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GEOGRAPHY

PROTECTION OF THE ENVIRONMENT *

Ministry for Conservation

Introduction

One of the significant aspects of public administration during the past decade has been the rise of interest in conservation and environment protection. Victoria, in the 1960s, saw an unprecedented expansion in conservation activities; several new organisations were established and major legislation was passed, as the State prepared to face a range of problems, the importance of which had previously been little recognised. In January 1973 these activities were drawn together with the formation of the Ministry for Conservation.

Since 1900, there have been a number of government departments in Victoria with an interest in specialised aspects of conservation, but by the early 1960s it had become apparent that the main problem was one of organisation. There were too many separate bodies and too much miscellaneous legislation to provide a co-ordinated approach to those environmental issues which were increasingly becoming a matter of public concern. To provide this co-ordination, the Ministry for Conservation was established by bringing together the experience and knowledge of six major government agencies which had previously worked separately in the field of conservation and environment protection. These agencies are: the Environment Protection Authority, Fisheries and Wildlife Division, Land Conservation Council, National Parks Service, Port Phillip Authority, and Soil Conservation Authority. More recently, additional organisations have been added to the Ministry: the Melbourne Zoological Gardens, the Sir Colin MacKenzie Fauna Park, and the Victoria Archaeological Survey.

The responsibilities of the Ministry are to achieve protection and preservation of the environment and to ensure proper management and utilisation of the land and living aquatic resources of the State. To meet these responsibilities it co-ordinates the activities of its component agencies, each of which is engaged in a number of areas of environmental activity. The work of these agencies is also assisted by a central co-ordinating group which has been developed since the Ministry was formed in 1973, and whose activities include environment assessment, conservation planning, information and extension services, and broad-based regional environmental studies of those areas of Victoria where major development is likely to occur.

There is also recognition that conservation problems frequently transcend departmental, State, and political boundaries, thus requiring the Ministry to integrate and co-operate in work with a wide range of persons and organisations.

* This section should be read in conjunction with Chapter 1.

Environment assessment and studies

Among the most significant responsibilities of the Ministry's central co-ordinating group is that of environmental assessment. In many parts of the world, the management tool of "environmental effects studies" (sometimes referred to as environmental impact statements) has become established; in Victoria, procedures have been established to provide environmental assessments of the likely effects of major government and private development projects. Already, government departments throughout Victoria as well as some private groups planning development have recognised the need for a proper understanding of the environmental effects of their activities. They have voluntarily accepted responsibility for studying the likely environmental effects of their projects and are co-operating with the Ministry for Conservation during the course of these studies.

The assessment team offers advice to developers at an early stage to ensure that the framework for an environmental effects study is sufficiently comprehensive. This may need to take into account the potential of land and water resources affected, the sociological implications, and possible alternatives—including the "do nothing" alternative. On completion, the study report is examined by the Ministry and a recommendation made to the Victorian Government.

A key factor in making valid environmental decisions is an adequate knowledge of the ecological effects of development proposals. At present two broad-based regional studies—of Port Phillip Bay and Western Port Bay—are being undertaken by the Environmental Studies Section of the Ministry, and a major new study has commenced for the Gippsland Lakes area and its catchment in eastern Victoria. The object of these studies is to provide comprehensive scientific information for planning and decision making purposes. First stage work has been completed for both Western Port and Port Phillip Bays, involving data gathering and resource mapping. The second stages, now under way, are concentrating on specific problem areas defined in the earlier work. (See also pages 37–46.)

Conservation planning

Associated with the Environmental Assessment Group and the Environmental Studies team is the Conservation Planning Group. The group contributes useful advice to Commonwealth and Victorian Government departments, local councils, and other groups so that environmental matters such as use, allocation, and distribution of resources will be taken into account at an early stage of planning for new projects.

The development in Victoria of conservation practices, including conservation planning, has arisen from the fact that man is an integral part of and, dependent on, his environment for his survival. A failure to understand or respect this dependence can lead to damaging consequences. The resolution of environmental problems lies in a rational approach to the use and management of resources so that human needs, both now and in the future, are provided for in a manner which does not permanently damage the environment's natural balance.

The role of the Conservation Planning Group then became one of taking account of the environmental constraints seen to be necessary by natural resource managers and incorporating these constraints into the planning process, where the ultimate decisions are made with respect to development and use of the community's resources.

Further reference, 1976

Environment Protection Authority

Early pollution control legislation in Victoria arose out of concern in a number of areas administered by different departments: the Health Department

over the health effects of air and water pollution, the Fisheries and Wildlife Division over the water pollution impact on fisheries conservation, Local Government over visual pollution and noise nuisance, and so on. Each department introduced its own legislation with varying degrees of effectiveness to cover its own area of concern.

The Environment Protection Act was introduced in 1970 and set up a new body—the Environment Protection Authority—to provide an overview, and to replace the outworn earlier laws. The Authority has over-riding responsibility in Victoria for control of all forms of pollution—of air, of water, of land, and by noise, and must consider all the beneficial uses of the environment enjoyed by the community at large. In this way the Authority must consider not merely the human health hazards or the effects on animals and fish of a polluted environment, but also the rights of the farmer to unpolluted water for irrigation or stock watering, the rights of industry to water suitable for industrial purposes, or the citizen's right to bathe safely on our beaches or enjoy the visual amenity of an unpolluted countryside.

Environment protection policies

The Act introduced an approach to pollution control new to Australia. Instead of concentrating on each major source of pollution to see how much it could reasonably be reduced (the old "best practical means" approach), it introduced the concept of environmental quality management, an approach to pollution control based on an initial assessment of air or water quality or ambient noise levels required to meet the general needs of the community as a whole. This is achieved through the declaration of a State Environment Protection Policy for each segment of the environment, and the first of these policies, for the waters of Port Phillip Bay, was proclaimed on 10 April 1975. This policy divides the Bay up into a number of segments based on the differing beneficial uses of the water—bathing, fish conservation, industrial water supply, navigation, etc.—and stipulates appropriate water quality criteria to maintain these uses. The policy also sets out an attainment programme and a target date by which it is anticipated adequate water quality will be achieved. Community input to policies at the drafting stage ensures that they represent the views of as wide a section of the public as possible.

The Authority intends that Environment Protection Policies will ultimately cover all sections of Victoria, so that in addition to policies for bays, rivers, and lakes, there will also be policies for air-sheds setting out desired air quality criteria, and noise policies laying down maximum noise levels to be maintained in different areas at various periods during the day and night.

Pollution control

Once a policy has set out a rationale for pollution control, bearing in mind the high cost to the community of a clean environment, the Environment Protection Act has three methods of controlling pollution: first, by proceeding against anyone who pollutes the environment either wilfully or by negligence; second, by limiting the discharge of wastes by means of a licensing system; and finally by regulatory control, for example, of the manufacture, sale, or use of equipment or materials which cause pollution. Prosecutions under the Environment Protection Act can result in fines of up to $5,000 and approximately 30 such prosecutions have been undertaken each year since the proclamation of the Act.

Pollution is an inevitable consequence of industrialised man's activities and the waste discharge licence system recognises that industry, in particular, must dispose of its wastes somewhere. Every significant discharge to water, to air, or to land must be licensed and the licence will normally carry conditions which ensure that the wastes are adequately treated before disposal and can be

assimilated into the environment without detrimental effects. Licence conditions remain in force, unless amended or revoked, in perpetuity, but a fee is payable annually in recognition of the cost of issuing and maintaining surveillance of the licence. Breaches of licence conditions again attract stiff penalties.

The regulatory powers under the Act enable controls to be placed on forms of pollution not amenable to the first two methods. For example, the Victorian Government has on the advice of E.P.A. enacted regulations limiting the level of lead which may be added to petrol sold in Victoria. This should prevent the concentration of lead in the atmosphere rising above its present level.

Environmental administration

To carry out this task of co-ordination and control, the E.P.A. has a staff of about 200 of whom 80 are technically qualified in a wide range of professions. The three members of the Authority are appointed by the Governor in Council and the staff divides into 10 branches. Geographically part of the licensing and enforcement function is delegated to a number of government agencies, specifically, the Melbourne and Metropolitan Board of Works, the State Rivers and Water Supply Commission, and the Dandenong Valley Authority in respect of water, the Health Commission in respect of disposal to land, and the Latrobe Valley Water and Sewerage Board in respect of disposal to air, land, and water.

Environment protection involves a great deal more than controlling pollution and the Authority carries out comprehensive monitoring programmes of air and water quality in addition to conducting surveys into urban noise levels and the composition and disposal patterns of domestic garbage. It undertakes an advisory role, as well as an education and information role, for the benefit of statutory planning authorities, industry, and the community at large in order to minimise future degradation. Many special studies and investigations are also undertaken into particular problems such as the eutrophication of certain inland lakes, the effects of motor vehicle exhaust emissions on the Melbourne air-shed, and the impact of freeway noise on urban areas.

Further reference, 1976

Land Conservation Council

The Land Conservation Council was established in February 1971 with the proclamation of the *Land Conservation Act* 1970. The Council of twelve members is composed of an independent chairman appointed by the Governor in Council, and the heads of the following government agencies: the Soil Conservation Authority, Department of Agriculture, Forests Commission, Department of Crown Lands and Survey, Mines Department, State Rivers and Water Supply Commission, Fisheries and Wildlife Division, and the National Parks Service. The other three members are persons with experience in various aspects of conservation and are appointed by the Governor in Council.

The functions of the Council are:

(1) To carry out investigations and make recommendations to the Minister on the use of public land in order to provide for the balanced use of land in Victoria (public land being defined as land which is not within a city, town or borough; and which is unalienated land; and includes land permanently or temporarily reserved under the Land Act, State forest, land vested in any public authority other than a municipality or sewerage authority, and land vested in the Melbourne and Metropolitan Board of Works);

(2) to make recommendations to the Governor in Council on the constitution and definition of water supply catchment areas; and

(3) to advise the Soil Conservation Authority concerning policy on the use of all land in any water supply catchment area.

The legislation provides for consideration of land for all purposes, but it specifically requires that uses which tend to have been given less consideration

and even a low priority since first settlement, should not be neglected in the future. In making any recommendation the Council must take into account the present and future needs of the people of Victoria in relation to the preservation of areas which are ecologically significant; the conservation of areas of natural interest, beauty, or historical interest; the creation and preservation of areas of reserved forest; the creation and preservation of areas for leisure and recreation, and in particular of areas close to cities and towns for bushland recreation reserves; the creation and preservation of reserves for the conservation of fish and wildlife; the preservation of species of native plants; and land required by government departments and public authorities in order to carry out their functions.

Victoria illustrates the problem of how modern civilisation demands land for various purposes, some compatible, others conflicting or competitive. Where there are conflicting or competitive demands for land, decisions must be made on the basis of significant scientific and other criteria.

The Council has divided the State into 17 study areas. However, before the Council can make recommendations for a study area it must conduct an investigation and publish a factual report describing the resources and the forms of land-use in the area. Notices of intent to commence an investigation in an area are published in the Victorian Government *Gazette* and in newspapers, including those circulating within the districts concerned.

The report is compiled by the research staff of the Council from information supplied by government departments, universities, various organisations including local groups, and from information arising out of research commissioned by the Council. The report is a factual description of the resources of the area and contains chapters on the physical characteristics of the land such as the geology, physiography, climate, soils, flora, and fauna. The report also describes the ways in which land in the study area is used. These uses include nature conservation and recreation, the production of food, fibre and timber, minerals and road making materials, and the provision of transport and power distribution systems. An account is given of these uses in terms of their physical requirements and the demands that each use places on the resources of the Study Area are assessed. The hazards to which the land may be prone such as soil erosion, salting, fire, and pests and their effects on land-use are also described.

When investigation of the Study Area is completed, notices are published indicating the availability of the report and inviting the public to make submissions to the Land Conservation Council on how the public land can best be used to serve the needs of the community. The publication of the report ensures that both the Council and members of the community will have the same information available for their consideration. It also enables all interested parties 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 the study. The Council makes its recommendations only after due consideration of all submissions. The recommendations made by the Council are initially published as Proposed Recommendations, a copy of which is sent to all parties from whom submissions were received and to all government agencies and local authorities in the study area concerned. Further submissions are then received and considered by the Council prior to publication of the Final Recommendations which are forwarded to the Minister for the Victorian Government's consideration.

Of the 17 study areas, the Land Conservation Council has published descriptive reports for South West District 1, South Gippsland District 1, North East District 1, North East District 2, North East Districts 3, 4 and 5, Melbourne, East Gippsland, Mallee, Corangamite and the Alpine Study Areas. Of these, Final Recommendations have been published for South West District 1, South Gippsland District 1, North East Districts 1 and 2, Melbourne, North East Districts 3, 4 and

5, Mallee, and East Gippsland. It is anticipated that proposed recommendations will be published for the Corangamite and Alpine Study Areas during 1977.

The final recommendations for the Melbourne Study Area are of particular significance as about 3 million people, representing nearly 80 per cent of the population of the State, are surrounded by or live in the area covered by these recommendations. In addition to making specific recommendations about individual areas of land, this report includes recommendations on general policies regarding the use of public land on coasts, water frontages, and road reserves, and for land used for the production of sand and gravel. The 16 colour maps accompanying the recommendations are of particular value as they show, in considerable detail, the public land in the vicinity of Melbourne and clearly indicate the nature and location of all recommendations.

To date, the Land Conservation Council has recommended the creation of numerous national, State, regional, and multi-purpose parks. The Council has also established several new categories of land-use and has recommended that land be set aside for the following purposes:

Reference Areas. Areas of land which are typical or important examples of a particular land type and which should be preserved in their natural state as far as possible, in order to serve as a standard against which altered or manipulated parts of the land type can be compared.

Education Areas. These are areas of land containing major land types to be used for environmental education.

Bushland Reserves. Relatively small and frequently isolated areas of land carrying remnants of native vegetation which provide diversity in predominantly agricultural regions and which should be used for passive recreations such as picnicking and walking.

Uncommitted Land. Areas of land of known or unknown capability which have been set aside to provide for the future needs of the community, both foreseen and unforeseen.

In addition to the above, the Land Conservation Council has reserved areas for the preservation of flora and fauna and set aside many small areas of public land to be used for recreation at a varying intensity according to the condition of the remaining natural vegetation. Areas have also been recommended to be used for timber production, mining, public utilities, and agriculture.

Further reference, 1976

Soil Conservation Authority

Under the *Soil Conservation and Land Utilization Act* 1958 and associated legislation, the Soil Conservation Authority has extensive responsibilities involving mitigation and control of erosion; the promotion of soil conservation; the determination of land-uses to achieve these objectives; the provision of advisory and technical services to landholders and other government authorities directed towards the efficient use and development of land and on-farm water resources; the protection of water catchments; supervisory responsibility over all activities which may disturb the soil at altitudes over 1,200 metres; and the control and prevention of erosion along the Victorian coastline. In meeting these responsibilities, the Authority has to recognise the range of characteristics and capabilities of the widely differing land types involved. These are determined by the interactions of climate, geology, topography, hydrology, soils, and flora and fauna.

At the time of its inception in 1950, authoritative Victorian land resource data was sparse and fragmented. As its activities developed, the new Authority recognised the need to understand the interaction between the environmental factors. Such an understanding would enable it to recommend improved land management practices; these would allow the desired production from the land without damaging its productive ability, or adversely affecting other land-uses.

The data would also have considerable value for other research workers and organisations concerned with soils and other land resources. Techniques for collecting the necessary information about the land and its interpretation were therefore developed.

Some basic assumptions assist in the collection and collation of this data. Areas of land which are reasonably uniform for management purposes are usually characterised by the presence of specific combinations of environmental factors—soil, native vegetation, topography, climate, and rock type. These areas of land are referred to as *components*. Because they are often small, individual identification and accurate mapping of each component would involve excessive work. The components, however, are usually associated with others in an easily identified pattern. These pattern areas may be mapped, and are referred to as *land systems*. The features of the components within the land systems are described, and their relationship to one another can be shown on a landscape cross section, usually taking the form of a diagrammatic profile. Land systems have been mapped at a reconnaissance level over the whole of Victoria, and some 60 per cent of the State's area has been covered by systematic land system surveys.

To enable land to yield more of the produce demanded of it, it is often necessary to change one or more of its environmental features. Forest vegetation may be cleared and replaced by grassland; soil may be regularly disturbed by cultivation; in urban areas, large areas of the land may be covered with paving materials and constructions, such as roads, airports, and buildings, which prevent water reaching the soil. Even the use of native forests for recreation can cause some featural change in the environmental associations of the forests. Because land is a dynamic entity, such changes in one feature usually affect others. In some instances, these effects occur over a short time and soon become obvious. Often, the changes are slow and cumulative and they do not become apparent until the problem assumes severe proportions.

The effects of some kinds of land-use are studied by the Authority through special research projects. One such is the Northern Slopes Project, in which the effects on soil erosion of changing forest vegetation to pasture, and the redistribution of salt in the soil, are being studied. Another is the Conservation Cropping Project, in which quantitative studies are being made of the effects of various cropping practices.

A long term research study is concerned with determining the hydrologic characteristics of several types of water catchments. Changes which result from changes in land-use are measured, such as in the Parwan Experimental Area, near Bacchus Marsh. This area has been used to study the effect of changing from annual pasture to deep-rooted perennial pasture. At Stewarts Creek, near Daylesford, one of several sub-catchments which had native forest cover has been converted to pasture, and another has been planted with pines. This will enable comparative studies of the effects on stream flow to be made. Another area in the high rainfall forests at Reefton, in the Upper Yarra district, is being studied to evaluate the effect of normal forest management practices on the hydrology of the catchment. A set of small catchments on Long Corner Creek, in the Buffalo River valley, is to be used to study the effect of converting the typical forest in that area to pine plantations.

Before changes in land-use are made on these experimental catchments, to make the planned studies possible, a long period of calibration is needed to enable the research teams reliably to predict the results of different weather patterns on the stream flow. After the changes, a further long period of study is needed to provide sufficient data for reliable interpretation.

From such projects, much information has already been collected about the characteristics of Victoria's land, and the effects of land-use on it, and the studies are continuing. So that this information can be used by those who are

involved with land-use and management decisions, procedures are now being developed which will enable the effects of different kinds of use and management to be evaluated systematically. This involves the development of land capability rating systems for a range of important land-uses.

Further reference, 1976; Destruction of vermin and noxious weeds, 1963; Soil, land-use, and ecological surveys, 1966; Farm water supplies, 1968; Group conservation, 1969; Land Utilization Advisory Council, 1970; Land Conservation Council, 1975

Port Phillip Authority

The Port Phillip Authority is a statutory body appointed under the provisions of the *Port Phillip Authority Act* 1966. The Authority comprises a full-time chairman and four part-time members representing various government agencies who have interests relating to coastal areas.

Port Phillip Bay is an important natural resource providing recreational enjoyment for the populations of the City of Melbourne and nearby communities. Because of this importance the Authority has the responsibility of recommending to the Victorian Government appropriate methods of controlling uses and demands in ways that will preserve beaches and the natural beauty of the foreshores. Any works or the erection of structures within the Port Phillip area are subject to a consenting system prior to their undertaking and the Authority, in the consideration of these proposals, takes into account the future uses of the areas involved, the effect on public interest, and the aesthetic acceptability of any work.

A number of surveys aimed at providing basic data upon which many of its decisions are made have been carried out by the Authority. These have included beach usage, beach populations, car parking, and vegetation management.

Plans and maps of the entire coastal area are being continually prepared by the Authority and cover aspects of ground cover, facilities, jurisdictional boundaries, and land forms.

A recent appointment by the Authority has resulted in the employment of an experienced horticultural adviser who is responsible for advising management bodies on techniques and methods of plant care along the coastal strip. The maintenance of coastal vegetation is most important if the recreational amenity of foreshore areas and beaches are to be preserved.

To assist the Authority in its function, a Consultative Committee under the provisions of the Act deals with matters referred to it by the Authority or the Minister of Conservation. This Committee comprises members of the Authority and representatives of government and other government agencies with one member representing the public interest.

Further reference, 1976; Port Phillip Bay Environmental Study, 1975; Western Port Bay Environmental Study, 1975; Gippsland Lakes Environmental Study, 1975

National Parks Service

Responsibilities

The National Parks Service, until 1975, was involved in running only traditional national parks and, in many of these parks, the day-to-day management was the responsibility of Committees of Management. The new National Parks Act, which was proclaimed on 1 December 1975, made basic changes to the responsibilities of the Service.

First, it provided for the Service to run not only traditional national parks, but many other types of parks as well. Second, the National Parks Service became directly responsible for management of all parks, with Committees of Management becoming advisory committees to retain local and specialist assistance.

The new Act, together with the activities of the Land Conservation Council, has increased the responsibilities of the Service which was reorganised in 1975 with substantial increases in staff and resources. The Service now has five

branches at Head Office—Management, Administration, Resources and Planning, Protection, and Interpretation.

The organisation has also been decentralised into regions by establishing five districts—South-western, based on Portland; Nepean, with headquarters on Arthurs Seat; East Gippsland, with headquarters at Bairnsdale; South Gippsland, with headquarters in Wilsons Promontory National Park; and North-east, with headquarters in Wangaratta. Each district is managed by a superintendent with administrative staff to support him. Some parks are supervised from head office, but eventually all parks will be allotted to districts.

The new Act provided for Rangers to become public servants. The Service has continued to recruit and train new field staff and at the end of 1975 it began the first sub-professional training course in co-operation with the Forests Commission. This course was attended by senior rangers and consists of three separate sessions held at the Creswick School of Forestry. At the conclusion of the course, participants will be issued with a Certificate of Applied Science, which is recognised by the Education Department.

The additional responsibilities have made the Service into a major recreation and land manager responsible for protecting a wide variety of resources and enabling people to use and enjoy the parks. The Service now manages the popular ocean beaches between Cape Schanck and London Bridge on the Mornington Peninsula—the Cape Schanck Coastal Park. Other new parks included in the 1975 Act are at Brisbane Ranges and Warrandyte, both of which are important conservation and recreation areas close to Melbourne.

The Service has taken over Tatra Inn Ski and Holiday Resort in Mount Buffalo National Park and has now become heavily involved in providing skiing facilities, with both Dingo Dell and Cresta skiing facilities under its management. It has also spent much effort and money in improving its numerous camps, the largest being at Tidal River in Wilsons Promontory National Park.

Park protection

Park protection involves many aspects, such as fire protection, law enforcement, control of noxious weeds, exotic plants and exotic animals, and control of damage by people. Fire protection is one of the most important of these. The National Parks Act gives the Director the responsibility of protecting the parks from injury by fire, and under the Forests Act, it is the duty of the Forests Commission to undertake fire prevention and suppression in parks under the control of the Service. That Act also provides that protective works be undertaken only by agreement with the Service. The Forests Commission and the Service have set up a joint Fire Protection Committee. Substantial sums are allocated by the Service for fire protection works to reduce hazards in the parks. The Service issued, in 1975, its policy on fire management so that its neighbours and the public will know its attitude towards both wildfire and the use of fire in reducing hazards and in maintaining habitat.

The National Parks Service is concerned with fire prevention and suppression, public safety, educating the public in matters relating to fire, and the place of fire in the natural environment. Specialised prevention and suppression methods must be used if the Service is to carry out the objects of its Act and protect the many fragile ecosystems in parks. Whenever the choice exists, prevention measures adopted are those which cause least damage to park values; thus, for example, burnt or slashed firebreaks rather than bulldozed, graded, or ploughed breaks are used and, in suppression work, minimal use of earth moving equipment and maximum use of aircraft and chemical retardants is favoured.

Although wildfires resulting from natural causes are recognised by the Service as natural phenomena, all wildfires in parks, irrespective of their cause, are controlled. A number of Australian plant and animal communities require the influence of fire, but the Service believes that this is best retained by the

use of prescribed fire of the appropriate intensity and frequency rather than letting haphazard wildfires burn. Much more is still to be learned about the place of fire in the natural environment before it can be safely used on a broad scale; the Service uses caution in manipulating natural communities with prescribed fires. It also believes that use of fires by the public for cooking and warmth are an important part of park enjoyment and aims to provide facilities which will minimise the risk of such fires escaping.

The fire protection plans for parks have to take into account the protection not only of the environment, but also that of people, and this is becoming a more onerous duty as the use of parks in summer time increases.

Park interpretation and research

The Service has made progress in some of its newer fields of endeavour—park interpretation and education. Interpretation programmes which have been provided in a number of parks have been very popular. Haining Farm, which is used to teach city school children about farms, is also proving successful.

The Service's involvement in research is still very limited and it is continuing its policy of "farming out" its research needs to academic institutions.

Land resources

The land under the control and management of the National Parks Service is set out in the following tables:

VICTORIA—PARKS UNDER THE CONTROL OF THE NATIONAL PARKS SERVICE AT JUNE 1976

Item	Hectares
A. *National parks*	
1. Alfred	2,300
2. Brisbane Ranges	1,132
3. Bulga	36
4. Captain James Cook	2,750
5. Churchill	193
6. Fern Tree Gully	450
7. Fraser	3,100
8. Glenaladale	163
9. Hattah Lakes	17,800
10. Kinglake	5,700
11. The Lakes	2,100
12. Lind	1,166
13. Little Desert	35,300
14. Lower Glenelg	27,300
15. Mallacoota Inlet	5,250
16. Morwell	140
17. Mount Buffalo	11,000
18. Mt Eccles	400
19. Mt Richmond	1,700
20. Organ Pipes	65
21. Port Campbell	700
22. Tarra Valley	140
23. Wilsons Promontory	49,000
24. Wingan Inlet	1,900
25. Wyperfeld	56,500
Total—national parks	226,285

VICTORIA—PARKS UNDER THE CONTROL OF THE NATIONAL PARKS SERVICE AT JUNE 1976—*continued*

Item	Hectares
B. *Other parks declared under the National Parks Act*	
1. Cape Schanck	900
2. Warrandyte	135
Total—other parks	1,030
C. *New parks approved by the Victorian Government and managed by the National Parks Service pending legislation to bring them under the National Parks Act*	
1. Arthurs Seat, Greens Bush, and Seawinds	625
2. Burrowa-Pine Mountain	16,720
3. Cape Nelson	176
4. Discovery Bay Coastal Reserve	8,097
5. Haining	61
6. Holey Plains	10,800
7. The Lakes Coastal Reserve	15,420
8. Mt Worth	164
9. Warby Range	2,750
10. Werribee Gorge	207
11. Westerfolds	123
Total—new parks	55,143
D. *Land Act Reserves (mainly small blocks of purchased land) managed in conjunction with 11 existing parks*	816
Total—all parks	283,279
Percentage of total area of Victoria	1.24
Percentage of public lands of Victoria	3.11

A special article on national parks in Victoria, supported by photographs and a map, appears on pages 1–35 of the *Victorian Year Book* 1975.

Royal Botanic Gardens and National Herbarium

Australia's largest reference collection of living and dried plant species and library of taxonomic and horticultural literature is deposited in the Royal Botanic Gardens and National Herbarium in Melbourne. The community needs these resources for scientific, legal, horticultural, and recreational purposes and the demand for services has increased significantly in recent years.

Horticultural display

During the last two years the National Herbarium has, with the Royal Horticultural Society of Victoria, served as the focal point for the display of specialist horticultural collections of living plants ranging from cacti, succulents, bromeliads, daffodils, dahlias, and chrysanthemums, to bonsai and beautifully landscaped indoor plant displays.

Legal activities

The growing interest of sections of the community with drug plants has involved the National Herbarium staff with identification of drug plants in the various forms in which they are disguised to avoid detection and diluted with other plant materials for profit. In 1970–71, 9 hours of professional time was spent identifying drug plants; 1971–72, 21 hours; 1972–73, 200 hours;

1973–74, 250 hours; and 1974–75 (following the introduction of charges) 121 hours. The principal species involved was *Cannabis sativa.*

Identification

Identification of plants is a very different science from that of taxonomic description of new species. The demand for the identification of plants has become so great that charges have been introduced for this service for the first time. Furthermore, the demand for plant identification in resource surveys has become so substantial that amateurs are becoming self-supporting consultants in this field.

The criteria on which plants are recognised and described as new species are those that must also be used if the identity of a species is in doubt. For scientific and legal purposes of identification, this requires the comparison of the unknown plant with the original description and specimen. This time consuming and therefore expensive process of identifying plant species too often curtails other work on plants, particularly surveys, and so new ways for rapidly identifying plants are being explored in the Herbarium.

Scientific activities

Herbarium botanists working on the Australian flora during the past 150 years have been fully occupied describing plant species new to botanical science. From 1929 to 1969, 612 vascular plant species were added to the flora of Victoria and between each of the years 1967 and 1969, 15 new species were added and 18 old species re-defined. In the six years from 1970 to 1975, more than 42 new native species have been described, 30 species introduced, 61 native species re-defined, and 6 introduced species re-defined. Thus, on average, 10 to 15 species are added to the Victorian flora each year.

A sound knowledge of the rate at which the flora and vegetation resources are changing can only arise from a thorough understanding of the number of plant species and how they are distributed.

The last complete census of Victorian plants was carried out in 1969. In order to assist census work it was found necessary to divide Victoria into regions each covering an area of 1 degree latitude by 1.5 degrees longitude.

The census showed that the number of vascular species stood at 3,232. It was noticed that many more species are found within a restricted range than over a wide distribution. This pattern is brought out clearly in the table below. The implications of this are significant for the preservation of large numbers of small areas of high species diversity.

VICTORIA—PLANTS: VASCULAR SPECIES: DISTRIBUTION

Number of regions (1 x 1.5 degrees) in which plants are distributed	Number of species found in regions	Number of regions (1 x 1.5 degrees) in which plants are distributed	Number of species found in regions
1	552	11	92
2	450	12	108
3	360	13	76
4	271	14	59
5	275	15	49
6	210	16	48
7	182	17	38
8	161	18	21
9	142	19	12
10	124	20	2

NOTE. The total number of species at the end of 1969 was 3,232, comprising 689 spp. introduced and 2,543 spp. native.

Floristic surveys

With the growing realisation that plants provide the most reliable indication of environmental quality and land utilisation strategies, the demand for biological resource surveys has grown during the past five years.

The application of a floristic definition of a plant community was first tested in the Dandenong Ranges in 1971 and extended to the Cranbourne sand dune flora in 1972 ; the methods are now to hand for surveying communities throughout Victoria. The urgency for such a floristic survey is very evident near Melbourne, where one of the last of the three remaining communities of the Western basalt plains flora, along a railway reserve near Altona, is fast approaching extinction. The very existence of these species could eventually be known only from paintings and dried specimens in the Herbarium. However, the Royal Botanic Gardens has taken preliminary steps to domesticate some of these species with horticultural potential, and restocking of national parks and reserves is possible through such urban renewal programmes as the joint Commonwealth–Victorian Government Western Region Tree and Shrub Programme.

Floristic mapping is important in adopting sound land management strategies for maintaining healthy Australian flora and compatible fauna in reserves throughout Victoria. This, in turn, gives Victorians the greatest opportunity to enjoy such flora and fauna under the most natural conditions possible in reserves. Considerable effort is now required to extend these surveys to define all plant communities in Victoria.

Cranbourne Annexe

The Royal Botanic Gardens Annexe at Cranbourne is an area reserved for the display of Australian flora. To ensure that the development of the area is compatible with sound biological and regional planning constraints, surveys of both aspects have been carried out. By 1971 more than 150 vascular plant species had been recognised.

The floristic survey of 1972 and 1975 demonstrated the existence of two floristic and structurally distinct plant communities. These two communities are best shown in the table on page 60. The first of these is sub-divided into groups 1 to 4, and the second is sub-divided into groups 5 to 8. The most common species in the first community are *Leptospermum myrsinoides, Casuarina pusilla, Epacris impressa* (the Victorian floral emblem), *Monotoca scoparia, Leucopogon virgatus, Hypolaena fastigiata, Amperea xiphoclada,* and occasionally by *Eucalyptus viminalis.* This community is found on the top and slopes of the highly acid sand dunes on deep podsol soils with a high permeability to water. There is a sharp transition between the first and second floristically defined community, often in the space of two or three metres. The most common species in the second community are *Melaleuca squarrosa, Leptospermum juniperinum,* and *Gahnia sieberana. Eucalyptus cephalocarpa* is occasionally found in this community which occurs in interdunal depressions, on humus podsol soils subject to seasonal waterlogging.

Outside the Cranbourne annexe reserve, but within 30 metres of it, flat clay soils support a *Eucalyptus radiata* woodland with an understory predominantly of grasses (*Themeda australis, Danthonia pallida,* and *Poa*). Thus, under the same climatic conditions, sands and clay soils support structurally different vegetation, and on the sandy soils two quite different plant communities have been recognised. The floristic composition of each depends upon the degree to which the soils are waterlogged.

Research by zoologists from Monash University has demonstrated the presence of sixteen mammals, six of which are introduced species in the area. The grey kangaroo (*Macropus gigantea*), last sighted in the reserve in 1969, is a grazer, and areas of grassland such as the woodland area west of the annexe would be necessary to support a population of these animals. Koalas are also native to the

VICTORIA—PLANT COMMUNITIES IN THE VEGETATION AT THE CRANBOURNE ANNEXE OF THE ROYAL BOTANIC GARDENS

Plant	Community 1 — Sand hill vegetation; well-drained sandy soil				Community 2 — Dune depressions; waterlogged, peaty soils			Clay soils	Plant
	Group 1 — Hill tops	Group 2 — Upper slopes of hills—mature vegetation	Group 3 — Upper slopes of hills in early stages of regeneration	Group 4 — Lower slopes of hills	Group 5 — Water table close to soil surface; above surface part of the year to form a swamp	Group 6 — Possibly regeneration stage of Group 5; seasonal swamp	Group 7 — Water table above surface for most of year; perennial swamp	Group 8 — Depressions where soil has high clay content	
Dillwynia cinerascens	1 1 1								Grey Parrot–Pea
Lepidosperma concavum	2 2 2 2 2								Hill Sword-Sedge
Platylobium obtusangulum	1 1 1 1 1								Common Flat-Pea
Pimelea humilis	1 1 1 1 1								Common Rice-Flower
Casuarina pusilla	2 2 2 2 2	1 1 1	1 1 1						Dwarf She-Oak
Leucopogon ericoides	1 1 1	1 1 1 1 1	1 1 1 1 1						Pink Beard-Heath
Hypolaena fastigiata	1 1 1 1 1	1 1 1 1 1	1 1 1 1 1	1 1 1 1 1					Tassle Rope-Rush
Leptospermum myrsinoides	2 2 2 2 2	3 3 3 3 3	2 2 2 2 2	2 2 2 2 2					Silky Tea-Tree
Epacris impressa	1 1 1 1 1	1 1 1 1 1	2 2 2 2 2	1 1 1 1 1					Common Heath
Monotoca scoparia	1 1 1 1 1	1 1 1 1 1	1 1 1 1 1	1 1 1 1 1					Prickly Broom-Heath
Leucopogon virgatus	1 1 1 1 1	1 1 1 1 1	1 1 1 1 1	1 1 1 1 1					Common Beard-Heath
Campylopus spp.	1 1 1 1 1	1 1 1 1 1	1 1 1 1 1	1 1 1 1 1					Moss
Cladonia spp.	1 1 1 1 1	1 1 1 1 1	1 1 1 1 1	1 1 1 1 1					Cup Lichens
Eucalyptus viminalis	1 1 1	1 1 1		2 2 2 2 2					Coast Manna Gum
Drosera whittakeri		1 1 1		1 1 1					Scented Sundew
Dillwynia glaberrima		1 1 1 1	1 1 1 1 1	1 1 1 1					Smooth Parrot-Pea
Amperea xiphoclada		1 1 1	1 1 1 1 1	1 1 1 1 1					Broom Spurge
Aotus ericoides		1 1 1 1 1	2 2 2 2 2	1 1 1 1 1					Common Aotus
Acacia oxycedrus		1 1 1 1	1 1 1 1 1						Spike Wattle
Banksia marginata		1 1 1							Silver Banksia
Hibbertia acicularis			1 1 1 1 1						Prickly Guinea-Flower
Platysace heterophylla			1 1 1 1 1						Slender Platysace
Hibbertia fasciculata			1 1 1 1 1						Bundled Guinea-Flower
Stypandra caespitosa			1 1 1 1						Tufted Blue-Lily
Gahnia sieberana			1 1 1 1 1		2 2 2 2 2	2 2 2 2 2			Red-Fruit Saw-Sedge
Leptospermum juniperinum				1 1 1 1 1	2 2 2 2 2	2 2 2 2 2	2 1 1	2 2 2 2 2	Prickly Tea-Tree
Melaleuca squarrosa					2 2 2 2 3	2 2 2 2 2			Scented Paper-Bark
Eucalyptus cephalocarpa					1 1 1				Mealy Stringybark
Lepidosperma longitudinale						2 2 2 2 2	3 4 5 5 5	1 1 1 1	Spreading Rope-Rush
Schoenus brevifolius						1 2 2 1	3 2 1		Pithy Sword-Sedge
Calorophus lateriflorus						2 2 2 2 2			Zig-Zag Bog-Rush
Melaleuca ericifolia								3 3 3 3 3	Swamp Paper-Bark
Lophocolea semeteres								1 1 1 1 1	Liverwort
Lepyrodia muelleri								2 2 2 2	Common Scale-Rush
Cassytha glabella		1 1 1 1 1	1 1 1 1 1	1 1 1 1		1 1 1		1 1 1 1	Dodder-Laurel (parasite)

NOTE. Each column of figures represents the species content of a single 5 x 5 m sample-plot (quadrat). The numbers 1–5 represent the area covered by any species within a quadrat. 1 = the species covers less than 5 per cent of the quadrat area. 2 = the species covers between 5 per cent and 20 per cent of the area. 3 = the species covers between 20 per cent and 50 per cent of the area. 4 = the species covers between 50 per cent and 75 per cent of the area. 5 = the species covers between 75 per cent and 100 per cent of the area.

area but have not been sighted for three years, possibly because their food trees were removed during the 1960s. A few black-tailed wallabies (*Wallabia bicolor*) occur in both of the heath communities. Their numbers could be increased with protection from interference from feral dogs. Echidnas (*Tachyglossus aculeatus*) are found in most groups, but feed most often in the sandy soils of groups 1 to 4 where ants are most abundant.

Twenty short-nosed bandicoots (*Isoodon obesulus*) live in an area of 8 hectares which is a high density for this species. Their greatest density is found in group 3 plants. Half their number can be found in plant groups 2 and 4 and only very rarely in groups 5 and 6. The species feeds by scraping shallow holes in the soil to procure both insect and vegetable food, and they start breeding in August.

The rare New-Holland mouse (*Pseudomys novaehollandiae*) is known from only four areas in Victoria. All these localities support coastal heathland dominated by *Leptospermum myrsinoides*. At Cranbourne eleven individuals show a preference for group 3 flora and are found to a lesser extent in plant groups 2 and 4, but never in groups 5 or 6. This species appears to feed above ground on seeds. The native swamp rat (*Rattus lutreolus*) is the most abundant small mammal present and burrows to feed on roots and underground storage organs of plants.

All marsupials and rodents that live in these heaths show greatest avoidance of the plant communities in the wettest interdunal areas although some species avoid them more than others.

The most popular plant group (3) for mammals is clearly in the drier *Leptospermum myrsinoides* community which was regenerating well after clearing and burning in 1969.

In addition to the mammals there are 86 bird species, 66 of which breed locally.

PHYSICAL FEATURES

Boundaries and areas

Creation of Victoria

The boundaries of the Port Phillip District of New South Wales were defined in *Imperial Act* 5 & 6 Victoriæ c.76 of 30 July 1842 ("An Act for the Government of New South Wales and Van Diemen's Land") as follows:

'. . . the Boundary of the District of Port Phillip on the North and North-east shall be a straight Line drawn from Cape Howe to the nearest Source of the River Murray, and thence the Course of that River to the Eastern Boundary of the Province of South Australia.'

Previously, by *Imperial Act* 4 & 5 William IV c.95 of 15 August 1834, *Letters Patent* of about 19 February 1836, and *Imperial Act* 1 & 2 Victoriæ c.60 of 31 July 1838, the eastern boundary of the Province of South Australia was fixed as '. . . the One hundred and forty-first Degree of East Longitude . . .'.

By *Imperial Act* 13 & 14 Victoriæ c.59 of 5 August 1850 ("An Act for the better Government of Her Majesty's Australian Colonies"), the District of Port Phillip was granted the right to separate from New South Wales.

Boundaries

On 2 May 1851 "The Victoria Electoral Act of 1851" was passed (*New South Wales Act* 14 Victoria No. 47) which provided for the division of the Colony of Victoria into electoral districts. A schedule to the Act set forth the boundaries of the electoral districts, being based on the boundaries of the counties then in existence. Those boundaries of the electoral districts which formed the boundaries of Victoria were described as:

'a line running in a westerly direction from Cape Howe to the source of the nearest tributary of the Murray';

'the River Murray';
'the South Australian frontier';
'the 141st meridian being the line dividing the Colony of New South Wales from South Australia';
'the sea';
'the sea shore';
'the sea coast';
'including the Lawrence and Lady Julia Percy's Islands';
'including all the islands at Port Fairy';
'Port Phillip Bay';
'the shores of Port Phillip Bay';
'the waters of Port Phillip';
'including the small islands near the channels at the mouth of Port Phillip and those of Geelong Bay';
'including French and Phillip Island and the small islands in Western Port Bay'.

Writs for the election of a Legislative Council in Victoria were issued on 1 July 1851, thereby establishing the Colony of Victoria.

Murray River

The separation of Victoria from New South Wales in 1851, and the successful navigation of the Murray by steam vessels, encouraged widespread evasion of New South Wales customs duties on articles taken across from Victoria and South Australia. The question arose as to which Colony had jurisdiction over the waters of the Murray River. The position was finally clarified with the passing of the New South Wales Constitution Statute (*Imperial Act* 18 & 19 Victoriæ c.54 of 16 July 1855) which decreed that the whole watercourse of the Murray River from its source to the eastern boundary of the Colony of South Australia was thereafter to be within the Territory of New South Wales, thus fixing the left bank as the boundary between Victoria and New South Wales.

Cape Howe to the Murray River

In 1866 following the discovery of gold on the tributaries of the Snowy River near where the boundary was thought to be, it became evident that the remaining portion of the New South Wales–Victoria boundary should be marked on the ground. A definitive point at Cape Howe was agreed upon by the two colonies following an on-site conference between the New South Wales Surveyor General (P. F. Adams) and the Victorian Government Astronomer and Superintendent of Geodetic Survey (R. L. J. Ellery). This point was marked and named Conference Point.

Late in 1869, Alexander Black, a Victorian geodetic surveyor, was directed to determine the headwaters of the Murray River. This he identified as a certain spring near Forest Hill. Black then proceeded to clear and mark the western portion of the boundary while another Victorian geodetic surveyor, Alexander C. Allan, marked the eastern portion. The marking was completed in early 1872 and the line, which extended some 115 kilometres through extremely rugged country, passed within 5.6 metres of the provisionally established Conference Point.

The official technical description of the boundary gave as the initial azimuth 116° 58′ 09″ .42 from the spring to Station No. 1 on Forest Hill (452.6 metres away), while from a point on the coast at Cape Howe, 176,492.1 metres from the spring, the azimuth of the same line extending out to sea was given as 115° 53′ 41″ .36 to a point distant one league (that is, 5.56 kilometres) from high waterline at Cape Howe.

The total length of the New South Wales boundary including the Murray River is about 2,050 kilometres.

Victoria–South Australia border

The boundary between South Australia and Victoria has had an interesting history, involving heroic work by surveyors and later much litigation between the colonies which culminated in an appeal to the Privy Council.

Prior to the creation of the Province of South Australia, New South Wales covered all of the mainland of Australia as far west as the 135° east meridian. South Australia was established in the 1830s, the boundaries being '. . . . on the North the Twenty-sixth Degree of South Latitude, on the South the Southern Ocean, . . . , and on the East the One hundred and forty-first Degree of East Longitude . . . '. Thus the western boundary of New South Wales between the 26° south parallel and the coast was defined by the 141° east meridian.

By the late 1830s it had become apparent that the south-eastern corner of South Australia would need to be located and marked on the ground, as the Hentys of Portland Bay had extended their pastoral activities over the Glenelg River to Mount Gambier and there were disputes as to which Government (South Australia or New South Wales) had jurisdiction there.

Late in 1846 surveyors Henry Wade from New South Wales and Edward R. White from South Australia commenced the marking of the 141° east meridian. Their starting point was some 2 kilometres west of the Glenelg River which had previously been determined to be the most likely position of the meridian. In July 1847 after completing 198 kilometres of the boundary, the party was forced to discontinue the survey due to sickness. Subsequently both colonies issued proclamations adopting the boundary as marked. Surveyor White was requested to proceed with the survey and in December 1850 reached the Murray River after suffering months of overwhelming privations which contributed to his early death.

Doubts about the accuracy of the determination of the 141° east meridian (upon which Wade's and White's surveys were based) were expressed in the 1840s and grew in the 1850s, but no action was taken until the late 1860s. Although there was no conclusive evidence, the Governments of South Australia and New South Wales were agreed that it was desirable to verify the longitude of the line marked by Wade and White, before proceeding with the marking of the boundary between those two colonies north of the Murray River.

There was reason to believe that a more accurate location of the 141° east meridian could be established. Since the determinations of the position of the 141° east meridian near the coast between 1839 and 1845 there had been increases in scientific knowledge, larger and more accurate instruments were available, and the electric telegraph had been developed. Furthermore, as the result of the appointment of government astronomers in Sydney and Melbourne, there were more accurate values for the longitudes of these cities. In May 1868 a temporary observatory was established at Chowilla and as a result of careful observations, and with the aid of the newly developed electric telegraph, George Smalley, New South Wales Government Astronomer, and Charles Todd, South Australian Superintendent of Telegraphs, determined the 141° east meridian to be approximately 3.60 kilometres east of the boundary marked by White.

After many years of vain efforts asking Victoria to relinquish the land between the marked boundary and the more accurately determined 141° east meridian, the South Australian Government in 1911 appealed to the High Court of Australia. When this appeal failed, it appealed to the Privy Council which ruled in favour of Victoria in 1914. Thus ended the dispute; the boundary as marked, approximating to a longitude of 140° 58′ east, was confirmed as the State boundary.

There remains the question of the location of the border in the far north-western corner of Victoria, along the Murray downstream from the 141° meridian (as determined by Smalley and Todd) to Wade and White's line. The

length of this section of the river is about 10 kilometres with Victoria to the south and South Australia to the north of the river.

Recent legal opinion suggests that ordinary common law principles would apply; consequently, the boundary is presumably the centre thread of the Murray as at 1842 (as modified by slow and imperceptible natural changes in its course since then).

Offshore boundaries

The *Imperial Act* 13 & 14 Victoriæ c.59 of 5 August 1850 which separated the Colony of Victoria from New South Wales described only the land boundaries of the new Colony; no southern boundary was defined. However, the northern boundary of Van Diemen's Land (Tasmania) was defined in 1825 as the latitude 39° 12′ south and this has generally been accepted as the southern limit of Victoria's jurisdiction. It lies about 7 kilometres south of Wilsons Promontory. The lateral offshore boundaries between Victoria and the adjoining mainland States have not been defined.

In 1973 the Commonwealth Government passed the Seas and Submerged Lands Act (No. 161 of 1973), and it received the Royal Assent on 4 December 1973. The Act declares that the sovereignty in respect of the territorial sea of Australia, and in respect of the airspace over it and in respect of its bed and subsoil, is vested in and exercisable by the Crown in right of the Commonwealth. The Act gives the Governor-General power to proclaim the breadth of the territorial sea, and the power to proclaim the baseline from which the territorial sea is to be measured. The Act declares that the sovereignty in respect of the internal waters of Australia (that is to say, any waters of the sea on the landward side of the baseline of the territorial sea) not within the limits of a State, and in respect of the airspace over those waters and in respect of the sea-bed and subsoil beneath those waters, is vested in and exercisable by the Crown in right of the Commonwealth.

Baselines from which the territorial sea is to be measured are delimited according to procedures spelt out by the Convention on the Territorial Sea and the Contiguous Zone which was signed at Geneva on 29 April 1958, and under which Australia has obligations under international law.

The six Australian States challenged the validity of the Seas and Submerged Lands Act in the High Court of Australia, but in the decision handed down on 17 December 1975, the High Court dismissed all actions thereby confirming that, broadly speaking, the sovereignty of the Crown in right of the States extends only to low-water line. This applies both to the mainland and to islands off the coast which belong to the State, which in the case of Victoria would probably mean all islands between 140° 58′ and 149° 58′ east longitude (approximately) to the north of 39° 12′ south latitude.

Depth

Although no depth limitation for Victoria was given in the Imperial Statutes defining the boundaries of Victoria, it has always been accepted that the Crown has sovereignty to the centre of the earth. The Land Act of 1891 imposed a depth limit in new Crown grants and, since 8 August 1892, 99 per cent of Crown grants issued have been limited to the surface and down to a depth of 50 feet (15.24 metres) below the surface. Since 3 July 1973 the depth limitation for new Crown grants has been 15 metres. A well or spring to obtain water from the ground is not necessarily subject to the depth limitation imposed in the Crown grant.

The exceptions to the 15 metres depth limitation on freehold tenure are: (1) In areas close to coal mines, gravel deposits, etc., where the depth limits were fixed in 1909 at 25 feet (7.62 metres), sometimes 20 feet (6.10 metres), or 30 feet (9.14 metres)—e.g., Wonthaggi, Kirrak, Korumburra, Woolamai, and

THE BOTANICAL ART OF MARGARET STONES

Botanical art goes back to the civilisation of Minoan Crete. It was used with woodcut prints in the manuscripts of Greek herbalists for the accurate identification of plants of medicinal value; was extended more widely as woodcuts were superseded by engraved and etched plates; and reached high technical standards in eighteenth century Europe and Britain. The highest standard of botanical art combines accurate botanical observation and attention to detail with artistic skill in an elegant display of plant form. Few artists have achieved such exacting standards in this discipline.

A limited number of Australian women artists are maintaining these high traditional standards of botanical art. Refined modern techniques of mechanical reproduction bring their work to the attention and enjoyment of a wider range of readers in the community, although there is as yet no botanical journal specialising in the publication of these illustrations of flowering plants.

If voucher specimens from the plants that are drawn are correctly identified and lodged in the National Herbarium, where they are given a number identical to one in the drawing, the botanical art also becomes a work of scientific value.

Margaret Stones is one of the world's leading exponents in the field of botanical art. Born in Colac, Victoria, on 28 August 1920 and trained at the Swinburne Institute of Technology and the National Gallery School, Margaret Stones now lives and works in London. Since 1956 she has been associated with the Royal Botanic Gardens at Kew, contributing to the illustrations in Curtis's *Botanical Magazine,* a scientific journal of botanical art which was first published in 1787.

The M.M. Gibson (Gardens) Trust and the Gardens Branch Research Committee of the Royal Botanic Gardens in Victoria have encouraged a number of Victorian artists with latent ability in the field of botanical art to further their skills by commissioning drawings of species of scientific interest in the Victorian flora. In 1975 the Gibson Trust also provided assistance for Margaret Stones

Acknowledgement is made to the M. M. Gibson (Gardens) Trust for permission to reproduce Miss Margaret Stones' botanical drawings.

to return briefly to Victoria, and commissioned her to draw some of the remnants of the basalt plains grass and shrub flora on the western approaches to Melbourne during the spring of 1975 and the following summer. Examples of this work can be seen in Plates 1–4.

The indigenous grassland and herb-dominated vegetation of the basalt plains has suffered more extensive changes than any other in Victoria. Some species are believed to be extinct, others are extremely rare (see Plate 3), and it is unusual to see a plant native to the region. Most of the area passed from Crown land into private ownership during the early to mid-nineteenth century and was farmed intensively. The few areas of woodland were reduced to provide wood for fuel, fencing, and buildings, and converted into grasslands for agricultural and pastoral purposes. *Eucalyptus microcarpa* (grey box) shoots and seedlings are attractive to sheep, and grazing has prevented regeneration of this species. The most significant effect of grazing on the original grassland has been the disappearance of tall perennial *Themeda australis* (kangaroo grass) (see Plate 1), and to a lesser extent the confinement of *Stipa aristiglumis* to a grassland of shorter perennial grasses *Danthonia* (see Plate 2) and *Stipa variabilis* (wallaby and spear grasses). With the addition of higher density grazing and fertilisers, these native grasses give way to short perennial grasses of mixed native and introduced species of *Danthonia, Enneapogon nigricans, Vulpia bromoides,* and various species of *Bromus* and *Medicago.* At high levels of trampling and grazing by stock, the vegetation has become dominated mainly by introduced annuals *Arctotheca calendula* (Cape weed), *Cynara cardunculus* (wild artichoke), *Silybum marianum* (variegated thistle) *Romulea* (onion grass), and *Trifolium* (clover). The pasture grasses most frequently seen sown on the plains are *Phalaris tuberosa* or *Lolium perenne* and *Holcus lanatus.*

As urbanisation superseded agricultural use of these soils, additional species have made their appearance on waste ungrazed ground of urban allotments, notably, *Avena* spp. (wild oats), *Poa annua* (winter grass), *Plantago lanceolata* (ribwort), *Sonchus oleraceus* (sow-thistle), *Hypochaeris radicata* (flat weed), and *Oxalis pes-caprae.*

The drawings of Margaret Stones illustrate the species in the earlier stages of this succession.

PLATE 1. *Themeda australis* R.Br. Stapf. 1810 1919. Kangaroo grass. (MEL 503468, 503469).
This tall perennial native grass was a dominant feature of the original grassland on the basalt plains. The early disappearance of this species from lands grazed by sheep has been recorded by numerous writers.

PLATE 2. *Danthonia setacea* R.Br. 1810. Bristly wallaby-grass. (MEL 503467).
This widespread species had never been published as present on the basalt soils until its discovery by the artist at St Albans in 1975 prompted this record. Danthonias are important "indicator species" of disturbance and grazing.

PLATE 3. *Rutidosus leptorrhynchoides* F. Muell. 1866. Button wrinkle-wort. (No Voucher specimen).
This showy species is one of about ten that are confined to the basalt plains soils in Victoria, and it is becoming increasingly rare.

PLATE 4. *Goodenia pinnatifida* Schlechtd. 1848. (No Voucher specimen). This is an unusual form of this highly variable species, because it lacks the more characteristic pinnatifid leaf margins. Like many herbaceous plants on these soils, most of the plant is underground.

Tarwin. Crown Grants issued since 3 July 1973 in Wonthaggi and Kirrak are to be the same as elsewhere, namely 15 metres.
(2) On sites for buildings with deep foundations—e.g., 30 metres, 61 metres.
(3) Some land at Morwell and Hazelwood—305 metres.
(4) Lands vested in the Commonwealth. The depth limitation is usually 76 metres (occasionally 15 metres) but by Sections 8 and 10 of the *Lands Acquisition Act* 1955–1973, the Commonwealth can compulsorily acquire Crown lands to unlimited depth, thus implying that the State of Victoria extends to the centre of the earth.

Height

Although no height limitation for Victorian territory was given in the Imperial Statutes defining the boundaries of Victoria, it has generally been accepted that the Crown has complete and exclusive sovereignty over the air space above its territories.

The Convention on Civil Aviation of 1944 (the Chicago Convention), to which Australia was a party, recognises that every contracting State has complete and exclusive jurisdiction over the air space above its territory. Territory is defined for the purposes of the Convention as being the land areas and territorial waters adjacent thereto under the sovereignty of the contracting State.

The Commonwealth Parliament has the constitutional power to legislate to give effect to the Chicago Convention and in relation to air navigation with respect to trade and commerce with other countries and among the Australian States.

The Victorian Parliament has power to make laws relating to the control and use of the air space above its territory which are not inconsistent with laws made by the Commonwealth Parliament on the matter.

In pursuance of its constitutional powers the Commonwealth Parliament has passed legislation regulating air navigation within the air space over the whole of Australia. The Victorian Parliament has passed the Air Navigation Act of 1958 which provides that the Air Navigation Regulations made under the Commonwealth Air Navigation Act, to the extent that they do not apply to the air space over Victoria of their own force, apply to air navigation within that air space as Victorian law.

Geographic position and area

The most southerly point of Wilsons Promontory, in latitude 39° 08′ S., longitude 146° 22½′ E., is the southernmost point of the mainland of Victoria and similarly of the Australian continent; the northernmost point is where the western boundary of the State meets the Murray, latitude 33° 59′ S., longitude 140° 58′ E.; the point furthest east is Cape Howe, situated in latitude 37° 31′ S., longitude 149° 58′ E. The westerly boundary lies upon the meridian 140° 58′ E., and extends from latitude 33° 59′ S. to latitude 38° 04′ S.—a distance of 451 kilometres.

Victoria covers an area of about 227,600 square kilometres. It is, therefore, slightly smaller than Great Britain which (if inland water is included) contains 229,900 square kilometres.

The following table shows the area of Victoria in relation to that of Australia, the other States, and mainland Territories:

AUSTRALIA—AREA OF STATES AND TERRITORIES

State or Territory	Area	Percentage of total area
	square kilometre	
Western Australia	2,525,500	32.88
Queensland	1,727,200	22.48
Northern Territory	1,346,200	17.52
South Australia	984,000	12.81
New South Wales	801,600	10.44
Victoria	**227,600**	**2.96**
Tasmania	67,800	0.88
Australian Capital Territory	2,400	0.03
Australia	7,682,300	100.00

Mountain areas

A wedge of mountainous country extends across Victoria; it tapers from the high peaks of the north-east and far east of the State to the western limits of the highlands at the lower Dundas Tableland near the South Australian border. This belt of high country, which includes the Great Dividing Range, separates the Northern, Wimmera, and Mallee plains from the plains and uplands of the coastal areas and forms the watershed dividing the northern flowing tributaries of the Murray River from the southern flowing streams.

Considerable physiographic and geological variation occurs in the highlands with granitic intrusives, volcanic complexes, and sedimentary, metamorphic, and tectonic structures all in evidence. Broad plateaux, high plains, and extensive ridge and valley terrain are the chief topographic characteristics with only occasional high peaks and deep gorges occurring. A broad low pass to the north of Melbourne (the Kilmore gap) provides an easy route across the highlands and this is utilised by the major road and rail links to the north. The Kilmore gap provides a convenient reference point at which to divide the highlands into eastern and western sections.

Eastern section

The highlands of eastern Victoria consist of strongly dissected and steeply sloping forested country with narrow ridges and deep V-shaped valleys. The area which includes the highest peaks is contiguous with the Kosciusko massif in New South Wales, but the Victorian mountains lack the clear evidence of past glacial activity that can be found in limited areas of Kosciusko. Frost weathering has been intensive at higher elevations and some spectacular accumulations of weathered rock occur as block streams or rock rivers such as at Mt Wombargo near the headwaters of the Murray River.

The high country is not typically alpine in character: sharpened peaks and precipitous bluffs are rare although the Cobberas, The Bluff, and the Mt Buffalo gorge all have impressive cliffs. One distinctive feature of the generally dissected mountain landscape is the High Plains country. Flat to gently undulating topography at elevations of 1,300 metres and above occurs, for example, as the Nunniong, Bogong, and Dargo High Plains, and the High Plains of the Snowy Range. These plains are remnants or residuals of formerly more extensive upland surfaces and include many different rock types—the basalts of the Bogong and Dargo High Plains being two of the best known.

Although snow capped for the winter season with a snow line at about 1,000 metres, even the highest peaks—Mt Bogong (1,986 metres) and Mt Feathertop (1,922 metres)—become free of snow in summer.

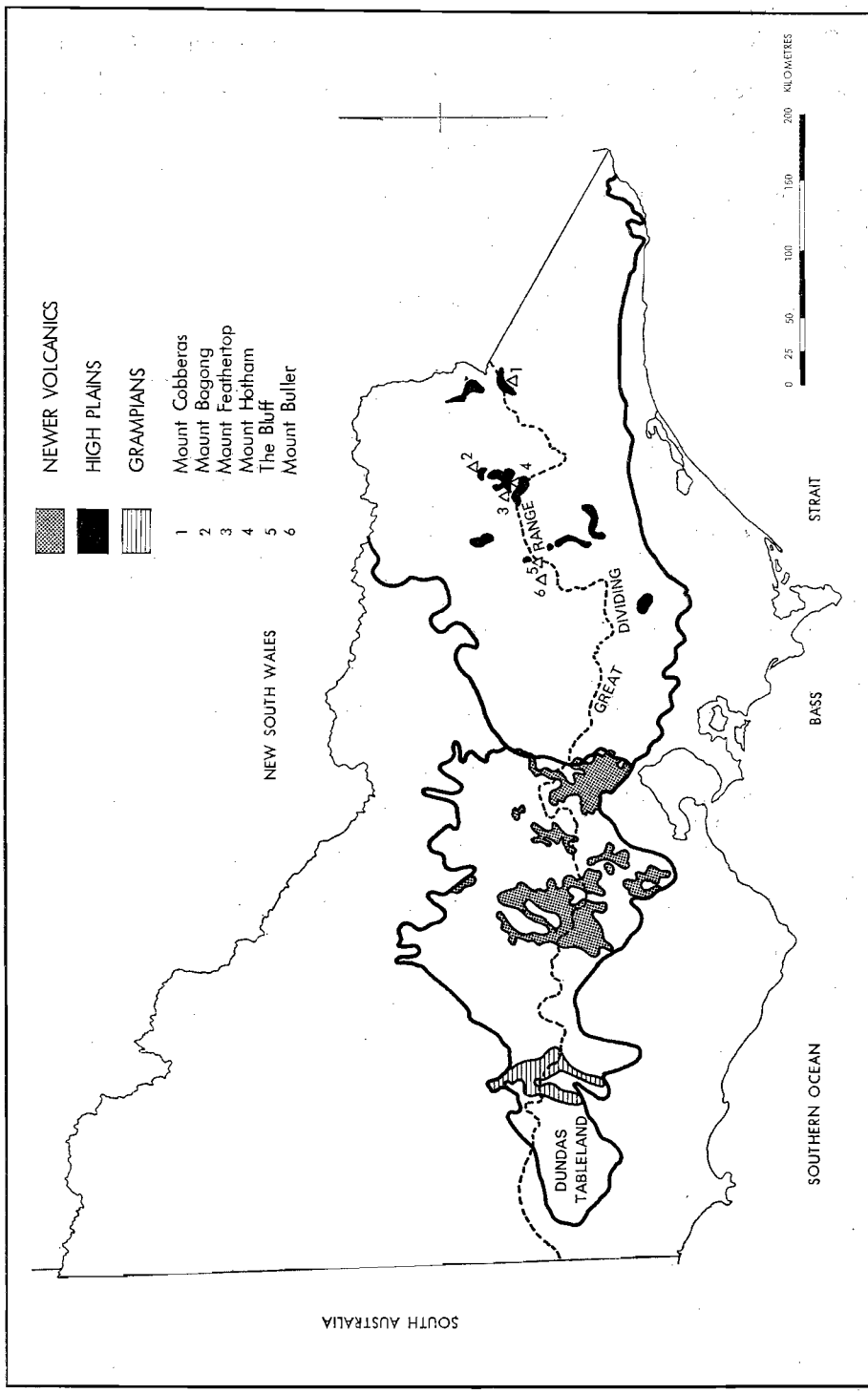

FIGURE 5. Mountain areas of Victoria.

Western section

The highlands here are of much lower relief than the eastern section and in places lack the clearly defined watershed of the eastern ranges. A notable feature is the concentration of volcanic activity (Newer Volcanics) extending from just north of Melbourne to the Ballarat district in the west. Over 200 eruption points have been identified with many of the lava flows now forming ridges which bury the pre-volcanic stream channels and give rise to auriferous deep leads (gold-bearing gravels). Diversion and modification of river courses by lava flows has led to the formation of waterfalls, for example, on the Coliban River at Trentham Falls where the river runs across lava and cascades over 20 metres onto bedrock.

The following table lists some of Victoria's highest mountains:

VICTORIA—HEIGHT OF SELECTED MOUNTAINS
(metre)

Mountain	Height	Mountain	Height
Bogong	1,986	Niggerhead	1,843
Feathertop	1,922	McKay	1,843
Nelse North	1,883	Cobboras No. 1	1,838
Fainter South	1,877	Cope	1,837
Loch	1,874	Spion Kopje	1,836
Hotham	1,861	Buller	1,804

The most rugged section of highland in western Victoria is The Grampians, a series of resistant sandstone ridges etched out by differential weathering and removal of softer siltstones and shales. The highest peak, Mt William (1,167 metres), has a spectacular easterly facing escarpment and a broad plateau-like summit surface. The Grampians form a major water catchment for the Wimmera and Glenelg systems and provide recreation and wildlife preservation opportunities.

Coastline

The Victorian coastline comprises many types of environments. Broad sandy beaches and impressive cliffed headlands along the ocean coast contrast with mangrove-fringed mudflats and marshland of the sheltered embayments and estuaries. There are approximately 1,200 kilometres of ocean coast between Cape Howe and the South Australian border; in addition three large embayments —Port Phillip Bay (260 kilometres), Western Port (140 kilometres), and Corner Inlet (80 kilometres)—partially enclose protected waters and provide opportunity for port and harbour development.

Much of the ocean coast is exposed to high wave energy from strong and regular ocean swells and storm wave activity generated in the Southern Ocean. In western Victoria, swells arrive predominantly from the west and south-west, while the coastline of eastern Victoria (particularly east of Wilsons Promontory) is subject to swell from the south-east across the Tasman Sea. The shape of the long gently curving Ninety Mile Beach from Corner Inlet to Lakes Entrance is determined by wave action from this swell.

Three general coastal types may be recognised: cliffed coasts, sandy coasts, and salt marsh and swamp coasts. The most extensive cliffed section is west of Port Phillip Bay from Torquay to Warrnambool, including a zone where the Otway Ranges lie adjacent to the coastline. The sandstone rocks of the Otways generally dip seaward and form steep cliffs, commonly with a level rock bench called a shore platform lying between high and low tide marks. Intricate weathering and erosion forms develop, etching out details of rock structures in the cliffs and platforms. Along this sector, sandy beaches are rare, being confined to small embayments or river mouths and often containing a high component of gravel.

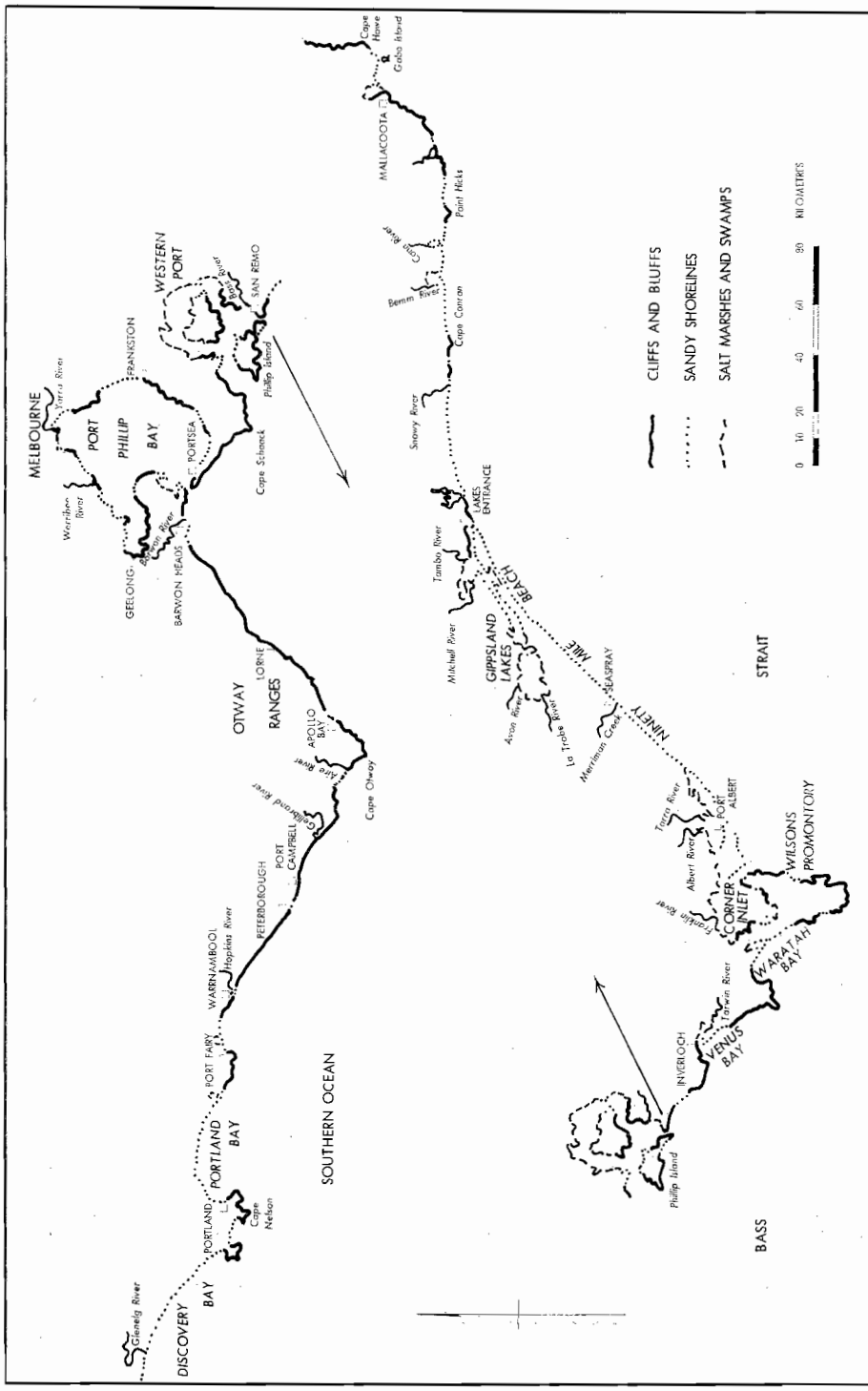

FIGURE 6. Predominant coastal landforms in Victoria.

West of Cape Otway to Warrnambool and particularly from the Gellibrand River to Peterborough is a spectacular cliffed coastline cut into soft horizontally bedded limestones and clay rocks. Wave action has eroded along fractures and weaknesses in the rock to produce near-vertical cliffs up to 60 metres high and forming blowholes, arches, and isolated rock stacks. Many of these features may be observed in the Port Campbell National Park.

High cliffed sectors are formed in volcanic rocks near Portland where Cape Duquesne and Cape Bridgewater illustrate many of the features associated with volcanic explosions and lava flows. As well, the coast at Cape Schanck and the ocean coast of Phillip Island is cliffed into layers of early Tertiary lava flows. Along the Gippsland coast sandstones form high cliffs at Cape Paterson and Cape Liptrap, while the plunging cliffs of Wilsons Promontory are of granite. Shore platforms occur in both the sandstone and the volcanic rocks but no such feature is found along the granite sectors.

Sandy beaches backed by extensive dune topography extend around Discovery Bay in far western Victoria. In many places these sand ridges are actively eroding and sand is spilling and blowing inland to cover coastal vegetation. Similar erosion is noted along the Ninety Mile Beach and on the sandy beaches and dunes further east between Lakes Entrance and Cape Howe.

Estuary and lagoon systems occur at river mouths or where embayments have been partially or wholly enclosed by sand. Rivers such as the Snowy, the Barwon, and the Glenelg have lagoons occupying their lower reaches and the river mouth may be constricted by the growth of sandy spits. These may be breached and modified by flood discharge: in the floods of early 1971 the Snowy River shifted its outlet over one kilometre to the west by breaking through the dune-capped barrier that deflects the entrance eastward of Marlo.

The Gippsland Lakes are an extensive lagoon system enclosed behind broad sandy barrier systems. In the sheltered lake waters deposits of silt and mud have accumulated among the reed swamps at the mouths of rivers to form long silt jetties or deltas. The largest of these, the Mitchell delta, and its companion at the mouth of the Tambo River are no longer extending but are subject to erosion by wave action.

In the shallow and sheltered waters of Western Port and Corner Inlet, mangrove swamps and salt marsh form a broad coastal fringe. Creeks and channels cross the soft, sticky mud-flats exposed in front of the mangrove fringe and form intricate patterns of tidal drainage. Smaller areas of mud and mangrove occur in the estuaries of the Barwon River and the Tarwin River; in the latter, the rapid spread of an introduced, salt-tolerant plant (*Spartina anglica*) is of particular interest.

Survey and mapping

The Division of Survey and Mapping of the Department of Crown Lands and Survey is responsible for the development of the National Geodetic Survey within Victoria; the preparation of topographic maps in standard map areas; the survey of Crown lands under the provisions of the *Land Act* 1958; the co-ordination of surveys throughout the State under provisions of the *Survey Co-ordination Act* 1958; surveys for the Housing Commission, the Rural Finance and Settlement Commission, and other departments and authorities; and the documentation of these surveys.

An Australia-wide primary geodetic survey was completed in 1966, and in Victoria this is continuously being extended to provide a framework of accurately fixed points for the control of other surveys and for mapping. A State-wide network of levels was completed in 1971. The datum, based on mean sea level values around the whole coast of Australia, is known as the Australia Height Datum (AHD), and its adoption obviates the multitude of

local datums formerly in use throughout the State. Issued lists of level values on the AHD are in metres.

An official map of Victoria showing highways, roads, railways, watercourses, towns, and mountains, together with other natural and physical features, has been published in four sheets at a scale of 1:500,000. A less detailed map of Victoria is also available in one sheet at a scale of 1:1,000,000. Topographic maps at a scale of 1:250,000 providing a complete map coverage of the whole State have been published by the Division of National Mapping of the Department of National Resources and the Royal Australian Survey Corps. A joint Commonwealth–State Government mapping project, commenced in 1966, is proceeding with the production of topographic maps at a scale of 1:100,000 with a 20 metre contour interval. A number of these maps has been published. The Mines Department and the Forests Commission also contribute to State mapping by publishing maps for geological and forestry purposes.

A series of 26 maps at a scale of 1:25,000 showing streets, rivers, creeks, and municipal boundaries in Melbourne and its suburban area, including the Mornington Peninsula, has been produced. A long-term programme for production of general purpose standard topographic maps, at 1:25,000 scale with a 10 metre contour interval, has been planned to extend this map coverage over the greater metropolitan area, and to embrace many of the larger provincial centres. Other maps of urban and suburban areas at 1:10,000 scale, showing full subdivisional information, are being prepared of the Mornington Peninsula area; similar maps of various rural centres are on programme in conjunction with Commonwealth Government maps at the same scale required for census purposes.

Large scale base maps have been prepared for rapidly developing areas throughout the State, including the outer metropolitan area, Mornington Peninsula, Ballarat, Geelong, Bendigo, Phillip Island, and a number of other rural areas. These maps were originally compiled at a scale of 1:4,800 (400 feet to 1 inch) with a 5 foot contour interval. However, with the introduction of the metric system, all new maps will be prepared at a scale of 1:5,000, generally with a 2 metre contour interval. The publication *Official Map and Plan Systems Victoria* has been issued setting out the standard format size and numbering systems which have been adopted for the production of maps and plans at the standard scales of 1:20,000, 1:16,000, 1:10,000, 1:5,000, 1:2,500, 1:1,000, 1:500, and 1:250. The systems are based on the Australian Map Grid (AMG), which fulfils the basic principles necessary for the complete integration of surveys.

The Division carries out cadastral surveys of Crown lands for the purpose of defining boundaries and for determining dimensions and areas of reservations and of allotments for the subsequent issue of Crown grants. This information forms the basis for the compilation of county, parish, and township plans, which are published at various scales and show details of the original subdivision of Crown lands. Recently further investigations have been made with the object of introducing a fully integrated topographic-cadastral map and plan system. Although cadastral requirements may result in the publication of plans using an additional range of scales, it will be a fundamental principle that the Australian Map Grid will be the basic framework of their compilation.

As part of its mapping activity, the Department provides an aerial photography service and maintains an aerial photography library of approximately 300,000 photographs from which prints and enlargements may be obtained. Maps, plans, and aerial photographs are available for purchase from the Central Plan Office of the Department.

Further reference, 1976; Hydrography, Coastline, 1966; Coastal physiography, 1967; Plant ecology of the coast, 1968; Marine animal ecology, 1969; Marine algae of the Victorian coast, 1970; Erosion and sedimentation on the coastline, 1971; Conservation on the Victorian coast, 1972

Physical divisions

This article should be read in conjunction with the sections on geographical features, area, and climate.

The chief physical divisions of Victoria are shown in Fig. 7 on page 73. Each of these divisions has certain physical features which distinguish it from the others, as a result of the influence of elevation, geological structure, climate and soils, as is recognised in popular terms such as Mallee, Wimmera, Western District, and so on. The following is a table of these divisions :

1. Murray Basin Plains:
   (*a*) The Mallee
   (*b*) The Riverine Plains
   (*c*) The Wimmera
2. Central Highlands :
   A. The Eastern Highlands
   B. The Western Highlands :
      (*a*) The Midlands
      (*b*) The Grampians
      (*c*) The Dundas Tablelands
3. Western District Plains :
   (*a*) The Volcanic Plains
   (*b*) The Coastal Plains
4. Gippsland Plains :
   (*a*) The East Gippsland Plains
   (*b*) The West Gippsland Plains
5. Southern Uplands :
   (*a*) The Otway Ranges
   (*b*) The Barabool Hills
   (*c*) The Mornington Peninsula
   (*d*) The South Gippsland Highlands
   (*e*) Wilsons Promontory

Murray Basin Plains

These plains include the areas commonly known as the Mallee, the Wimmera, and the Northern Plains or Riverine Plains. The plains are effectively subdivided by a north-south fracture known as the Leaghur Fault which runs sub-parallel with the Loddon River immediately west of Kerang.

From the Murray River to the Central Highlands, eastwards of the Leaghur Fault, is the remarkably flat landscape of the Riverine Plains, which are coalescing alluvial plains of the Murray, Loddon, and Campaspe Rivers, formed by fluvial sedimentation. Crossing the Riverine Plains is an extensive system of dry former stream courses now choked with sand, and known as prior streams.

West of the Leaghur Fault the landscape and soil are very different. Here the *Mallee* country starts, with its irregular surface of undulating sand ridges, mainly of fine sand, which largely trend north-south and appear to be stranded coastal ridges and dunes left on the margin of a retreating sea. The Mallee is in fact the marine plain from the former Murray Basin, with a mere veneer of wind-blown sands overlying fossiliferous Tertiary marine sands and silts, which reach eastwards to the Gredwin Ridge on the Avoca–Loddon divide near Kerang. Westward of the Loddon River, all the Mallee streams, because of low flow volumes, percolation and high evaporation, fail to reach the Murray River and terminate in brackish or saline shallow lakes commonly bordered with lunette ridges.

The *Wimmera* is essentially the low alluvial fans, alluvial plains, and abandoned river channels lying between the Western Highlands and the Murray Basin or the Mallee, as the sand-strewn surface of this basin is commonly known.

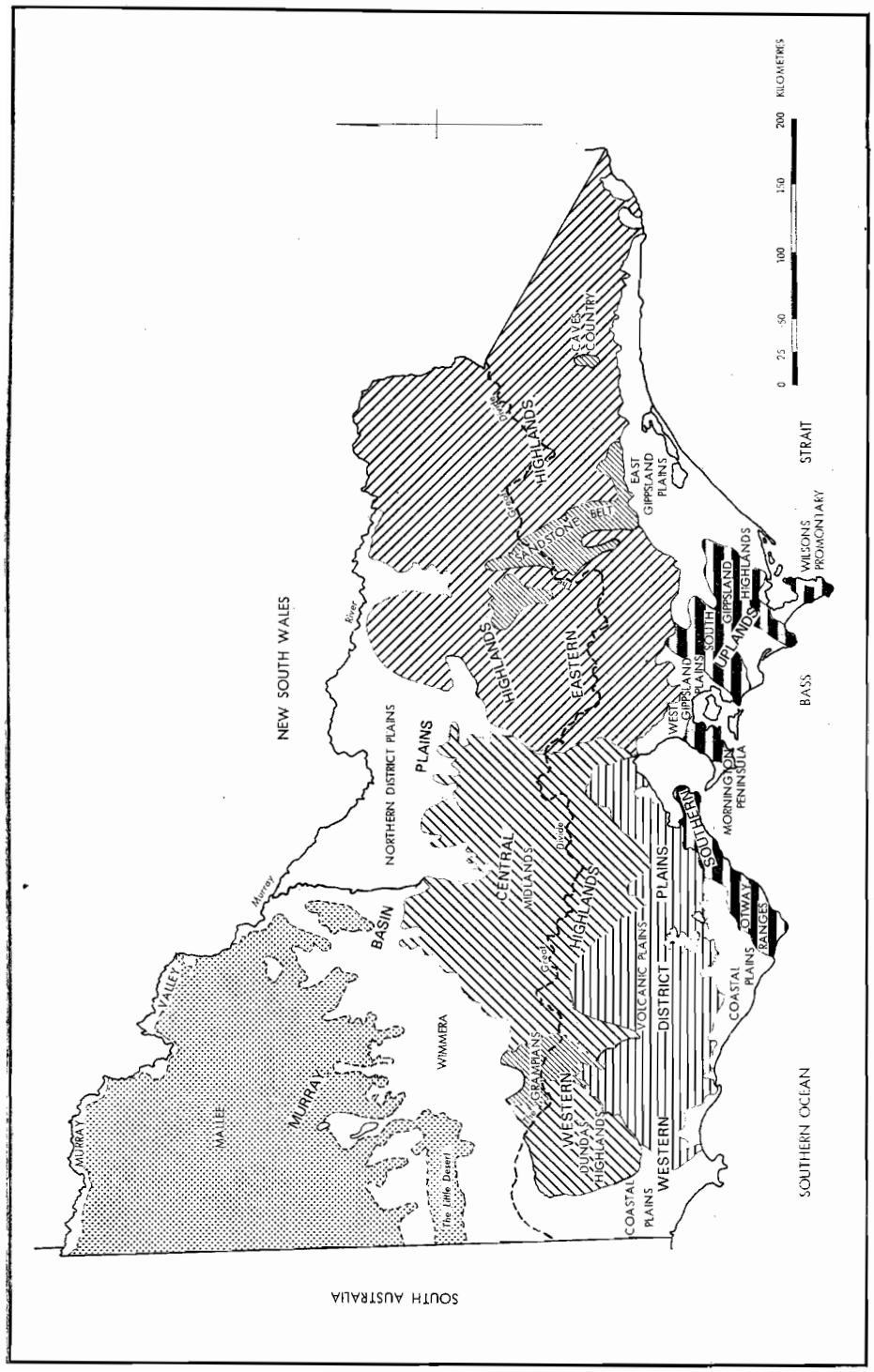

FIGURE 7. Physiographic divisions of Victoria.

Central Highlands

Extending east to west across Victoria is a mountainous and hilly backbone known as the Central Highlands. In eastern Victoria, it is rugged and mountainous, and with plateau-like features commonly capping elevated mountain areas. Known as the *Eastern Highlands,* these mountains in eastern Victoria attain elevations of above 1,800 metres at the highest points such as Mt Bogong and Mt Hotham, and elevations of at least 1,200 metres are common. The major rivers of Victoria with high flow-rates, with the exception of the Glenelg River, all rise in the Eastern Highlands, and characteristically show steep-sided deep and narrow valleys. Residuals of Lower Tertiary basalts occur in the Eastern Highlands, filling old valleys as at the Dargo High Plains and the Bogong High Plains.

The topography of the Eastern Highlands has been strongly influenced by the variety of rock types and structures present. Thus a flat-topped and step-like landscape is found in the hard almost flat-lying Upper Devonian sandstones and rhyolites between Briagolong and Mansfield ; plateaux are preserved in granite at Mt Buffalo and the Baw-Baws ; and lower elevations with dendritic drainage are generally seen in areas of folded Lower Palaeozoic mudstones.

The *Western Highlands,* in contrast to the Eastern, are much lower in elevation and generally are subdued hills rather than mountains. Rugged areas are mostly found only near fault scarps. The general elevation reaches a maximum of about 600 metres at Ballarat, but elevations are mostly considerably less. Resistant masses of igneous rocks such as Mt Macedon and Mt Cole rise well above the general level, but fall well short of the main peaks in the Eastern Highlands. Extensive flat and only slightly dissected areas of basalt from the Upper Tertiary cover parts of the Western Highlands, conspicuously in the Ballarat area where they have yielded rich soils, and above the basalt flows rise prominent eruption points such as Mt Warrenheip near Ballarat.

The Grampians, sharp-crested strike ridges of hard sandstone reaching 1,200 metres in height, are prominent mountains rising far above the declining general level of the highlands as they trend westwards. The westerly extremity of the Western Highlands is the Dundas Tablelands, a warped plateau reaching to Dergholm, formed in contorted Lower Palaeozoic rocks capped with laterite and dissected by the Glenelg River System.

Valleys in the Western Highlands are generally broad rather than deep, apart from where rejuvenating movements have occurred along fault scarps to cause, in some cases, gorges.

The Central Highlands owe their elevation—and relief caused by resultant erosion—to varied upwarping movements and faulting during late Tertiary time.

Western District Plains

The Western District Plains stretch westwards from Werribee to Camperdown, Hamilton, and Portland. They subdivide naturally into volcanic plains and coastal plains.

Volcanic Plains

With an area of 2,300 square kilometres, the volcanic plains are the third largest volcanic plains in the world. They begin at an east-west line through Colac and Warrnambool and reach northwards to the foot of the Grampians.

The Volcanic Plains are almost horizontal, with only a slight southward inclination, and are composed of Pliocene to Holocene basalt flows and some basaltic ash. The Camperdown area shows extensive minor irregularities known locally as " Stony Rises ", formed by lava collapse during solidification : these are so young that they are unmodified by erosion and soil formation. Volcanic cones, frequently of scoria, rise sharply from the plains as at Mt Elephant (394.4 metres) and Tower Hill (98.4 metres), and to some cones can be traced

extensive areas of basalt. Much of the scoriaceous basalt of the "Stony Rises" can thus be linked with Mt Porndon (289.2 metres). Crater lakes in some cones occupy craters formed by explosive vulcanism.

The plains are crossed by some streams such as the Hopkins River with narrow incised valleys, but much drainage is internal, with precipitation finding its way to shallow lakes and underground.

Coastal Plains

Coastal plains, interrupted by the Otway Ranges, extend from Torquay to Warrnambool and northwards to Colac. They are flat or undulating, and are essentially the uplifted surface of Tertiary sedimentary rocks, including limestones, partly dissected by streams and commonly veneered with Quaternary dune limestone and sands. The limestones beneath the plains are cavernous, and are high yielding aquifers for groundwater.

Gippsland Plains

As a planar surface, the Gippsland Plains begin near Yallourn and Port Albert, and spread eastwards to the Bairnsdale area, between the ocean and the Eastern Highlands. Further east, through Orbost to Cann River, they form coastal downs—a dissected coastal plain—rather than a plain.

West of Yallourn, the Gippsland Plains continue, but they are fractured by late Tertiary block faulting to give the Moe Swamp and the Western Port Sunkland down faulted blocks, and uplifted areas such as the Drouin block and the Haunted Hills which are now maturely dissected. Faulting is responsible for related plains bordering the South Gippsland coast in the Wonthaggi area and landward from Cape Liptrap.

The present plains are the upper surface of a Tertiary and Quaternary basin, in which thick sequences of marine and fresh-water sediments have accumulated, including the major brown coal seams of the Latrobe valley. The plains are generally covered with piedmont-type sands, sandy clays and gravels, which originated from the Eastern Highlands during the final late Tertiary movements which elevated them to their present height, and into these gravels the streams have cut broad alluvium-filled valleys with flights of terraces that can be traced back into the Highlands.

A former coastline can be recognised behind the present coastline in the Bairnsdale–Lakes Entrance area. The conspicuous Ninety Mile Beach is a barrier bar which has cut off some of the Gippsland Lakes from the sea, and both spits and islands inland from the beach betray a complex history of barrier formation and erosion related to changed sea levels. Present-day coastal dunes are prominent along sections of the Ninety Mile Beach, and earlier dunes and beach ridges are found on the barriers; earlier dunes are even found north of Woodside and east of Stratford.

Southern Uplands

South-west of the Gippsland Plains is a steep mountainous region, the Southern Uplands, formed by upwarping and faulting, and separated from the Eastern Highlands by the westerly extension of the Gippsland Plains appropriately named by J. W. Gregory as the "Great Valley of Victoria". These mountains, together with the Barrabool Hills near Geelong and the Otway Ranges, are formed of freshwater Cretaceous sandstones and mudstones, and all display a characteristic rounded topography, due in part to very extensive land-slipping and structural weakness in these rocks.

Areas of weathered basalt from the Lower Tertiary are found on the Uplands in plateau-like form at Thorpdale and Mirboo North in South Gippsland, and many smaller remnants are found elsewhere in these ranges; the basalts yield rich soils.

The Otway Ranges similarly originated by upwarping and faulting during Tertiary time.

A further element in the Southern Uplands is the Mornington Peninsula, which is a raised fault block of Palaeozoic granites and sedimentary rocks separating the downwarped Western Port Sunklands and the Port Phillip Sunklands. A subdued spit of calcareous dune rock extending westwards from the Peninsula to Portsea almost closes Port Phillip Bay.

Land surface of Victoria

The present topography of Victoria is the result of interaction between the rock types present, themselves events in geological history, changes in elevation and deformation recorded in that history, processes such as weathering and erosion—including climatic effects—and the stage of development reached by these processes. Hard resistant rocks, for example, will after prolonged erosion tend to stand out in relief, whereas softer more weathered rocks will be topographically more depressed. Over extensive lengths of geological time without major sea-level changes, erosion will tend to wear down a land mass to a surface of low relief—known as an erosion surface—not far above sea-level. In the highlands of Victoria remnants of several such erosion surfaces can be recognised as plateau-like features raised to elevations of hundreds or thousands of metres by uplifts.

Jurassic erosion surface

In the Eastern Highlands, plateau remnants are widespread as, for example, the Cobboras, the Mt Hotham area, Mt Buffalo, the Snowy Plains, Mt Wellington, and the Baw-Baw Plateau: they are all in hard rocks such as granite, rhyolite, and massive sandstone. These plateau remnants, and ridge tops at similar levels, are relics of the most ancient landscape or erosion surface preserved in Victoria. They are the surviving parts of a sub-planar surface which was close to sea-level in Jurassic time, before uplift and warping late in the Jurassic commenced its destruction, and began to form troughs or sedimentary basins in which the sediments represented in the Otways and the South Gippsland Highlands were deposited during Cretaceous time. These upwarps had already begun to define the Central Highlands.

Later evolution

Uplift and downwarping continued intermittently during Tertiary time, with the development of sedimentary basins such as the Murray Basin in north-west Victoria and the Gippsland and Otway Basins in southern Victoria. In the basins was deposited detritus carried down by streams from the rising Highlands, and in swamp conditions great thicknesses of brown coal were laid down in the Gippsland Basin. Deep valleys were cut into the Central Highlands, which were then lower than their present height; in some of these valleys gold-bearing gravels were deposited. Parts of the landscape and some of the valleys were filled with Lower to Mid-Tertiary basalts.

Erosion proceeded to advanced stages during parts of the Tertiary Period, as attested by remains of younger erosion surfaces, preserved at lower levels than the Jurassic erosion surface on the Kinglake Plateau, the hill summits immediately east of Melbourne and around the Dandenong Ranges to Gembrook, and elsewhere in the Central Highlands.

By Miocene time, downwarping movements were at their maximum. Embayments of the sea covered much of Gippsland, the Port Phillip Basin, an extensive area of western Victoria south of Lismore and the Grampians (the Otway Basin), and north of the Grampians the Murray Basin spread as far as Broken Hill, New South Wales. The record of this transgression is left in limestones and other sedimentary deposits. Retreat of the sea towards its present position during the Pliocene was accompanied by further uplift of the Central Highlands, leading to further erosion, valley deepening, and the accumulation of extensive sheets of sands, clays, and gravels both on the lowland plains and as piedmont gravels on the spurs leading down to the lowlands.

The Upper Tertiary and even Quaternary saw vast volcanic activity in central and western Victoria. From Melbourne to Hamilton basalts and tuffs were outpoured and ejected. Flows followed pre-existing valleys in the Western Highlands, burying auriferous gravels as deep leads in the Ballarat district.

Final downwarpings, assisted by the melting of glacial ice at the end of the Pleistocene, led to the drowning which has given Port Phillip Bay and Western Port their present configurations, and concomitant upwarps in the Central Highlands elevated them to their present level.

Changing climate has played a role in this physiographic evolution. Thus the mid-Tertiary, with the rich flora evident in the brown coals, appears to have been a time of higher rainfall than at present, with the resultant of larger streams with more erosive power, and changing Quaternary climates are recognised in the changing regimes evident in the former lakes and prior streams of the Riverine Plains.

Geology of Victoria, 1976

Hydrology

Water resources

The average annual rainfall over Victoria is about 660 mm. As the area of the State is 227,600 square kilometres, the total precipitation is, therefore, about 148 million megalitres. Only 21 million megalitres appear in the average annual flow of the State's river systems. It is not yet known how much of the remainder soaks underground to recharge groundwater resources, but this will be elucidated by a long-term programme of investigation being carried out by the Victorian Mines Department.

Victoria's surface water resources are unevenly distributed in both space and time. Their distribution in space can be conveniently described by considering the State as being divided into four segments, by an east-west line along the Great Dividing Range and a north-south line through Melbourne. The north-west segment contains 40 per cent of the State's area, and the other three segments 20 per cent each. Surface water resources, represented by average annual river flow, are heavily concentrated in the eastern segments, each accounting for about 40 per cent of the total. The western segments account for only 20 per cent of total flow, with only 3 per cent in the north-west segment.

Quality of stream flow also deteriorates from east to west. Waters of the eastern rivers mostly contain less than 100 parts per million of total dissolved solids. In the western rivers the figure is generally above 500 parts per million, except near their sources, and increases downstream to figures in excess of 1,500 parts per million.

River flows in Victoria exhibit a marked seasonal pattern, and marked variability in annual flow from one year to another and from place to place, affecting the usability of the transitory local surface supplies of fresh water.

Over the State as a whole, about 60 per cent of the average annual flow is accounted for between July and October. In western streams this percentage approaches 75 per cent. Everywhere, flows typically recede in the summer and autumn, at the time of year when water requirements for most uses are at a peak.

Rivers

Topography

The topography of Victoria is dominated by the Great Dividing Range, which extends from a triangular mountainous mass in the east, through the narrower and lower central highlands, and terminates at the Grampians in the west. This divide seperates the State and its rivers into two distinct regions: those rivers flowing northwards towards the Murray River and those flowing southwards towards the sea. The only other significant high country within Victoria is formed by the Otways in the south-west and the Strzelecki Ranges in South Gippsland.

Geography

Of all the major Victorian rivers, the Snowy River is the only stream not wholly situated within the State, the headwaters of this river being in the Snowy mountains of New South Wales. The Murray River, although an important water supply source for Victoria, is legally wholly in New South Wales as the State boundary coincides with the southern bank of this stream.

Of the major northern rivers, all except three flow into the Murray River. The three exceptions—the Avoca, Richardson, and Wimmera Rivers—finish their course at inland lakes in the Wimmera-Mallee region, with the Avoca, on rare occasions, overflowing its lakes system, to reach the Murray River.

Of the major southern rivers, the Latrobe, Thomson, Macalister, Avon, Mitchell, and Tambo Rivers all flow into the Gippsland Lakes system, which is linked with the sea by an artificial cut constructed many years ago for navigation purposes. The Woady-Yaloak River in the west flows to the inland Lake Corangamite, while the remaining southern rivers find their way directly into the sea.

Water availability

The eastern rivers of Victoria, both northerly and southerly flowing and those rising in the Otway ranges, have their sources in high rainfall country and provide abundant water resources, while those in the western portion of Victoria, with the exception of the Glenelg, have limited useful yield and many are frequently dry in summer. In fact, approximately 78 per cent of Victoria's available water resources originate in the eastern half of the State and only 22 per cent in the lower ranges to the west.

Physical properties

The actual physical properties of Victorian rivers differ markedly from the east to the west. Rivers in the far east to north-eastern regions of Victoria flow for most of their journey through mountainous terrain in deep gorges, and then into flood plains, before reaching either the Murray River or the sea. Heavy shingle has been scoured from the bed and banks of these fast flowing mountainous streams and finally deposited downstream in the plain area. Water quality of these streams is clear and free from excessive suspended mud and silt.

Rivers in central and western Victoria, on the other hand, have comparatively short mountainous sections, and for the majority of their length wander sluggishly through undulating to flat country. Velocities of flow are far less than for their mountainous counterparts, and material carried by these streams consists of fine silt and clay which causes the muddy turbid waters, distinctive of these central and western rivers.

For those rivers that flow to the sea, there is a tendency at the river mouth for the formation of sand spits and dunes, with the consequent obstruction of the mouth. Some of the smaller streams become blocked entirely and breach only in times of flood.

Salinity

Rivers in the eastern highlands, flowing mainly through heavily timbered mountain tracts, generally have very good quality water suitable for all purposes. In the lower central highlands, salinities vary from stream to stream but generally flows are fresh in the winter and spring and slightly saline in the summer and autumn. In the south-west regions of Victoria, catchments consist mainly of grasslands, with scrub regions in the north-west, and streams here are slightly to moderately saline for most of the year.

Flooding

Rainfall throughout Victoria is erratic during the year and hence the majority of the State's rivers are prone to flooding at any time, with rivers in Gippsland

often subject to summer flooding. Flooding problems on a number of major streams have been markedly reduced by the construction of dams which, although designed for the supply of water and not for flood mitigation, provide substantial temporary storage above the full water supply level.

VICTORIA—MAIN STREAM FLOWS

Stream	Length	Drainage area	Annual stream flows in million cubic metres (to 1969)				
			Mean	Max.	Min.	No. of years gauged	Site of gauging station
	kilometre	square kilometre					
NORTHERN RIVERS							
Murray	1,926 (from source to Victorian border)	6,527 (upstream of Jingellic)	2,368	6,123	675	80	Jingellic, N.S.W.
Mitta Mitta	286	5,058	1,411	4,256	250	49	Tallangatta
Kiewa	185	1,145	632	2,071	166	84	Kiewa
Ovens	228	5,827	1,572	4,143	221	29	Wangaratta
Broken	193	1,924	247	1,091	19	84	Goorambat
Goulburn	566	10,772	2,139	7,369	145	88	Murchison
Campaspe	246	3,212	236	820	1	78	Elmore
Loddon	381	4,178	231	740	9	78	Laanecoorie Reservoir
Avoca	270	2,624	76	395	3	80	Coonooer
Wimmera	291	4,066	128	589	..	77	Horsham
SOUTHERN RIVERS							
Snowy	162 (in Victoria)	13,421	1,814	4,002	381	33	Jarrahmond
Tambo	200	943	58	121	21	5	Swifts Creek
Mitchell	251	3,903	921	2,188	193	32	Glenaladale
Thomson	209	1,088	400	680	175	50	Cowwarr
Macalister	202	1,891	496	1,533	45	51	Lake Glenmaggie
Latrobe	251	4,144	940	3,240	271	55	Rosedale
Bunyip	63	661	153	304	69	47	Bunyip
Yarra	246	2,328	804	1,494	176	52	Warrandyte
Maribyrnong	183	1,303	107	327	4	39	Keilor
Werribee	124	1,155	79	314	7	53	Melton Reservoir
Moorabool	153	1,114	70	221	1	24	Batesford
Barwon	188	1,269 (excluding Leigh and Moorabool Rivers)	58	102	7	4	Inverleigh
Hopkins	282	1,347	32	127	1	38	Wickliffe
Glenelg	457	1,570	144	540	3	60	Balmoral

Lakes

Lakes may be classified into two major groups : those without natural outlets which are called closed lakes, and those with a natural overflow-channel which may be termed open lakes. For closed lakes to form, annual evaporation must exceed the rainfall : this is the case over most of Victoria.

Closed lakes occur mainly in the flat western part of the State. They fluctuate in capacity much more than open lakes and frequently become dry if the aridity is too high. For example, Lake Tyrrell in the north-west is usually dry throughout the summer and can consequently be used for salt harvesting.

The level of water in an open lake is more stable because as the lake rises the outflow increases, thus governing the upper lake level and partially regulating streams emanating from it. This regulation enhances the economic value of the water resources of open lakes, but Victoria does not possess any natural large lake-regulated streams. However, there are small streams of this type in the Western District, such as Darlots Creek partly regulated by Lake Condah and Fiery Creek by Lake Bolac.

Salinity is often a factor which limits the use of lake water ; even the use of freshwater lakes is not extensive in Victoria due to the cost of pumping. The average salinity of closed lakes covers a wide range depending upon the geological conditions of the catchments and the water level.

Lake Corangamite is Victoria's largest lake. It can be regarded as a closed lake, although during the wet period in the late 1950s it rose to within 1.2 metres of overflowing. The total salt content of the Lake is about 16.32 million tonnes, giving it a salinity somewhat higher than seawater under average water level conditions.

The Gippsland Lakes are a group of shallow coastal lagoons in eastern Victoria, separated from the sea by broad sandy barriers bearing dune topography, and bordered on the ocean shore by the Ninety Mile Beach. A gap through the coastal dune barrier near Red Bluff, which was opened in 1889, provides an artificial entrance to the lakes from the sea. However, seawater entering this gap has increased the salinity of some lakes, which in turn has destroyed some of the bordering reed swamp and led to erosion. The Gippsland lakes have been of value for commercial fishing and private angling and also attract many tourists. Coastal lagoons of this type rarely persist for more than a few thousand years and as deposition of sediment proceeds and bordering swamps encroach, the lakes will gradually be transformed into a coastal plain.

A number of Victorian lakes and swamps have been converted to reservoirs. Waranga Reservoir is an example of this, as are Lake Fyans, Batyo Catyo, and Lake Whitton in the Wimmera. A good example of lake utilisation is the Torrumbarry irrigation system on the riverine Murray Plains near Kerang in north-west Victoria.

Groundwater resources

Groundwater resources move slowly through pores and cracks in soil and rock and respond sluggishly to seasonal and annual fluctuations in recharge. For this reason, groundwater can be regarded as a generally more reliable source of water through drought periods. However, mapping of resources in terms of depth, yield, and quality is much more complex than the mapping of visible surface resources.

The present position, very broadly stated, is that there are groundwater resources of reasonable quality and yield for domestic and irrigation purposes over about 4,000,000 hectares or about one sixth of Victoria's area, mainly in the far west and south-west and in alluvial valleys in the north and south-east.

On the other hand, there is about half the State's area, in the central and western sectors, where groundwater is generally not available at qualities better than 3,000 parts per million of total dissolved solids.

Groundwater has played a very important part in providing supplies of water for domestic and stock use in pastoral settlement. It is also used for some isolated town supplies, and is being increasingly used for irrigation, the area irrigated from groundwater now being about 12,000 hectares.

For the future, there are prospects of generally increased use for irrigation, and for the augmentation of town water supplies on the south-west coast, in the Barwon Valley, and in Gippsland. However, these prospects can only be clarified by continuing investigation.

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