
<i>Nothofagus cunninghamii</i>	Myrtle beech	Strzeleckis, Wilsons Promontory

Appendix 5A

BIRDS

These lists apply only to the study area. Neighbouring regions are not considered. The following abbreviations are used. An asterisk (*) indicates an exotic species.

Distribution	Habitat	Status
T Throughout study area	F General forest habitat	M Migratory
I Islands	C Coastal communities	N Nomadic (numbers fluctuate)
C Coastal plains and shoreline	H Heathland	C Common
L Latrobe Valley and Boola Forest	A Agricultural land and grasslands	F Frequent in favoured habitat
S Strzeleckis	W Wetlands, rivers and creeks	U Uncommon
W Wilsons Promontory	S Softwood plantations	V Very unusual
O Ocean	O Ocean	R Rare (or rarely recorded in the case of seabirds)
M Mullungdung - Boodyarn	E Estuary	B Known with certainty to breed in study area
	B Beach	
	T Towns	
	Ae Aerial	

Common names and their sequence have been taken from the publication:

Norris, K.C., Gilmore, A.M., and Menkhorst, P.W. Vertebrate fauna of South Gippsland. *Memoirs of the National Museum of Victoria*, 1979, 40, 105--99.

NON-PASSERINES

Common name	Scientific name	Distribution	Habitat	Status	Remarks	Nest location
Emu	<i>Dromaius novaehollandiae</i>	WM	FHS	CB		Ground
Great crested grebe	<i>Podiceps cristatus</i>	ICO	WE	U		Floating on water
Hoary-headed grebe	<i>Poliocephalus poliocephalus</i>	ICO	WE	C		Floating on water
Australasian grebe	<i>Tachybaptus novaehollandiae</i>	T	W	UB		Floating on water
Rockhopper penguin	<i>Eudyptes chrysocome</i>	WO	O	NV	Breeds in Antarctic	
Little penguin	<i>Eudyptula minor</i>	ICOW	O	CB	Islands	Burrows in dunes
Wandering albatross	<i>Diomedea exulans</i>	O	O	NR		
Black-browed albatross	<i>Diomedea melanophrys</i>	O	O	NR		
Grey-headed albatross	<i>Diomedea chrysostoma</i>	O	O	NR		
Yellow-nosed albatross	<i>Diomedea chlororhynchos</i>	O	O	NR		
Shy albatross	<i>Diomedea cauta</i>	O	O	NF	Common off Wilsons Promontory	
Southern giant-petrel	<i>Macronectes giganteus</i>	O	O	NR		
Northern giant-petrel	<i>Macronectes halli</i>	O	O	NU		
Southern fulmar	<i>Fulmarus glacialis</i>	O	O	NU		
Cape petrel	<i>Daption capense</i>	O	O	NR		
Great-winged petrel	<i>Pterodroma macroptera</i>	O	O	NU		
White-headed petrel	<i>Pterodroma lessonii</i>	O	O	NC	Dead birds frequently found on Wilsons Promontory beaches	
Soft-plumaged petrel	<i>Pterodroma mollis</i>	O	O	NR		
Blue petrel	<i>Halobaena caerulea</i>	O	O	NR		
Broad-billed prion	<i>Pachyptila vittata</i>	O	O	NR		
Lesser broad-billed prion	<i>Pachyptila salvini</i>	O	O	NF		
Antarctic prion	<i>Pachyptila desolata</i>	O	O	NR		
Slender-billed prion	<i>Pachyptila belcheri</i>	O	O	NR		
Fairy prion	<i>Pachyptila turtur</i>	O	O	NR		
Flesh-footed shearwater	<i>Puffinus carneipes</i>	O	O	NR		
Sooty shearwater	<i>Puffinus griseus</i>	O	O	NR		
Short-tailed shearwater	<i>Puffinus tenuirostris</i>	CIW	O	NCB	Breeds offshore islands	Burrows in dunes
Fluttering shearwater	<i>Puffinus gavia</i>	O	O	NU		
Hutton's shearwater	<i>Puffinus huttoni</i>	O	O	NR		
Little shearwater	<i>Puffinus assimilis</i>	O	O	R		
Wilson's storm-petrel	<i>Oceanites oceanicus</i>	O	O	NR		
White-faced storm petrel	<i>Pelagodroma marina</i>	O	O	NU	Breeds Mud Island, Port Phillip	
Common diving-petrel	<i>Pelecanoides urinatrix</i>	IO	O	NUB	Breeds offshore islands	Burrows
Australian pelican	<i>Pelecanus conspicillatus</i>	ICL	WE	N	Rare Wilsons Promontory	Ground
Australasian gannet	<i>Morus serrator</i>	WO	O	NC		Ground
Darter	<i>Anhinga melanogaster</i>	CLW	WE	R		Trees in swamps

Common name	Scientific name	Distribution	Habitat	Status	Remarks	Nest location
Black-faced shag	<i>Leucocarbo fuscescens</i>	ICW	E	C	Breeds Tasmanian islands	Rock-ledges
Great cormorant	<i>Phalacrocorax carbo</i>	T	WE	U)	Common Corner Inlet, Shallow Inlet, Anderson Inlet	Rock-ledges, tree branches
Pied cormorant	<i>Phalacrocorax varius</i>	O	E	U)		Trees, ground
Little black cormorant	<i>Phalacrocorax sulcirostris</i>	CLO	WE	U)		Trees
Little pied cormorant	<i>Phalacrocorax melanoleucos</i>	T	WE	U		Tree branches
Pacific heron	<i>Ardea pacifica</i>	T	AWE	U	Swamps and watercourses	Tree branches
White-faced heron	<i>Ardea novaeollandiae</i>	T	AWE	CB		Tree branches
Cattle egret *	<i>Ardeola ibis</i>	ICLW	AW	C		Trees, bushes, reeds
Great egret	<i>Egretta alba</i>	ICLW	WE	U		Trees
Little egret	<i>Egretta garzetta</i>	IC	WE	R		Trees
Eastern reef egret	<i>Egretta sacra</i>	W	W	NR		Ground, cliff ledges
Rufous night heron	<i>Nycticorax caledonicus</i>	C	W	RR		Tree branches
Australasian bittern	<i>Botaurus poiciloptilus</i>	CLW	WE	R		Reeds
Sacred ibis	<i>Threskiornis aethiopica</i>	T	AWE	CB		Reeds
Straw-necked ibis	<i>Threskiornis spinicollis</i>	T	AW	C		Reeds
Royal spoonbill	<i>Platalea regia</i>	ICL	E	U	Breeds on granitic offshore islands	Tree branches
Yellow-billed spoonbill	<i>Platalea flavipes</i>	ICLW	WE	NU		Tree branches
Black swan	<i>Cygnus atratus</i>	T	AWE	CB		Ground
Cape Barren goose	<i>Cereopsis novaehollandiae</i>	IC	AE	RB		Ground
Australian shelduck	<i>Tadorna tadornoides</i>	T	AWE	CB	Recorded from Jack Smith Lake	Hole in tree, bank
Pacific black duck	<i>Anas superciliosa</i>	T	WE	CB		Ground
Mallard *	<i>Anas platyrhynchos</i>	C	W	R		Ground
Grey teal	<i>Anas gibberifrons</i>	T	WE	C		Ground, hole in tree
Chestnut teal	<i>Anas castanea</i>	CW	WE	F	Recorded from Jack Smith Lake	Ground, hole in tree
Australasian shoveller	<i>Anas rhynchos</i>	T	WE	R		Ground
Pink-eared duck	<i>Malacorhynchus membranaceus</i>	CW	WE	NR		Reeds
Hardhead	<i>Aythya australis</i>	T	W	RB		Ground, hole in tree
Maned duck	<i>Chenonetta jubata</i>	T	AW	CB		Hole in tree
Blue-billed duck	<i>Oxyura australis</i>	WC	W	U		Ground
Musk duck	<i>Biziura lobata</i>	T	WE	U		Ground
Osprey	<i>Pandion haliaetus</i>	W	O	NR		Rock ledges, trees
Black-shouldered kite	<i>Elanus notatus</i>	T	A	MU		Tree branches
Letter-winged kite	<i>Elanus scriptus</i>	W	A	MV		Tree branches
Whistling kite	<i>Haliastur sphenurus</i>	T	FHAW	UB		Tree branches
Brown goshawk	<i>Accipiter fasciatus</i>	T	F	U		Tree branches
Collared sparrowhawk	<i>Accipiter cirrhocephalus</i>	CS	CF	R		Tree branches
Grey goshawk	<i>Accipiter novaehollandiae</i>	WS	F	U		Tree branches
White-bellied sea-eagle	<i>Haliaeetus leucogaster</i>	CW	E	UB		Tree branches
Wedge-tailed eagle	<i>Aquila audax</i>	T	FCHA	FB		Tree branches, rock ledges
Little eagle	<i>Hieraaetus morphnoides</i>	T	FA	U		Tree branches
Marsh harrier	<i>Circus aeruginosus</i>	T	AW	CB		Ground

Common name	Scientific name	Distribution	Habitat	Status	Remarks	Nest location
Black falcon	<i>Falco subniger</i>	C	C	R		Tree branches
Peregrine falcon	<i>Falco peregrinus</i>	T	FCHA	UB		Rock ledges, hollow trees
Australian hobby	<i>Falco longipennis</i>	T	FCHAT	U		Trees
Brown falcon	<i>Falco berigora</i>	T	CA	U		Trees
Australian kestrel	<i>Falco cenchroides</i>	T	CA	CB		Hollow trees, rock crevices
Stubble quail	<i>Coturnix novaezelandiae</i>	T	A	MU		Ground
Brown quail	<i>Coturnix australis</i>	CS	HA	U		Ground
King quail	<i>Coturnix chinensis</i>	W	H	R		Ground
California quail *	<i>Lophortyx californicus</i>	C	A	R	Acclimatized King Island	Ground
Painted button-quail	<i>Turnix varia</i>	T	F	R		Ground
Buff-banded rail	<i>Rallus philippensis</i>	T	AW	RB		Tussocks
Lewin's rail	<i>Rallus pectoralis</i>	W	W	R		Reeds
Baillon's crane	<i>Porzana pusilla</i>	W	W	R		Reeds, low shrubs in water
Australian crane	<i>Porzana fluminea</i>	W	W	R		Tussocks
Spotless crane	<i>Porzana tabuensis</i>	W	W	R		Tussocks
Dusky moorhen	<i>Gallinula tenebrosa</i>	T	W	NR		Tussocks, reeds
Purple swamphen	<i>Porphyrio porphyrio</i>	T	W	UB		Tussocks, reeds
Eurasian coot	<i>Fulica atra</i>	T	W	R		Reeds
Brolga	<i>Grus rubicundus</i>	W	W	R	Recorded from Wilsons Promontory	
Pied oystercatcher	<i>Haematopus longirostris</i>	C	B	CB	Beaches	Beaches
Sooty oystercatcher	<i>Haematopus fuliginosus</i>	C	B	UB	Frequents rocky beaches	Rocky beaches
Masked lapwing	<i>Vanellus miles</i>	T	CAWT	CB		Ground
Banded lapwing	<i>Vanellus tricolor</i>	C	A	R	Woodside - Alberton area	Ground
Grey plover	<i>Pluvialis squatarola</i>	IC	EB	MR	Breeds Arctic	
Lesser golden plover	<i>Pluvialis dominica</i>	IC	EB	MR	Breeds Arctic	
Hooded plover	<i>Charadrius rubricollis</i>	ICW	EB	UB	Breeds Australia	Ground
Mongolian plover	<i>Charadrius mongolus</i>	C	EB	MR	Breeds Himalayas, Siberia	
Double-banded plover	<i>Charadrius bicinctus</i>	C	EB	MU	Breeds New Zealand	
Large sand plover	<i>Charadrius leschenaultii</i>	C	EB	MR	Breeds Russia	
Red-capped plover	<i>Charadrius ruficapillus</i>	C	EB	UB	Breeds Australia	Ground
Black-fronted plover	<i>Charadrius melanops</i>	CWM	WEB	MU	Breeds Australia	Ground
Black-winged stilt	<i>Himantopus himantopus</i>	C	WE	R		Ground
Banded stilt	<i>Cladorhynchus leucocephalus</i>	C	WE	NR	Frequents salt lakes near coast	Ground
Red-necked avocet	<i>Recurvirostra novaezelandiae</i>	C	W	R		Ground
Ruddy turnstone	<i>Arenaria interpres</i>	C	EB	MR	Breeds Arctic	
Eastern curlew	<i>Numenius madagascariensis</i>	IC	EB	MC	Breeds Siberia	
Whimbrel	<i>Numenius phaeopus</i>	IC	E	MR	Breeds Asia	
Little curlew	<i>Numenius minutus</i>	W	WE	MR	Breeds Siberia	
Grey-tailed tattler	<i>Tringa brevipes</i>	C	E	MR	Breeds Siberia	
Common sandpiper	<i>Tringa hypoleucos</i>	C	E	MR	Breeds Asia	

Common name	Scientific name	Distribution	Habitat	Status	Remarks	Nest location
Greenshank	<i>Tringa nebularia</i>	IC	E	MU	Breeds Asia	
Terek sandpiper	<i>Tringa terek</i>	IC	E	MR	Breeds Siberia	
Latham's snipe	<i>Gallinago hardwickii</i>	T	AW	MU	Breeds Japan	
Bar-tailed godwit	<i>Limosa lapponica</i>	IC	E	MC	Breeds Arctic	
Red knot	<i>Calidris canutus</i>	C	E	MR	Breeds Arctic	
Great knot	<i>Calidris tenuirostris</i>	IC	E	MR	Breeds Siberia	
Sharp-tailed sandpiper	<i>Calidris acuminata</i>	IC	WEB	MU	Breeds Siberia	
Red-necked stint	<i>Calidris ruficollis</i>	IC	WEB	MC	Breeds Siberia	
Curlew sandpiper	<i>Calidris ferruginea</i>	IC	E	MC	Breeds Siberia	
Sanderling	<i>Calidris alba</i>	IC	B	MU	Breeds Arctic	
Great skua	<i>Stercorarius skua</i>	O	O	MF	Breeds New Zealand	
Arctic jaeger	<i>Stercorarius parasiticus</i>	O	O	MF	Breeds Arctic	
Silver gull	<i>Larus novae-hollandiae</i>	ICWO	CWOEB	CB		Ground
Pacific gull	<i>Larus pacificus</i>	ICWO	COEB	CB		Ground
Kelp gull	<i>Larus dominicanus</i>	W	OEB	RB	New Zealand species	Ground
Whiskered tern	<i>Chlidonias hybrida</i>	C	W	R	Breeds Australia	Floating on water
White-winged tern	<i>Chlidonias leucoptera</i>	C	W	MR	Breeds Europe, Asia	
Gull-billed tern	<i>Gelochelidon nilotica</i>	IC	WE	R	Breeds Australia	Ground
Caspian tern	<i>Hydroprogne caspia</i>	IC	WEB	U	Breeds Australia	Sand
Common tern	<i>Sterna hirundo</i>	IC	EB	MR	Breeds Arctic	
Arctic tern	<i>Sterna paradisaea</i>	W	O	MR	Breeds Arctic	
White-fronted tern	<i>Sterna striata</i>	WC	CO	MR	Breeds New Zealand	
Little tern	<i>Sterna albifrons</i>	C	EB	RB	Breeds Australia	Sandbars
Fairy tern	<i>Sterna nereis</i>	WC	EB	RB	Breeds Australia	Sandbars
Crested tern	<i>Sterna bergii</i>	WC	O	CB		Ground
Feral pigeon *	<i>Columba livia</i>	CL	AT	UB		Hole in tree, buildings, cliffs
Spotted turtle-dove *	<i>Streptopelia chinensis</i>	CL	TC	UB		Trees, scrub
Common bronzedwing	<i>Phaps chalcoptera</i>	T	F	UB		Shrubs, low trees
Brush bronzedwing	<i>Phaps elegans</i>	T	FC	UB		Shrubs, low trees, ground
Wonga pigeon	<i>Leucosaroria melanoleuca</i>	L	F	RB	Hintoul Creek	Tree branches
Yellow-tailed black-cockatoo	<i>Calyptorhynchus fuscus</i>	T	F	F		Hole in tree
Gang-gang cockatoo	<i>Callocephalon fimbriatum</i>	T	F	F		Hole in tree
Galah	<i>Cacatua roseicapilla</i>	T	AT	R	Range increasing	Hole in tree
Pink cockatoo	<i>Cacatua leadbeateri</i>	W	A	V	Probably aviary escapee	
Sulphur-crested cockatoo	<i>Cacatua galerita</i>	LC	FA	U		Hole in tree
Rainbow lorikeet	<i>Trichoglossus haematodus</i>	CW	FC	NC		Hole in tree
Musk lorikeet	<i>Glossopsitta concinna</i>	C	FC	NR		Hole in tree
Purple-crowned lorikeet	<i>Glossopsitta porphyrocephala</i>	W	FC	NR		Hole in tree
Little lorikeet	<i>Glossopsitta pusilla</i>	LC	FC	NR		Hole in tree
Scaly-breasted lorikeet	<i>Trichoglossus chlorolepidotus</i>	C	C	NV	Recorded Inverloch	
Australian king-parrot	<i>Alisterus scapularis</i>	LS	F	NR		Tree hollows
Cockatiel	<i>Nymphicus hollandicus</i>	W	C	V	Vagrant	Hole in tree or stump

Common name	Scientific name	Distribution	Habitat	Status	Remarks	Nest location
Ground parrot	<i>Pezoporus wallicci</i>	WC	H	R		Ground
Swift parrot	<i>Lathamus discolor</i>	C	F	MU	Normally breeds Tasmania but some stay in study area over summer	
Crimson rosella	<i>Platycercus elegans</i>	T	F	CB		Hole in tree
Eastern rosella	<i>Platycercus eximius</i>	T	FA	CB		Hole in tree
Port Lincoln parrot	<i>Barnardius zonarius</i>	C	C	V	Population originated from aviary escapees	
Red-rumped parrot	<i>Psephotus haematonotus</i>	W	AH	NR		Hole in tree
Blue-winged parrot	<i>Neophema chrysostoma</i>	T	FCHA	CB		Hole in tree, stump
Pallid cuckoo	<i>Cuculus pallidus</i>	T	FA	MC		Parasitic
Brush cuckoo	<i>Cuculus variolosus</i>	L	F	MR	Haunted Hills, Rintoul Creek	Parasitic
Fan-tailed cuckoo	<i>Cuculus pyrrhophanus</i>	T	FC	MCB		Parasitic
Horsfield's bronze-cuckoo	<i>Chrysococcyx basalis</i>	T	FCH	MU		Parasitic
Shining bronze-cuckoo	<i>Chrysococcyx lucidus</i>	T	F	MU		Parasitic
Powerful owl	<i>Ninox strenua</i>	S	F	RB	Unverified report Wilsons Promontory	Tree branches, hollows
Southern boobook	<i>Ninox novaeseelandiae</i>	T	F	CB	Recorded Seal Is.	Hole in tree
Barking owl	<i>Ninox connexa</i>	L	A	R	Occasionally nests in rabbit burrows	Hole in tree
Barn owl	<i>Tyto alba</i>	T	A	C	Recorded Notch Island	Hole in tree
Eastern grass owl	<i>Tyto longimembra</i>	W	C	NR		Tussocks
Sooty owl	<i>Tyto tenebricosa</i>	S	F	R	Reported Tarra Valley and Wilsons Promontory	Hole in tree
Tawny frogmouth	<i>Podargus strygoides</i>	T	F	U		Tree branches
Australian owl-nightjar	<i>Aegotheles cristatus</i>	CLS	F	R		Hole in tree
White-throated nightjar	<i>Caprimulgus mystacalis</i>	S	F	R		Ground
White-throated needletail	<i>Hirundapus caudacutus</i>	T	Ae	MC	Breeds Himalayas, Siberia	
Fork-tailed swift	<i>Apus pacificus</i>	T	Ae	MR	Breeds Himalayas, Siberia	
Azure kingfisher	<i>Ceyx azurea</i>	CL	W	R		Hole in bank
Laughing kookaburra	<i>Dacelo novaeguineae</i>	T	FCA	CB		Hole in tree
Sacred kingfisher	<i>Halcyon sancta</i>	T	F	UB		Hole in tree or bank
Rainbow bee-eater	<i>Merops ornatus</i>	L	A	MRB	Breeds Tyers - Glengarry area	Hole in sandy bank

PASSERINES

Common name	Scientific name	Distribution	Habitat	Status	Remarks	Nest location
Superb lyrebird	<i>Menura novaehollandiae</i>	CLS	F	F	Introduced into Wilson's Promontory but did not survive	Ground, scrub, trees
Singing bushlark	<i>Mirafra javanica</i>	W	A	NR		Ground
Skylark *	<i>Alauda arvensis</i>	LC	A	C		Ground
Welcome swallow	<i>Hirundo neoxena</i>	T	FHA	CB		Cliffs, buildings
Tree martin	<i>Cecropis nigricans</i>	T	FHA	U		Hollow in tree or cliff
Fairy martin	<i>Cecropis ariel</i>	CWM	HAW	NC		Hollows in trees or caves, buildings, river banks
Richard's pipit	<i>Anthus novaehollandiae</i>	T	A	UB		Ground
Black-faced cuckoo-shrike	<i>Coracina novaehollandiae</i>	T	FHST	C	In all treed habitats except tall open-forest	Tree branches
White-bellied cuckoo-shrike	<i>Coracina papuensis</i>	LWM	F	NR		Tree branches
Cicadabird	<i>Coracina tenuirostris</i>	L	F	R	Boola forest	Tree branches
White-winged triller	<i>Lalage swerii</i>	CLW	FC	NR		Tree branches
White's thrush	<i>Zoothera dauma</i>	T	FC	CB		Fork of tree
Blackbird *	<i>Turdus merula</i>	T	FCHAT	CB		Shrubs
Song thrush *	<i>Turdus philomelos</i>	L	AT	RB		Shrubs
Rose robin	<i>Petroica rosea</i>	LSW	FA	MRB	Tall open forest; farmland in winter	Scrub, tree branches
Pink robin	<i>Petroica rodinogaster</i>	T	FA	MRB	Tall open forest; farmland in winter	Tree branches
Flame robin	<i>Petroica phoenicea</i>	T	FA	MCB	Tall open forest; farmland in winter	Tree branches
Scarlet robin	<i>Petroica multicolor</i>	T	F	MCB	Tall open forest; farmland in winter	Tree branches, charred stumps
Eastern yellow robin	<i>Eopsaltria australis</i>	T	FC	CB		Tree branches
Jacky winter	<i>Microeca leucophaea</i>	T	F	U		Tree branches
Crested shrike-tit	<i>Palcouneulus frontatus</i>	T	F	F		Tree branches
Olive whistler	<i>Pachycephala olivacea</i>	T	FCH	CB		Tree branches
Golden whistler	<i>Pachycephala pectoralis</i>	T	F	CB		Shrubs, small trees
Rufous whistler	<i>Pachycephala rufiventris</i>	T	F	CB		Shrubs, trees
Grey shrike-thrush	<i>Colluricincla harmonica</i>	T	FC	CB		Shrubs, trees, ground
Black-faced monarch	<i>Monarcha melanopsis</i>	SW	FC	MR		Tree branches
Leaden flycatcher	<i>Myiagra rubecula</i>	LW	F	NR		Tree branches
Satin flycatcher	<i>Myiagra cyanoleuca</i>	T	F	MUB		Tree branches
Restless flycatcher	<i>Myiagra inquieta</i>	CLS	A	NR		Tree branches
Rufous fantail	<i>Rhipidura ripifrons</i>	LS	F	CB	Tall open forest	Tree branches
Grey fantail	<i>Rhipidura fuliginosa</i>	T	FCHAS	CB		Tree branches
Willie wagtail	<i>Rhipidura leucophrys</i>	T	A	CB		Tree branches
Eastern whipbird	<i>Psophodes olivaceus</i>	T	F	CB		Low bush
Spotted quail-thrush	<i>Cincoloma punctatum</i>	T	F	UB		Ground, tussocks

Common name	Scientific name	Distribution	Habitat	Status	Remarks	Nest location
Clamorous reed warbler	<i>Acrocephalus stentoreus</i>	T	W	UB		Reeds
Little grassbird	<i>Megalururus gramineus</i>	CLM	WE	UB	Also on Bass Strait islands	Low scrub
Golden-headed cisticola	<i>Cisticola exilis</i>	CL	WE	CB		Thick shrubs
Rufous songlark	<i>Cinclocephalus mathewsi</i>	WM	F	R		Ground
Brown songlark	<i>Cinclocephalus emeralis</i>	LWM	F	MR		Ground
Superb fairy-wren	<i>Malurus cyaneus</i>	T	FCHS	CB		Low shrubs
Southern emu-wren	<i>Stipiturus malachurus</i>	C	H	CB		Low shrubs, tussocks
Pilotbird	<i>Pycnoptilus floccosus</i>	LS	F	UB		Ground
Large-billed scrubwren	<i>Sericornis magnirostris</i>	LSW	F	R	Mature tall open forest	Trees, tree-ferns, vines
White-browed scrubwren	<i>Sericornis frontalis</i>	T	FCHWS	CB	Dense shrubs	Ground
Chestnut-rumped hylacola	<i>Sericornis pyrrhopygius</i>	WM	F	RB	Woodlands with heathy understorey	Low shrubs
Calamanthus	<i>Sericornis fuliginosus</i>	T	HE	CB	Uncommon in heath	Low dense shrubs
Weebill	<i>Smicropus brevirostris</i>	W	F	R		Low scrub
White-throated gerygone	<i>Gerygone olivacea</i>	L	F	MR		Tree branches
Brown thornbill	<i>Acanthiza pusilla</i>	T	FCHW	CB	Dense shrubs	Low bushes
Buff-rumped thornbill	<i>Acanthiza reguloides</i>	T	F	U		Scrub, low trees
Yellow-rumped thornbill	<i>Acanthiza chrysorrhoa</i>	T	A	CB		Scrub, low trees
Yellow thornbill	<i>Acanthiza nana</i>	T	FC	RB		Tree branches
Striated thornbill	<i>Acanthiza lineata</i>	T	F	CB		Tree branches
Varied sittella	<i>Daphoenositta chrysoptera</i>	T	F	CB		Tree branches
White-throated treecreeper	<i>Climacteris leucophaea</i>	T	F	C		Hole in tree
Red-browed treecreeper	<i>Climacteris erythropis</i>	T	F	R	Tall open forest	Tree hollow
Brown treecreeper	<i>Climacteris plumbeus</i>	W	F	R		Tree hollow
Red wattletail	<i>Anthochaera carunculata</i>	T	FC	C	Woodland with <i>Banksia</i> spp.	Tree branches
Little wattletail	<i>Anthochaera chrysoptera</i>	C	C	C		Tree branches
Noisy friarbird	<i>Philemon corniculatus</i>	M	F	R		Tree branches
Regent honeyeater	<i>Xanthomyza phrygia</i>	L	F	NR		Tree branches
Bell miner	<i>Manorina melanophrys</i>	LM	F	FB		Tree branches
Noisy miner	<i>Manorina melanoccephala</i>	T	F	UB		Tree branches
Levin's honeyeater	<i>Meliphaga lewinii</i>	LS	F	RB		Tree branches
Yellow-faced honeyeater	<i>Lichenostomus chrysops</i>	T	F	CB		Shrubs, trees
Singing honeyeater	<i>Lichenostomus virescens</i>	C	C	R		Shrubs
White-eared honeyeater	<i>Lichenostomus leucotis</i>	T	FC	CB		Low shrubs
Yellow-tufted honeyeater	<i>Lichenostomus melanops</i>	LM	F	U	Related helmeted honeyeater reputedly once common in Strzeleckis	Tree branches, low scrub
White-plumed honeyeater	<i>Lichenostomus penicillatus</i>	T	FT	C		Tree branches
Brown-headed honeyeater	<i>Melithreptus brevirostris</i>	T	F	MCB		Tree branches
White-naped honeyeater	<i>Melithreptus lunatus</i>	T	F	C		Tree branches
Crescent honeyeater	<i>Phylidonyris pyrrhoptera</i>	T	FCHS	CB	Dense shrubby stratum to 2m	Shrubs
New Holland honeyeater	<i>Phylidonyris novaehollandiae</i>	T	FC	CB		Low trees, thick shrubs
Tawny-crowned honeyeater	<i>Phylidonyris melanops</i>	CW	H	CB		Low shrubs
Eastern spinebill	<i>Acanthorhynchus tenuirostris</i>	T	F	CB		Tree branches, thick scrub
Scarlet honeyeater	<i>Mysomela sanguinolenta</i>	LW	F	NR		Tree branches

Common name	Scientific name	Distribution	Habitat	Status	Remarks	Nest location
White-fronted chat	<i>Ephthianura albifrons</i>	T	CAWE	CB		Low shrubs, tall grass
Mistletoebird	<i>Dicaeum hirundinaceum</i>	T	F	UB		Tree branches
Spotted pardalote	<i>Pardalotus punctatus</i>	T	F	CB		Hole in tree or bank
Striated pardalote	<i>Pardalotus striatus</i>	T	F	CB		Hole in tree or bank
Silvereye	<i>Zosterops lateralis</i>	T	FCH	C	Thickets of shrubs	Shrubs, small trees
European goldfinch *	<i>Carduelis carduelis</i>	T	AT	CB		Shrubs, low trees
European greenfinch *	<i>Carduelis chloris</i>	LC	CT	R		Shrubs, low trees
House sparrow *	<i>Passer domesticus</i>	T	AT	CB		Buildings, shrubs
Tree sparrow *	<i>Passer montanus</i>	C	C	R		Hollows in trees
Red-browed firetail	<i>Emblema temporalis</i>	T	F	CB		Shrubs, small trees
Beautiful firetail	<i>Emblema bella</i>	T	PH	R		Shrubs, small trees
Common starling *	<i>Sturnus vulgaris</i>	T	AT	CB		Buildings, holes in trees
Common myna *	<i>Acridotheres tristis</i>	T	AT	CB		Holes in trees
Olive-backed oriole	<i>Oriolus sagittatus</i>	LM	F	MCB		Tree branches
Satin bowerbird	<i>Ptilonorhynchus violaceus</i>	L	F	MR	Boola forest	Tree branches
White-winged chough	<i>Corcorax melanorhamphos</i>	LM	F	U		Tree branches
Australian magpie-lark	<i>Grallina cyanoleuca</i>	T	FAT	CB		Tree branches
White-browed woodswallow	<i>Artamus superciliosus</i>	CSWM	FA	NR		Tree branches, shrubs
Dusky woodswallow	<i>Artamus cyanopterus</i>	T	F	CB		Tree branches
Grey butcherbird	<i>Cracticus torquatus</i>	T	FA	UB		Tree branches
Australian magpie	<i>Gymnorhina tibicen</i>	T	AT	CB		Tree branches
Pied currawong	<i>Strepera graculina</i>	WLS	FCHAS	MR		Tree branches
Grey currawong	<i>Strepera versicolor</i>	T	F	RB		Tree branches
Australian raven	<i>Corvus coronoides</i>	T	FA	CB		Tree branches
Forest raven	<i>Corvus tasmanicus</i>	W	F	CB		Tree branches
Little raven	<i>Corvus mellori</i>	T	F	C		Tree branches

Appendix 5B

MAMMALS

The abbreviations used in this list are the same as those in the list of birds, except for the following:

Status

R	Rare	Re	Restricted
U	Uncommon	W	Widespread
C	Common	S	Survival doubtful

Common names and their sequence have been taken from the publication:

Norris, K.C., Gilmore, A.M., and Menkhorst, P.W. Vertebrate fauna of South Gippsland. *Memoirs of the National Museum of Victoria*, 1979, 40, 105--99.

Common name	Scientific name	Distribution	Habitat	Status	Remarks
Echidna	<i>Tachyglossus aculeatus</i>	T	FCHS	CW	Reported Snake Island
Platypus	<i>Ornithorhynchus anatinus</i>	T	W	URe	Not on islands
Tiger cat	<i>Dasyurus maculatus</i>	WL	F	ReS	Few recent reports
Quoll	<i>Dasyurus viverrinus</i>	W	C	ReS	Sight records in 1960, no specimens collected
Tuan	<i>Phascogale tapoatafa</i>	T	PC	RW	Not on islands
Brown antechinus	<i>Antechinus stuartii</i>	T	FHS	CW	Not on islands
Swainson's antechinus	<i>Antechinus swainsonii</i>	SWM	FCHS	CW	
Swamp antechinus	<i>Antechinus minimus</i>	ICWM	CHW	URe	Common on Great Glennie Island
White-footed dunnart	<i>Sminthopsis leucopus</i>	CLW	FCH	URe	
Short-nosed bandicoot	<i>Isaodon obesulus</i>	CL	FCH	CW	Western part of study area
Long-nosed bandicoot	<i>Perameles nasuta</i>	T	FW	CW	Not on islands
Common wombat	<i>Vombatus ursinus</i>	T	FCH	CW	Not on islands
Koala	<i>Phascogale cinereus</i>	T	F	CW	
Brush-tailed possum	<i>Trichosurus vulpecula</i>	T	FAST	CW	Not on islands
Bobuck	<i>Trichosurus caninus</i>	SWM	F	CRe	Restricted to dense gully vegetation in foothills; forested ranges
Common ringtail	<i>Pseudocheirus peregrinus</i>	T	PCWST	CW	Not on islands
Sugar glider	<i>Petaurus brevirostris</i>	T	F	CW	Not on islands
Yellow-bellied glider	<i>Petaurus australis</i>	LS(?)	F	URe	Reported from Balook
Greater glider	<i>Scolinobates volans</i>	LSM	F	CW	
Feathertail glider	<i>Acrobates pygmaeus</i>	LSWM	F	CW	Northern half of study area; specimen collected Wilsons Promontory 1980
Eastern pygmy possum	<i>Cercartetus nanus</i>	ICLWM	PC	CW	
Potoroo	<i>Potorous tridactylus</i>	WS(?)	CH	URe	Reported from Balook, Tarra Valley
Red-bellied pademelon	<i>Thylogale billiardieri</i>	WC	C	RS	No recent sightings
Eastern grey kangaroo	<i>Macropus giganteus</i>	CLWM	FCAS	CW	
Red-necked wallaby	<i>Macropus rufogriseus</i>	LM	PH	CRe	
Black wallaby	<i>Wallabia bicolor</i>	T	FCHS	CW	
Grey-headed fruit bat	<i>Pteropus poliocephalus</i>	CL	CAT	RRe	Occasional vagrant
Red flying fox	<i>Pteropus scapulatus</i>	CL	CAT	RRe	Occasional vagrant
Little bat	<i>Eptesicus pumilus</i>	T	FA	CW	
Gould's wattled bat	<i>Chalinolobus gouldii</i>	T	FA	CW	
Bent-winged bat	<i>Miniopterus schreibersii</i>	CLW	FA	URe	Shelters in caves
Lesser long-eared bat	<i>Nyctophilus geoffroyi</i>	T	FCA	CW	

Common name	Scientific name	Distribution	Habitat	Status	Remarks
Hare *	<i>Lepus europaeus</i>	CL	CAS	UW	
Rabbit *	<i>Oryctolagus cuniculus</i>	T	FCHAS	CW	
Bush rat	<i>Rattus fuscipes</i>	T	FCHS	CW	
Black rat *	<i>Rattus rattus</i>	T	CHAST	CW	Abundant in coastal dune scrub
Swamp rat	<i>Rattus lutreolus</i>	T	FCHW	CW	
New Holland mouse	<i>Pseudomys novaehollandiae</i>	CWM	PH	RRe	Heath and woodland with heathy understorey
House mouse *	<i>Mus musculus</i>	T	FCHAST	CW	
Broad-toothed rat	<i>Mastacomys fuscus</i>	SW	PH	RRe	
Water rat	<i>Hydromys chrysogaster</i>	T	WO	URe	
Dingo	<i>Canis familiaris</i>	L	F	ReS	
Fox *	<i>Vulpes vulpes</i>	T	FCHAS	CW	
Cat (feral) *	<i>Felis catus</i>	T	FCHAS	CW	
Australian fur seal	<i>Arctocephalus pusillus</i>	IO	O	CW	
New Zealand fur seal	<i>Arctocephalus forsteri</i>	O	O	RRe	
Leopard seal	<i>Hydrurga leptonyx</i>	O	O	RRe	
Fallow deer *	<i>Dama dama</i>	I	FC	URe	Grassy clearings on Sunday Island
Hog deer *	<i>Axis porcinus</i>	ICW	FCH	CRe	
Sambar deer *	<i>Cervus unicolor</i>	IS	F	RRe	
Goat *	<i>Capra hircus</i>	IS	F	RRe	Sunday Island
Strap-toothed whale **	<i>Mesoplodon layardii</i>	O	O		
Sperm whale **	<i>Physeter catodon</i>	O	O		
Southern right whale **	<i>Balaena glacialis australis</i>	O	O		
Bottle-nosed dolphin **	<i>Tursiops truncatus</i>	O	O		
Risso's dolphin **	<i>Grampus griseus</i>	O	O		
Killer whale **	<i>Orcinus orca</i>	O	O		
Pilot whale **	<i>Globiocephala maculata</i>	O	O		

** These oceanic mammals have been sighted as specimens washed up on to beaches.

Appendix 5C

REPTILES

The abbreviations in this list are the same as those in the list of mammals except that in the Habitat column R represents rocky areas. The list has been compiled from the same source as the lists of birds and mammals.

Common name	Scientific name	Distribution	Habitat	Status	Remarks
Long-necked tortoise	<i>Chelodina longicollis</i>	L	W	CRe	
Jacky lizard	<i>Amphibolurus muricatus</i>	CM	H	URe	
Lace monitor	<i>Varanus varius</i>	LSM	F	CW	
McCoy's skink	<i>Anotis maccayi</i>	T	F	CW	
Mourning skink	<i>Egernia coventryi</i>	CW	HW	RRe	
Black rock skink	<i>Egernia saxatilis</i>	S	FR	URe	
White's skink	<i>Egernia whitii</i>	CLW	CH	CW	Isolated occurrence on Seal Island
Delicate skink	<i>Lampropholis delicata</i>	M	PH	CRe	
Garden skink	<i>Lampropholis guichenoti</i>	T	PH	CW	Not in tall open forest
Weasel skink	<i>Lampropholis mustelina</i>	CWM	F	UW	
Coventry's skink	<i>Leiolopisma coventryi</i>	S	F	URe	
Grass skink	<i>Leiolopisma entrecasteauxii</i>	CW	C	URe	
Metallic skink	<i>Leiolopisma metallica</i>	T	FC	CW	On most islands
Three-lined skink	<i>Leiolopisma trilineata</i>	CM	FCH	UW	
Bougainville's skink	<i>Lerista bougainvillii</i>	C	C	URe	Isolated occurrence on Seal Island
Spencer's skink	<i>Pseudemoia spenceri</i>	SW	F	URe	
Southern water skink	<i>Sphenomorphus tympanum</i>	T	FHAW	CW	
Blotched bluetongue	<i>Tiliqua nigrolutea</i>	T	FCHAW	CW	
Common bluetongue	<i>Tiliqua scincoides</i>	CM	FA	URe	Eastern part of study area
Copperhead snake	<i>Austrelaps superba</i>	T	FCHAW	CW	
Small-eyed snake	<i>Cryptophis nigrescens</i>	M	FR	RRe	
White-lipped snake	<i>Dryadalia coronoides</i>	T	FCHAW	UW	
Tiger snake	<i>Notechis scutatus</i>	T	FCHAW	CW	
Brown snake	<i>Pseudonaja textilis</i>	CM	FA	URe	
Red-bellied black snake	<i>Pseudechis porphyriacus</i>	CSM	FW	CRe	Eastern part of study area only

Appendix 5D

AMPHIBIANS

All amphibians found in Australia are members of the order Anura (the frogs). The source and abbreviations used are the same as those in the list of mammals.

Common name	Scientific name	Distribution	Habitat	Status	Remarks
Common eastern froglet	<i>Crinia signifera</i>	T	FW	CW	
Haswell's frog	<i>Geocrinia haswelli</i>	CM	HW	URe	Eastern Mullungdung Forest
-	<i>Geocrinia victoriana</i>	T	FW	CW	
Giant burrowing frog	<i>Heleioporus australiacus</i>	L	W	RRe	Small streams
Eastern banjo frog	<i>Limodynastes dumerillii</i>	T	FCHAW	CW	
Brown-striped frog	<i>Limodynastes peronii</i>	T	FCHAW	CW	Dams and swamps
Spotted grass frog	<i>Limodynastes tasmaniensis</i>	T	AW	CW	Farmland at higher altitudes
Toadlet	<i>Pseudophryne dendyi</i>	L	F	URe	
Southern toadlet	<i>Pseudophryne semimarmorata</i>	T	FAW	CW	Moist locations
Yellow-spotted toadlet	<i>Uperoleia marmorata</i>	M	W	URe	Swamps in heathy country
Brown tree frog	<i>Litoria ewingii</i>	T	FW	CW	
Lesueur's frog	<i>Litoria lesueurii</i>	S	FW	UW	In fast-flowing streams
-	<i>Litoria peronii</i>	L	W	RRe	
Leaf green tree frog	<i>Litoria phyllochroa</i>	L	W	RRe	
-	<i>Litoria raniformis</i>	T	W	CW	
-	<i>Litoria verreauxii</i>	T	FCHAW	CW	

Appendix 5E

FRESH-WATER AND ESTUARINE FISH SPECIES

Abbreviations are as follows:

Habitat	Distribution	Status			
F Fresh water	Most species occur throughout the study area; exceptions are commented upon individually	R	Rare	W	Widespread
E Estuarine		U	Uncommon	C	Common
M Marine (for part of life cycle)				Re	Restricted range in the study area

NATIVE FISHES

Common name	Scientific name	Habitat	Status	Remarks
Pouched lamprey	<i>Geotria australis</i>	FM	WC	Rarely seen marine species: breeding and larval stages in fresh water
Short-headed lamprey	<i>Mordacia mordax</i>	FM	WC	Rarely seen marine species: breeding and larval stages in fresh water
Freshwater herring	<i>Potamalosa richmondia</i>	FM	WC	Upper reaches of streams
Grayling	<i>Prototroctes maraena</i>	FE	RRe	Considered endangered
Australian smelt	<i>Retroptera semoni</i>	F	WC	May enter salt water
Short-finned eel	<i>Anguilla australis</i>	FM	WC	
Long-finned eel	<i>Anguilla reinhardtii</i>	FM	WC	
Yellow-eyed mullet	<i>Aldrichetta forsteri</i>	FEM	WC	Sporting fish; coastal
Freshwater hardyhead	<i>Craterocephalus fluviatilis</i>	F	WC	
Small-mouthed hardyhead	<i>Atherinosoma microstoma</i>	FEM	WC	Primarily a marine species
Blue-spot goby	<i>Pseudogobius olorum</i>	FEM	URe	Fowlett River only known location
Striped gudgeon	<i>Gobiomorphus australis</i>	F	UW	
Blackfish	<i>Gadopsis marmoratus</i>	F	UW	Slow-moving streams in hills
Tupong	<i>Pseudaphritis urvilli</i>	FEM	WC	
Pigmy perch	<i>Nannoperca australis</i>	F	WC	
Estuary perch	<i>Percaletes colonorum</i>	FEM	WC	Sporting fish; coastal
Australian bass	<i>Percaletes novemaculeatus</i>	F	URe	Merriman Creek, Tidal River (?)
Black bream	<i>Acanthopagrus butcheri</i>	E	WC	Sporting fish; coastal
Common galaxiid	<i>Galaxias maculatus</i>	F	WC	
Mountain galaxiid	<i>Galaxias truttaceus</i>	F	UW	
Cox's mountain galaxiid	<i>Galaxias brevipinnis</i>	F	UW	
Ornate mountain galaxiid	<i>Galaxias olidus</i>	F	WC	
Dwarf galaxiid	<i>Galaxiella pusillus</i>	F	RW	
Flat-headed galaxiid	<i>Galaxias rostratus</i>	F	UW	

Note: The freshwater crayfish *Euastacus spinosus* is a common invertebrate in fresh water throughout the study area

Appendix 5E (continued)

INTRODUCED FISHES

Common name	Scientific name	Habitat	Status	Remarks
English perch (redfin)	<i>Perca fluviatilis</i>	F	URc	Latrobe River
Mosquito fish	<i>Gambusia affinis</i>	F	WC	
Rainbow trout	<i>Salmo gairdneri</i>	F	WC	Sporting fish; less numerous than brown trout
Brown trout	<i>Salmo trutta</i>	F	WC	Sporting fish; liberated widely
Common (European) carp	<i>Cyprinus carpio</i>	F	WC	Latrobe River System, Tarwin River

Appendix 6

DECLARED NOXIOUS WEEDS

Notes	Common name	Scientific name
A	Amsinckia	<i>Amsinckia</i> spp.
A	Angled onion	<i>Allium triquetrum</i> L.
A	Apple of Sodom	<i>Solanum sodomaeum</i> L.
A	Bathurst burr	<i>Xanthium spinosum</i> L.
A	Bindweed	<i>Convolvulus arvensis</i> L.
CDF	Blackberry bramble	<i>Rubus fruticosus</i> L. agg.
A	Boneseed	<i>Chrysanthemoides monilifera</i> (L.) Norlindh
BDG	Boxthorn	<i>Lycium ferocissimum</i> Miers
BE	Californian thistle	<i>Cirsium arvense</i> (L.) Scop.
AG	Cape broom	<i>Genista monspessulana</i> (L.) L.A.S. Johnson
A	Cape tulip, one-leaf	<i>Homeria breyniana</i> (L.) G.J. Lewis
A	English broom	<i>Cytisus scoparius</i> (L.) Link (syn.: <i>Sarothamnus scoparius</i> (L.) W. Koch)
A	Fennel	<i>Foeniculum vulgare</i> Mill.
A	Flax-leaved broom	<i>Genista linifolia</i> L.
BDG	Furze	<i>Ulex europaeus</i> L.
A	Great mullein	<i>Verbascum thapsus</i> L.
BG	Hawthorn	<i>Crataegus monogyna</i> N.J. Jacq. - and its hybrids; <i>Crataegus laevigata</i> DC. (syn.: <i>C. oxyacanthoides</i> Thuill.) - and its hybrids

Appendix 6 (continued)

Notes	Common name	Scientific name
BDGH	Hedge acacia	<i>Acacia armata</i> R. Br.
A	Hemlock	<i>Conium maculatum</i> L.
A	Hoary cress	<i>Cardaria draba</i> L.
A	Horehound	<i>Marrubium vulgare</i> L.
BDE	Ox-eye daisy	<i>Chrysanthemum leucanthemum</i> L.
A	Paterson's curse	<i>Echium plantagineum</i> L.
CF	Ragwort	<i>Senecio jacobaea</i> L.
A	St. John's wort	<i>Hypericum perforatum</i> L.
BF	Slender thistle or shore thistle	<i>Carduus tenuiflorus</i> Curt. and <i>C. pycnocephalus</i> L.
A	Soursob	<i>Oxalis pes-caprae</i> L.
BF	Spear thistle	<i>Cirsium vulgare</i> (Savi) Ten.
A	Spiny broom	<i>Calicotome spinosa</i> Link.
A	Stinkwort	<i>Inula graveolens</i> (L.) Desf.
B	Sweet briar	<i>Rosa rubiginosa</i> L.
A	Thorn apple	<i>Datura ferox</i> L.
	" "	<i>Datura innoxia</i> Mill.
	" "	<i>Datura stramonium</i> L.
A	Tree of heaven	<i>Ailanthus altissima</i> (Mill.) Swingle
B	Tutsan	<i>Hypericum androsaemum</i> L.
BF	Variegated thistle	<i>Silybum marianum</i> (L.) J. Gaertn
A	Water hyacinth	<i>Eichhornia crassipes</i> (Mart.) Solms-Laub.

Appendix 6 (continued)

Notes	Common name	Scientific name
A	Wild teasel	<i>Dipsacus fullonum</i> L. ssp. <i>fullonum</i>
A	Wild watsonia	<i>Watsonia bulbillifera</i> Mathews and Bolus
A	Sparse	
B	Moderate	
C	Dense - particularly on areas not fully used for primary production	
D	Infestations increasing on non-farming areas	
E	Infestations increasing on pastured areas	
F	Would increase rapidly without rigid control measures	
G	Excluding existing hedges not exceeding 2 metres in height and 1 metre in width	
H	Native species	

Appendix 7

PLANT SPECIES IMPORTANT TO AGRICULTURE

(Listed in order of appearance in Agriculture chapter)

Common name	Botanical name	Common name	Botanical name
Pastures		Weeds	
Perennial rye grass	<i>Lolium perenne</i>	Flatweed	<i>Hypochaeris radicata</i>
White clover	<i>Trifolium repens</i>	Ribwort	<i>Plantago lanceolata</i>
Subterranean clover	<i>Trifolium subterraneum</i>	Common daisy	<i>Bellis perennis</i>
Cocksfoot	<i>Dactylis glomerata</i>	Bracken	<i>Pteridium esculentum</i>
Red clover	<i>Trifolium pratense</i>	Ragwort	<i>Senecio jacobaea</i>
Strawberry clover	<i>Trifolium fragiferum</i>	Rushes	<i>Juncus polyanthemus</i> and others
Lucerne	<i>Medicago sativa</i>	Blackberry	<i>Rubus fruticosus</i>
Yorkshire fog grass	<i>Holcus lanatus</i>	Thistles	<i>Cirsium vulgare</i>
Crested dog's tail	<i>Cynosurus cristatus</i>		<i>Cirsium arvense</i>
Rat's tail fescue	<i>Vulpia myuros</i>		<i>Carduus pycnocephalus</i>
Sweet vernal-grass	<i>Anthoxanthum odoratum</i>	Capeweed	<i>Arctotheca calendula</i>
Suckling clover	<i>Trifolium dubium</i>	Wild radish	<i>Raphanus raphanistrum</i>
Lotus	<i>Lotus</i> spp.	Dock	<i>Rumex crispus</i>
		Sheep sorrel	<i>Rumex brownii</i>
			<i>Rumex acetosella</i>

Appendix 8

AIRSTRIPS ON PUBLIC LAND

(Reference: Warragul 1:250,000 (SJ55-10))

Name	Grid reference	Operator	Elevation
Birrallee (Jack River)	453 251	F.C.V.	260
Mount Tassie	455 266	F.C.V.	600
Olsens (Mirboo East)	428 255	F.C.V.	427
Wilsons Promontory	427 198	N.P.S.	30

APPENDIX 9

Production of synthetic fuels

Coal-to-oil conversion plants having a total capacity of 300,000 barrels a day would be capable of supporting the existing Victorian refineries, and could satisfy Victorian demand to the year 2000.

Processes suggested for converting coal to oil fall into three main groups - namely, pyrolysis processes, gasification processes, and hydrogenation processes. Though hydrogenation processes are potentially the most efficient for producing oil from coal, none of the above would be considered commercially viable under prevailing conditions (1980). They could, however, be economic before the turn of the century.

Pyrolysis

Pyrolysis processes involve heating coal in the absence of air to yield tar, gas, and char products. The tar extracted may be upgraded to lighter fractions by combining it with additional hydrogen. Processes of this type have been used industrially for many years in East Germany. A recently proposed variation of this process that involves flash pyrolysis may be able to substantially improve the efficiency of conversion of coal to oil.

To produce 100,000 barrels a day (16 Ml a day), the raw coal requirements for a plant of the East German type would be around 150 million tonnes per annum, or some five times the current output from Latrobe Valley open cuts.

Sufficient char would be produced as a by-product in this process to fuel many times over the installed Victorian brown coal electricity generating plant; the disposal of this by-product would represent a major obstacle to the adoption of this process.

Gasification

In gasification processes, carbon monoxide and hydrogen are produced and then reacted at moderate temperatures and pressures over catalysts to produce hydrocarbons. The required mixture of carbon monoxide and hydrogen is produced by gasifying the coal with a mixture of oxygen and steam. (This is the Fischer-Tropsch process.)

Hydrogenation

Hydrogenation processes involve the use of hydrogenation reactions to remove oxygen, nitrogen, and sulphur from the coal and increase the hydrogen content.

Further direct hydrogenation of the coal is achieved by adding liquid hydrocarbons at high temperature and pressure to the coal (sometimes in the presence of a catalyst).

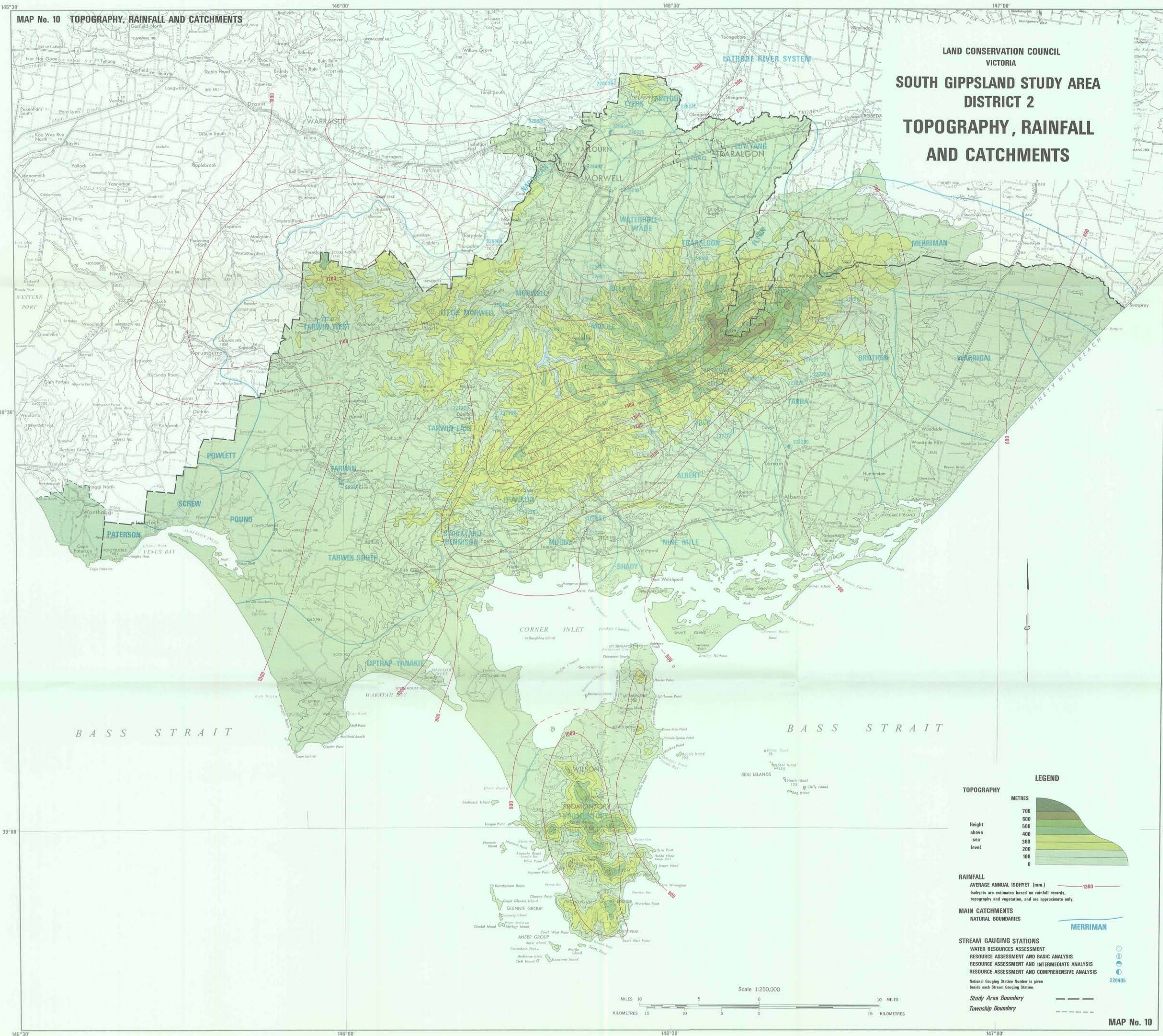
Solvent-refined coal processes basically involve non-catalytic hydrogenation of coal slurried with a liquid solvent (usually derived from coal). When the pulverised coal--solvent slurry is heated under pressure in a hydrogen-rich gaseous atmosphere, the coal--solvent slurry takes up some of the hydrogen and the coal effectively dissolves in the solvent, leaving a residue of insoluble mineral matter ('ash') and usually some undissolved coal substance.

The mixture is separated to give a liquid coal--solvent extract and a solid ash--undissolved coal residue. The coal--solvent extract is then treated to

remove the solvent, which is recycled through the process, leaving a product that, when cooled to ordinary temperature, yields liquid oil and solid solvent-refined coal.

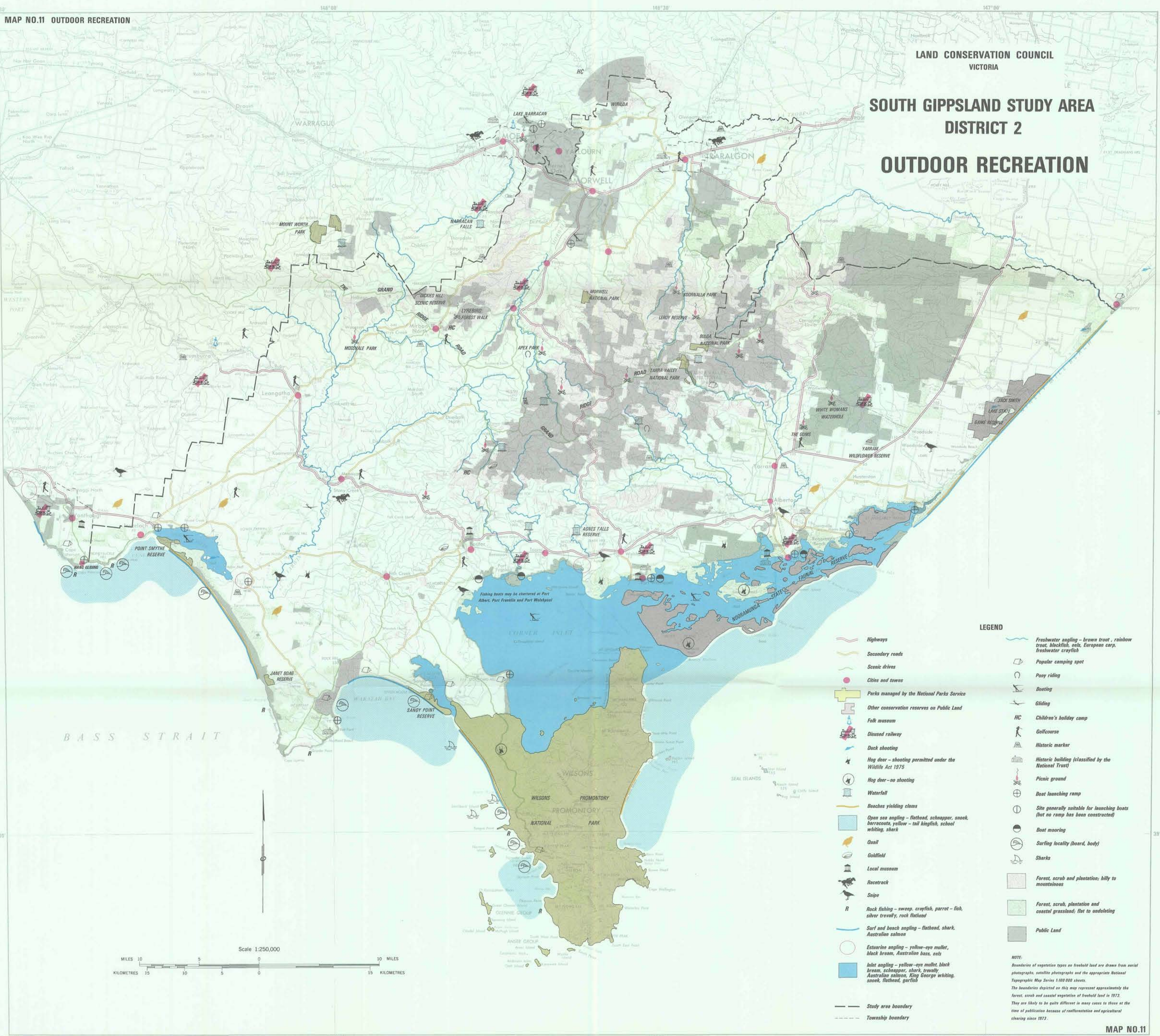
Direct-hydrogenation plant is estimated at this stage to require 30 million tonnes of coal per annum to produce around 100,000 barrels of oil per day. Full development of the necessary technology, however, is thought to be some 5--10 years away. Currently the Victorian government is associated with a joint Australian--West German study examining the feasibility of applying existing German technology using a combined gasification--hydrogenation process.

Another hydrogenation process with potential is the conversion of brown coal to methanol.



**SOUTH GIPPSLAND STUDY AREA
DISTRICT 2**

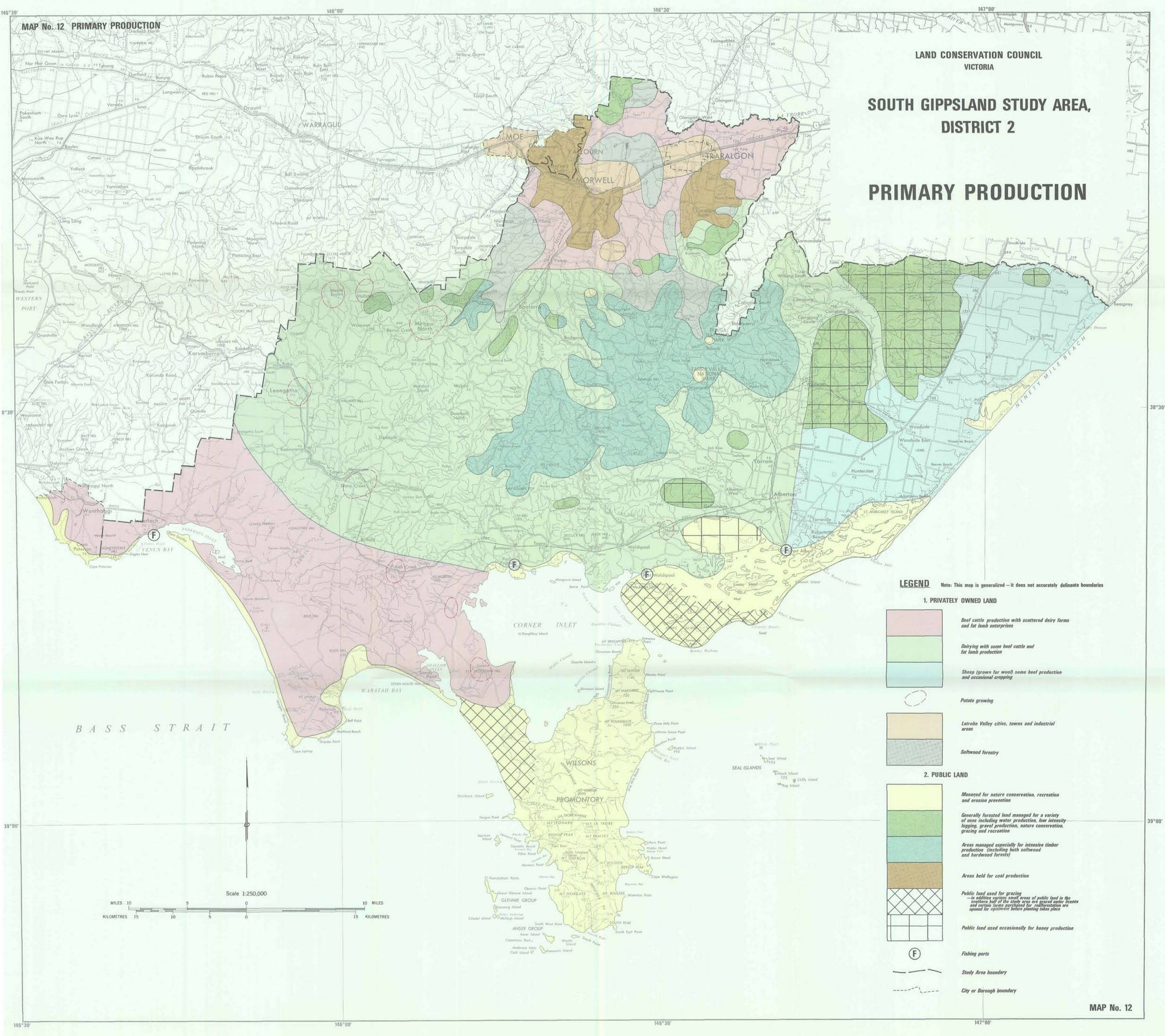
OUTDOOR RECREATION



LEGEND

- | | |
|--|--|
| Highways | Freshwater angling – brown trout, rainbow trout, blackfish, eels, European carp, freshwater crayfish |
| Secondary roads | Popular camping spot |
| Scenic drives | Pony riding |
| Cities and towns | Boating |
| Parks managed by the National Parks Service | Gliding |
| Other conservation reserves on Public Land | HC Children's holiday camp |
| Folk museum | Golfcourse |
| Disused railway | Historic marker |
| Duck shooting | Historic building (classified by the National Trust) |
| Hog deer – shooting permitted under the Wildlife Act 1975 | Picnic ground |
| Hog deer – no shooting | Boat launching ramp |
| Waterfall | Site generally suitable for launching boats (but no ramp has been constructed) |
| Beaches yielding clams | Boat mooring |
| Open sea angling – flathead, schnapper, snook, barracouta, yellow – tail kingfish, school whiting, shark | Surfing locality (board, body) |
| Quail | Sharks |
| Goldfinch | |
| Local museum | |
| Racetrack | |
| Snipe | |
| Rock fishing – sweep, crayfish, parrot – fish, silver trevally, rock flathead | |
| Surf and beach angling – flathead, shark, Australian salmon | |
| Estuarine angling – yellow-eye mullet, black bream, Australian bass, eels | |
| Inlet angling – yellow-eye mullet, black bream, schnapper, shark, trevally, Australian salmon, King George whiting, snook, flathead, garfish | |
| Study area boundary | |
| Township boundary | |

NOTE:
Boundaries of vegetation types on freehold land are drawn from aerial photographs, satellite photographs and the appropriate National Topographic Map Series 1:100 000 sheets.
The boundaries depicted on this map represent approximately the forest, scrub and coastal vegetation of freehold land in 1973. They are likely to be quite different in many cases to those at the time of publication because of reforestation and agricultural clearing since 1973.



MAP No. 12 PRIMARY PRODUCTION

LAND CONSERVATION COUNCIL
VICTORIA

SOUTH GIPPSLAND STUDY AREA, DISTRICT 2

PRIMARY PRODUCTION

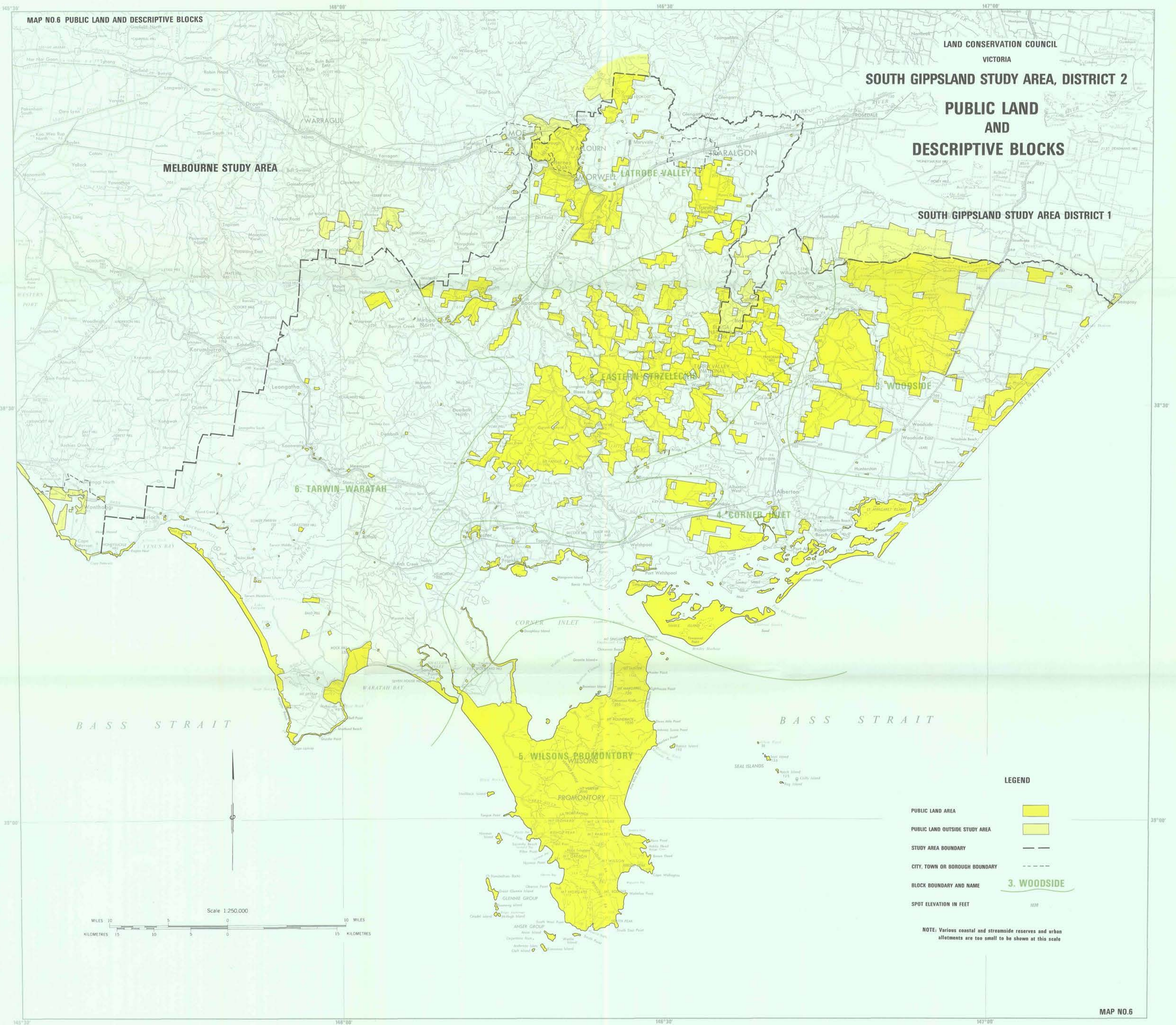
LEGEND Note: This map is generalized - it does not accurately delineate boundaries

1. PRIVATELY OWNED LAND

- Beef cattle production with scattered dairy farms and fat lamb enterprises
- Dairying with some beef cattle and fat lamb production
- Sheep (grown for wool) some beef production and occasional cropping
- Potato growing
- Lalor Valley cities, towns and industrial areas
- Softwood forestry

2. PUBLIC LAND

- Managed for nature conservation, recreation and erosion prevention
- Generally forested land managed for a variety of uses including water production, low intensity logging, gravel production, nature conservation, grazing and recreation
- Areas managed especially for intensive timber production (including both softwood and hardwood forests)
- Areas held for coal production
- Public land used for grazing - in addition various small areas of public land in the southern half of the study area are grazed under licence and certain areas purchased for reforestation are opened for agreement before planting takes place
- Public land used occasionally for honey production
- Fishing ports
- Study Area boundary
- City or Borough boundary



LAND CONSERVATION COUNCIL
VICTORIA
SOUTH GIPPSLAND STUDY AREA, DISTRICT 2
**PUBLIC LAND
AND
DESCRIPTIVE BLOCKS**

MELBOURNE STUDY AREA

SOUTH GIPPSLAND STUDY AREA DISTRICT 1

6. TARWIN-WARATAH

4. CORNER INLET

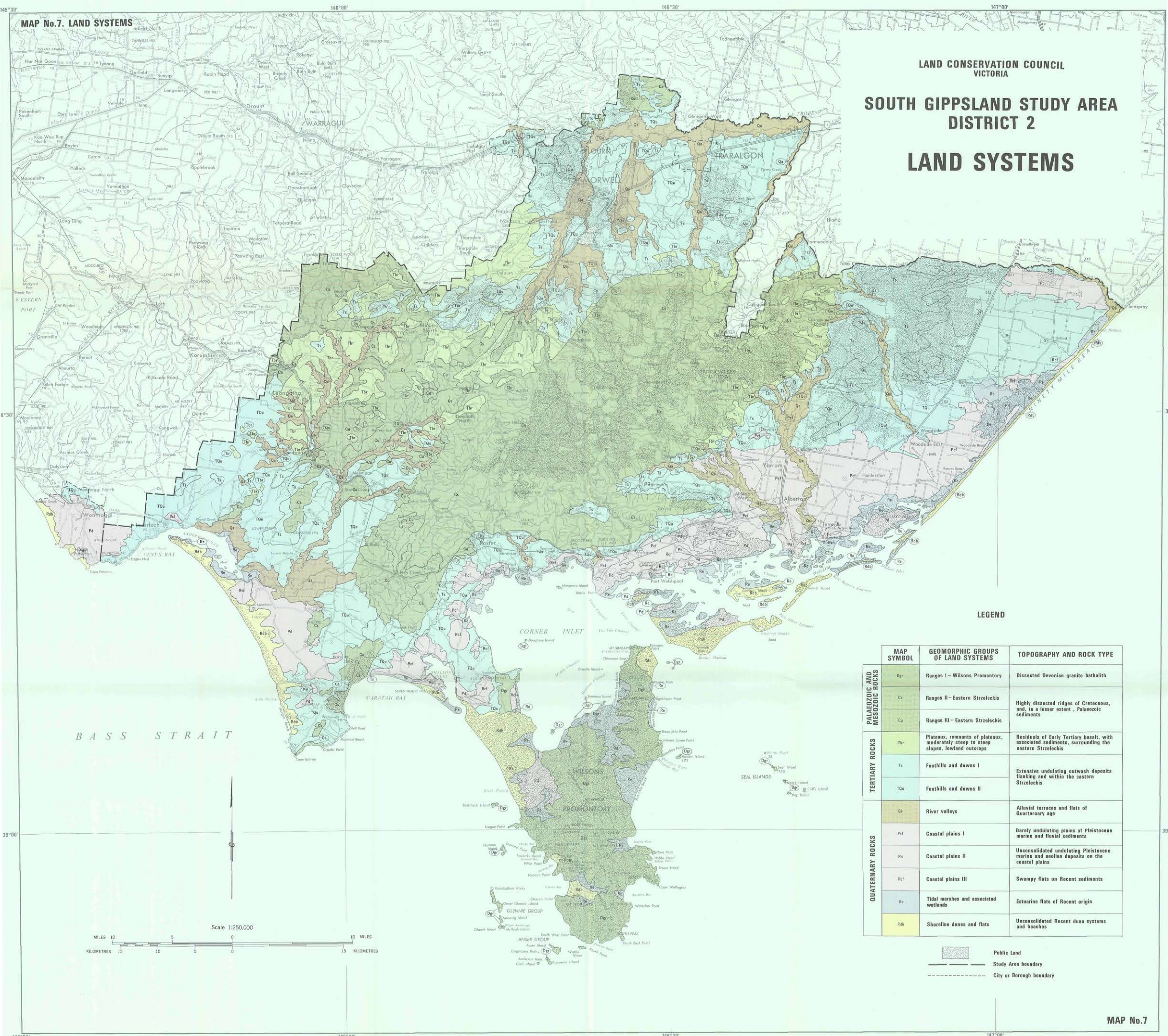
5. WILSONS PROMONTORY

LEGEND

- PUBLIC LAND AREA
- PUBLIC LAND OUTSIDE STUDY AREA
- STUDY AREA BOUNDARY
- CITY, TOWN OR BOROUGH BOUNDARY
- BLOCK BOUNDARY AND NAME
- SPOT ELEVATION IN FEET

3. WOODSIDE

NOTE: Various coastal and streamside reserves and urban allotments are too small to be shown at this scale



LAND CONSERVATION COUNCIL
VICTORIA

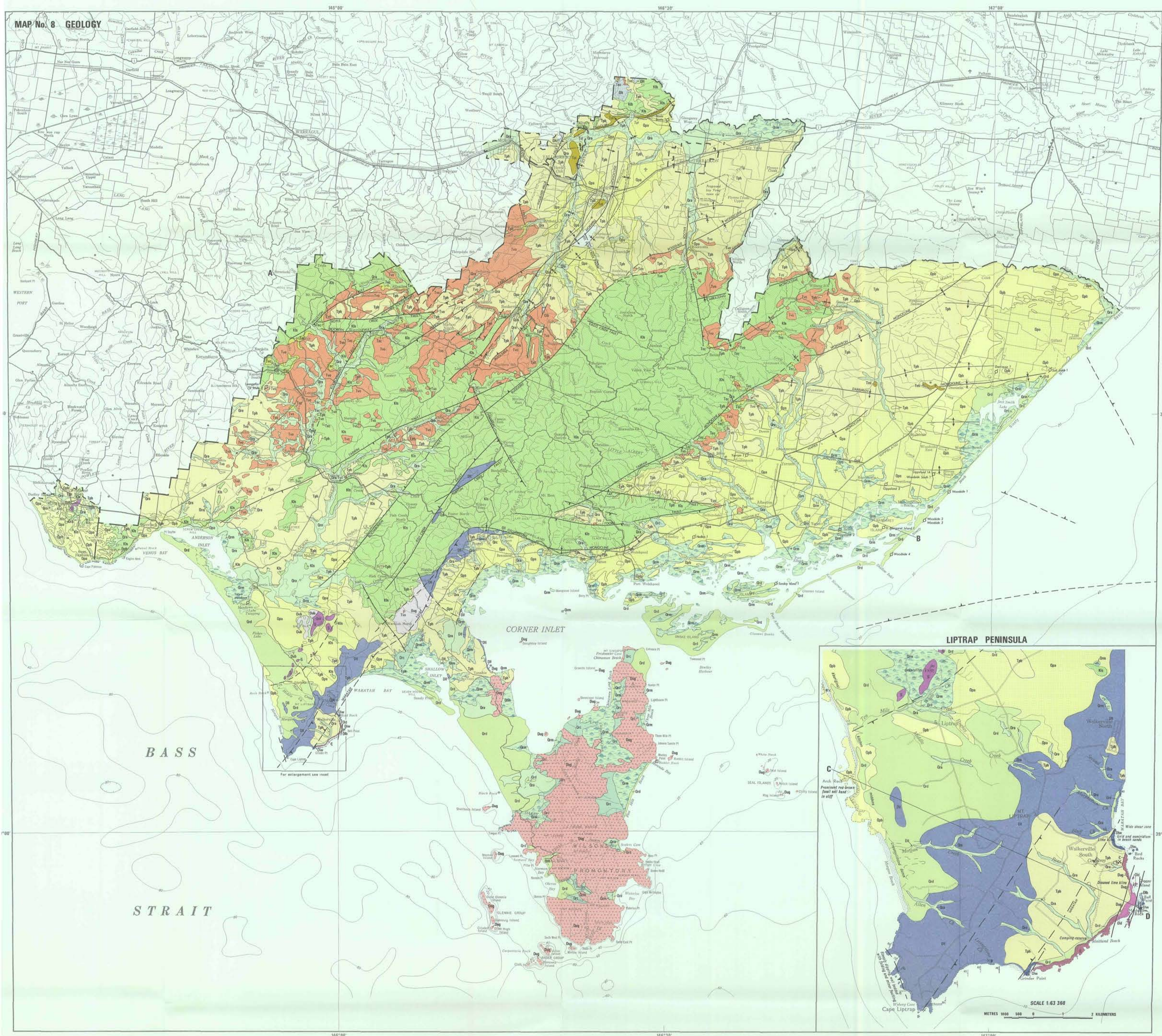
**SOUTH GIPPSLAND STUDY AREA
DISTRICT 2**

LAND SYSTEMS

LEGEND

	MAP SYMBOL	GEOMORPHIC GROUPS OF LAND SYSTEMS	TOPOGRAPHY AND ROCK TYPE
PALAEOZOIC AND MESOZOIC ROCKS	Dgr	Ranges I - Wilsons Promontory	Dissected Devonian granite batholith
	Cs	Ranges II - Eastern Strzeleckis	Highly dissected ridges of Cretaceous, and, to a lesser extent, Palaeozoic sediments
	Cs	Ranges III - Eastern Strzeleckis	
TERTIARY ROCKS	Tbr	Plateaux, remnants of plateaux, moderately steep to steep slopes, lowland outcrops	Residuals of Early Tertiary basalt, with associated sediments, surrounding the eastern Strzeleckis
	Ts	Foothills and downs I	Extensive undulating outwash deposits flanking and within the eastern Strzeleckis
	TQu	Foothills and downs II	
QUATERNARY ROCKS	Qs	River valleys	Alluvial terraces and flats of Quaternary age
	Pcl	Coastal plains I	Barely undulating plains of Pleistocene marine and fluvial sediments
	Pd	Coastal plains II	Unconsolidated undulating Pleistocene marine and aeolian deposits on the coastal plains
	Rcl	Coastal plains III	Swampy flats on Recent sediments
	Re	Tidal marshes and associated wetlands	Estuarine flats of Recent origin
	Rdb	Shoreline dunes and flats	Unconsolidated Recent dune systems and beaches

Public Land
Study Area boundary
City or Borough boundary



LAND CONSERVATION COUNCIL
VICTORIA

SOUTH GIPPSLAND STUDY AREA, DISTRICT 2

GEOLOGY

