

victoria's

# biodiversity



DIRECTIONS IN MANAGEMENT

*the variety of all life-forms...  
the different plants, animals and micro-organisms,  
the genes they contain,  
and the ecosystems of which they form a part.*



Natural Resources  
and Environment

AGRICULTURE  
RESOURCES  
CONSERVATION  
LAND MANAGEMENT

# **' Victoria's Biodiversity: – Directions in Management'**

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## Victorian Biodiversity in the Year 2020: A History of the Future

Throughout the world, Victoria has been recognised for over a decade as the premier state in Australia for the protection and enhancement of its biodiversity assets. It has the nation's most comprehensive reserve system forming the cornerstone for the sustainable use of Victoria's terrestrial, freshwater and marine ecosystems. In 2020, these 'jewels in Victoria's crown' are highly valued by the local community and international visitors.

As our understanding of the biodiversity of Victoria increased many 'conservation' issues were resolved because there was an increased awareness of what each component added to the health of the environment. Biodiversity conservation had been fully incorporated into all planning processes and the role of plants and animals in maintaining beneficial natural processes, for example nutrient recycling, was universally understood. Intensive studies on our threatened species and communities over many years has led to increased protection and recovery of many of these species and communities. Some knowledge gained from these studies gave us deeper insights into the nature of living in Victoria, while some Victorian plants have contributed to new pharmaceutical discoveries.

There have been many visual changes over the past

20 years, one of the most notable of which is that native vegetation has been restored along almost 90 per cent of the rivers and streams. This has dramatically extended wildlife habitats both on the banks and in the stream while the water quality of most of our rivers and streams has markedly improved.

The quality and quantity of our freshwater resources were recognised in the 1990s as one of the primary limiting factors in the Victorian environment and some sectors of the economy. These resources are now being very carefully managed to maximise biodiversity outcomes for catchments and for the bays and estuaries to which they flow. In the urban landscape Victorians have learnt that better water conservation and recycling alleviates the need for additional dams despite the substantial increase in population.

In the rural landscape, programs such as Landcare and Land for Wildlife, begun more than 30 years ago, have taken deep root in the community, where most people now view the conservation of biodiversity as part of their everyday lives. Conservation custodianship has been internalised as a result of this ground-breaking work. Over this period, urban Victorians began to take a greater interest in their local areas and in the rural landscape of Victoria. This trend was assisted through the expanding 'Friends Groups' which gave urban people the opportunity for direct involvement in conservation activities in significant areas.

This generation of rural and urban Victorians have a deeper appreciation of and empathy for the landscape, its biodiversity and its place in their quality of life than had the previous generation.

The historical loss of native vegetation was reversed by the turn of the millennium and Victoria has for 20 years been in a situation of net gain. The pivotal 'net increase' goal was introduced as part of the State/Commonwealth partnership under the Natural Heritage Trust program in 1997. The gains were achieved through improving the health of existing remnants and by strategic revegetation. Through restoration in 'biolinks' Victoria had obtained an international reputation for ameliorating the potentially adverse effects of the enhanced greenhouse effect on biodiversity. The quality of native vegetation and habitat has also improved since natural resource management regimes shifted to an ecologically sustainable basis.

Victorian forest products are now sought after in the high value markets as being proven to be 'grown green'. In the rural landscape, the wine industry in Victoria led the way in environmental quality assurance, achieving a strategic advantage in the global market place. Other biodiversity assets were increasingly recognised in traditional industries; for example our native grasslands were incorporated in drought management strategies on many grazing properties. Our management of fisheries has become ecologically sustainable, and Victoria enjoys international prestige for its fully integrated approach to the management of exotic marine organisms.

The development of key biodiversity monitoring methods promoted accelerated change, allowing landholders and management agencies to assess the quality of ecological communities and measure changes over time. This was an important breakthrough, as it gave people practical tools for working out how to modify their production and conservation management practices to achieve zero or positive impacts on biodiversity. Monitoring undertaken across the State provided information that enhanced Victoria's 'clean and green' reputation, assisting all Victorian export industries and attracting international tourism.

By the end of the millennium, management of all land and water resources had agreed on definable ecological goals, which were implemented through whole-farm planning, forest agreements, the planning system and other land management planning and approval systems. One example of the change that this approach has brought is the increased use of cleared private land for plantations of native timber trees, wildflowers and bush tucker species. Strategic revegetation also helped ameliorate some of the salinity and soil degradation problems that faced Victoria.

Early in the new century it was recognised that international markets preferred and were willing to pay for natural resources, especially foods that were produced in an ecologically sustainable manner. Many Victorian industries flourished as their value-added products became known for being not only clean and green, but clean and grown green! The domestic market both responded to and promoted these trends. Many companies brought about these changes through environmental management systems which achieved and went beyond international standards in the area of biodiversity conservation. The role of the Victorian Government in supporting the early development of this approach was crucial.

In response to consumers and changing community values, leaders in all types of businesses have become genuinely committed to conservation goals and are ameliorating impacts on biodiversity. 'Biodiversity-friendly' has become a shared part of our quality of life. Once again, Victoria showed international leadership and developed methods for including a biodiversity component in product life-cycle analysis methods. 'Biodiversity friendliness' is now a standard element of product descriptions, similar to the energy efficiency ratings introduced in the 1980s. During the past 25 years the increasing adoption of the 'custodianship' approach by Victorians had led to both a better quality of life and better biodiversity conservation outcomes. Now, in the year 2020, a deeper sense of place and quality of life has developed through better knowledge and understanding of and empathy with our natural heritage.

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## Foreword

Victoria's Biodiversity – Directions in Management documents the methods which will be used to achieve the aspirations we have for conserving biodiversity into the future. It is one of three documents which together comprise the Victorian strategy for conserving and maintaining our biodiversity. Victoria's Biodiversity – Our Living Wealth describes

the state's broad ecosystems and the plants and animals they support. Victoria's Biodiversity – Sustaining Our Living Wealth shows how we can integrate biodiversity conservation into actions throughout the community.

This document presents a systematic and robust approach to defining biodiversity assets and for reporting on performance management across diverse interests.

It presents a practical application of the biogeographical region approach which has been foreshadowed both internationally and nationally as an appropriate framework for planning and management of biodiversity. Descriptions of the landscape, waters and seascape, their values, condition and our management responses are detailed for each of the Victorian bioregions defined under this system. The bioregional framework is designed to be responsive to changes in technical information, community values and industry needs, and to improvement in our understanding of our biodiversity and the way we monitor and report on it.

It also allows local communities to appreciate the biodiversity assets within their own landscapes.

Victoria is well placed to provide a performance reporting system which is outcome based and will contribute to the partnership arrangement with the Commonwealth Government established under the Natural Heritage Trust.

I am pleased to endorse this document which satisfies our obligations under the Flora and Fauna Guarantee Act 1988 and the National Strategy for the Conservation of Australia's Biological Diversity, and which will contribute to biodiversity conservation by natural resource managers and the whole community.

Marie Tehan  
Minister for Conservation  
and Land Management



## Introduction

This is the third of the three documents that comprise Victoria's Biodiversity Strategy .

The aims of the Strategy are to:

- increase awareness of the need to conserve biodiversity;
- enable continued development of partnerships between the community, industry and government in the custodianship of our biodiversity;
- indicate the mechanisms, existing and proposed, for achieving the objectives of flora and fauna conservation and management in the context of ecological sustainability;
- provide perspectives on advances in flora and fauna conservation and directions for effective future action;
- detail strategic frameworks to prevent further loss of habitat, and a focus for better management of existing habitats and the continuation of natural ecological processes;
- highlight the need for protection and replenishment of the total area of native vegetation, with particular emphasis on threatened or depleted types such as Box-Ironbark forests, grasslands and riparian environments;
- highlight the major threatening processes in each bioregion that must be ameliorated to conserve biodiversity;
- highlight the habitats and environments that require urgent attention.

Our awareness of the environment, and our knowledge of land use and the ecology of our flora and fauna have all increased dramatically over the last two decades. In 1992, the Draft Flora and Fauna Guarantee Strategy was published. The numerous submissions and comments generated were used to help formulate this document. Other events, such as the publication of the National Strategy for the Conservation of Australia's Biological Diversity (see Appendix 1 for objectives), new legislative developments, such as the Catchment and Land Protection Act 1994, and more recently the Natural Heritage Trust Partnership agreement have all emphasised the importance of this strategy and provided further context for its implementation. It fulfils the requirements of the National Strategy and the Flora and Fauna Guarantee Act 1988.

This document, Victoria's Biodiversity – Directions in Management, addresses the critical issues of management and continues to build on achievements of the past. Part I provides a state-wide view and key management approaches in ecological land and water management. Part II describes the biodiversity assets and challenges that characterise each of Victoria's bioregions. These bioregions nest within the national categorisation for terrestrial environments, the Interim Bioregionalisation for Australia (IBRA), and for marine environments, the Interim Marine and Coastal Regionalisation for Australia (IMCRA).

Natural resource management across the State has changed over time and various responses, institutional, regulatory and voluntary, have been described in Sustaining our Living Wealth.

In some environments the direction forward is clear, in others problems remain ill-defined or the specific responses are not fully developed or implemented.

For this reason Part I considers management approaches according to the general conditions at the landscape scale: largely natural; remnant with altered ecological processes; and highly altered with intensive pressures. Common themes within these landscapes are examined. Part I also describes the tools available to us at present and how they can be improved to achieve the best biodiversity outcomes. Information technology offers a good example: Victoria has the best land information and biodiversity databases in Australia; it is important that these, and the products derived from them, are increasingly accessible to all managers, business and the community. This will lead to more informed decisions for the whole community and better outcomes for the Victorian environment.

Part II of Victoria's Biodiversity – Directions in Management provides details of the biodiversity in each of Victoria's 21 terrestrial and 6 marine bioregions, and the management responses required for protecting and restoring them. Victoria's bioregions are an integral part of the national bioregion classification system. Providing information on the natural assets in each bioregion, their current condition and the major management themes makes it possible for all Victorians, wherever they reside, work or spend recreational time, to better appreciate their local areas and the strategic needs of their local biodiversity assets.

The key to an efficient and effective biodiversity program is to take, in cooperation with the community and other stakeholders, systematic preventative action to reduce the causes of decline of native flora and fauna. This strategy emphasises systematic prevention or reduction of the causes of biodiversity decline or loss. It focuses on direct ecologically sustainable management of public lands and waters by government agencies in association with resource-based industries, and on cooperative management of biodiversity on private land, in partnership with landholders, the community and local government.

### Objectives for Management of Biodiversity

The National Strategy for the Conservation of Australia's Biological Diversity, the National Strategy for Ecologically Sustainable Development and the Flora and Fauna Guarantee Act 1988 all provide overarching objectives for the conservation and management of biodiversity. However, the range of historical impacts on biodiversity and the need for on-going sustainable use of natural resources, mean that it is neither feasible nor necessary for these objectives to be met at every locality or continually in particular localities. Many biodiversity values are common and widespread, and many are relatively robust and can recover from a range of impacts. It is therefore appropriate to express the intent of the objectives in practical goals that can provide scaled reference points against which to plan and measure the overall effectiveness of on-ground management actions. Each goal can be linked to performance indicators within all bioregions.

The goals for biodiversity management are to ensure that within Victoria:

- there is a reversal, across the entire landscape, of the long-term decline in the extent and quality of native vegetation, leading to a net gain with the first target being no net loss by the year 2000;
- the ecological processes and the biodiversity dependent upon terrestrial, freshwater and marine environments are maintained and, where necessary, restored;
- the present diversity of species and ecological communities and their viability is maintained or improved across each bioregion;
- there is no further preventable decline in the viability of any rare species or of any rare ecological community;
- there is an increase in the viability of threatened species and in the extent and quality of threatened ecological communities.

Attributes that define the condition of natural vegetation, or any ecological community, include the proportion of species remaining of the original complement and the persistence of the structural complexity of the vegetation.

Removing components of habitat on land or in water eliminates a proportion of the biodiversity, and, as ecosystems are linked decreases the naturalness, to varying degrees, of entire ecosystems.

If that habitat is not irretrievably damaged, then the condition of an ecological community can be gradually restored following appropriate management intervention.

The viability of species and communities is influenced by a range of attributes, including their ecological characteristics, quality, abundance, extent of occurrence, genetic diversity, broad distribution (which promotes risk spreading against chance events), linkages between other populations, and tolerance to various impacts in space and time.

#### 'Flora and Fauna Guarantee Act' 1988 Objectives

The flora and fauna conservation and management objectives are:

- to guarantee that all taxa of Victoria's flora and fauna other than the taxa listed in Schedule 1 can survive, flourish and retain their potential for evolutionary development in the wild;
- to conserve Victoria's communities of flora and fauna;
- to manage potentially threatening processes;
- to ensure that any use of flora or fauna by humans is sustainable;
- to ensure that the genetic diversity of flora and fauna is maintained;
- to provide programs:
  - of community education in the conservation of flora and fauna;
  - that encourage cooperative management of flora and fauna through, amongst other things, the entering into of land management cooperative agreements under the Conservation, Forests and Lands Act 1987;
  - that assist and give incentives to people, including landholders, to enable flora and fauna to be conserved;
- to encourage the conserving of flora and fauna through cooperative community endeavours.



### Management Approaches

This discussion of biodiversity conservation management recognises that, in general, the different approaches adopted depend on the extent of biodiversity assets that remain in the environment, the intactness of ecological processes and the related level of human habitation and use. In largely natural systems there are greater possibilities to allow the continuation of broad-scale ecological processes such as migrations and natural population fluctuations. There is also typically a greater range of options and more flexibility for planning to meet conservation requirements. In areas where natural ecosystems are more fragmented, typical of rural Victoria, natural ecological processes have been significantly altered at the broad scale by the history of clearing. In these landscapes our approaches, in partnership with landholders, therefore need to be more proactive, focusing on habitat restoration and intervention to control pests and predators and inappropriate population levels of native species. In the urban systems, where the ‘footprint’ of human habitation dominates, the impacts and on-going pressures on biodiversity are greatest, but opportunities for local stewardship and education are also significant.

In largely natural landscapes

In Victoria, natural landscapes with sufficient scale and quality to largely maintain their ecological integrity, have, for the most part, only been retained in areas remote from historical development. These large and less disturbed areas are predominantly in public ownership as our national parks and State forests. The sustainability of these areas is fundamentally due to their size and their intact and functional natural processes, which means they are relatively robust in response to most perturbations or fluctuations of environmental or human origin. Historical development patterns and public land-use decisions have meant that these areas are now Victoria’s major reservoirs of biodiversity, in contrast to the rural and urban landscapes where the depletion and fragmentation of natural areas has resulted in a concentration of the elements of biodiversity that are now considered threatened.

The key management approaches in the largely natural landscapes are:

- to maintain largely natural ecological processes in a ‘comprehensive, adequate and representative reserve system’ through Park Management Plans, the Regional Forest Agreement processes, Forest Management Plans, and Fire Management Plans;
- to protect the integrity of these areas by controlling broadscale threatening processes;
- to maximise the conservation of biodiversity assets outside this reserve system, in the context of other uses that are ecologically sustainable.

The key objective in these landscapes is to continue implementing and improving the processes that are already in place to manage the environments in our State forests, parks and reserves. It is also important that we continue to improve our understanding of the natural operation of ecological processes in these landscapes so we can maintain their long-term health, productivity and catchment protection values.

An important function of management in the largely natural landscapes is to provide the ‘backbone’ of a ‘comprehensive, adequate and representative’ (CAR)

system of terrestrial areas as part of a national reserve system. Comprehensiveness requires that the full range of natural communities and species is conserved;

adequacy requires the maintenance of ecological viability and integrity of populations, species and communities; and

representativeness should ensure that the full biotic diversity, including genetic diversity, is included. These requirements are articulated in the Scientific Guidelines for establishing the National Reserve System (1997), which include the nationally agreed biodiversity criteria for the CAR system developed for the National Forest Policy (JANIS 1996).

Summary of the biodiversity criteria for a CAR reserve system in the forest estate

- As a general criterion, 15 per cent of the pre-1750 distribution of each forest ecosystem should be protected in the CAR reserve system with flexibility considerations applied according to regional circumstances, and recognising that as far as possible and practicable, the proportion of Dedicated Reserves should be maximised.
- Where forest ecosystems are recognised as vulnerable, then at least 60 per cent of their remaining extent should be reserved. A vulnerable ecosystem is one which is:
  - approaching a reduction in areal extent of 70 per cent within a bioregional context and which remains subject to threatening processes; or
  - not depleted but subject to continuing and significant threatening processes which may reduce its extent.

## State-wide Overview

- All remaining occurrences of rare and endangered forest ecosystems should be reserved or protected by other means as far as is practicable.
- Reserved areas should be replicated across the geographic range of the forest ecosystem to decrease the likelihood that chance events such as wildfire or disease will cause the forest ecosystem to decline.
- The reserve system should seek to maximise the area of high quality habitat for all known elements of biodiversity wherever practicable, but with particular reference to:
  - the special needs of rare, vulnerable or endangered species;
  - special groups of organisms, for example species with complex habitat requirements, or migratory or mobile species;
  - areas of high species diversity, natural refugia for flora and fauna, and centres of endemism; and
  - those species whose distributions and habitat requirements are not well correlated with any particular forest ecosystem.
- Reserves should be large enough to sustain the viability, quality and integrity of populations.
- To ensure representativeness, the reserve system should, as far as possible, sample the full range of biological variation within each forest ecosystem, by sampling the range of environmental variation typical of its geographic range and sampling its range of successional stages.

Forest ecosystems are often distributed across a variety of physical environments and their species composition can vary along environmental gradients between the micro-environments within the ecosystem.

This approach will maximise the likelihood that the samples included in the reserve system will protect the full range of genetic variability and successional stages associated with each species, and particularly those species with restricted or disjunct populations.

- In fragmented landscapes, remnants that contribute to sampling the full range of biodiversity are vital parts of a forest reserve system. These areas should be identified and protected as part of the development of integrated regional conservation strategies.

Across the forest estate, in areas not included in the CAR Reserve System, the principles of Ecologically Sustainable Forest Management (ESFM) ensure that these areas contribute to biodiversity. The ESFM principles include protecting and maintaining biodiversity, ecological integrity where the health and vitality of the ecosystem are maintained, and invoking the precautionary principle. Forest Management Plans are the principal tools for defining the on-ground conservation actions in these areas and they will be developed for all forest areas.

Many bioregions are linked by catchment flows, and effective forest management assists in ensuring that the quality of water leaving the largely natural landscapes and entering other areas is maintained. In general, the freshwater and wetland environments in these landscapes, particularly where the headwaters are relatively intact, are in good condition. Codes of Practice (e.g. for timber harvesting, road making) and other guidelines (e.g. for minimising soil disturbance in alpine areas) are applied to management activities to keep these environments in their present or better condition.

Given that these areas support substantial components of our biodiversity, special attention needs to be given to the strategic management of some of the more invasive threats such as environmental weeds and introduced predators. Conserving biodiversity also requires complementary management of areas outside conservation reserves, State forest and the predominantly natural landscape. This involves a variety of mechanisms (see next chapter) under the theme of maximising biodiversity across the entire landscape.

### Key Directions

- Continue to maintain the ecological integrity and natural processes of intact natural landscapes, by minimising disruptive impacts on these areas and restricting those impacts to localised areas.
- Develop and maintain a comprehensive, adequate and representative forest and parks reserve system.
- Complete Forest Management Plans and negotiate Regional Forest Agreements with the Commonwealth, using the National Reserve Criteria (JANIS 1996) and the principles of Ecologically Sustainable Forest Management to guide these processes.
- Complete the development of criteria, indicators and processes which inform managers and the community on the condition of biodiversity assets and ecological health.

## State-wide Overview

- Investigate and implement strategic ways of managing the impacts on biodiversity assets of environmental weeds and introduced predators
- Develop agreed management strategies for land with significant conservation values.
- Continue to promote the investigation of natural ecological processes in these landscapes and adjust management regimes in response (e.g. the role of fire and grazing in the long-term ecological health of the natural systems);
- Encourage industry and recreational users of the natural landscapes to adopt, where they are not currently doing so, Codes of Practice with the objective of conserving biodiversity values.

### IN LARGELY NATURAL SEASCAPES

Victoria's seascapes generally have intact ecological processes operating in the two environments of the bays - estuaries and the open coast. The larger embayments and inlets are spread throughout central and eastern Victoria. For example, Port Phillip Bay covers 1950 square kilometres and has 260 kilometres of coastline and Western Port Bay covers 680 square kilometres and contains several large islands. The Victorian open coast extends out to 5.5 kilometres from the shore line and covers about 7000 square kilometres of the coast. Unlike the landscape, effectively all of Victoria's seascape is publicly owned.

The Victorian coast offers a rich diversity of flora and fauna and terrestrial and marine habitats along a compact and easily accessible coastline. The sustainability of these seascapes is due to their largely intact and functional natural processes. The knowledge base for the biodiversity of the marine environment has not been as well developed as that for the terrestrial environment, however new studies are beginning to redress this balance. Following four years of scientific investigation, the Port Phillip Bay Environmental Study (CSIRO, 1996) emphasised the potential impact of enhanced nutrient input and introduced marine organisms on ecosystem health and function. The study also highlighted the link between human activities in the catchment and the integrity of our estuaries and the ecosystems they contain. Over the past two decades or so we are coming to realise the implications of using our seascapes as transport routes and how vulnerable they are to the use of their natural resources (fish, petroleum etc.) and to human activities on the adjacent land. Sustainable management of this precious resource is a key priority if the values that are present now are to be retained for the future. Conserving Victoria's seascape biodiversity also requires integrating management of the hinterland and the open ocean to ensure that conservation of ecosystem function, habitats, and the harvesting of biological resources is sustainable.

The key management approaches in the largely natural seascapes are:

- to ensure the natural ecological processes are maintained, with priority given to catchment activities resulting in better control of nutrient inputs, and, to minimising the risk of exotic marine organisms in the Victorian seascape;
- to ensure that uses of seascapes are ecologically sustainable through the establishment of effective management regimes;
- to establish a comprehensive, adequate and representative reserve system of marine parks.

A current initiative that will help these approaches, the Victorian Coastal Strategy (1997), supports sustainable use of the natural resources and seeks to ensure the protection of significant environmental features. This overarching strategy sets out a framework for integrated planning for the coast and marine environments that will encourage the inclusion of biodiversity information in all stages of the planning process. The strategy further defines principles to guide future decision making and identifies priorities for improving management processes that threaten biodiversity along the coast.

Other strategic initiatives which will provide directions for improving the management of threatening processes are the State Environmental Protection Policies (SEPP) for Port Phillip Bay and Westernport, and the Parliament's Environment and Natural Resources Committee Inquiry into Ballast Water and Hull Fouling in Victoria.

The development of fisheries management plans based on ecologically sustainable development principles will improve biodiversity outcomes. These plans and policies all emphasise the need to recognise the links between catchment activities and the quality of coastal waters, and the vulnerability of the ecological and economic assets to exotic organisms.

A national initiative that will add to these approaches is the National Oceans Policy, due for release in mid 1998. The Victorian Government is working with other States, Territories and the Commonwealth to finalise a framework for the integrated planning and management of Australia's oceans. Management will be a shared responsibility between the relevant States and the Commonwealth, based on the jurisdiction responsibilities outlined in the Offshore Constitutional Settlement.

## State-wide Overview

Currently, about 5.4 per cent of Victoria's seascapes are in some form of protected area. On the open coast these are at Cape Patterson and Wilsons Promontory, and within the bays at the heads to Port Phillip and at Point Cook and at Shallow Inlet and Corner Inlet. Extensive areas of the larger bays and estuaries are also listed under the Convention on Wetlands of International Importance, also known as the Ramsar Convention.

The Environment Conservation Council is to complete a marine and coastal investigation by 30 June 1998. The Council will investigate and make recommendations on the protection of significant environmental values and the sustainable use of the marine, coastal and estuarine areas excluding the Gippsland Lakes. This includes establishing a preferred approach and priorities for the progressive establishment of a representative system of marine parks in Victoria. Recent investigations and inventories into the biological assets of our marine environments will help this investigation.

### Key Directions

- Integrate planning for the marine environment and adjacent areas.
- Improve management of processes that threaten biodiversity, particularly land and ship sourced pollution, and invasion of exotic organisms.
- Establish a representative system of marine parks.
- Increase partnership arrangements between community, industry and government to address issues.
- Develop an environmental management plan for Port Phillip Bay.
- Increase our knowledge of the marine biodiversity.

### In rural landscapes

The broadacre farm and pastoral landscapes in Victoria are predominantly used to produce food and fibre for local and export markets. These landscapes are also the source of a wide range of natural resources such as water, minerals and construction materials. Rural communities service not only farming activities but also the wider demands of society for tourism, recreation, communication and energy services.

Early European settlers sought the most fertile soils, sited their farms and towns close to water resources and had an obvious preference for flat, open grasslands where cereals could be readily grown. As a consequence some ecosystems were almost totally converted to agricultural production and are not adequately protected in the reserve system. Up to 70 per cent of the State's wetland environments are in the rural landscape and in many cases are depleted. The stream and river environments are characteristically more degraded than those flowing through extensive areas of native vegetation. Biodiversity assets in this environment persist as remnants of the original vegetation types and vary in both condition and extent.

The key management approaches in rural landscapes are:

- to integrate catchment management into the planning framework to achieve sustainable development of natural resource-based industries and the conservation of biodiversity;
- to protect environmental values as part of the reform of water management and the development of bulk water entitlements;
- to maintain and enhance the viable remnants of native vegetation and habitats through a combination of public land reserve management, planning processes and cooperative agreements on private land in the context of Regional Vegetation Plans;
- to ensure that public agencies managing land or water incorporate biodiversity goals in their work programs, and ensure that they have the necessary skills and access to tools to achieve continuing improvements in their performance;
- to support the participation of rural landholders and communities in conserving biodiversity through initiatives such as Landcare and Land for Wildlife.

The rural landscape is predominantly agricultural but is categorised by a multitude of management regimes, both public and private. There are many thousands of licensed occupations. Further, Vicroads, Public Transport Corporation, local government and Cemetery Trusts and many other public authorities have responsibility for areas that contain important biodiversity assets. For example there are over 330 sites of botanical significance on rail reserves, over 60 cemeteries have significant biodiversity assets and 45% of the remaining western plains grassland sites occur on roadsides. This pattern of occupancy contrasts with the broad areas of natural environments, where the essential two management regimes focus on timber production, conservation, catchment protection, recreation and tourism.

Catchment Management Authorities (CMA) have been established recently to provide a focus for the development, management and conservation of land and water resources in each of the nine Regions. Together with the Port Phillip

## State-wide Overview

Catchment and Land Protection Board, each CMA has produced a Catchment Management Strategy. The purpose of the strategies is to coordinate sustainable land and water management and biodiversity conservation is a central objective. The Catchment Management Authorities are cooperating closely with Victoria's 78 local councils to ensure the proper planning and management of activities in catchments.

Water is a critical component in the conservation of biodiversity in this landscape. The quantity, quality and seasonal flow of water all contribute to the health of the aquatic environments. Modification to the natural water regimes has affected the in-stream biota (e.g. fish), wetlands and associated flora and fauna, and forest types of the flood plains. Adequate environmental flows are crucial for biodiversity in the rural environment.

The rural landscape offers exciting possibilities for enhanced protection, rehabilitation and restoration of biodiversity consistent with sustainable productive use. The Government recognises the immense challenges that rural landholders face in contributing to the conservation of biodiversity. Addressing these challenges, such as the long term decline of trees in the landscape and the widespread impacts of rising groundwater, within an environment where pressure is placed on landholders to increase agricultural outputs, needs an integrated and cooperative approach.

Government is working in partnership with rural landholders towards a higher level of protection of biodiversity values. The development and implementation of Regional Vegetation Plans, produced under CMAs, will be an important component in achieving sustainable production and conserving biodiversity. They will be supported by scientifically based advice and will provide a regional focus for protecting, enhancing and restoring native vegetation. Rural communities increasingly recognise that remnant native vegetation makes a significant contribution to the overall health of their living environment by improving soil stability, water quality, and the productivity of farm enterprises while protecting native flora and wildlife. Restoring and repairing natural ecological processes is perceived as a major aim of management. This perception is reflected in a recently completed study of vegetation changes between 1990 and 1993. The annual rate of clearing dropped to about 1500 ha per year compared to 9407 ha a year in 1987–1990 and 10 766 a year between 1972 and 1987 (Victorian Catchment and Land Protection Council Annual Report 1995/96, pp. 15 & 16).

While remnant landscapes contain some of the most vulnerable biological resources, the protection and enhancement of those resources is not straightforward. Management options used in the extensive areas of native vegetation may not be effective in these landscapes. In many rural areas mature trees are not being replaced by regeneration, leading to a decline in hollow availability for a suite of dependent bird and mammal species. Components of the more natural environment, such as native predators, have disappeared and it is now necessary for land managers to intervene to control some populations of native species. It is only when total grazing pressure is managed that species of some plants will regenerate. On public land, grazing of native vegetation needs to be linked to defined management outcomes which reflect the ecological processes and biodiversity values.

Remnant vegetation is fragmented in the rural landscape. Government agencies, private landholders and local groups are already working on revegetation projects to reconnect previously isolated vegetated areas, such as at Black Range, Dundas, Goulburn River and in the Mallee. Reconnection of vegetation (biolinks) presents a high potential value for enhancing the habitat for the

long-term survival of flora and fauna. Restoration and revegetation is a major challenge with potential benefits to biodiversity, water quality and the amelioration of land degradation and salination.

Grasslands, grassy woodlands and shallow freshwater marshes are examples of ecological communities that are now highly restricted in extent and are heavily dependent on private landholders for their continued existence. Private landholders are being encouraged to restore these native plant communities and where possible to connect them to adjacent areas of public land. These often tiny remnants contain the only regional habitat of some flora and fauna species. The Plains Wanderer is now only found on a few sites in what were once extensive grassy plains across northern Victoria, and most of these are on private land.

The Good Neighbour Initiative encourages cooperative management of common issues between government authorities and adjacent landholders. The Land for Wildlife Scheme is an indication that landholders feel increasing custodianship for conserving biodiversity.

This is a voluntary scheme to which over 4000 landholders, who manage over 110 000 ha of vegetative and wetland habitats, have committed part of their properties for conservation.

Similarly, the Landcare movement has increasingly incorporated the enhancement of biodiversity into its core goals. The focus on Property Management Planning through the Victorian Farm\$mart program also provides an opportunity to build on the economic benefits of biodiversity conservation.

## State-wide Overview

Public authorities and larger commercial companies are using business planning to incorporate ecologically sustainable development goals and biodiversity conservation measures into their management processes. Public Authority Management Agreements are suitable mechanisms through which these bodies can advance biodiversity conservation. Industry has increasingly adopted quality systems, including those that demonstrate positive performance in environmental management such as International Standard ISO 14001. Training and accrediting staff in environmental and habitat management will lead to better and more efficient outcomes.

The Commonwealth owns numerous parcels of land in Victoria and uses them for a variety of purposes including military installations. A number of these areas are of high conservation value, either because of their location as enclaves within reserves or because their use has excluded or minimised human entry and development pressure. The Commonwealth Endangered Species Protection Act 1992 provides for the protection of endangered and vulnerable species on Commonwealth land and water and for Commonwealth agencies to conduct their activities so as not to further threaten these species and communities.

Biodiversity outcomes will be enhanced through good strategic direction, coordination and planning. The community will play a critical role and will take a major part in the achievement of on-ground outcomes.

### Key Directions

- Build on cooperation between CMAs and local councils to ensure that biodiversity values are protected in rural landscapes.
- Develop and implement Catchment Management Strategies and Regional Vegetation Plans to provide for sustainable utilisation of natural resources while enhancing biodiversity values across the landscape.
- Promote the use of Land Management Co-operative Agreements, Public Authority Management Agreements, codes of practice, guidelines, Environmental Management Systems (e.g. ISO 14001), and reporting on biodiversity in annual report and audits.
- Support landowners through schemes such as Landcare, property management planning, and Land for Wildlife to enhance the practical management of biodiversity, and target assistance to depleted or otherwise significant habitats.
- Develop an off-reserve system within the rural landscape incorporating Public Authority Management Agreements, Trust for Nature, Land for Wildlife and other cooperative, mutually beneficial mechanisms.
- Ensure biodiversity diversity data and advice are available and accessible to all planning processes, landholders, industry and the community for achieving ecologically sustainable development.
- Maintain a partnership model for integrated pest plant and environment management as embodied in the Good Neighbour Initiative.
- Continue to recognise significant contributions to biodiversity conservation through State and National Landcare awards.

### IN URBAN AND URBAN FRINGE AREAS

Land in urban areas and on the fringe of urban development has similar biodiversity conservation issues to those of the rural landscapes, but with additional pressure and less flexibility within the local landscape. This type of land occurs extensively around metropolitan Melbourne but also around the regional centres of Victoria. Because of its proximity to urban areas, the land has development potential and consequently increased economic value. Urban fringe areas may have retained significant biodiversity values.

The key management approaches in urban areas and urban fringes are:

- to assist local government, developers, communities and urban infrastructure providers to protect and manage sites of significance;
- to promote and facilitate urban community involvement in the stewardship of biodiversity values;
- to focus resources on the more ecologically viable remnants.

Established urban areas often have small remnants of habitat, which are highly valued by the local community. The biodiversity values remaining in these areas can be particularly important for providing unique examples of pre-existing flora and fauna, for protecting sites of biological significance and as seed sources for revegetation with indigenous species. Importantly, those areas provide local and other urban dwellers with a direct link to the natural heritage of a locale, contributing to a sense of place in urban environments.

Threats to these biodiversity values include habitat removal and increased fragmentation, environmental weeds, cats and dogs, intensive recreation pressures, urban infrastructure projects, and ecologically inappropriate fire management. These areas typically need intensive management to protect them from degrading.

## State-wide Overview

Protecting biodiversity values in the urban fringe landscape is often more difficult than in the broader rural landscape because of the value of the land, increased human presence and interference and the risk involved in some management practices. Conversely, creative and careful planning and management can produce opportunities for ‘hobby farms’, ‘bush retreats’, or novel urban developments to protect and enhance biodiversity values.

New format planning schemes developed under the Victorian Planning Provisions (VPP) will provide both a consistent framework and a strategic direction for decisions on land use and development (see section on Legislation and Self Regulation). These apply state-wide but are particularly relevant in urban and urban fringe areas. The earlier in the planning cycle the biodiversity values can be identified to all interested parties, the more chance there is of achieving the best biodiversity outcome for all stakeholders.

The Department of Infrastructure, through its publication *Victoria in Future*, has projected populations for all local government areas and identified future growth areas. These projections will provide a focus for setting priorities to improve our knowledge and information base. This will enable us to maximise the opportunities for the most significant sites to be conserved and remain relatively viable in the long term and ensure that biodiversity values can be considered in planning decisions. It will also assist our ability to make decisions about where to direct limited resources, so that sites with good long-term ecological viability are not overlooked in favour of urban or urban fringe sites with lower biodiversity value or higher vulnerability.

The long-term maintenance of biodiversity values and the relative cost of maintaining the ecological viability of important sites must be taken into account.

In urban areas there will need to be increased community custodianship and direct management. In some urban fringe areas, particularly where biodiversity values are already degraded, urban development may have the potential to enhance local biodiversity through targeted planting of indigenous species, improvement of waterways and disposal of wastewater.

In urban fringe areas, where property sizes are larger, some of the new landholders may have little knowledge or experience in land management and may unwittingly degrade biodiversity values. Land for Wildlife, Landcare and Property Management Planning for small landholders, could address this through education and provision of carefully targeted expert advice.

### Key Directions

- Increase the provision of accessible strategic advice, such as the new format planning schemes being developed under the VPP, to local government planning processes to promote development in the least sensitive areas and to protect and promote corridor areas such as the Metropolitan green wedges.
- Enhance current information management systems so that information about biodiversity values for any particular area can be easily accessed early in the planning cycle by local government, developers, and conservation groups.
- In the urban fringe encourage landholder involvement in schemes such as Landcare, Farm\$mart, Land for Wildlife.
- Promote community group projects that assist in restoring and rehabilitating flora and fauna habitats, e.g. Botanic Guardians.



## State-wide Overview

### Community Involvement

Active involvement by the community is one of the greatest resources available in managing Victoria's biodiversity across all landscapes. Victoria has a rich history of people coming together to better understand, enjoy and protect our biological heritage. For example, the Field Naturalist Club in Victoria, established in 1880 and with affiliates throughout rural Victoria, has a continuous record of field studies and publications. Similarly, Birds Australia, established in Melbourne in 1901 as the Royal Australasian Ornithologists Union, plays an active part in the conservation and management of Victoria's fauna. The extensive coverage of the first Atlas of Australian Birds (Blakers et al. 1986) was the result of hundred of thousands of volunteer hours under the auspices of Birds Australia. Large numbers of volunteers regularly monitor groups of species (e.g. wading species) and specific threatened species (e.g. Hooded Plover) across Victoria.

On-ground management of biodiversity conservation is reflected in the actions of many individual landholders and community groups. Despite the attrition of habitat over this century, many landholders have been successfully managing habitats on their properties — about 800 000 ha of forest and woodlands and about 135 000 ha of wetlands remain on private land. In the 1980s, the Land for Wildlife scheme was developed by Fisheries and Wildlife and the Bird Observers Club of Victoria, to provide a voluntary vehicle for landholders to actively and openly protect, enhance and restore wildlife habitat on their properties. The scheme now has over 4000 members who manage over 110 000 ha of habitat throughout the State. LFW has been adopted as a national model for voluntary participation of landholders. At a more formal level, Trust for Nature encourages the covenanting of habitats and properties in order to provide them with permanent legal protection. Currently there is over 8500 ha under covenant.

The Landcare Movement, developed in Victoria in the 1980s, now has over 700 Landcare groups, with a membership estimated at 22 000. Originally conceived to help landholders come together to resolve land protection and pest plant and animal problems, the program has evolved to increasingly incorporate biodiversity considerations into farm planning and environmental restoration. This is evident, for instance, in the involvement of Landcare groups in the recovery program for the threatened Eastern Barred Bandicoot.

There are many community groups involved across the breadth of biodiversity conservation and management issues. Some groups have long histories of assisting the management of specific environments (e.g. sporting shooters and wetlands). Historically, local field naturalists clubs and groups for growing native plants have actively studied, monitored and rehabilitated natural habitats. In some cases this interest evolves into raising funds for land purchases to protect biodiversity values.

Some 'Friends' groups focus on a certain area for protection or restoration. Friends of Merri Creek, for example, has focused on the natural rehabilitation of an urban creek and riparian environment. Over 200 Friends of Parks groups assist Parks Victoria in park management. Other friends groups focus on both an area and a significant biodiversity asset, such as Friends of Eltham Copper Butterfly. The Threatened Species Network

(Victoria) has liaised with over 100 small community groups that focus on a particular threatened species or community. At present, there are about 15 groups (from Otways to East Gippsland) surveying for the Tiger Quoll. These groups provide invaluable volunteer labour and enthusiasm. Participants are able to acquire on-ground experience and a deeper understanding of the Victorian landscapes. They complement and are coordinated with other programs, for example the Friends of the Regent Honeyeater work with the Land for Wildlife program and the species recovery process.

Botanic Guardians is a scheme that promotes community groups to manage and monitor populations of threatened plant species. In four years of operation over a hundred community groups such as Cemetery Trusts, school groups and Country Fire Authority brigades, have become involved in active conservation management, many for the first time. Such involvement produces valuable conservation information and increases understanding throughout the community. Recent environmental initiatives such as Coast Action also incorporate community group participation. Greening Australia, through activities such as the spring planting festivals, has provided an opportunity for individuals not involved in specific groups to make a contribution to Victoria's biodiversity.

As a consequence of their long history in Australia, the Aboriginal people have developed a cosmology that incorporates special and unique knowledge of biodiversity and land management. Their use of fire is a significant example. The current extent of this knowledge base varies markedly across Australia and, where strong, is an irreplaceable asset, some of which the Aboriginal people may choose to share in the public domain. Where such knowledge, or information derived through archeological survey, is available it should be incorporated into our thinking to increase our depth of ecological understanding and the sense of place of all Victorians.

## State-wide Overview

As our knowledge of the management of specific ecosystems increases, natural resource managers need to work in partnership with specific conservation groups to achieve better outcomes across all landscapes.

### Key Directions

- Emphasise involving the community in the conservation of biodiversity through partnerships with government and industry.
- Provide local information on biodiversity values and management to facilitate active community involvement.

### Legislation and Self-Regulation

To maintain and enhance their standard of living, the entire Victorian community relies on industries that use biological resources. These industries provide employment, directly and indirectly, and contribute significantly to the economy. Their activities are regulated through a variety of legislation including the National Parks Act 1975, Forest Act 1958, Fisheries Act 1995, Wildlife Act 1975 and Environmental Protection Act 1970. Recent legislation relating to natural resource-based industries, such as fisheries, incorporates principles of ecologically sustainable development. The Planning and Environment Act 1987 is critical to planning land use and development in Victoria. The new format planning schemes developed under the Victoria Planning Provisions (VPP) will provide both a consistent framework and a strategic direction for decisions on land use and development. A key component of the VPP is the State Planning Policy Framework (SPPF), which applies to all land in Victoria.

The SPPF includes a biodiversity objective, to 'assist the protection and conservation of biodiversity, including native vegetation retention and provision of habitats for native plants and animals'.

Recent legislation such as the Catchment and Land Protection Act 1994, Fisheries Act 1995 and the Coastal Management Act 1995 has taken an approach to natural resource management in which partnerships between the community, business and government are integral. The Flora and Fauna Guarantee Act 1988 (FFG) and the Fisheries Act 1995 together provide a framework for and management approaches to the protection of biodiversity and the sustainable use of flora and fauna across the State. The FFG recognises community awareness and cooperative programs as key measures for conservation.

Industry, private landholders, public authorities and community groups can participate in biodiversity conservation in ways that range from on-site management to broad strategy-making, from business planning to recovery planning, from voluntary activities to legal compliance. By incorporating biodiversity considerations into their overall business goals they can consider the impacts of their activities. The provision of comprehensive information on the status of biodiversity will facilitate compliance with existing legislation as will the development of criteria and guidelines for assessing and avoiding adverse impacts. Some organizations are also beginning to examine methods for including biodiversity in product life-cycle analyses.

Industry self-regulation is supported by international standards for Environmental Management Systems (EMS). For example ISO 14001 requires a participating organisation to develop an environmental policy; identify its impacts on the environment; develop a plan to reduce those impacts and meet continuous improvement goals. The 'safety net' behind this suite of tools is the FFG with its objectives, voluntary mechanisms and legal controls. For example, it provides clarity for a wide range of clients and decision-making processes by listing the species and communities that are threatened with extinction, and the processes that pose a threat to a range of flora and fauna.

A Scientific Advisory Committee (SAC) makes recommendations on whether to list or de-list species, communities or potential threatening processes, to the Minister, who then makes recommendations to the Governor in Council. Anyone can participate in this process by nominating items and commenting upon preliminary recommendations of the SAC.

An Action Statement sets out what has been done to conserve or manage the listed item, and what will be done. Other provisions within the Act include determination of Critical Habitat. Interim Conservation Orders can be applied to Critical Habitats of listed species or (only on Crown land and waters) ecological communities.

Protected flora controls apply to commercial harvesting on private land and to any kind of 'taking' from public land.

The protected flora and listed fish controls provide a powerful and flexible instrument that operates at several levels.

At an industry level, Governor in Council Orders remove the need for separate permits in all but the most serious cases. The Orders contain guidelines to help businesses plan and conduct their activities with biodiversity objectives in mind.

At a site level, protected flora permits are used to set sustainability conditions for a range of 'taking' activities including deliberate harvesting, research and incidental damage during other activities.

There are many opportunities for public authorities to have 'due regard' to the conservation objectives of the Act and integrate these with other business goals.

Public Authority Management Agreements (PAMAs) can

provide for the management of species, communities and potentially threatening processes.

The taking, keeping and trading of native fauna is controlled under the Wildlife Act 1975, which also regulates native and introduced game species.

#### Key Directions

- Facilitate compliance with existing legislation through the provision of accessible information on biodiversity, which will enhance community awareness and the development of voluntary codes of practice.

## State-wide Overview

- Provide accessible information on biodiversity condition and threats specific to the local areas for use under the Local Planning Provisions.
- Promote the adoption of ecological sustainability through guidelines and other standards embodied in Action Statements and recovery programs in the public and private sector through Environmental Management Systems such as ISO 14001.
- Encourage public authorities to develop explicit and well-documented strategies to demonstrate that they meet the FFG's requirement to take account of biodiversity conservation objectives.
- With industry, encourage the development of methods for considering biodiversity in whole of life-cycle analyses.
- Expedite the listing of all eligible species, communities and potentially threatening processes.
- Develop Action Statements for listed items giving priority to species and ecological communities threatened nationally, or of particular significance to Victoria.
- Develop and implement Action Statements for priority threatening processes in the context of increasing community and agency custodianship.

## State-wide Overview

### Information Systems

Biodiversity is intimately related to the landscape and one of the primary requirements for improving and maintaining biodiversity is a detailed knowledge base of where the plants, animals and ecological communities are located.

Information that describes the plants and animals of the State, both marine and terrestrial, has been being recorded for over a hundred years. Field naturalists, tertiary and research institutes have contributed to this knowledge. Satellite imagery and other forms of remote sensing have further enhanced the traditional sources of data.

Victoria has excellent databases that cover many aspects of our biodiversity and use state-of-the-art systems to analyse, display and map the State's terrestrial and freshwater flora and fauna. Three million records collectively contained in the Atlas of Victorian Wildlife, Victorian Flora Information System and Wetlands databases provide comprehensive information on plant and animal distribution which is constantly being updated. The Site Register focusses on alerting land managers and developers to the management issues at sites with significant flora and fauna. The ability to utilise this information for planning and management purposes will be enhanced as these databases are integrated with other major Geographic Information System (GIS) datasets held in NRE's extensive Corporate Geospatial Data Library. These data sets include fire history, Ecological Vegetation Classes, Public Land Boundaries, roads and streams. Information from the GIS Library can be overlaid, allowing detailed analysis and presentation for biodiversity management and monitoring.

An interactive system has been developed to enable the precise locations of all flora and fauna data to be plotted onto a 1:100 000 scale, high quality map series called BioMap. BioMap accesses data directly from NRE's Corporate Geospatial Data Library and allows some 6000 combinations of user-definable map themes to be selected. These maps allow the information to be presented to local government and others in a form suitable for planning and management purposes and can be used as a reference source. Real-time World Wide Web (WWW) mapping systems, which display the distribution of rare or threatened flora and fauna along with a description of their FFG and Rare or Threatened status, are currently being developed.

New technologies such as PC-based GIS, the WWW and CDROM mean that data can, in time, be made readily accessible to land managers and the public. CDs using an interactive display combined with high quality pictures and a description for each species have been produced for Victorian plants, butterflies and fish.

Technological advances will also provide the means to promote a greater understanding of complex ecological and natural systems processes — for example fire and its role in determining vegetation mosaics in the landscape.

The use of computer simulations to predict the effects of global warming through the enhanced greenhouse effect on the distribution of selected fauna demonstrated the value of such techniques. Such work is being refined and extended to predicting the occurrence of existing and developing habitat for important species (e.g. forest owls in the North East). Future computer modelling and remote sensing will be critical in enhancing both our understanding and our capacity to monitor management responses to conserving biodiversity assets. The results of these studies need to be presented in useable forms for the policy makers, land and water managers and the public.

#### Key Directions

- Maintain and improve the coverage and quality of current databases on the distribution, conservation status and management requirements of native plants and animals species. Finalise coverage of critical state-wide databases, e.g. Ecological Vegetation Class mapping.
- Facilitate wide and innovative access to biodiversity data for planners and managers, industry and the community.
- Utilise and develop biodiversity and other databases to increase our understanding of critical stages in the life histories of native plant and animal species and of ecological processes across the Victorian land and seascapes.

### Reporting Framework

The Victorian Government's Management Improvement Initiative has emphasised accountability for performance through shifting the focus of programs and reporting from activities (resource inputs) to achievements (outputs and preferably outcomes).

Biodiversity is an inherently multi-faceted and complex area and sharpening the focus on achievements in its management is a challenging task that is being tackled in many places around the world. Species variously respond to ecological parameters in time and space but do not recognise human constructs in the environment like legal or administrative frameworks. Accordingly, conservation management routinely needs to take an across-tenure view of habitat requirements and to reconcile the diverse needs of native species and ecosystems with the diverse pursuits and priorities of the relevant land and resource managers. The Department of Natural Resources and Environment is responsible for this integration; in particular, the Flora and Fauna Program coordinates reporting back to the Government on the performance of biodiversity conservation programs.

The broad objectives of the Biodiversity Reporting Framework are to clarify the achievements of biodiversity conservation activities and to ensure that appropriate feedback on outcomes continually improves the design and targeting of programs.

The reporting systems being developed are based on integrated adaptive management and are intended to:

- readily support refinement of priorities and strategic approaches through continuous improvement;
- allow quantitative review of progress towards program goals;
- identify expected performance with respect to natural resource managers who share responsibility for achieving overall conservation targets for particular species and communities;
- allow hierarchical reporting of state-wide, bioregion-based or business-based trends;
- translate readily to national overviews including State of Environment reporting and the Montreal Process for forestry;
- successfully blend scientific rigour and affordability;
- promote broad understanding and the use of common knowledge and language;
- lead in the direction of adequate understanding of causal relationships.

The Adaptive Management Cycle for Biodiversity Conservation outlines the relationships between the activities that influence the efficiency and effectiveness of applied conservation management. Some activities are inputs to management (e.g. plans, standards), some are management actions (e.g. fencing some vegetation), some are environmental outcomes (e.g. increased cover of native vegetation) and others are biodiversity outcomes (e.g. increased population of target species due to habitat improvement).

While the ultimate focus is on biodiversity outcomes, each area of activity plays a key role in an integrated program and is worthy of reporting on as part of an overall performance assessment.

In the Adaptive Management Cycle for Biodiversity Conservation the areas of activity and associated performance indicators are:

Strategic direction — including the development of legislative and regulatory mechanisms, the preparation of strategies or policies for specific issues (e.g. grasslands, environmental weeds, environmental flows) and the development of standards through codes of practice (e.g. Timber Harvesting, Rooding, Fire Management).

Inventory — improving the knowledge of assets, including their distribution, conservation status and ecological requirements. Performance indicators are based on relative completeness of inventories with respect to taxonomic groups, geographic coverage and vegetation community/habitat mapping.

Planning — including analyses of natural assets with respect to relative significance and threats; establishment of clear targets for management of the key assets at risk (specifying, for example, the number of breeding pairs of a threatened species to be supported; the area of ecological community in which natural processes will be maintained; the area of disturbed vegetation which will be restored or rehabilitated; the area and/or range of age classes of habitat to be maintained or created; the type of monitoring to be undertaken); and the development of management approaches to specific risks (e.g. conservation priority zoning schemes; predator, pest plant/animal or grazing pressure control programs; ecological burning or environmental flow regimes; applied research tasks).

Performance indicators are based on the coverage and quality of plans, which may be tenure-based (e.g. Forest Management Plans, Parks & Reserves Ecological Management Statements), issue-based (e.g. Catchment Management Authority Regional Vegetation Plans, Salinity Management Plans, Fire Management Plans), or asset-based (e.g. Flora & Fauna Guarantee Action Statements).

## State-wide Overview

**Management** — including on-ground or at-sea actions across the full spectrum of natural resource management responsibilities. On public land and sea these will be specified in annual work programs, contracts and various forms of service agreement. Performance indicators are based on achievement of quantitative targets for generic tasks (e.g. area under active pest or predator control; area of rehabilitated or re-established vegetation; area burnt for specific ecological management objectives).

Note that results are a combination of planned actions, other actions that are unintended and possibly undesirable and, most significantly, of natural events including seasonal climate, disease outbreak, catastrophic fire or extreme weather effect.

**Monitoring Actions** —undertaking a strategic selection of monitoring activities which adequately cover the spectrum of management issues, and which use appropriate degrees of sophistication varying as follows:

- **Qualitative Monitoring** — the unstructured observation of changes in elements of biodiversity (e.g. opportunistic observation of pest plant/animal introduction or disease outbreak), or structured observations without quantitative design or intent (e.g. photopoints or paired plots intended only to visually illustrate changes);
- **Surveillance Monitoring** — the process of repetitive observations of one or more elements of biodiversity, according to pre-arranged schedules in time and space (e.g. annual population counts of a rare species at a particular locality);
- **Research Monitoring** — as in surveillance monitoring, but explicitly designed to understand the changes detected in terms of causal links to specific management actions or natural events (e.g. sampling of populations under differing management regimes with the statistical design power to link key factors);
- **Risk-Based Assessment** — the process of assigning magnitudes and probabilities to the adverse effects of human activities and/or catastrophic natural events; a process which seeks to use unambiguous quantitative endpoints by which to judge results of management

Performance indicators are based on the number of management issues with appropriate monitoring programs and the achievement of annual targets for gathering the information required by these programs.

**Environmental Outcomes Monitoring** — including measures of environmental condition with a focus on physical features. Although not actual measures of biodiversity, these outcomes are directly relevant to habitat quality and are often the only features that can be readily assessed across whole systems. Performance indicators are based on some of the established indicators of health (e.g. extent and condition of vegetation cover, Index of Stream Condition, extent of pest plants).

**Biodiversity Outcomes Monitoring** — including measures of biodiversity condition selected from a matrix of features reflecting levels of organisation (landscape, ecological community, population, genetic) and different biodiversity attributes (composition, structure, function). Some measures will only be meaningful for a particular feature at a particular location (e.g. recovery of an individual population), whilst others can be aggregated with similar measures to generate indices (e.g. number of threatened species). Performance indicators are based on a variety of features, for example

depletion/rehabilitation of extent and quality of specific vegetation communities or habitat types; population trends of sensitive/threatened/indicator species; retention of specified sites of significance; quantitative assessment of success in managing specific risks.

Implementation of the Biodiversity Reporting Framework is facilitating common and mutually beneficial approaches to monitoring across government businesses, other organisations and individuals that share responsibility for delivering and encouraging biodiversity conservation. Given the challenging nature of the task, integration through the specification of quality assurance standards and the use and development of common core datasets and indicators is essential. Establishing practical priorities and increased awareness of what different monitoring activities do and do not tell us is an important discipline to develop. Additionally, the Framework must integrate with related tasks that are undertaken in other resource management areas (e.g. the developing Decision Support System for Integrated Catchment Management and Sustainable Agriculture).

The bioregions used in Part II summarise ecological characteristics at the landscape scale, providing a sound and integrated geographic basis for clarifying responsibilities that are shared across various resource and land managers. Subsequently, strategic planning and on-ground management is undertaken from a variety of perspectives, each with a geographic focus relating to its logistical needs. Land management agencies and individuals hold tenure-based perspectives; issue-based perspectives are used, for example, with salinity management and fire management; and asset-based perspectives include planning for threatened species or ecological communities. Reporting on overall achievements in biodiversity is then most appropriately undertaken by returning to the bioregional framework.

**Key Directions**



## State-wide Overview

- Implement the Biodiversity Reporting Framework, in cooperation with natural resource managers, to provide integrated feedback on the success of biodiversity conservation and management programs.
- Develop practical priorities for monitoring programs and quality assurance guidelines for monitoring techniques.
- Provide appropriate public access, for example through the NRE Website, to information that summarises achievements in biodiversity conservation on a bioregional basis.
- Increase the proportion of overall land and water resources directed to monitoring and reporting, and shift the focus of these activities from efficiency to effectiveness measures.

### **A Framework for Responding to Challenges in the Management of Biodiversity**

Native flora and fauna are inherently diverse and exist within complex systems. Beyond the broad themes and management approaches that have been discussed in Part I, there is need for a framework which can both simplify this complexity and connect us more directly to the biodiversity assets and challenges in our own neighbourhoods and working environments. Biogeographic regions (bioregions) capture the patterns of ecological characteristics in the landscape or seascape, providing a natural framework for recognising and responding to biodiversity values. As bioregions reflect underlying environmental features, they can also be related to the patterns of use of land and sea. Thus they can be used to identify the relationships between many natural resource based activities and biodiversity assets.

Bioregions identified in Victoria form part of national frameworks for terrestrial and marine environments, the Interim Bioregionalisation for Australia (IBRA) and the Interim Marine and Coastal Regionalisation for Australia (IMCRA). These national frameworks were prepared through the cooperative efforts of Commonwealth and State/Territory agencies at the request of the Australian and New Zealand Environment Conservation Council (ANZECC). Of the 80 IBRA regions delineated across Australia, eleven occur in Victoria with eight of these shared with adjacent States. Of the 60 IMCRA regions delineated around Australia, five occur in Victorian waters with three of these shared with adjacent States. The broad scale that is appropriate for national purposes may not discriminate adequately between areas with meaningful differences at the state-wide scale.

This is particularly the case for terrestrial systems where further refinement has delineated 21 Victorian bioregions and described them in a Victorian context (see map showing location and relationships of national and Victorian bioregions). The following discussions of bioregions have been aggregated into descriptive areas, where appropriate, in order to retain the link to the national framework and to reduce repetitiveness in the text. The following table indicates the relationships between the national and Victorian frameworks and their presentation in the text.

## Victorian Bioregions

<b>IBRA or IMCRA Region*</b>	<b>Descriptive Area</b>	<b>Victorian Bioregion</b>
Murray-Darling Depression	VICTORIAN MALLEE	Lowan Mallee Murray Mallee Wimmera
Victorian Volcanic Plain	VICTORIAN VOLCANIC PLAIN	Victorian Volcanic Plain
Naracoorte Coastal Plain	GLENELG PLAIN	Glenelg Plain
Victorian Midlands	VICTORIAN MIDLANDS	Dundas Tablelands Greater Grampians Goldfields Central Victorian Uplands
NSW South Western Slopes	NORTHERN INLAND SLOPES	Northern Inland Slopes
Riverina	VICTORIAN RIVERINA	Victorian Riverina
Australian Alps	VICTORIAN ALPS	Victorian Alps
South Eastern Highlands	VICTORIAN HIGHLANDS	Highlands - Southern Fall Highlands - Northern Fall Otway Ranges
South East Coastal Plain	COASTAL PLAINS	Warrnambool Plain Otway Plain Gippsland Plain
Furneaux	WILSONS PROMONTORY	Wilson's Promontory
South East Corner	EAST GIPPSLAND	East Gippsland Uplands East Gippsland Lowlands
all terrestrial	WETLANDS	all terrestrial
all terrestrial	RIVERS AND STREAMS	all terrestrial
Victorian Embayments	BAYS, INLETS AND ESTUARIES	
Otway		
Central Victoria		
Central Bass Strait	OPEN COASTS	
Flinders		
Twofold Shelf		

\* within or immediately adjacent to Victoria

In the aquatic environments within the landscape, ecological processes are largely dominated by the dynamic flows and fluctuations of water, with the adjacent terrestrial environment playing an important but secondary role. Accordingly, the terrestrial bioregions are less relevant for aquatic environments and the discussion of biodiversity in these environments is presented from a state-wide perspective for Wetlands and Rivers and Streams. In the marine environment, information is most readily available at a coarser scale than on the land and therefore the discussion of biodiversity is presented by aggregating IMCRA regions into Bays, Inlets and Estuaries and Open Coasts. All freshwater and marine environments can be profoundly influenced by activities in the surrounding or adjacent terrestrial environments, and the importance of managing vegetation, particularly in riparian corridors, for the appropriate quality and quantity of water is reflected in the discussion of the terrestrial bioregions.

Knowledge of biodiversity assets across Victoria is variable but dynamic and continually improving. Our awareness of what and where species exist, of the habitats and communities they exist in, and of the related ecological processes, depends on the type of organism and the research effort in a particular area.

To enable comparison between bioregions, the following discussions use datasets that may not be the most sophisticated possible, but are available at a relatively consistent level across Victoria. For example, the general

## Victorian Bioregions

assessments of habitat/vegetation retention use Broad Vegetation Types (BVTs) rather than Ecological Vegetation Classes (EVCs). Current and pre-European coverage of BVTs are modeled from 1:250 000 scale land system, climate and other information and are thus limited in use to strategic overviews. EVCs are mapped at 1:100 000 and 1:25 000 scales based on substantial on-ground survey and are the vegetation mapping dataset of choice for detailed conservation planning and management; however there is not yet a complete state-wide coverage. Estimates of BVT retention are based on the Department of Natural Resources and Environment dataset for tree cover as at 1987, since a reassessment of tree cover as at 1995 is not yet completed.

Figures on the tenure status of BVTs are based on a broad division into conservation reserves, other public land and private land. More accurate information, particularly on conservation status, is available elsewhere for some parts of Victoria (e.g. East Gippsland Forest Management Plan, Central Highlands Regional Forest Agreement documents), where EVCs are the basis for determining representativeness of ecosystems in the reserve system and where the contribution of management zones in State forest is appropriately included.

Some biodiversity conservation and management issues are widespread in the environment (e.g. environmental weeds, introduced predators, population control of native grazers, fire regimes) or have particular challenges relating to extreme depletion (e.g. grasslands) or ecological sensitivities (e.g. old growth forest, dependent owls, rainforests). Although these issues are discussed in each bioregion according to their relevance, it is also effective to implement specific policy and planning approaches through Codes of Practice, targeted conservation programs and action plans. This variety of management issues is reflected in the extent to which Victoria's flora and fauna have become extinct or depleted. Around 600 of the 4000 native species of vascular plants and vertebrate animals have been identified as being threatened with extinction in Victoria.

Our knowledge of the conservation status of most invertebrates and non-vascular plants is much poorer. Clarification of the status of biodiversity in Victoria is provided by the Flora and Fauna Guarantee Act 1988, and so far:

- 22 potentially threatening processes have been listed, of which three have Action Statements;
- 23 ecological communities have been listed and three of these have Action Statements;
- 245 vertebrate animals and vascular plants and 25 invertebrates have been listed;
- 85 of these listed species are covered by Action Statements.

The challenge of securing these species and ecological communities and preventing further threats is clearly a complex one, and relies on a combination of state-wide and bioregional responses.

The discussion of each descriptive area is structured in the following way:

- A schematic map showing the location of the descriptive area within Victoria (with the bioregions shaded differently where there is more than one) against a background of Catchment Management Areas labeled as follows:

MA - Mallee	WI - Wimmera
GL - Glenelg	NC - North Central
CO - Corangamite	PP - Port Phillip
GB - Goulburn-Broken	NE - North East
EG - East Gippsland	WG - West Gippsland;
- The Bioregional Landscape – placing the reader in their bioregional landscape through links to major features and administrative frameworks;
- The Natural Capital of the Landscape – summarising the natural history inheritance within the bioregion or area;
- Land Management Themes – how the landscape has been used in the past and how we are using it now;
- Biodiversity Condition – summarising the overall consequences for biodiversity of the variety of land uses;
- Management Responses – focusing on the most important challenges for biodiversity conservation and management.

Tables and charts for each terrestrial bioregion illustrating comparative data for the following:

- Pre-European area and percentage remaining of Broad Vegetation Types;
- Number of native terrestrial vertebrate and vascular plant species in each common life form;
- Land tenure of Broad Vegetation Types;
- Number of vascular flora and vertebrate fauna species in each rare or threatened category for each common life form;
- Proportion of vertebrate fauna and vascular flora that are threatened, not threatened or introduced.
- Similar information is provided for each aquatic descriptive area.

### Victorian Mallee

#### Bioregions: Lowan Mallee, Murray Mallee, Wimmera

##### The Bioregional Landscape

The Victorian Mallee extends north and north-west from the Victorian Highlands to the New South Wales and South Australian borders. Annual rainfall ranges from 500 mm in the south to less than 250 mm in the north. It is part of the much larger Murray-Darling Depression IBRA region which extends into New South Wales and South Australia. The area is characteristically of low elevation and three bioregions are recognised. The Wimmera bioregion corresponds to the flat to gently undulating Wimmera plains of the southern part of the area. The Lowan Mallee bioregion extends in three lobes eastwards from the South Australian border, in part dividing the Wimmera plains. These three lobes correspond broadly to: the southern section of the Murray-Sunset National Park; the Big Desert including Wyperfeld National Park; and the Little Desert National Park. The Lowan Mallee bioregion is typified by a complex array of jumbled dunes and east-west trending dunes with intervening plains of deep white siliceous sand. The Murray Mallee bioregion is typified by an extensive, undulating sandy plain that is often overlain by linear, east-west aligned, stabilised sand dunes with intervening heavier textured swales. It occurs over much of the eastern portion of the area but extends to the South Australian border in the north. The Lowan Mallee and Murray Mallee soils in particular are exceptionally prone to wind erosion when cleared.

The Victorian Mallee characteristically has few surface water bodies because its soils are highly permeable and its climate promotes high evaporative losses. The Murray River flows along the northern edge of the bioregion and the northerly flowing Avoca River more or less defines

the eastern edge. Anabranches of the Murray River form the Hattah Lakes complex and define the southern edges of Wallpolla, Mulcra and Lindsay islands. The Wimmera River/Outlet Creek and the Yarriambiack, Tyrrell and Lalbert creeks are northward-flowing intermittent creeks that originate beyond the southern edge of the area. They all fail to reach the Murray River, terminating in freshwater or saline lake systems. The Hattah Lakes, which are a declared wetland of international significance under the Ramsar Convention, are contained within the Hattah-Kulkyne National Park, which is itself a designated Biosphere Reserve under the UNESCO 'Man and the Biosphere' program. The Wimmera River north of Lochiel is listed as a Heritage River, reflecting its important biodiversity values. The terminal lakes of this system include Lake Hindmarsh, which is a Ramsar-declared wetland, and the often dry Lake Albacutya. Also of major significance for geological, archaeological and nature conservation reasons is the Lake Tyrrell Wildlife Reserve, which is the terminal lake for the Tyrrell Creek. Lake Buloke in the south supports large numbers of waterbirds when full and is the most popular duck hunting area in the State.

The most significant of the conservation reserves in the Wimmera bioregion support remnants of Plains Grassy Woodlands, particularly at Glenlee, Barrett and Gerang Gerang. Highly significant remnants also occur in the Brynterion and Barrabool State forests.

Prior to European settlement, the Mallee and Wimmera were occupied by Aboriginal people of eight language groups. The bulk of the area was occupied by the Wergaia, who were found in the southern and central Mallee and the Wimmera as far east as Lake Tyrrell and almost to the Loddon River. In the north the people were concentrated along the main watercourses, the Wimmera/Outlet Creek system and the Murray. Further south, where conditions were somewhat less harsh the population was probably slightly more dispersed. However the freshwater lakes and swamps such as Lake Buloke and Lake Hindmarsh were undoubtedly focal points, offering both water and abundant food supplies which permitted gatherings of large groups from several tribes.

##### The Natural Capital of the Landscape

The Victorian Mallee is a large area and has a correspondingly complex and diverse array of vegetation communities occurring as complex mosaics in the landscape. Many individual species of fauna utilise a range of ecosystems and consequently are widely distributed across the area. Characteristic of the Lowan Mallee and Murray Mallee bioregions are multi-stemmed mallee eucalypts, which dominate several communities. These are interspersed with small to large stands of Slender Cypress-pine, Buloke and Belah woodlands, grasslands and Savannah Mallee on high ground, while halophytic shrublands occur on lower ground close to or intersecting the water table. The river and creek systems allow the persistence of significant stands of River Red Gum and Black Box Woodland as well as lake-bed communities. Desert Stringybark communities are found in and around the Little Desert and the southern Big Desert. The Wimmera plains were originally covered by woodlands variously dominated or co-dominated by Yellow Gum, Buloke, Black Box and Grey Box with large areas of native grassland occurring between the woodlands.

## Victorian Mallee

Seventy-eight per cent of Victoria's mammal extinctions have occurred in this area, with at least 11 species in the small to medium size range lost. Many extant species are found nowhere else in Victoria (e.g. Red Kangaroo, Paucident Planigale, Mallee Ningau, Mitchell's Hopping-mouse). The Silky Mouse and Western Pygmy-possum are

restricted to the Big and Little Deserts. The avifauna is distinctive, with raptors, parrots and honeyeaters the dominant groups. Victoria's only megapode, the Malleefowl, occurs here. Clearing and subsequent habitat fragmentation has led to the decline of many species including the Black-eared Miner, Malleefowl, Australian Bustard and Western Whipbird. In Victoria, the Malleefowl is restricted to Mallee Eucalypt Shrublands with a preference for habitat that has not been burnt for at least 40 years. The White-browed Treecreeper is significantly affected by clearing of its habitat of Slender Cypress-pine, Buloke and Belah woodlands. The reptile fauna is especially well developed, with a greater diversity in the Victorian Mallee than in any other area of the State. Fire and past clearance of native vegetation may play the major role in the restricted range of some cryptic species such as the Mallee Worm-lizard, whereas human interference still has a detrimental effect on others such as the Carpet Python. Two threatened amphibians, 11 threatened fish and at least five threatened invertebrates occur or used to occur in the Victorian Mallee.

### Land Management Themes

Small rural towns occur across the whole of the area,

but the major regional centres are Mildura, Horsham and Swan Hill. Cereal and coarse grain cropping and livestock industries dominate the dryland areas while irrigated horticulture along the Murray and Wimmera rivers makes a significant economic contribution. The area falls wholly or in part within the jurisdiction of three municipalities and seven shires.

The national parks of the western side of the area make up 40 per cent of Victoria's national park estate and include representation of all local BVTs. As the Lowan Mallee bioregion dominates these major blocks of public land, the heathy vegetation communities are best represented. Vegetation communities associated with the region's better agricultural soils in the Murray Mallee and Wimmera bioregions, especially Grassland, Plains Grassy Woodland, Wimmera Mallee Woodland, Slender Cypress-pine, and Buloke and Belah woodlands have been extensively cleared for agriculture. Therefore the Grassland and Plains Grassy Woodland BVTs and many significant vegetation communities below the BVT level of resolution are under-represented, especially in the Murray Mallee and Wimmera bioregions. East of the Calder Highway to Swan Hill and south to Donald and Warracknabeal, public land is largely confined to scattered small blocks, streamside reserves and lakes. Freehold land retains only about three per cent of its original native vegetation as remnants. Therefore roadsides and unused road reserves are particularly important in preserving remnant stands of native vegetation and providing corridors for the movement of wildlife. Their role in connecting with other larger remnants should not be underestimated. Off-reserve conservation in the Victorian Mallee is vital to the achievement of Victoria's conservation objectives.

Overall, approximately 70 per cent of Victoria's mallee vegetation has been cleared. As a direct consequence of farming practices, the 1930s saw a part of the Victorian Mallee become one of the worst wind eroded areas in Australia, resulting in the passing of soil conservation legislation in Victoria. The area also gained notoriety for rabbit populations of plague proportions exacerbating the effects of stock grazing on leased land and severely affecting particularly grassy and woodland communities on reserved land.

Many mallee species require fire to regenerate. Heath of the Lowan Mallee appears to be affected by fire intensity, whereas timing appears to be the critical factor in mallee shrublands and grasslands of the Murray Mallee.

Riverine communities require intermittent flooding. River regulation has altered not only the timing of floods but also the size and frequency of flooding. Creeks that formerly ran dry for extended periods continue flowing while others that were more often wet now remain dry except for exceptionally high floods. These changes affect not only adjacent floodplain vegetation but also aquatic fauna that may be dependent upon certain flooding regimes.

### Biodiversity Condition

A relatively high proportion of public land occurs in the north-west of the area. The best represented and least modified BVT in this area is Heathland. Pest plants and animals have made least incursion on this BVT largely due to lack of water and its undisturbed nature. Here the fire regime is the single most important factor in maintaining biodiversity. Other BVTs reserved for conservation purposes have been modified through past management practices. Prior to reservation, parts of the Murray-Sunset and Hattah-Kulkyne national parks had long pastoral histories. Timber from woodland communities was utilised for fencing, horticultural trellising and firewood. Grazing pressure exerted by stock, rabbits and feral animals such as goats modified the landscape, converting woodlands to grasslands with a high proportion of weed species. Remnant dams support artificially high populations of native grazers in their hinterlands. Routine kangaroo culling has taken place within a section of Hattah-Kulkyne National Park since 1990, with evidence that a subsequent increase in some plant species can be directly attributable to a reduction in grazing pressure.

## Victorian Mallee

Modified flooding regimes have a significant impact on each bioregion's waterways, notably the Outlet Creek system, which together with the terminal lakes and Lake Albacutya forms part of the Wimmera Heritage River system. River Red Gum and Black Box communities associated with this system provide important habitat for a range of species, notably the Regent Parrot. Regulation of the Wimmera River has resulted in a drastic reduction in the frequency of flows, with some areas not receiving any since the 1920s.

With 70 per cent of the area cleared, habitat loss is the single most important factor affecting biodiversity. In addition to the widespread loss of communities, clearing has resulted in increased recharge and subsequent rising saline ground water. The Victorian Mallee contains some of the worst salt-affected land in the State, with large areas affected by dryland salinity and more concentrated effects in irrigated horticultural areas. Low-lying areas such as the Hattah Lakes are at threat from a further rise in ground water while floodplains of the Murray River may have yet to experience the full effect of increased salinity.

Native vegetation in the largely cleared areas is in many cases retained as isolated reserves or remnant patches on private land. Road and other linear reserves are the sole means of linking many of these patches. While remnant grasslands are relatively well represented in the north they are susceptible to high grazing pressure and weed invasion. Elsewhere grasslands occur only as small remnants where edge effects and continued clearing for agriculture pose the greatest threat.

In the Wimmera bioregion the main threats to remnants are invasion by introduced grasses and clearing. Other threats include inappropriate tree planting into remnants, drift from aerial spraying, expansion of irrigation and stock grazing without replacement of senescent trees.

Of the 223 known threatened species and undetermined number of threatened ecological communities in this suite of bioregions there are:

- 102 listed vertebrates and plants, of which 21 have Action Statements;
- six listed invertebrates, of which three have Action Statements;
- one listed community, which does not yet have an Action Statement.

### Management Responses

The range of management responses in the Victorian Mallee reflects the three broad themes: maintenance of largely natural landscapes of the Lowan Mallee; rehabilitation of previously grazed landscapes in the Sunset and Hattah-Kulkyne areas; and protection of remnants in a rural landscape.

In mallee heaths and heathlands that are well represented in the national parks, the need for greater understanding of fire ecology is particularly important. The large remote areas typical of the Lowan Mallee provide an opportunity for management of fire for biodiversity objectives to be undertaken at a broad scale.

In large areas of native vegetation efforts are directed at restoring the ecological balance after past uses. Proactive management of total grazing pressure, hydrological regimes, pest plants and animals, and salinity is critical for the protection of biodiversity. The relationship between these factors and biodiversity is in some cases poorly understood and requires an ongoing commitment to research and monitoring. Control of introduced species continues to be a high priority in many areas and the Hattah-Kulkyne National Park is a part of the national monitoring program to gauge the impact of the calicivirus release on the biodiversity assets affected by rabbits. Grazing pressures from over-population of kangaroos have now been monitored for nearly a decade and routine culling will continue to be undertaken where demonstrable benefits to ecosystem health and threatened flora conservation can be realised.

Areas outside the major reserves rely on sympathetic management of remnant vegetation on private land, linear reserves and isolated small blocks of public land. Intrinsic to this is a high level of community education and incentives in the form of assistance in identifying sites of significance and their management requirements. Regional Vegetation Plans will provide strategic direction for these activities and will recognise the inherent importance of remnants on roadsides and unused road reserves and their role in providing wildlife corridors. The requirement for continuing assistance through conservation programs for works such as fencing remnant vegetation or undertaking pest plant and animal control is significant in areas that have been extensively cleared. Conservation covenants and land purchase may be the only options for poorly represented remnant communities such as the Plains Grassy Woodlands of the Wimmera plains. Raising community awareness of the nature and significance of these communities will prevent inappropriate tree planting.

Together with the state-wide key directions outlined earlier, land and water managers and planners in each bioregion should consider the following priorities.

- Target Land for Wildlife and land protection grants to owners protecting and enhancing Northern Plains Grassland, Buloke, Belah or Sandalwood Woodlands and riparian vegetation.



## Victorian Mallee

- Manage kangaroo populations in parks and reserves as part of a program to restore threatened vegetation communities.
- Protect and enhance aquatic environments, floodplain wetlands and riparian vegetation by managing environmental flows and grazing on the banks of the Murray and Wimmera rivers and terminal, northward flowing streams.
- Determine and implement ecologically based fire regimes, particularly in the Lowan Mallee, as part of integrated processes outlined in the Code of Practice for Fire Management
- Protect roadside habitat from soil drift due to wind erosion.
- Manage and protect floodplain wetlands and other low lying areas of natural habitat from the effects of rising salinity.
- Complete Ecological Vegetation Class mapping of the Little Desest and the Wimmera and facilitate identification of all sites of biological significance in the rural landscape in conjunction with local government, and encourage appropriate use of this information in local planning schemes.

## Victorian Volcanic Plain

### Victorian Volcanic Plain

#### Bioregion: Victorian Volcanic Plain

##### The Bioregional Landscape

The Victorian Volcanic Plain is an area of flat to undulating plains in south-western Victoria, stretching from Melbourne west to Portland, south to Colac and north to Beaufort. It is characterised by vast open areas of grasslands, small patches of open woodland, stony rises denoting old lava flows, the low peaks of long extinct volcanoes dotting the landscape and numerous scattered large shallow lakes. Few major rivers cross the Victorian Volcanic Plain, although the Hopkins River system is a prominent landscape feature. The major land use is agriculture, especially sheep and cattle grazing and cropping.

Settlement on the Victorian Volcanic Plain is generally sparse, although denser in areas on the outskirts of Melbourne, Geelong and Ballarat. Being one of the first areas settled for agriculture in Victoria, there is very little public land, and consequently parks and conservation reserves are generally small and scattered. Important parks and reserves include Mount Napier State Park, Mount Eccles National Park, Inverleigh Common, and Cobra Killuc and Derrimut reserves. Nine lakes in the Victorian Volcanic Plain, including Lake Corangamite and Lake Murdeduke, are included in the Ramsar Convention on wetlands of international importance. Several of the Victorian Volcanic Plain lakes are also popular duck hunting reserves.

Aboriginal people of seven language groups inhabited the Victorian Volcanic Plain before European settlement. The Girai wurrung, Dhauwurd wurrung and Djab wurrung were in the west, the Djargurd wurrung and Gulidjan around Lake Corangamite, and the Watha wurrung and Woi

wurrung in the eastern part of the plain. Their use of fire to encourage new growth, which attracted game, and in hunting greatly influenced the diversity of species and may have assisted in maintaining the open plains landscape.

Major regional centres include Camperdown, Hamilton and Portland. The bioregion covers parts of many local government areas and parts of the Corangamite CMA, South West CMA and Port Phillip CaLP areas, with a small part in the Wimmera CMA area.

##### The Natural Capital of the Landscape

The most prominent BVTs in this bioregion were grass lands and associated communities. Other vegetation included woodlands, shrublands, riparian vegetation and extensive wetlands. The grassland communities are floristically rich, usually dominated by Kangaroo Grass with a wide variety of perennial herbs. The bioregion supports a wide variety of reptiles, birds of prey, waterbirds and several ground-dwelling birds, but few mammal species. Several species including Eastern Barred Bandicoot, Corangamite Water Skink and Basalt Rustyhood Orchid are endemic to the Victorian Volcanic Plain, and the Striped Legless Lizard is most strongly associated with this bioregion.

Only a handful of small conservation reserves, including Cobra Killuc Wildlife Reserve and Derrimut Grassland Reserve preserve small remnants of native grassland. Several of the larger lakes are important sites for colonial nesting waterbirds including Australian Pelican and Gull-billed Tern, while tens of thousands of water birds and waders occur on Lake Goldsmith in some years. The remaining native ecosystems, particularly those severely depleted such as grasslands, woodlands and shallow freshwater wetlands, are all highly significant and vital for biodiversity conservation in the bioregion.

##### Land Management Themes

The open and fertile grassy plains provided ready opportunities for pastoralism, and early settlers soon moved into the district. As a result, the Victorian Volcanic Plain is now largely private land used almost entirely for agriculture, particularly grazing and cropping. The bioregion supports some of the most productive grazing country in Australia. As a consequence there is very little public land, other than road and rail reserves, in the area. Almost all of the native ecosystems have been severely depleted, with remnants occurring in small and isolated patches. Some of the larger grassland remnants and most of the shallow freshwater wetlands are on private land, whereas most of the deeper permanent wetlands are public reserves. The heavy basaltic soils of the plains and the frequent fires of pre-European times resulted in extensive areas of open grassland, and many grassland plants are adapted to frequent burning and grazing by native herbivores. Fire management of the dissected remnants remains one of the major problems facing conservation managers today.

##### Biodiversity Condition

Once the major habitat covering many thousands of square kilometres of the Victorian Volcanic Plain, native grasslands are now reduced to a few thousand hectares in extent, with much of this in small fragmented road and rail reserves and cemeteries. A few larger patches remain on private land. Much of the riparian habitat has been removed

## Victorian Volcanic Plain

or reduced to narrow bands of trees with little regeneration. Almost all of the woodlands have been cleared, with little regeneration of remaining areas on private land because of grazing and cropping. Over 75 per cent of the shallow freshwater wetlands have also been lost or extensively modified through drainage. Most of the larger deep, usually permanent wetlands remain, although much of the original shoreline vegetation has been removed. Changes in catchment hydrology of some of the larger lakes has caused problems due to altered runoff from cleared and drained lands. The remnant habitats are under threat from weed invasion, grazing, cropping, vehicle movement and soil disturbance. Urban, industrial and major project developments to Melbourne's west are also placing pressure on some remnant grasslands. Dryland salinity and increasing salinity of some lakes is a problem.

Extensive habitat loss has resulted in many plants and animals becoming extinct or threatened; these include the Eastern Barred Bandicoot, Plains-wanderer, Brolga, Striped Legless Lizard, Southern Lined Earless Dragon, Dwarf Spider Orchid and Basalt Rustyhood. The Victorian Volcanic Plain has a high proportion of extinct or threatened flora and fauna relative to the rest of Victoria. The remaining grassland areas are crucial to the conservation of many threatened species. Small and restricted plant populations are extremely vulnerable to the slightest disturbance such as a vehicle driving on the site. The lake systems, particularly the Ramsar listed wetlands, are important for waterbird conservation. Lake Corangamite has one of very few Australian Pelican breeding colonies in Victoria. The protection of colonial breeding and roosting sites is very important for the conservation of a range of waterbirds.

With much of the Victorian Volcanic Plain in private ownership and relatively few conservation reserves, biodiversity conservation will require the cooperation of private land owners and managers. Many of the threatened plant species now restricted to narrow road or rail reserves will depend for their conservation on the sympathetic management of these areas. Land for Wildlife and Public Authority Management Agreements (PAMAs) are already being used to promote the protection of these areas on private and public land, and some significant sites are protected under these arrangements.

Of the 119 known threatened species and undetermined number of threatened ecological communities in this bioregion there are:

- 80 listed vertebrates and plants, of which 19 have Action Statements;
- two listed invertebrates, of which one has an Action Statement;
- two listed communities, of which one has an Action Statement.

### Management Responses

The extensive depletion and fragmentation of many of the bioregion's ecosystems means that the remaining areas are highly significant for biodiversity conservation. Given the large proportion of private land in the Victorian Volcanic Plain and the scattered small conservation reserves, biodiversity conservation will rely heavily on the owners and managers of private land and the network of road and rail reserves and other public land. The emphasis will be on working with landowners and managers to identify and protect these remnants and the threatened species, communities and critical habitats of the region through schemes such as Land for Wildlife. The Regional Vegetation Plans of the Catchment Management Authorities in this bioregion will provide a focus for the protection, restoration and revegetation of depleted habitats. Early identification of threatened communities will be encouraged, so that this information can be included in planning and approval processes. There is already considerable interest from the local community in conservation initiatives such as the Eastern Barred Bandicoot reintroductions and the Striped Legless Lizard recovery program.

The approach will be to build on these strengths, by providing incentives and assistance for the protection of remnant grasslands, woodlands and shallow freshwater wetlands on private land and using PAMAs and roadside vegetation protection mechanisms for protection of significant habitats on other public land. Emphasis will be given to protecting and enhancing riparian corridors. Management plans will be prepared and implemented for all significant conservation reserves, including Ramsar wetlands. FFG Act processes and native vegetation retention regulations will also be used to protect threatened species and communities.

Concentrated predator and environmental weed control is vital where small, fragmented habitats and population and colonial breedings sites persist.

Together with the state-wide key directions outlined earlier, land and water managers and planners in the bioregion should consider the following priorities.

- Implement a grasslands conservation program, with particular emphasis on a reserve system supplemented by off-reserve components (landholders and property management, road and rail sides) and management of environmental weeds. Emphasis should be placed on long-term viability, thus there should be concentration on larger sites away from urban areas.

## Victorian Volcanic Plain

- Finalise management plans for significant wetlands, including all Ramsar wetlands.
- Identify all sites of biological significance in the rural landscape in conjunction with local government and encourage appropriate use of this information in local planning schemes.
- Target Land for Wildlife and property management planning extension to properties with native grasslands and wetlands, particularly those likely to support threatened species.
- Focus revegetation and rehabilitation efforts on the riparian environments.
- Maintain appropriate water regimes for freshwater wetlands.
- Focus efforts on threatened species that are endemic or for which the volcanic plains are important (e.g. Eastern Barred Bandicoot, Corangamite Water Skink) and encourage habitat protection (e.g. prevention of rock removal at Striped Legless Lizard sites) and rehabilitation.
- Protect forest areas (e.g. Stony Rises) from fragmentation.

### Glenelg Plain

#### Bioregion: Glenelg Plain

##### The Bioregional Landscape

The Glenelg Plain is located in the south-western corner of Victoria and comprises the Victorian part of the Naracoorte Coastal Plain IBRA region.

The Glenelg Plain extends from south-east of Edenhope, for some 230 kilometres to the southern Victorian coastline. The bioregion abuts the west end of the Warrnambool Plain bioregion near the rural township of Heywood. Portland Bay is the south-eastern coastal limit of the Glenelg area.

The bioregion is predominantly flat and low lying, with all sections ranging from sea level to less than 200 metres above sea level. The IBRA region features parallel dune limestone ridges with intervening swamps, closed limestone depressions and young volcanoes at Mount Gambier. Floristically, the bioregion is varied. Coastal communities are composed of beach and dune vegetation, coastal cliffs and saltmarshes. Wet heathlands occur on very infertile soils that are frequently waterlogged. These heath communities, up to 2 metres high, are interspersed with tree-heaths, having scattered low trees. Woodlands occur through much of the region, particularly in the north. Heathy Woodlands make up a large proportion of this and there are lowland forests, predominantly Brown Stringybark, providing the basis for hardwood logging in the south-eastern portion.

The Glenelg River is the area's most significant waterway. Its listing as a Heritage River south of Dartmoor to its mouth at Nelson, reflects its important biodiversity values. Several smaller rivers flow on the south-eastern portion of the Plain, particularly the Fitzroy and Surrey rivers, and Darlots Creek.

The Buandig and Dhauwurd wurrung were the Aboriginal peoples of this area prior to European settlement. It seems that the people here were able to form relatively permanent settlements due to the greater predictability of seasonal food supplies such as eels. Evidence of these settlements is seen at Lake Condah, where the remains of stone huts associated with fish traps can still be found.

Large expanses of the bioregion have been cleared for agriculture, although approximately 30 per cent of the area is reserved Crown land. Significant reserves include Lower Glenelg, Mount Eccles and Mount Richmond national parks, Dergholm and Mount Napier state parks, Crawford River Regional Park and Discovery Bay Coastal Park. State forests include Cobboboonee, Curra Curt, Narrawong, Weecurra, Drajurk and Dergholm.

Most of the bioregion is situated within the rural municipality of the Shire of Glenelg and is within the Glenelg Catchment Management Authority's area of responsibility.

##### The Natural Capital of the Landscape

The Glenelg Plain supports four BVTs. The most prominent community in this diverse region is Heathy Woodland, dominated by Brown Stringybark. To the south east of the bioregion, Lowland Forest dominates. Several areas of Plains Grassy Woodland, once dominated by Red Gum and easily converted to pasture have generally been cleared and modified. The Coastal Grassy Woodland, once occurring between Casterton and Coleraine, was quickly settled and replaced with exotic pasture species.

The bioregion supports a wide variety of reptiles, birds of prey, waterbirds, woodland and ground-dwelling birds, and an array of mammal species. Threatened species include the Red-tailed Black-Cockatoo, Brolga, Rufous Bristlebird, Hooded Plover, Powerful Owl, Heath Mouse, Spot-tailed Quoll, Brush-tailed Phascogale, and numerous orchids including at least four spider-orchids and the Leafy Greenhood. One species of fish, the Variegated (Ewen's) Pygmy Perch, is restricted to south-western Victoria and adjacent areas of south-eastern South Australia.

Much of the sandy soil areas of the Glenelg Plain have been cleared for agriculture and plantation establishment. Broad-scale drainage works have drained numerous wetland systems throughout the bioregion, although several wetland systems of national significance remain: the Glenelg River estuary, Mundi-Selkirk wetlands, Long Swamp complex at Discovery Bay Coastal Park and Lindsay Werrikoo wetlands.

##### Land Management Themes

Portland was the first European settlement in Victoria where activities were generally confined to the coast until native grasslands were discovered between today's townships of Casterton and Coleraine. Graziers then moved further afield into the plains and grassy woodlands described by Major Mitchell as 'Australia Felix' during his journey of 1836. An expanding pastoral industry was quickly established.

Geological reports of sand areas further west towards the South Australian border suggested appropriate sites for broad-scale establishment of *Pinus radiata* plantations, which was achieved following the Second World War. Today, plantation establishment of both pine and Blue Gum is increasing throughout the entire bioregion, with establishment

## Glenelg Plain

rates nearing 2500 hectares per year. Hardwood logging occurs throughout State forests, which constitute almost 30 per cent of the bioregion.

Drainage of shallow wetlands continues throughout the bioregion, with sites usually being planted to exotic pasture species once drained. As a result, native marsh and riparian vegetation and dependent species are becoming depleted throughout the area. There is an increase in centre-pivot irrigation systems in the northern section of the bioregion.

### Biodiversity Condition

Approximately half of the Glenelg Plain has been cleared and sown to exotic pasture or plantation species, with the other half remaining as native vegetation. Of this, national parks and reserves managed by Parks Victoria make up some 40 per cent. About 10 per cent of existing native vegetation remains on private land.

A range of threatened birds and one mammal found on the Glenelg Plain are a focus for conservation management.

Species include Brolga, Red-tailed

Black-Cockatoo, Plains-wanderer, Hooded Plover,

Little Tern, Rufous Bristlebird, Orange-bellied Parrot,

Grey-crowned Babbler and the Heath Mouse which is now restricted to this bioregion and East Gippsland. Several of these species depend on private land for habitat. Australasian Gannets have, over recent years, established mainland Australia's first recorded gannet colony, at Point Danger, south of Portland. The most apparent threats to the colony, as with many other colonial native fauna species, are fox predation and human disturbance.

Much of the bioregion remains reserved Crown land. Land for Wildlife is increasingly adopted by landholders with remnants of native habitat on their properties, and several Public Authority Management Agreements (PAMAs) are in place with local governments to protect endangered species. Botanic Guardians groups are increasing also, with several voluntary groups currently working to protect native grasslands, particularly in cemetery grounds.

Of the 59 known threatened species and undetermined number of threatened ecological communities in this bioregion there are:

- 49 listed vertebrates and plants, of which 17 have Action Statements;
- no listed invertebrates;
- no listed communities.

### Management Responses

Strategies being implemented towards ensuring sustainable biodiversity management include Coast Action, Landcare, Botanic Guardians, Public Authority Management Agreements, Whole Farm Planning and in one instance (Portland Aluminium) special arrangements within an industrial development area. Further, a review of local government planning schemes has seen the development of overlay controls to protect biodiversity values. Private landowners are increasingly being encouraged to practise sustainable land management, including preservation of remnant vegetation and the habitat within it, through programs like Land for Wildlife, Landcare and Farm\$mart. Increasing effort towards the eradication of foxes and rabbits is protecting biodiversity values. The 'mission' of the recently formed Catchment Management Authorities is to 'ensure the sustainable development of natural resource-based industries, the protection of land and water resources and the conservation of natural and cultural heritage'. Private forestry developments are being encouraged and companies involved are seeking cleared land for plantations.

Together with the state-wide key directions outlined earlier, land and water managers and planners in the bioregion should consider the following priorities.

- Complete EVC mapping program of all native vegetation on the Glenelg Plain, identify sites of biological significance in the Glenelg and West Wimmera shires in conjunction with local government, and encourage appropriate use of this information in Local Planning Schemes.
- Finalise the West Regional Forest Agreement Process for the bioregion.
- Establish PAMAs with public authorities managing all grassland and significant woodland sites, particularly roadsides.
- Encourage conservation and enhancement of streamsides and Plains Grassy Woodlands and efforts to promote natural recruitment in these areas.
- Target Land for Wildlife and property planning extension to properties supporting Plains Grassy Woodland, areas supporting the habitat of the Red-tailed Black-Cockatoo, areas of natural wetlands and areas that will increase the viability of biolinks.
- Develop and implement ecological fire management regimes, especially for the Heath Mouse and Red-tailed Black-Cockatoo, as part of integrated processes outlined in the Code of Practice for Fire Management.
- Prepare and/or implement management plans for parks and reserves with priority given to those that support nationally threatened species (e.g. Hooded Plover in Discovery Bay).

### Victorian Midlands

#### **Bioregions: Dundas Tablelands, Greater Grampians, Goldfields, Central Victorian Uplands**

##### The Bioregional Landscape

The Victorian Midlands cover 3.7 million hectares of undulating terrain stretching east-west across central Victoria. This area is characterised by patches of woodland and forest interspersed with a rural landscape with modified pastures and some cropping. It contains the upper catchments of north flowing rivers — the Wimmera, Avoca, Loddon and Campaspe and south flowing rivers — the Werribee, Moorabool and Hopkins. The Victorian Midlands straddles the south western portion of the Great Dividing Range with rainfall being higher on and south of the Divide than to the north.

Prior to European settlement, aboriginal people of seven or eight language groups inhabited the Midlands. The Jardwadjali were found in the Dundas Tablelands and Grampians, while the Djadja wurrung lived in the goldfields and upper Loddon valley. Further to the east the Aboriginal people included the Ngurai-illam wurrung and Duang wurrung, who extended through this region from the Riverina plains.

The Victorian Midlands area comprises four bioregions. Dundas Tablelands is an undulating area to the west of the Grampians, much of which has been cleared for agriculture. The Greater Grampians bioregion is dominated by the striking parallel ranges and valleys which comprise the Grampians National Park, and retains substantial areas of native vegetation. The topography of the Goldfields bioregion is dominated by rolling plains and low hills between Stawell and Wangaratta, north of the Great Dividing Range. It supports fragmented native forests and woodlands, mostly on the relatively poor soils.

The Central Victorian Uplands bioregion extends from Beaufort in the west through Ballarat, Seymour and Alexandra to Beechworth in the east. This bioregion was formerly dominated by foothill forest, some of which is still found on the upper slopes. The flatter and more fertile areas are largely cleared for agriculture.

The major towns in the Victorian Midlands developed during the gold rushes of last century. Together, Ballarat and Bendigo support over 150 000 people. Other centres of population include Stawell, Ararat, St Arnaud, Daylesford, Kyneton, Maryborough and Alexandra. There is a general trend of decline in population from farming areas and the smaller towns, although some localities are growing as a result of tourism, such as the Daylesford area, or their proximity to Melbourne, such as the Woodend–Gisborne area.

Important parks and reserves in the Victorian Midlands include the Grampians and Brisbane Ranges national parks, Whipstick, Warby Range and Lerderderg State parks, Mount Bolangum and Deep Lead flora and fauna reserves, and the Hepburn Regional Park. No major parks or reserves occur within the Dundas Tablelands bioregion.

Within the Victorian Midlands, the major primary industry activities are agriculture (sheep and cattle grazing, cropping and viticulture), mining and timber production. The area retains a significant manufacturing sector focused on Bendigo and Ballarat, and an expanding services sector featuring retail, education and tourism businesses. The area also includes important water catchments and water storages.

Parts of many shires are represented in the Victorian Midlands. The Catchment Management Authorities of Wimmera, Corangamite, Loddon and Goulburn catchments also cover this area.

##### The Natural Capital of the Landscape

At the time of European settlement the Victorian Midlands were dominated by forests and woodlands. The Aboriginal inhabitants are believed to have actively managed the landscape with fire to promote the growth of food plants and enhance populations of grazing animals. Twelve BVTs occurred in the Midlands, including most of the Box Ironbark Woodland Complexes in Victoria, as well as substantial areas of Valley Grassy Forest Complexes, Inland Slopes Woodland Complexes, Herb-rich Woodland Complexes and Plains Grassy Woodland Complexes.

Today, the Victorian Midlands continue to support a wide variety of forest and woodland species; 980 species of flora have been recorded, of which 96 are rare or threatened; 502 species of fauna have been recorded, of which 105 are rare or threatened. Species endemic to the Victorian Midlands and found in more than one bioregion include Mount William Beard-heath, Creeping Grevillea, Twining Scale-rush and Scented Bush-pea. Threatened fauna species in the region include the Powerful Owl, Brush-tailed Phascogale and Common Dunnart.

Each of the four bioregions within the Victorian Midlands is distinct. At the time of European settlement, the Dundas Tablelands were dominated by Plains Grassy Woodland Complexes, Grassland Complexes and Inland Slopes Woodland Complexes. Endemic flora species in the Dundas Tablelands bioregion include Mossy Woodruff, Reader's Daisy, Hairy Raspwort and Hoary Bush-pea. The Greater Grampians bioregion remains dominated by Dry Foothill

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Forest Complexes, Inland Slopes Woodland Complexes, Herb-rich Woodland Complexes and Plains Grassy Woodland Complexes with small patches of Heathy Woodland Complexes and Valley Grassy Forest Complexes. The Greater Grampians is well recognised as an exceptionally rich area for plants, supporting a large number of endemic species, with a diverse range of fauna.

The Goldfields bioregion was dominated by Box-Ironbark Forest but also had large areas of Dry Foothill Forest Complexes, Inland Slopes Woodland Complexes, Plains Grassy Woodland Complexes and Herb-rich Woodland Complexes. Endemic flora species of the Goldfields bioregion include several orchids, Narrow Goodenia, Whorled Zieria and Goldfields Grevillea.

Dry Foothill Forest Complexes dominated the Central Victorian Uplands, but large areas of Moist Foothill Forest Complexes and Valley Grassy Woodland Complexes also occurred. This bioregion also supports a range of endemic plants.

### Land Management Themes

The flatter and more fertile areas of the Victorian Midlands have been substantially cleared for agriculture, principally sheep and beef cattle grazing. There has been a major increase in cultivation of grapes for the wine industry over the past two decades. Honey production based on nectar resources from native vegetation and introduced pasture species is also widespread within this area.

Timber harvesting remains an important land use in the Victorian Midlands. Much of the forests were extensively cut for timber to meet the demands of the gold mining industry of last century. A variety of wood products (sawlogs, posts and firewood) is still produced in State forest areas and on private land. Eucalyptus oil is also produced in some areas, where suitable species occur.

Gold mining is the most significant mineral development industry in the Victorian Midlands. Although the area of land affected by mining today is relatively small, large areas of the Victorian Midlands are covered by exploration licences. The production and storage of water for domestic and agricultural purposes is important in the area. Among the major impoundments are Rockland and Wartook reservoirs and Lake Bellfield in the west, with Eppalock and Eildon lakes, and Coliban, Laanecoorie and Lauriston reservoirs in the central and eastern areas.

Nature conservation is a significant land use on public land in parts of the Victorian Midlands, and is associated with an expanding nature-based tourism sector. Another recent trend has been the expansion of areas devoted to rural living and hobby farms, especially within commuting distance of Melbourne or major centres such as Ballarat and Bendigo.

### Biodiversity Condition

The biodiversity values associated with the more fertile valleys, tablelands and plains of the Victorian Midlands have generally fared worse than those associated with the less fertile slopes and hills.

In fertile areas where native vegetation has been cleared, most of the native biodiversity has been lost. Remnants of vegetation in these landscapes are often degraded, many having been affected by grazing, weed invasion, timber harvesting and altered fire regimes. Degradation and fragmentation of habitat in these fertile landscapes has led to the local extinction of native species where they depended on particular habitat features which have been lost.

This fragmentation and alteration of habitat is likely to have been a key factor in threatening the survival of a number of species. Characteristic rare and threatened fauna in the Victorian Midlands include the Brush-tailed Phascogale, Squirrel Glider, Swift Parrot, Regent Honeyeater, Bush Stone-curlew, Pink-tailed Worm-lizard, Woodland Blind Snake and Common Dunnart. Fauna known to have formerly occurred in the Victorian Midlands and that are now extinct are the Eastern Hare-wallaby, Tasmanian Bettong, and White-footed Rabbit-rat. Species that are extinct in the Victorian Midlands but survive elsewhere in Victoria or Australia

are the Bridled Nailtail Wallaby, Rufous Bettong, Eastern Quoll, Southern Purple-spotted Gudgeon and Dingo (pure forms). There have also been many fauna extinctions on the bioregion scale.

Plants species that have been recorded in the Victorian Midlands but are now extinct in Victoria are the Long-tail Spleenwort, Rough Wax-flower and Spike Grass.

In the less fertile parts of the Victorian Midlands, substantial areas of native vegetation remain. In some cases this vegetation is in remarkably good condition — weed-free, structurally diverse, species-rich and with ecological processes largely intact. For example, parts of the Grampians National Park fit this description. In other cases, the spread of weeds and pest animals, the loss of hollows or fallen timber and changes to fire regimes have meant that some degree of habitat degradation has occurred across even relatively large blocks of vegetated public land. Large areas of the Goldfields and Central Victorian Uplands bioregions were cleared during the gold rushes of the late nineteenth and early twentieth centuries.

The rivers, streams and wetlands of the Victorian Midlands have generally been greatly modified, largely as a result of altered flow regimes and the loss and degradation of riparian and fringing vegetation, leading to stream bank erosion



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and increased sedimentation. The introduction of exotic fish has added to predation pressure and competition for some native species, while reduced flows and less-frequent flooding has affected the life cycle of some aquatic species. Some of the BVTs that previously occurred across the Victorian Midlands have been significantly depleted by clearing for agriculture.

Ninety per cent of the Dundas Tablelands bioregion has been cleared for agriculture. Remnants of Plains Grassy Woodland Complexes constitute 30 per cent of the remaining area of this BVT in Victoria. In the Greater Grampians bioregion, Plains Grassy Woodland Complexes is the only BVT that has been substantially cleared and remains poorly reserved.

Fragmented but considerable remnants of Box– Ironbark Forest BVT occur within the Goldfields bioregion, while most other BVTs are almost all cleared for agriculture. Moderate proportions of the Mallee and Dry Foothill Forest BVTs remain, mostly on public land outside conservation reserves. The Goldfields bioregion has a very high number of threatened flora species and many of these are not present or adequately represented in conservation reserves.

Fragmented but moderately extensive remnants of Foothill Forest BVT remain within the Central Victorian Uplands. Substantial areas of the Moist Foothill Forest and the Dry Foothill Forest BVTs remain within this bioregion, plus significant remnants of Valley Grassy Forest BVT, which has been depleted across its range in Victoria. The Central Victorian Uplands include a large number of rare or threatened fauna species (e.g. one of four Victorian populations of the Smoky Mouse).

The Grampians State Forest supports a significant remnant of Plains Grassy Woodland BVT.

The character and condition of each of the bioregions means that some potentially threatening processes are of higher priority in some than in others. In the Dundas Tablelands, many remnants on private land are continuously grazed by domestic stock, preventing adequate regeneration of woody species.

Even within the modified agricultural landscape, the ongoing decline of mature and senescent trees, without adequate recruitment, will further restrict the available habitat for hollow-dependent species, such as Red-tailed Black-

Cockatoos, Squirrel Gliders and some bats. Salinisation is a major threat to agricultural productivity and native vegetation alike. Elevated salinity in runoff and groundwater is especially damaging to aquatic systems. Further degradation of riparian zones and remnant vegetation in general is a major potential threat in this bioregion.

In the Greater Grampians, fire is a particularly important ecological factor for biodiversity and appropriate regimes need to be determined and integrated with fire management for other purposes. Foxes are suspected to be a major threat to fauna in the Greater Grampians, especially to threatened species such as the Brush-tailed Rock Wallaby in the Grampians National Park. Habitat fragmentation and incremental loss poses a threat to many species and communities within the Goldfields bioregion. Weed invasion and clearing are continuing threats to remnant vegetation. The decline of senescent trees on private land is also a threat to some species in this bioregion.

Particular mining techniques, such as open-cut and dredge mining, permanently remove existing native vegetation, although over relatively small areas. Others, such as doze and detect operations, cause substantial disturbance to native vegetation and require careful management.

Timber harvesting and firewood collection can modify extensive areas of forest on public and private land. Impacts are currently addressed to some extent on public land by forest management prescriptions.

Dryland salinity poses a threat to lower lying areas of this bioregion. Environmental weeds are a major threat in some areas, particularly on fertile soils near farmland, while rabbits remain a threat to palatable native plants, such as orchids.

Major potentially threatening processes in the Central Victorian Uplands include inappropriate fire regimes, weed invasion and habitat modification as a result of timber harvesting. Loss of native vegetation along rivers and streams continues to pose a threat to water quality and therefore native aquatic species.

Of the 155 known threatened species and undetermined number of threatened ecological communities in this suite of bioregions there are:

- 96 listed vertebrates and plants, of which 26 have Action Statements;
- eight listed invertebrates, of which four have Action Statements;
- two listed communities, of which one has an Action Statement.

### Management Responses

The major emphasis of future biodiversity conservation on public land in the Victorian Midlands will be on the relevant agreements and instruments for planning, management, monitoring and review of public land use and land management. These include Regional Forest Agreements, Forest Management Plans and Park Management Plans. These processes require access to accurate and current information. Information derived from surveys and research will be critical. The identification of sites of biological significance is particularly important.

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In the fragmented landscapes of the Victorian Midlands, where most land is in private ownership, the emphasis will be on cooperation with the local community to identify and protect remnant vegetation, especially areas of high biological significance, and to restore degraded areas. The active involvement of Catchment Management Authorities, particularly through the Regional Vegetation Plans, will assist vegetation protection and restoration.

The full range of community involvement programs, including Land for Wildlife and the Botanic Guardians scheme, will be encouraged and facilitated.

Together with the state-wide key directions outlined earlier, land and water managers and planners in each bioregion should consider the following priorities.

### Dundas Tablelands

- Identify all sites of biological significance in the rural landscape in conjunction with local government and landholders and encourage appropriate use of this information in local planning schemes.
- Protect and enhance remnant vegetation on public land, including rail, water frontage and road reserves.
- Encourage private landholders to protect remnant vegetation on their land, using a range of incentives and programs, such as Land for Wildlife, targeting biolink zones, riparian vegetation, depleted BVTs such as Plains Grassy Woodland Complexes and Plains Grassland Complexes, and habitat for threatened species such as the Striped Legless-lizard and Yucca.

### Greater Grampians

- Determine and implement appropriate fire management regimes for the Grampians National Park and associated public land, as part of integrated processes outlined in the Code of Practice for Fire Management.
- Ensure the ecological sustainability of tourism developments.
- Protect remnants of the Plains Grassy Woodland BVT.

### Goldfields

- Complete and implement recommendations of Environment Conservation Council Special Investigation into the Box-Ironbark region.
- Complete and implement the Bendigo Forest Management Plan and the West Regional Forest Agreement.
- In conjunction with the mining industry, further research and develop improved rehabilitation practices for mine sites.
- Identify all sites of biological significance in the rural landscape in conjunction with local government and landholders and encourage appropriate use of this information in local planning schemes.
- Protect and enhance remnant vegetation on public land, including rail, water frontage and road reserves.
- Encourage private landholders to protect remnant vegetation on their land, using a range of incentives and programs such as Land for Wildlife, targeting biolink zones, riparian vegetation, depleted BVTs such as Grassland Complexes, Herb-rich Woodland Complexes and Inland Slopes Woodland Complexes and habitat for threatened species such as the Swift Parrot and Squirrel Glider.

### Central Victorian Uplands

- Complete and implement the Midlands and North East Forest Management Plans, and the North East and West Regional Forest Agreements.
- Finalise the bulk water entitlement process so that adequate and timely environmental flows are established for the rivers and wetlands.
- Identify all sites of biological significance in the rural landscape in conjunction with local government and landholders and encourage appropriate use of this information in local planning schemes.
- Protect and enhance remnant vegetation on public land, including rail, water frontage and road reserves.
- Encourage private landholders to protect remnant vegetation on their land, using a range of incentives and programs such as Land for Wildlife, targeting biolink zones, riparian vegetation, depleted BVTs such as Plains Grassy Woodland Complexes, and habitat for threatened species such as the Bush Stone-curlew

### Northern Inland Slopes

#### Bioregion: Northern Inland Slopes

##### The Bioregional Landscape

The Northern Inland Slopes bioregion is a small part of the New South Wales South Western Slopes IBRA region which extends across the Murray River into this State. It occurs on the granite, metamorphic and sedimentary lower foothills to the north of the Great Dividing Range in north-eastern Victoria. The bioregion comprises a number of blocks stretching from Corryong to near Shepparton, with a single outlier further west around Terrick Terrick. The landscape consists of foothill slopes and minor ranges separated by river valleys that drain northward from the High Country to the Murray River. Rainfall varies from a mean of 500 mm at Dookie to approximately 1000 mm at Beechworth. The major

rivers draining through the area, the Mitta Mitta, King, Ovens, Kiewa and Broken, have their origins in the Victorian Alps and Victorian Highlands bioregions to the south.

Prior to European settlement, the Aboriginal people who inhabited the Northern Inland Slopes were the same groups found at other times of the year along the Murray River, or on the Riverina plains and into the highlands. They included the Jodajoda in the west of the region, the Way Wurru, who were centred on the Ovens valley, and the Dhudhuroa in the East.

Clearing has been greatest in the valleys and in the west of the bioregion. This is also where population density is highest. The regional centres of Wodonga, Wangaratta and Benalla are all within or adjacent to this part of the bioregion.

The major land uses are agriculture and forestry. Sheep and cattle grazing are common on the hills while dairy farming is important in the more fertile valleys. The remnant vegetation consists of a series of isolated blocks on the rockier hilly areas, largely on public land, and smaller remnants and corridors in the valleys and slopes, which are predominantly on private land. The bioregion is fragmented, partly as a result of the natural topographic dissection of the bioregion by major river floodplains, and partly as a result of broadscale clearing. This presents major challenges in management to ensure the conservation of the region's biota.

Important reserves in the area are Chiltern Box-Ironbark and Burrowa-Pine Mountain National Parks, Warby Ranges, Mt Lawson, Terrick Terrick and Mt Granya State Parks, Boweya Flora and Fauna Reserve and Reef Hills Regional Park. Approximately 7.5 per cent of the area is included in reserves intended primarily for conservation. The bioregion spreads across three Catchment Management Areas, the North-East, Goulburn Broken and North Central, and through several shires.

##### The Natural Capital of the Landscape

The bioregion was once covered with a diversity of drier forest and woodland types, including Box-Ironbark Forest, Granite Hills Woodland Grassy and Heathy Dry Forest, Herb-Rich Woodlands and Valley and Riverine Grassy Woodlands. A distinctive feature of the bioregion is the overlap of species found mainly in New South Wales and those typical of Northern Victoria. Several species of flora and fauna reach the southern limits of their range here. They include the Carpet Python, Rainbow Skink, Mugga Ironbark, and Deanes Wattle.

The Box-Ironbark Forest remnants are extremely important for nectar feeding birds including the nationally endangered Swift Parrot and Regent Honeyeater. The bioregion has a particularly rich reptile fauna with over a third of the State's species found here. The granitic hills and outcrops are critical to a number of reptiles, including the vulnerable Carpet Python and flora such as Spur-wing Wattle, Green Grevillea and Hairy Hop-bush.

Other species found in the bioregion include the Squirrel Glider, Brush-tailed Phascogale, Turquoise Parrot, Grey-crowned Babbler, Warby Swamp-gum, Dookie Daisy, Narrow Goodenia, and Cupped Bush-pea. More than three-quarters of the bioregion has been cleared, with most of the area now rough grazing or pasture.

##### Land Management Themes

The Northern Inland Slopes were settled by Europeans in the nineteenth century. As was the case in many areas the earliest settlers made use of the grassy woodlands of the plains and valleys. The population of the bioregion increased rapidly during the goldrush. Large areas, particularly in the Box-Ironbark Forests, were felled for fuel and timber for the mines. Clearing began in earnest as the goldrush waned and was initially concentrated in the valleys, but as these areas were selected then later settlers were forced to look to the more hilly areas. Where remnants have survived they are usually on the poorest soils, and the larger remnants are on public land. Very few remnants have been unaffected by grazing or logging at some stage.

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Whilst most private land is cleared, it still contains 30 percent of remnant vegetation. This fact coupled with the isolation of the conservation reserves makes the management of private remnants critical, both for their own habitat value, and in providing corridors between larger remnants on public land. Valley Grassy Forests and Riverine Grassy Woodlands are both greatly depleted. The majority of what little remains of these vegetation types is on private land, and practically none of either type is in the reserve system. The great importance of vegetation on private land to the region's biodiversity

makes liaison with landholders and municipal authorities particularly important in effective conservation. The relatively high human population levels found in and adjoining the bioregion generate some particular management issues. People are attracted by the lifestyle opportunities of living on 'bush blocks'. This increases pressure for development in the areas surrounding parks close to regional centres. In popular areas low level rural development could effectively surround conservation reserves isolating them further, and fragmenting existing links. Careful consideration needs to be given in planning decisions to the maintenance of the integrity of links between separate blocks of conservation reserves. This will ensure that the values which attract people to these areas are maintained.

### Biodiversity Condition

Clearing has been particularly extensive in the more fertile Valley and Riverine Grassy Woodlands. Very little of these vegetation types remain. Loss of habitat and the fragmented and disturbed nature of much of the remainder have already caused the loss of much biodiversity. What was once a continuous mosaic of forest and woodland systems across the bioregion, is now a patchwork of a few moderately sized blocks of native vegetation on public land (many of which are conservation reserves) and a scattering of remnants on private land, along road reserves and riparian corridors. In the area west of Benalla and the Warby Ranges small remnants and linear corridors are all that survive of the Box-Ironbark Forest.

Broad-scale clearing and overgrazing in the foothills have led to erosion problems. These compound the rate of habitat loss, as well as degrading aquatic habitats and increasing groundwater recharge. This causes salinity and waterlogging lower in the catchment and this in turn is one of the causes of tree decline.

Remnants throughout the area are of great conservation significance. Small remnants are all that remain in the bioregion of some vegetation classes, for example Riverine Grassy Forest. Linear remnants along streams and roads are important corridors linking small remnants in the locality. At a regional level they help to maintain connectivity between otherwise isolated conservation reserves. Small remnants are particularly exposed to 'edge effects', which degrade the habitat. These include invasion by environmental weeds, grazing removing understorey and preventing regeneration, tree decline and the introduction of plant pathogens. Environmental weeds have invaded and replaced the understorey in disturbed areas. St John's Wort, for instance, is a major weed in Mt Pilot Multi Purpose Park and has invaded several other parks. Environmental weeds can most easily invade small remnants and disturbed areas. Firewood collection is another source of habitat degradation, particularly in roadside reserves, and other easily accessible areas such as parks close to the major population centres. Fallen wood and dead trees are both important habitat components. They form habitat for invertebrates, some reptiles, and act as refuges and nest sites for arboreal mammals and birds. Squirrel Gliders, for instance, are reliant on tree hollows in mature and dead trees for nesting, and Grey-crowned Babblers forage for invertebrates in fallen dead wood on roadsides.

Of the 51 known threatened species and undetermined number of threatened ecological communities in this bioregion there are:

- 44 listed vertebrates and plants, of which 13 have Action Statements;
- one listed invertebrate which does not have an Action Statement;
- no listed communities.

### Management Responses

The management, enhancement and linking of the significant vegetation remnants on private land with parks and reserves is particularly important for biodiversity conservation due to the fragmentation of habitat in the Northern Inland Slopes. The systematic identification, assessment and mapping of remnants and critical habitat will provide the basis for arresting the decline of flora and fauna that has been a consequence of this fragmentation. This will allow identification of the largest and best quality remnants as has already been done for Box-Ironbark ecosystems. The Regional Vegetation Plans being prepared by the Catchment Management Authorities will provide strategic frameworks for protection of remnants and priorities for rehabilitation. Detailed information from Roadside Conservation Plans, vegetation mapping and the identification of sites of biological significance at the local scale will provide valuable input to these plans and to the revised Local Government Planning Schemes.

## Northern Inland Slopes

The coordinated approach to vegetation management across all land tenures will facilitate the maintenance of current vegetation corridors and provide the framework for the development of new linkages to enhance habitat values. Landcare and Land for Wildlife programs involving private landholders have played an important role in developing a greater awareness and more sensitive management of these significant conservation resources. The current focus on the development of woodlots and larger scale agroforestry on cleared farmland will provide an alternative source of firewood and relieve pressure on valuable remnants on private land and roadsides. Community involvement in conservation initiatives includes tree planting and population survey work for the Regent Honeyeater. Friends groups are also active in conservation activities in the Warby Ranges State Park and the Chiltern Box-Ironbark National Park.

Together with the state-wide key directions outlined earlier, land and water managers and planners in the bioregion should consider the following priorities.

- Identify all sites of biological significance in the rural landscape in conjunction with local government and land holders and encourage appropriate use of this information in local planning schemes.
- Target vegetation protection and revegetation works towards areas where they will enhance the conservation value of existing areas of significant EVCs including Grassy Woodland, Box-Ironbark Forest, Valley and Riverine Grassy Forest and of habitat for threatened species e.g. Regent Honeyeater.
- Enhance the long-term integrity of isolated blocks of native vegetation on public land through co-operative agreements with owners of vegetated land connecting these blocks.
- Complete and implement the North East Forest Management Plan and the North East Regional Forest Agreement.

### Victorian Riverina

#### Bioregion: Victorian Riverina

##### The Bioregional Landscape

The Victorian Riverina bioregion covers approximately

24 000 square kilometres of the northern Victorian riverine plain, from Rutherglen in the east to Swan Hill and the Avoca River in the west. The southern and eastern boundary of the bioregion occurs at an elevation of about 150 metres. Rainfall ranges from 350 mm per annum in the west to an average of 600 mm per annum in the east.

The majority of the Victorian Riverina falls within the riverine plains land system which is characterised by flat to gently undulating land on recent unconsolidated sediments with evidence of former stream channels. Additional land systems include wide flood plain areas associated with major river systems including the Avoca, Loddon, Campaspe, Goulburn, Ovens and Murray rivers. Isolated areas of low hills also occur within the region, predominantly east of the Goulburn River and south of the Broken Creek.

At the time of European settlement, the Wembawemba, Barababaraba Jodajoda, and Way Wurru were the Aboriginal peoples living along the Murray River, from the area around Swan Hill in the west to present day Albury in the east, while areas of the plains further south from the Murray River were home to the Ngurai-illam wurrung and the Daung wurrung. Kow swamp was of great importance as a meeting site, as was Barmah Lakes. In the warmer months people congregated along the rivers, where fish weirs and traps provided an important food source; in the cooler parts of the year the population moved away from the major water bodies and dispersed in smaller groups through the plains area. Grasslands and Grassy Woodlands once covered much of the Riverina but are now restricted to small but significant areas of public and private land. Major environmental features include the Barmah and Gunbower forests, the Kerang Lakes and Corop Lakes systems and the Murray River environment including the Gunbower Creek. These areas also comprise the major public land blocks within the region and provide a range of values for fauna, flora, recreation and tourism. Agriculture is the dominant land use with approximately 90 per cent of the land in private ownership. Major irrigation areas including the Shepparton Irrigation Region, the Rochester Irrigation District and the Torrumbarry Irrigation Region have been developed.

Major townships in the area include Swan Hill, Kerang, Charlton, Echuca, Benalla, Wangaratta and Rutherglen, with Shepparton being the largest centre. Catchment Management Authorities include the North Central and Goulburn Broken, and to a lesser extent the North East. Fifteen local government areas occur either wholly or partly within the Victorian Riverina bioregion.

##### The Natural Capital of the Landscape

Plains Grassy Woodland Complexes, Grassland Complexes, and Riverine Grassy Woodland Complexes are the three dominant BVTs in the bioregion. The Plains and Riverine Grassy Woodland Complexes are characterised by low density tree cover dominated by River Red Gum, Black Box, other box eucalypt species and/or Buloke and native Callitris pines. The shrubby layer, when present, included species such as Lightwood, Golden Wattle, Gold-dust Wattle and saltbushes. The Grassland BVT is dominated by Wallaby and Spear grasses with a mixture of herbs from the daisy, saltbush and pea families. Grassland Complexes and Grassy Woodland Complexes originally dominated much of the Riverina but are now largely fragmented. Since European settlement in the bioregion, these communities have been severely degraded and now only small remnant areas remain, with little protected on public land.

The bioregion supports numerous rare or threatened vertebrate species, and over 800 species of native vascular plants, of which over 70 are rare or threatened. Numbers of invertebrate fauna and non-vascular plants are not known.

##### Land Management Themes

The open grassland plains and Grassy Woodlands in the Victorian Riverina Bioregion were settled and developed early. After the 1860s vast areas of land were cleared or modified to make way for cropping and pasture development. Later, around the turn of the century,

large-scale irrigation schemes for the production of fodder crops, cereals and fruits were established on the Campaspe, Goulburn, Loddon and Murray rivers.

Problems of salinity and water logging were evident soon after irrigation began (as early as 1910) in the Kerang area. Vegetation clearance in the south has also had salinity impacts, contributing to rising water tables and saline discharge areas. Irrigation activities have resulted in increased salinity levels in the Murray River, due to the export of salt to the river. Much of this intensive agricultural land management has also resulted in increased nutrients in wetlands and rivers and tree decline through water logging, salinisation and insect attack. The greatest challenge facing natural resource managers in the Victorian Riverina is the development of land and water management regimes that can

## Victorian Riverina

reduce, halt and then reverse the degradation of land occurring through changed hydrological regimes and salinisation. This degradation threatens both biodiversity and agricultural productivity in the bioregion.

Fertile soils coupled with a secure water supply made most of the area suitable for intensive agriculture. As a consequence, there is very little public land within the bioregion. Extensive strips of public land adjacent to rivers still exist — regular flooding meant that they were not suitable for intensive farming, though much of this area is grazed. The larger River Red Gum forest blocks found in the Barmah, Gunbower and the Goulburn river areas have been intensively harvested since early settlement for timber products including sleepers, sawlogs and firewood. The composition and structure of the vegetation within these forest blocks has been substantially altered, resulting in a much younger, and in places, denser forest. These structural and age class changes have dramatically affected the diversity and abundance of faunal species, particularly those that are hollow-dependent. Changed flooding regimes and grazing in these areas has also modified the vegetation structure and composition.

All natural ecosystems in the Victorian Riverina have been depleted or highly modified, with only isolated vegetation patches remaining. Grasslands have been the most severely degraded with less than 1 per cent remaining, much of which is found on freehold land. Wetland systems within the bioregion have been altered due to changes in their hydrological cycle (restricted natural wetting and drying phases) and land management practices.

### Biodiversity Condition

Once the major habitat covering many thousands of square kilometres of the Victorian Riverina, native grassy woodlands and grasslands are now reduced to a tiny percentage of their original distribution. Northern Plains Grasslands have been listed as a threatened community under Schedule 2 of the Flora and Fauna Guarantee Act 1988. They are threatened by cultivation for cropping and irrigation, as well as inappropriate grazing regimes. Inappropriate use of fire, weed invasion, and increased use of nutrients and chemicals also impact on the vegetation quality. Flora diversity and structure can be affected by poor management and these have important implications for rare or threatened fauna species. Many threatened plant species are now restricted to narrow road or rail reserves and their conservation will depend on the sympathetic management of these areas. A number of tools including Land for Wildlife and Public Authority Management Agreements are already in place to promote the protection of these areas on private and other public land, and some significant sites are protected under these arrangements.

Grassy Woodland Complexes, located on the more fertile soils, were targeted for development for agriculture. This broad-scale clearing has resulted in a landscape composed of isolated (often senescing) trees, with little or no native understorey and a sprinkling of small remnants. Many of these remnants are too small or isolated to support viable populations of fauna. Temperate woodlands such as these have been identified as being amongst the most endangered and poorly conserved vegetation types. Faunal species still found within this bioregion include ground dwelling and arboreal mammals including Yellow-footed Antechinus, Fat-tailed Dunnart and Lesser Long-eared Bat. Reptiles (Bearded Dragon, Olive Legless Lizard, Striped Skink, Eastern Brown Snake, and Woodland Blind Snake), Amphibians (Southern Bullfrog, Common Spade-foot Toad and the Spotted Marsh Frog) were all found within the area.

Remnant forests and woodlands are confined mainly to rivers and floodplains, with isolated pockets scattered throughout the region. Large River Red Gum forests including Barmah and Gunbower Forest are under threat from changed flooding regimes and a reduction in floodplain inundation. Intensive management of Red Gum forests for timber production has resulted in a reduction in the amount of mature remnant forest. Hollow-dependent species such as the Barking Owl, Carpet Python, Superb Parrot and Regent Parrot are in decline across the region. Loss of woody debris ground cover has affected fauna such as the Bush Stone-curlew, and the altered water regime has significantly reduced the number of colonially nesting water birds.

The lake systems, particularly the Ramsar listed wetlands, are important for waterbird conservation. The Kerang Lakes system (Ramsar listed) contains ibis colonies and the protection of colony breeding and roosting sites is very important for the conservation of a range of water birds, of which there are over 50 species recorded. The two major wetland systems within this bioregion, Kerang Lakes and Corop Wetlands, have been largely degraded by inappropriate management and altered water regimes resulting in an absence of flushing flows and increased salinity. The increased salinity has caused large-scale tree death in these wetlands and the diversity and abundance of fauna and flora species have been dramatically reduced. Shallow wetlands including freshwater meadows and shallow freshwater marshes have been significantly reduced both in number and size, which has particular significance for faunal species that require shallow wetland habitat for breeding or nesting, such as the Brolga. Most of the permanent deep wetlands remain, but riparian vegetation and water quality (especially in the Kerang Lakes area) have been much reduced. The major impacts of European settlement included vast areas of land being cleared or modified to make way for pasture and cropping, and later, intensive irrigation resulting in species extinction, vegetation decline and

## Victorian Riverina

fragmentation, erosion, salinity and a loss in biodiversity. Rising water tables associated with changed land practices and irrigation have resulted in alteration of the natural vegetation patterns and a dominance of salt tolerant species. Pest plants and animals are widespread and have a serious impact upon the region. Introduced weeds, both agricultural and environmental, have reduced productivity and encroached upon the small, fragmented areas of remnant native vegetation. Pest animals including foxes, feral cats and starlings and carp prey upon or compete with native fauna for food and habitat. Rabbits and hares affect both agricultural productivity and reduce the recruitment and diversity of native flora.

Of the 99 known threatened species and undetermined number of threatened ecological communities in this bioregion there are:

- 67 listed vertebrates and plants, of which 18 have Action Statements;
- no listed invertebrates;
- one listed community, which does not have an Action Statement.

### Management Responses

The extensive depletion and fragmentation of many of the bioregion's ecosystems means that the remaining areas are highly significant for biodiversity conservation. Regional Catchment Strategies have been prepared for the North Central and Goulburn Broken Catchment Management Authorities. These strategies have identified the importance of biodiversity to the Victorian Riverina region and a number of actions have been identified for implementation. Key strategic actions to protect and enhance the regional biodiversity have been identified in catchment salinity management plans, the draft conservation program for native grasslands and grassy woodlands, the draft Mid-Murray Forest Management Plan and catchment action plans produced by Trust for Nature. Many Shires within the region have roadside

management plans and are beginning to address biodiversity protection in the revised Planning Schemes.

Given the large proportion of private land in the Victorian Riverina bioregion and the scattered small conservation reserves, biodiversity conservation will rely heavily on the owners and managers of private land and the network of road and rail reserves and other public land. Priorities for retention and rehabilitation should be directed towards those BVTs that are depleted (Riverine Grassy Woodland Complexes) and highly depleted (Plains Grassy Woodland Complexes, Grassland Complexes and Wimmera-Mallee Woodland Complexes). Land purchase to protect significant communities under-represented in the reserve system is at times a critical management option and has previously been applied within the Victorian Riverina. Use of the Land for Wildlife program to provide support and assistance to landholders will be a key process.

The bulk water entitlement process currently under way will identify the environmental requirements of rivers and associated wetlands, and attempt to provide these requirements. Preparation of an Environmental Allocation Annual Works Program to enable distribution of the environmental water allocation will ensure high priority wetlands along the Murray River obtain appropriate watering regimes. On-ground wetland works including construction of inlets and outlets will allow appropriate water regimes to be implemented. Management plans will be prepared and implemented for all significant conservation reserves, including Ramsar wetlands.

Together with the state-wide key directions outlined earlier, land and water managers and planners in the bioregion should consider the following priorities.

- Complete and implement the Mid-Murray Forest Management Plan and West Regional Forest Agreement, and management plans for all the major reserves.
- Finalise the bulk water entitlement process so that adequate and timely environmental flows are established for the rivers and wetlands.
- Reach Public Authority Management Agreements (PAMA) with public authorities that manage significant vegetation communities.
- Protect and fence remnants, encourage revegetation and property management planning which enhance off-reserve conservation of highly depleted vegetation types such as grasslands, Plains and Riverine Grassy Woodland Complexes, Box-Ironbark Forest Complexes, and Herb-Rich Woodland Complexes.
- Develop Roadside Conservation Plans for all shires particularly those in the west of the region to protect and enhance habitat for threatened species, such as the Grey-crowned Babbler.
- Develop a comprehensive conservation plan for the Northern Plains Grasslands.



### Victorian Alps

#### Bioregion: Victorian Alps

##### The Bioregional Landscape

The Victorian Alps bioregion extends over 3000 square kilometres above 1200 m in altitude, and is part of the Australian Alps IBRA region. The IBRA region consists of a series of high plateaus and peaks along the Great Dividing Range from the Baw Baw Plateau in the south to the Snowy Mountains of New South Wales and the Australian Capital Territory in the north. The IBRA region contains all of mainland Australia's highest peaks and most of the area above 1500 metres. The true alpine treeless area consists of a series of disjunct high altitude plateaus of which the Bogong High Plains is by far the largest, representing 60 per cent of the area. Many of Victoria's major river systems, including the Murray, Goulburn, Ovens, King, Kiewa and Mitchell, have their sources in the alpine and sub-alpine areas.

At the time of European settlement, the high country was not occupied by Aboriginal people throughout the year; however many of the groups who spent part of their time in the highlands or even the lowland plains would have visited the Alps in their annual movements. The high country was of great importance during the brief summer months, when up to hundreds of several language groups north and south of the Alps congregated to feast on the seasonally abundant Bogong Moths. This time was important for cultural exchange between groups who occupied exclusive areas in the foothills and lowlands for most of the year.

The major land uses in the bioregion are conservation, recreation (commercial tourism), forestry, hydro electricity generation and seasonal grazing. The alpine areas have no large permanent settlements except for the five Alpine Resort Areas. Almost all of the bioregion is public land. The major parks in the area are the Alpine National Park, Baw Baw National Park and Mount Buffalo National Park.

##### The Natural Capital of the Landscape

In the Australian context the alpine area represents a very small area of a unique environment on a dry, low continent. The Victorian Alps Bioregion consists of a complex mosaic of ecological communities determined by soils, climate and topography. There are treeless sub-alpine communities, grasslands, shrublands, heathlands, and bogs on the highest ground and in 'frost hollows' in high valleys. These areas form islands separated from each other by the sub-alpine Snowgum woodlands and, at lower altitudes Alpine Ash forest and river valleys. These woodlands and forests adjoin the South Eastern Highlands IBRA region. The extent of the true alpine treeless area is only about 180 square kilometres, yet this area contains many distinct communities. Many of these communities are extremely limited in extent, and often the characteristic species of alpine biota are themselves restricted to only one or two of these communities. The bioregion has a distinctive flora and fauna. On the Bogong High Plains, which comprise the largest block of treeless vegetation in the bioregion, 23 vegetation types have been identified. Of these types, thirteen are restricted to one per cent or less of the area. Three, the *Podocarpus* heathland, fen-bog pool and *Poa hothamensis* rocky grasslands have fauna endemic to the community. The dissected nature of the bioregion means that the isolated 'islands' often have their own unique species or sub-species — such as the Baw Baw Frog and a suite of invertebrate species. Different parts of the alpine bioregion exhibit different ecological features, for example the Baw Baw Plateau Sphagnum bogs are more extensive than elsewhere.

Much of the area may be snow-covered for up to four months of the year. Approximately 600 higher plants and 246 vertebrate species have been identified within the bioregion. Many of these species are associated with the subalpine woodlands and forest. The Australian Alps have many species which are specially adapted to, and limited by, the harsh climate. They include the Mountain Pygmy-possum, the Alpine Water Skink, the Baw Baw Frog, the Mt Stirling Stonefly, the Cushion Carraway and the Small Star-Plantain. Many of the endemic or threatened fauna species in the alps are associated with very restricted habitats or freshwater environments (e.g. bogs). The short summer growing season leads to a profusion of flowering in the Victorian Alps. Over the period from November to February this display is a very obvious and appealing aspect of the region's biodiversity.

##### Land Management Themes

Nearly all of the bioregion remains as public land which, although historically managed for different purposes has remained relatively intact. Inaccessibility, rugged topography and the hostile climate of the alpine area inhibited large-scale permanent settlement, but the high plateaus have been used regularly as summer pasture for cattle and sheep from the 1850s. Early settlements developed in the valleys during the gold rushes of last century were abandoned.

Biodiversity appreciation and conservation has evolved to become a major theme of this bioregion. The Alpine National Park is the largest in Victoria, having been expanded to its present size over many decades, and is a major tourist focal area. The Park encompasses all the major vegetation types of the bioregion with some types having very

## Victorian Alps

high representation in the reserve system. The Australian Alps Liaison Committee, comprising representatives of NSW, Victoria, ACT, and the Commonwealth ensures the co-ordination of strategic management across the entire alpine area of Australia. A comprehensive management plan, including biodiversity conservation is being implemented for the park which also provides a broad variety of recreational and tourism experiences. Some parts of the park are leased for the summer grazing of cattle.

The expansion of forestry operations in the Victorian Alps from the 1940s led to the development of an extensive road system through the area, which in turn permitted easier access for other users, particularly recreational users.

Hardwood production and fire protection in the region, are both undertaken within Forest Management Plans and Fire Management Plans, planning processes that include biodiversity conservation.

From beginnings in the 1950s skiing has expanded to become a major recreational industry in this bioregion. A rapid increase in popularity of skiing during the 1970s and 1980s created a demand for new skiing areas. Five resort areas support the downhill skiing industry and are focal points for cross country skiing, bushwalking and other recreational activities. The environmental attributes which make an area attractive to the skiing industry (high altitude slopes) correlate with those of some of the restricted habitats of threatened flora and fauna. Historically there have been some land management conflicts in the resorts. Recent developments have demonstrated that biodiversity conservation can be incorporated into some developments, e.g. ski-lifts at Mount Hotham have been constructed without eliminating the threatened Snowpatch community.

While much of the alpine area remains intact, the harsh climate, topography, short growing season, and extremely limited extent make many of the ecological communities found in the bioregion particularly sensitive to disturbance. Water production and catchment protection are important themes of this region. Being situated at the top of many catchments means that land use management must recognise both down stream benefits and effects. Dams and a series of aquaducts were constructed on the Bogong High Plains for the generation of hydro-electricity in the Kiewa scheme. Biodiversity Condition

The Victorian Alps bioregion remains largely uncleared and is in relatively good health. The large expanses, climate and the intactness of adjacent areas have all contributed to health of the bioregion and its naturalness remains a valued feature for all visitors. There have been no recorded extinctions of alpine flora or fauna although some populations of species have been eliminated from some locales. Most of the natural ecological processes continue to operate across the broad landscape and land managers have been able to learn from the past.

The removal of sheep grazing earlier this century assisted recovery of many ecological communities and reduced soil degradation. Cattle grazing continues across over half of the region and stocking rates are controlled under seven year licences. Cattle grazing does not occur in many significant areas, such as Mount Hotham,

Mount Bogong, the northern Bogong High Plains and the Baw Baw Plateau.

The ecological communities of the alpine areas, although evolved to survive in this harsh environment, are also highly sensitive to some forms of change. Invasion by environmental weeds is a present and potential problem. Some weeds may be kept in check by present climate or other factors, however some are aggressive invaders (e.g. English Broom) particularly where the soil is disturbed.

The five ski resort areas represent the most developed and altered areas of the Victorian Alps bioregion. While the total area of the resorts is relatively small it forms a significant proportion of the treeless area.

Developments in these areas need to be carefully planned and implemented. Codes of practice and environmental policies have been developed to safeguard areas of ecological significance and sensitivity. In some instances ameliorative actions have repaired past damage (e.g. the tunnel to restore habitat connectivity for the Mountain Pygmy-possum).

The bioregion has become increasingly popular for a wide range of other recreational activities such as camping, horseback tours, bushwalking and four-wheel driving. These activities require management so as to avoid sensitive areas and to ensure that participants do not become vectors for spreading environmental weeds.

Alpine species and communities are amongst those most vulnerable to the effects of enhanced greenhouse climate change resulting from global warming. Alpine communities have been “retreating” up the mountains as a result of warming since the last ice age. The robustness of these communities to climate change is enhanced by maintaining them in as healthy a condition as possible.

Of the 64 known threatened species and undetermined number of threatened ecological communities in this bioregion there are:

- 32 listed vertebrates and plants, of which 18 have Action Statements;
- five listed invertebrates, of which none has an Action Statement;
- four listed communities, of which none has an Action Statement.

Management Responses

## Victorian Alps

The Victorian Alps bioregion and the surrounding forest areas of the highlands form the largest continuous area of public land in the State. It is also the largest area where native vegetation predominates. These two factors offer flexible management opportunities not available in the fragmented landscapes found across much of Victoria. The current Regional Forest Agreement, National Park management processes and the use of planning schemes in the resort areas provide the opportunity to set a benchmark for integrated conservation in land management. The monitoring of the different uses and their impacts are integral to the management process.

The higher altitude ecological communities are the most sensitive and fragile in the bioregion. It is these areas that have the most pressure upon them; predominantly skiing, other recreation activities and grazing. The natural rarity and restricted nature of many of these alpine habitats requires careful management including identification, planning “around” sensitive habitats and high standards when modifying the environment for development. A high level of knowledge of the requirements of these species and particularly sensitive planning and management are required when developing infrastructure in these areas. Getting the biodiversity information into the planning processes as early as possible is a feature of biodiversity conservation in resort and park developments. Appropriate risk management, particularly for feral predators and environmental weeds requires coordinated and strategic efforts by all land managers in this bioregion.

Visitor management across parks, resorts and forests is an important theme in this bioregion. The Australian Alps Liaison Committee has initiated management and community education actions to ensure that the increasing visitor loads does not damage the natural values which visitors come to experience. The incorporation of biodiversity conservation into their business management planning by other industries and businesses will further contribute to protecting the specific values of the Victorian Alps.

Together with the state-wide key directions outlined earlier, land and water managers and planners in the bioregion should consider the following priorities.

- Continue the Australian Alps Liaison Committee bioregional cooperative management program for the alpine national parks.
- Implement cooperative and integrated environmental weed control programs, with emphasis on the high altitude treeless areas.
- Complete GIS mapping of the Ecological Vegetation Classes and sites of biological significance to enhance management planning to protect endemic and threatened alpine species and communities.
- Ensure biodiversity data is available to all land use planning processes.
- Monitor levels of recreational use of the Victorian Alps and manage to minimise impacts on biodiversity values.
- Continue to develop and promote ‘best practice’ in land management and develop appropriate codes of practice, particularly where it involves habitat and soil disturbance.
- Target predator control to specific populations of threatened species (Mountain Pygmy-possum, Broad-toothed Rat).

### Victorian Highlands

#### **Bioregions: Highlands - Southern Fall, Highlands - Northern Fall, Otway Ranges**

##### The Bioregional Landscape

The Victorian Highlands area includes mountain ranges and associated foothills of the Great Dividing Range between Melbourne and the New South Wales border and of the Otway Ranges to the south-west of Geelong. It is divided into three bioregions: Highlands - Southern Fall, Highlands - Northern Fall and Otway Ranges.

Many of Victoria's major river systems originate from within the Victorian Highlands which are composed of dissected uplands with moderate to steep slopes between 400 and 1200 metres in altitude.

The region has a temperate climate. Summers are generally warm; winters are cool to cold. Rainfall occurs throughout the year, but is greatest in the winter and spring. Snow falls are common above 900 metres in winter, with snow persisting for long periods during winter above 1200 metres. Annual rainfall varies between 1000 and 2000 mm. In some areas, a marked rainshadow effect is associated with higher ranges, such as in the Licola area, north-east of the Baw Baw Plateau.

Most of the Aboriginal peoples using the highlands at the time of European settlement also extended into lowland areas to the north or south. The dozen language groups or more, who made use of the various parts of the southern uplands would have occupied these areas on a temporary seasonal basis. This seasonal movement would also have included the major summer gatherings, which took place in alpine areas. The territory of the Gadubunud language group corresponded very closely with the Otway Ranges.

The Victorian Highlands area is generally sparsely settled despite the efforts of early pioneers to develop agricultural and mining pursuits. Parts of the Highlands - Southern Fall and the Otway Ranges bioregions were cleared for agriculture and settlement was attempted. Settlement in the Highlands bioregions is now generally restricted to the more gently undulating areas on the fringes such as the Dandenong Ranges, around Lake Eildon and Mansfield, and around Warragul and the more fertile river valleys.

Settlement in the Otways bioregion is concentrated between Beech Forest and Lavers Hill and coastal areas. Most of the settlement is based on agriculture, though tourism is increasing, especially along the coast at Apollo Bay, Lorne and Aireys Inlet.

Major conservation reserves within the Victorian Highlands include the Alpine, Morwell, Yarra Ranges, Dandenong Ranges, Kinglake, Mt Buffalo and Otway national parks. There are also numerous State, regional and other parks, conservation reserves and Historic Areas, the Wabba and Avon Wilderness Parks and the Razor-Viking, Mt Darling-Snowy Bluff and Indi wilderness zones.

The Victorian Highlands area is covered by several Catchment Management Authorities and is within the jurisdiction of many shires (see Appendix 3).

##### The Natural Capital of the Landscape

Moist Foothill Forest Complexes and Dry Foothill Forest Complexes, with smaller occurrences of Lowland Forest Complexes, Heathy Woodland Complexes and Valley Grassy Forest Complexes, dominate the vegetation of the Victorian Highlands.

The Moist Foothill Forest Complexes BVT is generally located on the protected southerly and easterly slopes and plateaus, and most commonly includes the ecological vegetation classes, Wet Forest, Damp Forest, Montane Wet Forest and Montane Damp Forest. The gullies and river valleys support a variety of ecological vegetation classes including Riparian Forest, Riparian Thicket and Montane Riparian Thicket. The Victorian Highlands contains Victoria's most extensive areas of Cool Temperate Rainforest.

The drier, more exposed northerly and westerly slopes and ridges support several ecological vegetation classes including low, dry forests such as Heathy Dry Forest, Grassy Dry Forest, Shrubby Dry Forest and Montane Dry Woodland frequently associated with Herb-rich Foothill Forest and Shrubby Foothill Forest on gentler, more protected sites. Mosaics of these ecological vegetation classes are particularly common north of the Great Dividing Range.

There are about 533 species of vertebrates, 1091 species of vascular plants and a poorly documented but very substantial and diverse invertebrate fauna. The bioregion supports a wide variety of vascular and non-vascular plants, arboreal and terrestrial mammals, reptiles, forest-dwelling birds and birds of prey including the large forest owls. Both the faunal emblems of Victoria, the Helmeted Honeyeater and Leadbeater's Possum are now restricted to this bioregion.

A number of species, including the Leadbeater's Possum, Giant Gippsland Earthworm, Tall Astelia, Gully Grevillea, Sticky Wattle, Aniseed Boronia, Tree Geebung, Forest Sedge, Buxton Gum and Shiny Phebalium, are endemic to the

## Victorian Highlands

Victorian Highlands. The rivers and streams of the Victorian Highlands support populations of native fish, including the endangered Barred Galaxias, and a wide variety of native aquatic invertebrates.

### Land Management Themes

The Victorian Highlands is predominantly forested public land, comprising State forest and numerous national parks, State parks and conservation reserves.

The extensive forests of the Victorian Highlands have supported timber harvesting industries since the late 1800s, and this remains the most important region for

timber in Victoria. The Victorian Highlands also contains significant areas of coniferous and eucalypt plantations.

Water production is a major land use, with significant catchment areas in each bioregion supplying water for domestic, agricultural and industrial purposes. Major impoundments include Thomson Dam, Lake Glenmaggie, Lake Dartmouth, Blue Rock Lake, West Barwon Dam, and the Upper Yarra and Maroondah reservoirs near Melbourne. Some of the impoundments also provide water to produce hydroelectric power for the Victorian electricity grid.

Tourism and recreation are major land uses in the Victorian Highlands. Popular activities include camping, fishing, deer hunting, bushwalking, canoeing, sight seeing and nature study.

In settled areas, sheep and cattle grazing and dairying are the primary land uses. Some public land areas are also used for grazing and apiculture.

Most mining activity in the Victorian Highlands is associated with the extraction of rock and gravel for road construction and maintenance mainly on public land. Gold is still mined commercially in the Walhalla–Woods Point area.

### Biodiversity Condition

Over three quarters of the vegetation cover of the Victorian Highlands remains and biodiversity assets and the operation of ecological processes are in relatively good to very good condition across the landscape.

A diverse range of forest types dominate the landscape particularly at higher elevations. In general the rivers and streams are in good or better condition. Where clearing has taken place it has been concentrated mainly in the larger river valleys and on the edges of the area, in the Dandenong and Strzelecki Ranges. As a result the depleted BVTs are those restricted to these areas, and include Cool Temperate Rainforest and Valley Grassy Forest.

The biodiversity of the region is in the best condition in the extensive forested areas found on public land. Here broad-scale management issues across the forest estate which influence the condition of biodiversity are forestry practices, fire management, prevalence of environmental weeds, introduced predators and plant diseases. These issues require long term management and apart from harvesting, need to be addressed in both reserves and production forests.

Two of the major challenges to be resolved in the context of implementation of Regional Forest Agreements and Forest Management Plans are the development and adoption of ecologically sensitive fire regimes and reconciliation of the needs of silvicultural systems, in terms of rotation lengths, felling patterns and the retention of sufficient areas of undisturbed habitat.

Timber harvesting, particularly clearfelling silvicultural systems, can result changes from a forest dominated by old trees with a diverse structure and species mix to even aged stands with simplified structure and few old trees. Planned rotation lengths of about 80 years mean that the regrowth on harvested areas will not attain mature or senescent growth stages before again being harvested. The result is the reduction or loss of some characteristics of mature or senescent forests upon which a significant part of the biota depends, particularly species that utilise tree hollows, such as possums and gliders, and those that depend on such species, like large forest owls. There is also evidence from some sites of changes in the composition of the understorey following harvesting, particularly the decline of tree ferns and other species that usually regenerate vegetatively after physical disturbance. Forest Management Plans and Regional Forest Agreements are addressing these problems

through the establishment of a network of special protection zones which complement the formal reserve system, and special management zones where forestry practices are modified to accommodate the needs of particular species found there.

Fire has been a major influence in shaping the ecosystems and evolutionary processes of the bioregion. The taller, wetter forests have evolved with relatively infrequent but high intensity fires, while the dry forests have evolved with more frequent fires. We cannot be sure of the exact pre-European fire regimes. It is likely that the scale and pattern of fire has changed significantly over the last 150 years, with consequent changes in the distribution of some species of flora and fauna. The frequency, intensity and seasonal timing of fires have all been manipulated to achieve particular management goals across the landscape.

Many species and ecosystems rely on a particular fire regime to facilitate regeneration, reinvigorate habitats and maintain ecological integrity. Fire which is too frequent, too infrequent, at the wrong intensity or during the wrong

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season may cause some species and ecosystems to decline or disappear. For example, rainforest is very fire sensitive and the larger, more intense fires of the type characteristic of severe fire seasons can deplete the area of rainforest. Frequent, low intensity burning, such as is used for most fuel reduction burns, favours certain species such as Wire-grass, some wattle species and Bracken at the expense of others which are either fire sensitive or require longer periods between fires to reach reproductive age.

Sustained increases in water turbidity and sedimentation rates pose a significant threat to stream fauna, especially the large invertebrates upon which many higher-order predators, such as native fish, rely. Poorly maintained roads, bridges and culverts are an important source of much of the sediment input to streams in the Victorian Highlands.

Prescriptions in the Code of Forest Practices and Forest Management Plans specify buffers for coupes and construction standards for roads, bridges and culverts designed to reduce the impact of logging and related infrastructure on water quality and related fauna (e.g. Spotted Tree Frog).

Soil disturbance which results from logging operations and their associated infrastructure has also facilitated the invasion of environmental weeds and spread of *Phytophthora*. Forest managers are increasingly aware of the need to address this risk when planning new infrastructure, and in ensuring that vehicles do not act as vectors for weeds and disease.

Water supply impoundments and their management can have a direct adverse impact on the instream movement, migration and downstream habitat suitability for aquatic flora and fauna. Water extractions from rivers and streams can also adversely affect the condition of aquatic habitats and ecosystems both within the Victorian Highlands and in adjoining, downstream bioregions. The impacts of instream barriers to migration and dispersal and alterations to stream flow regimes on aquatic ecosystems are likely to be substantial.

Much private land has been cleared, mainly for grazing. Clearing, as elsewhere in the state has focused on those areas and BVTs on the more fertile and accessible terrain. The small size of many of the retained patches of native vegetation on farmland or roadsides increases the potential impact of weeds, grazing by stock, roadworks and incremental clearing. As these are sometimes significant remnants of depleted vegetation types, protection and effective conservation management of these areas into the future is a major concern. Clearing of native vegetation on private land has been regulated

by the Native Vegetation Retention Controls under the State Chapter of the Planning Schemes (Planning and Environment Act 1989).

Weed invasions threaten native ecosystems in many parts of the bioregion. Introduced predators, especially foxes, feral cats and wild dogs, are a major threat to a suite of small and medium size mammals and smaller birds. Foxes and cats are widespread and the inaccessibility of large parts of the bioregion make systematic large-scale control programs difficult and expensive. Introduced trout are a significant potential threat to native freshwater fish, invertebrates and frogs, due to increased predation.

Of the 146 known threatened species and undetermined number of threatened ecological communities in this suite of bioregions there are:

- 79 listed vertebrates and plants, of which 32 have Action Statements;
- five listed invertebrates, of which one has an Action Statement;
- four listed communities, of which none has an Action Statement.

### Management Responses

The Victorian Highlands areas are a major reservoir of biodiversity in Australia, with the bulk of the area remaining as public land directly managed by the Victorian Government as State forest or conservation reserves.

The highest priority for biodiversity conservation in the Victorian Highlands is to ensure that the relevant processes for planning, management, monitoring and review of public land use and land management have access to accurate and current information, and that they operate effectively to deliver ecologically sustainable forest management. These processes and instruments include the Regional Forest Agreements, Forest Management Plans and National Park Management Plans.

The information required by these processes includes the locations, habitat requirements and ecological sensitivities of rare or threatened species and communities; the distribution, abundance and optimal management regimes of common species and ecological vegetation classes; and the responses of species, communities and ecosystems to various forms of disturbance, both human-induced and natural. The identification of sites of biological significance is particularly important.

Information will also be made available to the relevant Catchment Management Authorities and local government to ensure that decisions made within these spheres, particularly those affecting the fragmented landscapes around the fringe of the Victorian Highlands, are as favourable to biodiversity conservation as practicable. In particular, native

## Victorian Highlands

vegetation should be protected and enhanced wherever possible, especially along watercourses. The Catchment Management Authorities have recently prepared Regional Catchment Strategies and draft Regional Vegetation Plans. Of the potentially threatening processes and challenges affecting biodiversity in the Victorian Highlands, those to address as a priority are: establishing ecologically appropriate fire regimes, weed invasion, altered flow regimes in rivers and streams, the loss of habitat elements such as tree-hollows and predation by introduced predators. These require co-ordinated efforts across the landscape irrespective of tenure.

Together with the state-wide key directions outlined earlier, land and water managers and planners in each bioregion should consider the following priorities.

### Highlands - Northern Fall

- Complete and implement the North East and Central Highlands Forest Management Plans and Regional Forest Agreements.
- Implement management plans for national parks such as Kinglake, Mount Buffalo and Burrowa-Pine Mountain.
- Develop and implement ecological fire management regimes, especially for sensitive species and communities, such as heathlands, heathy woodlands and rainforests as part of integrated processes outlined in the Code of Practice for Fire Management.
- Develop and implement strategic weed and introduced predator management approaches, with special emphasis on protection of Broad Vegetation Types such as Valley Grassy Forest Complexes and threatened species such as Long-footed Potoroo.

### Highlands - Southern Fall

- Complete and implement Gippsland and Central Highlands Regional Forest Agreements and Tambo and Central Highlands Forest Management Plans.
- Implement management plans for national parks such as Yarra Ranges, Dandenong Ranges and Mitchell River, and the Avon Wilderness Park.
- Develop and implement ecological fire management regimes, as part of integrated processes outlined in the Code of Practice for Fire Management.
- Develop and implement strategic weed and introduced predator management approaches, with special emphasis on protection of habitats such as Riparian Forest.
- Encourage private landholders to protect remnant vegetation on their land, using a range of incentives and programs such as the Land for Wildlife program, targeting strategic areas, depleted BVTs such as Swamp Scrub Complexes and Riparian Forest Complexes, and habitat for threatened species such as the Helmeted Honeyeater.

### Otway Ranges

- Complete and implement the West Regional Forest Agreement and review the Otway Ranges Forest Management Plan.
- Prepare and/or implement management plans for Otway National Park, and Carlisle and Angahook-Lorne State parks.
- Develop and implement ecological fire management regimes, especially for heathlands and heathy woodlands as part of integrated processes outlined in the Code of Practice for Fire Management.
- Develop and implement strategic weed and introduced predator management approaches, with special emphasis on protection of habitats such as Riparian Forests and threatened species such as the Spot-tailed Quoll.

## Coastal Plains

### Coastal Plains

#### Bioregions: Warrnambool Plain, Otway Plain, Gippsland Plain

##### The Bioregional Landscape

The Coastal Plains area consists of several segments of coastal plains and hinterlands up to 200 metres in altitude, extending from Tyrendarra in the west to Lakes Entrance in the east and including Geelong, eastern Melbourne and the Mornington Peninsula. The area has a temperate climate with rainfall varying from about 500 to 1100 mm, typically with higher rainfall in winter. Adjacent areas of higher altitude (e.g. the Otway and Strzelecki Ranges) produce rainshadows in some parts of the area.

The area is synonymous with the South East Coastal Plain IBRA region and includes three Victorian bioregions.

##### Warrnambool Plain

The identifying features of the Warrnambool Plain are nutrient deficient soils over low calcareous dune formations and the distinctive cliffed coastline. Much of the limestone has been overlain by more recent sediments, and between the limestone dunes, areas of swamplands are characterised by highly fertile peats and seasonal inundation. The area east of Warrnambool is characterised by deeper soils of volcanic origins overlying limestone, which are dissected by streams.

Prior to European settlement, the Girai wurrung and the Dhauwurd wurrung were the Aboriginal people of the Warrnambool Plain, with the population mainly concentrated in open or lightly timbered country with access to permanent water. European occupation, mainly by graziers, commenced in the late 1830's. The major population and commercial centre of the bioregion is now the coastal city of Warrnambool. Most people live in towns on or near the coast and in smaller inland

towns. Long established tourist destinations include Port Campbell National Park, The Great Ocean Road and the adjacent Bay of Islands Coastal Park. A recent tourism feature during the winter months is the annual visitation of Southern Right Whales to Logans Beach at Warrnambool. Sheep and cattle grazing are widespread land uses, however the prime agricultural focus of the bioregion is the dairy industry. The coastal waters of the region support Southern Rock Lobster and abalone fisheries.

##### Otway Plain

The Otway Plain includes coastal plains, river valleys and foothills from the Bellarine Peninsula west to Princetown. A small isolated component at Werribee, on the western shore of Port Phillip Bay, is included.

The bioregion is characterised by coastal heathland and woodland, and open forests with heathy understoreys dominated by Brown Stringybark and Messmate. Dry sclerophyll forest dominated by Mountain Grey Gum and Messmate occurs around the Otway foothills. River Red Gum woodlands occur along some drainage lines. The bioregion is drained in the east mainly by the Barwon River (which originates in the Otway Ranges) and its tributaries, and several small coastal streams. In the west the bioregion is drained mainly by tributaries of the Gellibrand River, although some streams flow north to lakes Corangamite and Colac located in the Victorian Volcanic Plain.

Prior to European settlement, the Watha wurrung Gulidjan, and Djargard wurrung lived in the area including the Otway Plain. They were mainly concentrated in open or lightly timbered country with access to permanent water.

European occupation, mainly by graziers, commenced in the late 1830s.

Today most people live in towns on or near the coast and in smaller inland towns. Part of the greater Geelong urban area occurs in the bioregion, with Colac being the next largest city (on the edge of the bioregion). Smaller urban areas include Anglesea and Birregurra. The single largest land use is agriculture, with the focus on sheep and cattle grazing and dairy farming. Brown coal is mined near Anglesea.

##### Gippsland Plain

The Gippsland Plain includes lowland coastal and alluvial plains characterised by generally flat to gently undulating terrain. The coastline is varied and includes sandy beaches backed by dunes and cliffs, and shallow inlets with extensive mud and sand flats. The vegetation includes lowland forests, grasslands and grassy woodlands, heathlands, shrublands, freshwater and coastal wetlands, mangrove scrubs, saltmarshes, dune scrubs and coastal tussock grasslands.

The bioregion extends from the Melbourne Central Business District and the Mornington Peninsula through parts of central and south Gippsland to Lakes Entrance in the far east. A number of rivers and streams including the Yarra, Bass, La Trobe, Thompson, Macalister and Avon drain the bioregion.

The bays, beaches, estuaries and rivers of the bioregion provided a rich source of food for the original Aboriginal occupants. Fresh and saltwater fish and shellfish were harvested and numerous shell middens along the coast indicate that this was a common food source. The Gunai-Kurnai Nation, which included several language groups were centred



## Coastal Plains

on the coastal plain of South Gippsland and the La Trobe Valley, whilst the Bunurong were found along the coastal plains from Wilsons Promontory to Port Phillip Bay.

The Gippsland Plain is now the most populated bioregion in Victoria, including the demographic centre of Melbourne and major populations on the Mornington Peninsula and in the La Trobe Valley.

Outside the metropolitan suburbs south-east of Melbourne, the major industries are dairy, sheep, beef and potato production. Major commercial reserves of brown coal are centred around the La Trobe Valley which is the principal electricity-producing area in Victoria. Some hardwood and softwood production occurs, mainly within Mullungdung, Won Wron and Alberton State Forests. The bioregion includes many important coastal parks associated with the Mornington Peninsula, Westernport Bay and the Gippsland Lakes.

**The Natural Capital of the Landscape**

At the time of European settlement the Coastal Plains were dominated by lowland and foothill forests, heathy and grassy woodlands, and coastal scrubs and grasslands. There has been substantial clearing of all vegetation types, particularly those on the deeper more fertile soils, with Lowland Forests and Heathy Woodlands remaining the most abundant.

Coastal Heathlands and Heathy Woodlands are known for their diverse ground floras, particularly of terrestrial orchids, and are communities in which the importance of maintaining natural ecological processes through appropriate fire regimes is recognised. The vulnerable Metallic Sun Orchid occurs at the Bay of Islands Coastal Park and Port Campbell National Park. The Anglesea area is famous for its diverse and prolific display of orchids. Important large stands of Heathland and Heathy Woodland remain on French Island. Three of the State's four populations of the endangered New Holland Mouse occur in the Coastal Plains.

The coastal inlets that are adjacent to some of the plains are important areas for migratory waders and shorebirds in Australia, many species which are listed on the Japan-Australia Migratory Birds Agreement (JAMBA) and China-Australia Migratory Birds Agreement (CAMBA). Coastal areas are also important for a number of threatened species of shorebirds including Hooded Plover, both Pied and Sooty Oystercatchers, Orange-bellied Parrot and several species of terns.

Other interesting fauna occurrences of the Coastal Plains include: a Common Bent-wing Bat maternity cave at Lake Gilleear, one of only three in South East Australia; a Southern Right Whale calving nursery at Logans Beach, east of the Hopkins River mouth, at Warrnambool; and the Giant Gippsland Earthworm of the Gippsland Plain.

**Land Management Themes**

**Warrnambool Plain**

The land management themes of the Warrnambool Plain are tourism and recreation, and agriculture, particularly dairying and some beef production. The bioregion has been largely cleared of native vegetation and modified with the introduction of pasture species. Approximately 90% has been cleared, although some significant remnants of Manna Gum/Messmate bushland remain on private land. The most significant of these, the Ralph Illidge Sanctuary, at Naringal, is owned by Trust for Nature and is managed as a conservation reserve.

There are few small conservation reserves in the bioregion. Jancourt forest block is the largest forest area. Several significant areas of riparian vegetation exist within the bioregion. Most significant are the nationally significant wetlands of Yambuck and Lower Merri wetlands, and portions of the Lower Curdies River. Most wetlands throughout the region are small and on freehold land. Areas in the Lower Heytesbury are affected by salinity.

**Otway Plain**

Much of the Otway Plain is used for agriculture. The foothill forests support a minor forest industry based on timber, firewood and tea tree cutting, and private farm and commercial forestry is increasing. The largest forest area is the Wonga forest block about six km north of

Simpson. Only a small percentage of the remaining native vegetation is in conservation reserves, mainly flora and fauna and lake reserves. Roadsides often retain the last areas of some high value biodiversity assets.

Significant urban areas with related recreational and tourism activities occur on the Bellarine Peninsula and are expected to increase.

**Gippsland Plain**

Most of the coastline, including the major wetlands and inlets are public land covered by native vegetation and managed principally for nature conservation. However, the majority of the bioregion is private land most of which has been cleared of native vegetation to allow for agriculture, urban use and other development.

The bioregion contains substantial urban areas of Melbourne, including the eastern and south-eastern metropolitan suburbs, and this generates recreational and development pressure on the remnants and 'green' corridors which remain, typically along rivers and creeks. There are important reserves close to Melbourne such as Mornington Peninsula National Park, which are complemented by a series of regional and metropolitan parks. These parks and other features

## Coastal Plains

such as golf courses, frequently support local remnants of flora and fauna with some being significant sites for threatened species.

Tourism is a major industry along the coast including fishing, camping, hunting (in the east) and nature study.

Fire has been important in shaping the ecosystems of the bioregion. Little information is available on the nature and extent of aboriginal fire regimes, but it is likely that fire patterns have changed considerably since European occupation. It is believed that in general, fires in grassy ecosystems, lowland and coastal forests and heathlands are now less frequent than before European occupation but individual fires are probably more intense.

### Biodiversity Condition

#### Warnambool Plain

The remaining native ecosystems, particularly those severely depleted such as open coastal scrubs and shallow freshwater wetlands, are all highly significant and vital for biodiversity conservation in the bioregion. Land for Wildlife properties play an increasingly crucial role in protecting habitat in these landscapes. Vegetation remnants are at risk from weed invasion, whilst native fauna are increasingly affected by introduced predators (fox and feral cat), and by fragmentation and modification of habitats.

Water quality is of importance for the significant wetland assets in the bioregion, in particular nutrient levels in relation to dairy operations need to be carefully managed. Drainage of shallow freshwater marshes continues to affect some wetland species of flora and fauna.

#### Otway Plain

The biodiversity values of many of the rivers and streams are affected by grazing, drainage, salinity and pest plants. Nutrients and chemical run-off from the catchment also affects the quality of habitat in rivers, streams and lakes, and this has contributed to algal blooms occurring in wetlands outside the bioregion.

Grassy woodlands are only found in small fragments and regeneration of species such as Red Gum seldom occurs.

Cattle grazing sometimes degrades native vegetation on private land.

Fire regimes, particularly in heathland habitats, are key ecological factors for species such as Rufous Bristlebird, Ground Parrot and New Holland Mouse, and need to be appropriately defined and integrated with other fire management activities. Fire regimes, inappropriate subdivisions and road and track maintenance can impact on threatened flora species with small and restricted populations, such as Merrans Sun Orchid, Wrinkled Buttons, Yarra Gum and Snow Gum.

A variety of mammals, reptiles and ground dwelling birds continue to be impacted by introduced predators (fox and feral cat), competitors (starlings in nest hollows) and other activities (recreation in foreshore nesting habitats). The quality of native fauna habitat in several streams and lakes is effected by the presence of introduced trout. The quality of native vegetation is reduced in many stands by introduced animals (rabbits, wild pigs, deer and goats) and by environmental weeds (including Serrated Tussock, Ragwort, Furze and Spartina in the Barwon estuary) and urban expansion.

Wetlands occur throughout the region. Lake Connewarre in the lower Barwon area is a Ramsar wetland and supports many waterbird and wader species. The extensive wetland area at Werribee (also Ramsar listed) is managed by Melbourne Water. The saltmarshes here support the endangered Orange-bellied Parrot following its autumn migration to the mainland. Most other wetlands are small, on freehold land and vulnerable to grazing and drainage.

#### Gippsland Plain

The persistence of the different native ecosystems within the bioregion varies greatly according to the history of European settlement, and current land tenure and management. As a result, native ecosystems such as grasslands, grassy woodlands and heathy woodland communities whose habitat occurs principally on private land, are now severely depleted and threatened in the wild and largely restricted to small linear reserves such as roadsides. In contrast, coastal vegetation and some wetland systems are relatively secure.

Loss of native vegetation is still a major cause of habitat loss. Clearing is regulated by the Native Vegetation Retention provisions in planning schemes but some clearing on private land continues. Remnant areas of native vegetation on private land or roadsides are in many places being degraded by weed invasion, and grazing by stock, or disturbed by roadworks and incremental clearing. As these remnants include examples of ecosystems that are not well represented in reserves within the bioregion, management of these areas for biodiversity conservation remains a challenge.

Many species have evolved to rely on a particular fire regime to provide suitable habitat and facilitate regeneration. These regimes need to be identified and integrated with other fire management activities to avoid decline of species diversity. For example, insufficiently frequent fires in grassy ecosystems have led to shrub invasion and loss of native grass and herb flora. Fires are currently too infrequent in coastal heathlands and individual fires too large and intense

## Coastal Plains

to maintain the fine scale mosaic of vegetation age classes required by New Holland Mouse, one of the bioregion's endangered mammal species.

Introduced predators (particularly foxes) are considered a threat to the survival of native fauna, including species considered rare or threatened (e.g. Hooded Plover, Little Tern, Fairy Tern and New Holland Mouse).

The highly fragmented nature of remnant vegetation on private land greatly increases the vulnerability of stands to dieback. This is particularly evident in the grassy woodland communities where the small isolated nature of remnants and loss of fauna components has led to the breakdown of ecological processes and outbreak of disease and insect plagues. In recent years, Swamp Paperbark in reserves, roadsides and on private land in South and South-west Gippsland has suffered defoliation from infestations of Paperbark Sawfly.

The condition of the major rivers and streams is regarded as medium to poor due principally to siltation from accelerated erosion and nutrient run-off from agricultural land and intensive forestry production in the adjoining bioregion. Most banks have been largely denuded of native vegetation which has been replaced with introduced pasture grass or infested with willows. Many are unfenced and subject to grazing by domestic stock.

The biodiversity of freshwater and coastal wetlands in the east is being adversely affected by a number of factors including inappropriate flow regimes, increased brackishness associated with rising water tables, increased nutrient inputs, increasing incidence of algal blooms and infestations of European Carp. The documented decline in biodiversity values of these systems includes dieback of fringing vegetation associating with increasing salinity and substantial declines in population sizes of bird and fish species as a result of deteriorating water quality. Invasion by the environmental weed, *Spartina* is compromising the quality of habitat in intertidal areas.

The development of coastal habitats for housing and recreation is increasing the likelihood of human disturbance to previously isolated fauna populations, particularly shorebirds. In areas such as the Gippsland Lakes, the pressure from human disturbance is now sufficiently great to require active management of habitat areas to ensure the continuing breeding success of threatened species such as the Little Tern.

Of the 116 known threatened species and undetermined number of threatened ecological communities in this suite of bioregions there are:

- 74 listed vertebrates and plants, of which 29 have Action Statements;
- five listed invertebrates, of which two have Action Statements;
- four listed communities, of which none has an Action Statement.

### Management Responses

The extensive depletion and fragmentation of many of the ecosystems across the Coastal Plains means that remaining areas of native vegetation and habitat are highly significant for biodiversity conservation. Regional Catchment Strategies have been prepared by the Port Phillip Regional Catchment and Land Protection Board and the various Catchment Management Authorities across the area. These strategies have identified the importance of biodiversity in the area and of addressing conservation in an integrated manner with other catchment health issues. Regional Vegetation Plans are currently in production which, when approved and implemented, will provide local government and referral agencies with guidelines for the protection of remnant native vegetation on private land and land managed by shires and statutory authorities.

Given the large proportion of private land in the Coastal Plains area and the scattered small conservation reserves, biodiversity conservation will rely heavily on the owners and managers of private land and the network of road and rail reserves and other public land.

The inclusion of biodiversity protection in revised Planning Schemes is being pursued with Shires as is vegetation mapping and management on roadsides. Shires are encouraged to consult with NRE in relation to environmental significance and vegetation protection.

Roadside management plans have been prepared for some municipalities (e.g. Mornington Peninsula) Western Port roadsides, the Bellarine Peninsula and the Great Ocean Road (by VicRoads).

Interest in implementing conservation programs (such as Land for Wildlife) among private landholders is increasing. These will concentrate on protecting native vegetation, threatened species, communities and critical habitats.

Landholder groups are encouraged and provided with assistance to prepare project bids such as with the Natural Heritage Trust program.

Control of introduced predators will continue to be a high priority. The impact of predators on some species is well established however their impact on a suite of other species is less clear and is a priority for current research so that effective control programs can be developed and implemented. Cooperation with landholders is especially important in predator control and existing programs will be enhanced to maximise benefits both to stock and native fauna.

Liaison also occurs with other government departments and community groups for the development of fire management plans which integrate the use and prevention of fire for biodiversity conservation and other purposes.

## Coastal Plains

Together with the state-wide key directions outlined earlier, land and water managers and planners in each bioregion should consider the following priorities.

- Extend the coverage of Roadside Conservation Management Plans particularly in the Otway Plain and the eastern part of the Warrnambool Plain.
- Determine and implement ecologically based fire regimes in heathland habitats as part of integrated processes outlined in the Code of Practice for Fire Management.
- Protect grassland and grassy woodland sites, especially on the Gippsland Plain and South Gippsland.
- Identify sites of biological significance in conjunction with local government and land holders and encourage appropriate use of this information in local planning schemes, including recognition of appropriate areas for subdivision that have minimal biodiversity impacts.
- Focus management efforts on depleted ecological vegetation classes with an emphasis on sites with the best possibilities of long-term viability and cost-effectiveness.
- Support 'Friends Groups' in urban areas to actively manage significant sites on a priority basis, particularly along the coast.
- Minimise the impact of pets on native fauna, particularly in the urban fringe areas, by raising awareness and by encouraging responsible pet management.
- Protect remnant Red Gum sites in the Otway Plain.

### Wilsons Promontory

#### Bioregion: Wilsons Promontory

##### The Bioregional Landscape

The Wilsons Promontory bioregion is a spectacular area of rugged forested hills, tannin-stained creeks, dense heathy lowlands, sweeping white sandy beaches and prominent granite headlands surrounded by the cold waters of Bass Strait.

Prior to European settlement, the Boon wurrung people occupied the hills and coastline of South Gippsland including Wilsons Promontory. The marine resources of the area were of great importance to them. Clear evidence of this is seen in the shell middens that remain on the coastline today.

The bioregion lies entirely within the Wilsons Promontory National Park, which is one of Victoria's oldest national parks. With this long history of protection the Wilsons Promontory bioregion still maintains 96 per cent cover of native vegetation. Development is concentrated in about 90 hectares (less than one per cent of the bioregion) at Tidal River, with a visitor centre and facilities, visitor and staff accommodation and commercial developments. Cattle grazing formerly occurred within the Park (largely confined to the Yanakie Isthmus adjacent to the bioregion), but was phased out in 1992.

Wilsons Promontory National Park is a designated Biosphere Reserve under the UNESCO 'Man and the Environment' program, and is listed on the Register of the National Estate. The Wilsons Promontory bioregion lies within the local government area of South Gippsland and the West Gippsland Catchment Management Area.

##### The Natural Capital of the Landscape

Wilsons Promontory bioregion is almost entirely covered in natural vegetation, principally Moist Foothill Forests, Coastal Scrubs, Heathlands and Heathy Woodlands, and the mostly natural state is reflected in the variety of flora and fauna communities. The flora and fauna of the bioregion have similarities to that of parts of the Bass Strait islands which form the remainder of the Furneaux IBRA region.

There are several significant vegetation communities including the southernmost examples of warm-temperate rainforest, areas of cool temperate rainforest, stands of open forest on the mountains, and White Mangrove, the southernmost mangroves in the world. Mammals are a prominent faunal component, with heaths having populations of small mammals such as New Holland Mouse, White-footed Dunnart and Southern Brown Bandicoot, while woodlands and forests have Koala, Long-nosed Potoroo, and a variety of possums and gliders. The creek systems have a rich assemblage of native freshwater and estuarine fishes and no introduced fish.

##### Land Management Themes

The size, virtually intact condition and remote nature of much of the bioregion means that most ecological processes have been little altered, especially when compared with other bioregions in Victoria. Fire has probably the most substantial impact, with its frequency and intensity having a major influence on the composition and structure of vegetation communities, particularly heaths and heathy woodlands. Fire prevention and suppression have altered the natural fire regimes, with the result that fire-sensitive species including White Kunzea and Coastal Tea-tree have invaded some vegetation communities, reducing the floristic diversity. Reinstatement of ecological burning and managing successional change of vegetation to maximise biodiversity values and protect identified threatened species and communities are major issues.

The single land tenure (national park) and sole management agency (Parks Victoria) allows for effective integrated management for biodiversity conservation. Many areas in the bioregion are relatively remote, with minimal human impact, where access is deliberately kept to a minimum and natural processes allowed to run their course. Development and human impact are confined to a few locations where these impacts are more readily managed.

##### Biodiversity Condition

Almost all of the Wilsons Promontory bioregion is still in its natural state, with alteration and development confined to a few small discrete areas (less than one per cent of bioregion). This intact nature is reflected in the large number of species found in Victoria's smallest bioregion, with some 20 per cent of Victoria's vascular flora species (including about 30 per cent of its orchids), about half of its bird species and about one-third of the State's mammal species.

The bioregion is significant in that it is one of very few areas in Victoria where catchments have been almost entirely unmodified by drainage and engineering works or clearing, and are currently free of introduced fish species. This is reflected in the rich fish assemblages in the creeks and streams of the bioregion.

Nonetheless, European settlement has had an impact, with at least six fauna species no longer found there. Four species (Spot-tailed Quoll, Water Rat, Dingo and Platypus) are still found elsewhere in Victoria, while two (Eastern Quoll and Tasmanian Pademelon) are extinct on the Australian mainland but still occur in Tasmania.

## Wilsons Promontory

The adoption of ecologically appropriate fire regimes in the bioregion will enhance the biodiversity conservation values of the bioregion. Other threats to biodiversity which require attention are feral predator impact on populations of threatened fauna, environmental weeds and uncontrolled visitor impact on sensitive sites.

Of the 17 known threatened species and undetermined number of threatened ecological communities in this bioregion there are:

- 11 listed vertebrates and plants, of which two have Action Statements;
- no listed invertebrates;
- no listed communities.

### Management Responses

The Wilsons Promontory bioregion is currently managed for maintenance and enhancement of its natural values as a high priority. Management directions have been firmly set through Government policy and Land Conservation Council recommendations adopted by Government. These are the principles underpinning the development of the Wilsons Promontory National Park Management Plan (Parks Victoria July 1997), which will be the main instrument for managing the bioregion to maintain and enhance its substantial nature conservation values. Under the plan the vast majority (98 per cent) of the bioregion will be managed for its wilderness and nature conservation values, including reference areas, with the remainder managed for recreation and education. In particular the park will be established as a model of best practice in ecological management and environmental monitoring, through the development and implementation of a comprehensive Environmental Management Plan for Wilsons Promontory National Park.

Detailed actions are outlined in the Wilsons Promontory National Park Management Plan (Parks Victoria July 1997).

Major actions for biodiversity conservation include:

- Develop and implement an Environmental Management Plan for Wilsons Promontory National Park (which includes the whole of the Wilsons Promontory bioregion).
- Develop and implement a GIS-based baseline data collection and environmental monitoring program.
- Prepare a management plan for the Mount Vereker Creek Natural Catchment Area in accordance with the Heritage Rivers Act.
- Protect and preserve vegetation communities in accordance with the Environmental Management Plan.
- Prepare and implement a fire management plan based on ecologically appropriate fire regimes for maintaining the vigour and diversity of flora and fauna.
- Implement approved recovery plans, FFG Action Statements and other recovery instruments for relevant threatened flora, fauna and communities, especially the New Holland Mouse and Ground Parrot.
- Prepare and implement an integrated program of monitoring and control for pest plant and animal species (including invasive species and predators) and pathogens.

### East Gippsland

#### Bioregions: East Gippsland Uplands, East Gippsland Lowlands

##### The Bioregional Landscape

East Gippsland contains coastal plains, river valleys, foothills, tablelands and mountains up to 1400 metres elevation in the far east of Victoria. It stretches from near Stratford in the west to Cape Howe in the east, and from Lakes Entrance and the coast in the south to Swifts Creek and the 'straight line' part of the Victorian border in the north. East Gippsland is part of the South East Corner IBRA region which extends into New South Wales and within Victoria is considered to contain two bioregions — East Gippsland Uplands and East Gippsland Lowlands. The area is characterised by extensive, essentially continuous areas of forest and other native vegetation, with small isolated 'islands' of settlement in the river valleys, coastal plains and tablelands. The rainfall in most of the area is from 800 to over 1200 mm, however some areas, such as around Swifts Creek and Deddick, lie in rain-shadows with average rainfall of less than 700 mm. Several major and many minor streams drain the area, notably the Mitchell, Nicholson, Tambo, Buchan, Snowy, Brodribb, Bemm, Cann, Thurra, Wingan and Genoa rivers. The continuity of native vegetation over a very extensive area makes East Gippsland one of the great reservoirs of biodiversity in Australia; there are no other regions on mainland Australia where native vegetation is continuous from alpine environments to the coast. The area is also biogeographically important at the continental scale as the area of overlap between southern cool temperate and eastern warm temperate zones; thus it has many species of plants and animals which are absent from, or rare in, the rest of Victoria.

##### East Gippsland was home to five Aboriginal language

groups prior to European settlement. The Krauatunungalong and Brabralung occupied the south-western coast and hinterland; the Ngarigu used the upper Snowy River valley and tablelands; the Maap occupied the eastern forested part of the region; and the Thawa were found north and east of Mallacoota Inlet. The Aboriginal population before 1800 was probably a few thousand, with the highest densities of people along the coast and rivers where resources were most abundant and easily obtained.

European occupation, mainly by graziers, commenced in the late 1830s and proceeded from the north onto the tablelands and down the major rivers, and along the coast from the west and north. Settlement was slow until the late nineteenth century, when the discovery of small deposits of gold, land selection and the coming of the railway accelerated development. The timber industry was relatively minor until the 1950s whereafter it became a major activity and the mainstay of many of the towns in the area.

East Gippsland is still sparsely settled, with less than

20 000 people mostly living in the towns on or near the coast and in smaller villages in the valleys. The major centre is Orbost with other towns including Bruthen, Swifts Creek, Nowa Nowa, Buchan, Bendoc, Cann River and Mallacoota. The single largest land use is conservation. There are several large national parks including Mitchell River, Snowy River, Croajingolong, Errinundra, Coopracambra and part of the Alpine National Park. Timber harvesting is a major industry. In the settled areas, sheep and cattle grazing are important whilst vegetable growing and dairy farming are concentrated in the alluvial valleys and higher rainfall districts. Tourism is a growing industry, along with the infrastructure to support it. Both bioregions lie almost entirely in the East Gippsland Shire, with a small part of the Uplands in the far west in Wellington Shire. Similarly East Gippsland Catchment Management Authority (CMA) covers almost the entire area, with the same small part of the Uplands in the west covered by West Gippsland CMA.

##### The Natural Capital of the Landscape

There are about 15 Broad Vegetation Types in the East Gippsland bioregions. The most prominent of these are forested, with each of Lowland, Dry Foothill and Moist Foothill Forest Complexes covering hundreds of thousands of hectares. Other well represented BVTs and ecosystems are Coastal Scrub Complexes, Heathy Woodland Complexes, Riparian Forest Complexes and Rainforests, Rainshadow Woodland Complexes and wetlands. The great diversity of ecosystems means that the region is rich in both plants and animals. There are about 480 species of vertebrates, 1002 species of vascular plants and an unknown but very substantial invertebrate fauna and non-vascular flora. Whilst there are no endemic vertebrates, several species, including the Eastern Bristlebird, Diamond Python and Stuttering Frog are not found elsewhere in Victoria. The East Gippsland bioregions also support a significant proportion of the State's populations of many other animals, including the Long-footed Potoroo, Spot-tailed Quoll, Brush-tailed Rock-wallaby, Ground Parrot, Glossy Black-Cockatoo, Masked Owl, Giant Burrowing Frog and Eastern She-oak Skink. The extent of old forest makes the bioregions especially important for old forest dependent species such as arboreal mammals and owls. The relatively undisturbed rivers and estuaries support rich populations of native fish and invertebrates; the far eastern streams are particularly notable for the absence of introduced trout.

## East Gippsland

The flora includes numerous species endemic to the area and many others that are rare elsewhere in the State. Most of Victoria's Warm Temperate Rainforest and Dry Rainforest is found in East Gippsland, along with a high proportion of its Coastal Heathlands. Silurian Limestone Pomaderris Shrubland is found nowhere else in the State. There are notable outliers in the area, such as Rainshadow Woodland dominated by White Cypress Pine and White Box. Endemic plants include Betka Bottlebrush, Smooth Tea-tree, Forresters Bottlebrush, Mountain Correa, Marble Daisy-Bush and Leafy Phebalium.

### Land Management Themes

The East Gippsland Uplands and Lowlands bioregions are predominantly public land covered by native vegetation. A high proportion of this is in conservation reserves of one form or another and all is managed as native vegetation. This is a major advantage for biodiversity conservation as most ecosystem processes continue to operate more or less naturally across the landscape and the great majority of species and vegetation types are secure and require no active management. This land base also provides an excellent foundation for implementing effective conservation management at the landscape scale.

The extensive forests of the region have supported a major timber industry for several decades. The perceived impacts of timber harvesting are the principal resource use conflict in the region, and have generated considerable public controversy. About 34 per cent of the public land in the bioregions is available for timber harvesting, and about 6000 hectares of forest are harvested each year, predominantly by the clearfelling technique. This effectively converts old forest to regrowth, with resultant reduction in habitat quality for some species, especially those requiring tree hollows. About half of the private land in the area is cleared. Settlement and agricultural development by Europeans has been largely confined to the coastal plains, alluvial valleys and some parts of the tablelands. This pattern of settlement has resulted in the depletion of vegetation types that were restricted to those landforms, including Lowland Alluvial Rainforests and Grassy Woodlands.

Fire has been influential in shaping the vegetation of the region. Aboriginal fire regimes are difficult to infer, but it is likely that the scale and pattern of fire has changed significantly in the last 150 years, with consequences for the flora and fauna. It is likely that fires, at least in the lowlands and drier areas, are now generally less frequent than before settlement, but individual fires are probably more extensive and intense. The exact biotic consequences of this change are unclear, but are probably very significant.

### Biodiversity Condition

Compared to the rest of Victoria, much of the native vegetation and most of the streams of East Gippsland are in good condition and thus most of the biodiversity is reasonably secure. However there are still many threatened species, and several of the Ecological Vegetation Classes are either very rare or have declined substantially since European settlement. The most threatened vegetation types are those associated with the alluvial valleys and grassy woodlands, where development for agriculture has reduced them to small fragments which are often vulnerable to weed invasion, grazing and clearing. Most threatened species in the bioregions have become so because they are vulnerable to introduced predators, changes in the fire regime, sensitive to intensive logging or confined to specialised or very restricted habitat types.

The major biodiversity impacts of timber harvesting relate to the change from a forest dominated by old trees with a diverse structure and species mix to an even aged stand with simplified structure and few old trees.

Planned rotation lengths of the regrowth mean that these areas will not attain old growth form before again being harvested. The result within harvesting zones is a loss of forest with old growth features upon which a significant part of the biota depends, particularly species that utilise tree hollows, such as possums and gliders, and species which depend in turn on those species, such as large forest owls. There are also less well understood impacts, including change in the species composition of the regrowth, effects on soil biota and impacts on stream flow. The former Land Conservation Council and Forest Management Area planning processes have established a series of reserves and management zones for conservation which have restricted the area potentially available for timber harvesting in the region. Measures to ameliorate the smaller scale coupe level biodiversity impacts of timber harvesting management are being examined.

Further clearing of native vegetation on private land has been restricted by Native Vegetation Retention Regulations, but a small amount of clearing of mainly disturbed native vegetation continues, and there is considerable pressure to allow more, especially for plantations. Many of the retained patches of native vegetation on farmland or roadsides are under pressure from weeds, grazing by stock and incremental clearing. As these are sometimes significant remnants of severely depleted vegetation types, conservation management of these areas remains a concern.

Inappropriate fire regimes are likely to be a significant threatening process in the region. Many species, mainly in fire-prone ecosystems, rely on a particular fire regime to maintain habitat quality or facilitate regeneration. Fire which is too frequent, too infrequent or at the wrong time will cause them to decline or disappear. This is well demonstrated in



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heathland where species such as the Ground Parrot require fire every 10 to 15 years to optimise habitat quality. Eastern Bristlebird and Smoky Mouse may be declining because the pattern of fire in their limited habitat is not appropriate. In contrast, rainforest is very fire sensitive and large intense fires of the type now characteristic of severe fire seasons in East Gippsland can deplete its extent. Ecologically based fire planning is required to begin addressing these problems. Introduced predators, especially foxes and possibly feral cats, are a major threat to a suite of small and medium size mammals, notably the Long-footed Potoroo and the Brush-tailed Rock-wallaby. They have also been implicated in the local extinction of the Eastern Quoll and Tasmanian Bettong. Foxes and cats are widespread and the inaccessibility of large parts of the region makes systematic large-scale control programs difficult. Introduced trout may also constitute a significant threat to native freshwater fish, invertebrates and frogs.

Other less important or localised processes with potentially negative impacts on biodiversity values include sedimentation of streams, mining and quarrying, grazing by cattle and rabbits and weed competition.

The wetlands of the region generally remain in good condition, with most on public land, but there has been some drainage of shallow marshland on private land on the Snowy, Mitchell, Tambo, Cann and Genoa river flats. Estuaries and lower reaches of the major rivers are hotspots for species richness in the region and the intact nature of several such as the Wallagarough, Thurra, Wingan, Cann and Bemm rivers and Lake Tyers are especially important assets. Decline of remnant native vegetation on cleared private land continues and is a threat particularly to remnant grassy woodlands, such as Limestone Grassy Woodland. Effective conservation of these communities will require the cooperation of landholders, combined with local

government controls. Assessment of roadside vegetation has been completed for the south-western part of the East Gippsland Lowlands and is being extended to other areas. Perhaps because of the extensive native vegetation in the bioregion, the demand for programs such as Land for Wildlife and conservation covenants has been fairly low; however these remain important tools for encouraging voluntary conservation of strategically important values. Of the 149 known threatened species and undetermined number of threatened ecological communities in this suite of bioregions there are:

- 67 listed vertebrates and plants, of which 21 have Action Statements;
- three listed invertebrates, of which one has an Action Statement;
- seven listed communities, of which none has an Action Statement.

### Management responses

East Gippsland is a major reservoir of biodiversity in Australia; the management of flora and fauna in the area focuses on maintaining this value. It also has the virtue of being largely continuous native vegetation, mostly on public land, and thus amenable to landscape scale management of ecological and threatening processes, such as introduced predators and fire. There is therefore a strong focus on strategic planning to achieve landscape scale outcomes favourable to biodiversity conservation.

The forest management planning process in the East Gippsland Forest Management Area (FMA) has resulted in nearly 55 per cent of public land in the East Gippsland FMA being reserved in one form or another, with another 11 per cent not available for harvesting. Conservation guidelines have been implemented for all threatened and sensitive species in State forest, large representative areas of each EVC have been conserved as has most remaining old-growth forest and all heathland and rainforest. A system of linear reserves has been developed to connect the reserve system in State forest with the extensive system of statutory parks and reserves. A similar process, with similar anticipated outcomes, is to be applied to the balance of the bioregions. Attention to ameliorating the impacts of timber harvesting will continue, with a focus on harvesting and silvicultural practices at the coupe scale.

There is a clear need to develop fire management strategies which have an ecological basis, both to manage individual species and communities that are sensitive to fire regime, and to develop landscape-scale fire regimes with a sound ecological basis. This has commenced with initial attention to heathlands.

Control of introduced predators is and will continue to be a high priority. The impact of predators on some species is well established, but their impact on a suite of other species is less clear and is a priority for current research so that effective control programs can be developed and implemented. Cooperation with landholders is especially important in predator control and existing programs will be enhanced to maximise benefits to stock and native fauna.

Emphasis on conservation on private land is increasing; especially targeting those species and communities not well represented on public land and to reinforce the conservation ethic amongst landholders. There are extensive areas of native vegetation on private land and this makes a significant contribution to regional biodiversity. The emphasis will be on working with land owners and managers to identify and protect the remnant native vegetation and threatened species, communities and critical habitats. A high priority is the protection of remnant grasslands, woodlands and shallow

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freshwater wetlands on private land and using PAMAs and roadside vegetation protection mechanisms for protection of significant habitats on other public land. There is increasing interest from the local community in conservation initiatives such as the Little Tern program, the rock-wallaby reintroduction project, rare flora monitoring and roadside vegetation mapping.

The role of local government is being enhanced by inclusion of a biodiversity protection component in Shire Planning Schemes and close cooperation with shires in roadside vegetation mapping and management. Emphasis will be given to protecting and enhancing riparian corridors, in co-operation with Catchment Management Authorities (CMA). Management plans will be prepared and implemented for all significant conservation reserves, including Ramsar wetlands. FFG Act processes and native vegetation retention regulations will also be used to protect threatened species and communities. There is strong interest from the shires and the CMA in working with the department to prepare a comprehensive regional biodiversity strategy which will build upon the existing public land planning processes to establish a framework for landscape scale biodiversity conservation across all tenures within the region.

Together with the state-wide key directions outlined earlier, land and water managers and planners in each bioregion should consider the following priorities.

### East Gippsland Uplands

- Continue to implement and monitor the effectiveness of the East Gippsland Regional Forest Agreement and Forest Management Plan.
- Prepare and implement management plans for Errinundra, Snowy River, Coopracambra and Alpine national parks.
- Develop and implement ecological fire management regimes, for the management of individual species and communities with particular sensitivity to fire regime (e.g. rainforests).
- Develop and implement strategic weed and introduced predator management approaches, with special emphasis on preventing the spread of weeds into 'pristine' habitats and protecting threatened species such as the Brush-tailed Rock-wallaby.

### East Gippsland Lowlands

- Continue to implement and monitor the effectiveness of the East Gippsland Regional Forest Agreement and Forest Management Plan.
- Prepare and implement management plans for national parks and State parks such as Croajingolong National Park.
- Develop and implement ecological fire management regimes, for the management of individual species and communities with particular sensitivity to fire regime (e.g. Smoky Mouse, Eastern Bristlebird, Ground Parrot, rainforests).
- Develop and implement strategic weed and introduced predator management approaches, with special emphasis on preventing the spread of weeds into 'pristine' habitats and protecting threatened species such as the Long-footed Potoroo.
- Encourage private landholders to protect remnant vegetation on their land using a range of incentives and programs such as Land for Wildlife, targeting strategic areas such as the lower Snowy and Brodribb valleys district, depleted Broad Vegetation Types such as Grassland Complexes and Grassy Woodland Complexes, Shallow Freshwater Wetlands and Lowland Alluvial Rainforests.

### Wetlands

#### Bioregion: All Terrestrial

##### Relationships with the Landscape

Wetlands are a unique part of Victoria's landscape, supporting distinctive communities of plants and animals. They range widely in character including such diverse areas as alpine bogs, floodplain billabongs, River Red Gum forests, Coastal Tea-tree swamps, large open lakes, shallow seasonal swamps, estuaries, intertidal mudflats and inland hypersaline lakes.

Victoria's 13 114 wetlands now occupy 535 453 hectares or two per cent of the State and are distributed unevenly across the landscape. Not surprisingly, the greatest concentrations of wetlands are in the lowland plains and in the Victorian Embayments marine bioregion. Wetlands are much less common in bioregions of higher relief, for example the Victorian Alps, and in the dunefields of the Victorian Mallee.

Wetlands are difficult to define and classify. The definition used by the Convention on Wetlands of International Importance, also known as the Ramsar Convention, is very broad; it includes natural lakes, swamps and estuaries, rivers and streams, shallow marine areas (including beaches and rocky shores), and artificial wetlands such as reservoirs, sewage farms, irrigated agricultural land and farm dams. This section focuses primarily on natural inland lakes, swamps, estuaries and intertidal mudflats. It does not cover artificial wetlands. Instream habitats and bays, inlets and estuaries are dealt with under different sections.

The wetlands discussed in this section are those naturally occurring depressions or floodplains which are covered temporarily or permanently by fresh, brackish or saline water.

They are classified into six categories.

- Freshwater meadows — shallow freshwater wetlands holding water for less than four months of the year.
- Shallow freshwater marshes — shallow freshwater wetlands that usually dry out in mid-summer and refill with the onset of winter rains.
- Deep freshwater marshes — deep freshwater wetlands that remain flooded for most of the year but may dry out occasionally.
- Permanent open freshwater wetlands — deep freshwater wetlands that hold water permanently.
- Semi-permanent saline wetlands — saline wetlands flooded for less than eight months of the year, including salt pans and salt meadows.
- Permanent saline wetlands — saline wetlands that rarely dry out, including tidal areas and saline inland lakes.

Different wetland types characterise different landscapes. Freshwater meadows are very common on the floodplains of the Victorian Riverina bioregion, particularly along the Murray, Ovens and Goulburn rivers and in the Kerang–Echuca area. They are also common in the south-west of the State, particularly around Edenhope, Hamilton and Camperdown. Shallow and deep freshwater marshes also occur in these areas and in the Gippsland Plain bioregion. Saline wetlands are a feature of the southern Victorian Volcanic Plain near Colac, the drier parts of the State, and the Wimmera River, Mildura, Lake Tyrrell and Kerang areas, the Gippsland coast and Port Phillip Bay and Western Port.

##### The Natural Capital of Wetlands

Wetland ecosystems are highly productive and characterised by a high rate of nutrient recycling. Nutrients enter wetlands from their catchments and are trapped and stored in wetland sediments. Nutrients in sediments, those captured by microscopic phytoplankton in the water column or those released from decaying wetland vegetation, form the basis of the nutrient cycle in wetlands. Organic plant matter broken down into detritus by bacteria and fungi is consumed by organisms such as snails, crustaceans, insect larvae and worms. Phytoplankton are eaten by zooplankton and these and other invertebrates form the diet of the larger vertebrates such as fish, frogs, reptiles and birds.

Wetland flora is distinctive and varied. It typically includes several different plant forms including algae; floating plants such as the tiny fern Azolla and duckweed Lemna; benthic plants which are attached to the bottom but grow submerged such as seagrasses and pond weeds; emergent macrophytes such as reeds, rushes, sedges, herbs, grasses, trees and shrubs. Trees and shrubs characteristic of wetlands include paperbark and tea-tree species, Lignum, glasswort species, River Red Gum, Black Box and White Mangrove.

The distinct communities of wetland species that are a feature of different wetland types in different regions are the result of individual species' responses to a suite of factors such as climate, altitude, geomorphology, soil type, water regime, nutrient status and water chemistry. Examples of distinctive wetland communities include sphagnum bogs in alpine regions, coastal salt marshes dominated by species of glassworts, River Red Gum forests and reed swamps dominated by the Common Reed or Cumbungi, and seagrass beds typical of estuaries, inlets and bays. Plants in wetlands respond to factors such as water depth, period of inundation and light penetration, resulting in vegetation

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zones within many wetlands. Some wetlands are densely vegetated while others have areas of open water or are devoid of larger plants except around their margins.

Aquatic invertebrates are a notable component of the wetland biota. In many inland temporary wetlands the cycle of drying and refilling is important in driving pulses of invertebrate productivity. During dry periods, organic matter accumulates in wetlands. When these flood, the detritus quickly gives rise to very high numbers of invertebrates, which are an important factor in stimulating breeding in many fish and waterbird species.

More than 100 species of waterbirds use Victorian wetlands. Intertidal habitats, such as those in Corner Inlet, provide essential habitat for large numbers of migratory waders. Wetlands are important breeding areas for waterbirds. Some colonially nesting species, such as terns, ibis, pelicans, spoonbills, egrets and cormorants, form breeding colonies when conditions are right at certain wetlands. Appropriate management and conservation of these key wetlands and also the shallow seasonal wetlands used for feeding at breeding time are critical to the breeding success of these species. The large open permanent saline lakes in the Colac area are important sites for waterfowl to take refuge in during moulting when they are temporarily flightless.

Reptiles, amphibians and fish play a major role in wetland food webs. Estuaries and mangrove areas are particularly important habitats for the juveniles of many commercial fish species.

There has been a dramatic reduction in natural wetland area since European settlement. Thirty-seven per cent of Victoria's wetland area has been lost, primarily as a result of drainage. The greatest losses of original wetland area have been in the freshwater meadow (43 per cent), shallow freshwater marsh (60 per cent) and deep freshwater marsh (70 per cent) categories. The majority of decline has been on private land. The map above illustrates the extent of wetlands before European settlement. Of particular note is the original extent of Koo Wee Rup Swamp to the north of Western Port, which has since been almost totally drained. Wetland loss has also been significant in the Riverina and the south-west of the State.

The number of artificial wetlands has increased since European settlement, but the vast majority of these are farm dams of less than one hectare in area. Artificial wetlands provide habitat for some wetland flora and fauna species but are often of low ecological value as they have unnatural water regimes and lack the habitat diversity of natural wetlands. Few artificial wetlands have been constructed with the purpose of enhancing biodiversity values.

### Management Themes

Wetlands are valuable to the Victorian community for conservation, aesthetic and economic reasons. Their value and proper functioning as flora and fauna habitat is important not only for biodiversity conservation but also as the basis for many of their other values. Healthy functioning wetlands maintain water quality by trapping sediments and utilising and storing nutrients. They also assist in flood protection by storing floodwater and releasing it slowly. Many commercial and recreational fish species depend on wetlands for at least some part of their life cycle. Forestry and recreation are significant economic uses of the River Red Gum forests along the Murray River. Wetlands are important to agriculture in supporting waterbirds that feed on insect pests, in providing sources of water for stock and in providing opportunities for grazing and for aquaculture.

Recreational uses of wetlands are also highly valued by the community. Activities such as recreational fishing, boating, swimming, duck hunting, birdwatching and bushwalking attract many people to wetlands and, in places such as the Gippsland Lakes, provide the basis for tourist industries. Wetlands are valuable as areas for study and education and as sites of archaeological and cultural significance.

They also contribute to the scenic quality of the landscape throughout Victoria.

Three-quarters of the wetland area in Victoria is on public land but this is only 20 per cent of the total number of wetlands. Wetlands on public land are generally larger and more permanent while those on private land tend to be smaller and less permanent. Many wetlands on public land are managed to protect biodiversity as part of the protected area network; some are managed for multiple uses, including forestry (for example, some River Red Gum forests along the Murray); and some as part of irrigation water supply and wastewater disposal systems or for recreation. Wetlands on private land are most often managed within the context of broader agricultural land use.

### Biodiversity condition

The impact of European settlement on Victoria's wetlands has been severe. Some wetlands have been totally lost and many that remain have been affected by one or more degrading processes. The main process contributing to wetland loss and degradation in Victoria has been total or partial drainage. Thirty-seven per cent of the State's natural wetland area has been lost in this way. About half of this consists of wetlands which were totally destroyed, while the other half of the lost area involves the reduction in size of many wetlands. An additional 30 per cent of the original area of wetland in Victoria has been degraded through partial drainage or changes in water regime. Although the rate has slowed since early this century, wetland drainage still continues. Over 90 per cent of the area lost has been on private

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land. Areas most affected by drainage are south-western Victoria and the irrigation areas around Kerang and Shepparton.

Another critical issue in wetland conservation is the maintenance of appropriate water regimes. Changes in water regime can drastically change wetland appearance and functioning, disrupting natural productivity cycles, causing changes in vegetation, including loss of existing species, and changes in habitat. Altered water regimes have many causes including wetland drainage, lowered or raised water tables, construction of levee banks, the use of wetlands for water storage or wastewater disposal associated with irrigation and drainage schemes, and urban development. Altered water regimes are responsible for a significant proportion of wetland change. Almost all wetlands with less permanent water regimes are on private land, while about one-third with more permanent water regimes are on public land. A significant factor affecting the water regime of floodplain wetlands is river regulation, which has reduced the exchange of nutrients and organic matter between rivers and floodplains and led to changes in the flooding regime, the community structure of billabongs, fish movement and fish and waterbird recruitment.

The extent of wetland change due to increasing salinity is less significant at a state-wide level than the effects of drainage and changed water regimes, but is still important in some Victorian bioregions. Wetlands may become saline due to rising water tables bringing saline water to the surface or by the disposal of saline irrigation tailwaters. Native vegetation clearing and irrigation practices have contributed to salinity problems in many agricultural areas of Victoria and many wetlands in these areas, particularly in north central Victoria, are affected by salinisation. Some coastal wetlands, such as the Gippsland Lakes, are becoming more saline because estuaries are now open to the sea more often than they were prior to European settlement.

Grazing livestock in wetlands often contributes to degradation through such effects as soil compaction, increased nutrient input, changes in turbidity, spread of weeds, selective grazing and trampling of indigenous wetland vegetation and erosion. However, light grazing can sometimes be a suitable tool in controlling weeds or reducing fire hazard in wetlands. Grazing in wetlands occurs mainly on private land but also on some public land. The strategic management of stocking rates, duration and timing of grazing and type of stock can lessen the impact of grazing on wetland ecosystems.

Runoff with an increased nutrient load from rural and urban catchments may result in algal blooms and eutrophication in wetlands which may then be closed to recreation in summer. Other issues affecting wetlands include pollution, sedimentation, dredging to improve navigation in coastal wetlands and land filling (usually in conjunction with urban expansion). Wetland pest plants, such as *Spartina*, and pest animals, such as European Carp, can be very invasive and difficult to control once they have entered wetland systems. Issues associated with recreational use include the poisoning of waterbirds from ingesting spent lead shot discharged by duck hunters and stocking wetlands with introduced fish to support recreational fishing.

At least nine potentially threatening processes listed under the Flora and Fauna Guarantee Act 1988 affect wetlands. As a result of the threats to wetland ecosystems, many species that depend on wetlands are now threatened with extinction. Five wetland communities have been listed under the Act.

Fifteen Action Statements under the Flora and Fauna Guarantee Act 1988 have been prepared for species and potentially threatening processes associated with wetlands.

International and national policy setting

Australia is a signatory to the Ramsar Convention, which imposes obligations to include wetland conservation considerations in land use planning and promote the wise use of all wetlands; to list at least one site of international significance and maintain the ecological character of listed sites; to establish nature reserves based on wetlands; and to promote training in the fields of wetland research and management. Victoria, together with the other States and Territories, administers the obligations of the Convention in relation to its jurisdiction in partnership with the Commonwealth. Victoria has ten sites of international significance listed on the Ramsar Convention and has, to date, identified 161 wetlands for inclusion in *A Directory of Important Wetlands in Australia* (Second Edition).

Australia is also party to the Japan-Australia Migratory Bird Agreement (JAMBA) and the China-Australia Migratory Bird Agreement (CAMBA). These bilateral agreements, also administered in partnership with other States and Territories and the Commonwealth, call for the protection of the habitats of the migratory bird species listed in the agreements. Many of these species frequent Victorian wetlands, most notably migratory waders. Seven of the 30 most important Australian sites for migratory waders are in Victoria. In 1996, a program was launched in response to the need for international action to protect migratory shorebirds along the East Asian–Australasian Flyway. The East Asian–Australasian Shorebird Reserve Network links wetlands that are internationally important for shorebirds. To date, 19 sites have joined the Network from eight countries. The Shorebird Reserve Network highlights the importance of wetland areas for shorebirds and promotes activities for their conservation. Victoria has nominated Corner Inlet to

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the network. The Commonwealth Government released a Wetlands Policy in January 1997. A key strategy is for the Commonwealth to work in partnership with State and Territory governments to promote wetlands conservation.

Mechanisms for this include the

development of complementary wetland policies, ongoing identification of nationally important wetlands, strengthening links between the Commonwealth and States on shared wetlands issues, and instituting formal partnership agreements in relation to specific wetland issues.

Several Victorian wetlands are included on the Register of the National Estate. The Commonwealth is required to consider the effects on listed areas of proposals for which the Commonwealth has a decision-making role and not to take action that adversely affects a listed site unless there is no feasible or prudent alternative.

The Murray-Darling Basin Ministerial Council is developing a Floodplain Wetlands Management Strategy which will focus on issues in the management of floodplain wetlands in the basin, including those along the northern flowing rivers north of the Great Dividing Range in Victoria.

### Management Responses

The vision for wetlands is to protect Victoria's wetland biodiversity by promoting the conservation and wise use of all wetlands. The principal outcomes sought are:

- maximum retention and restoration of existing wetlands, as far as practicable;
- viable wild populations of native wetland-dependent flora, fauna and ecological communities;
- a representative selection of Victoria's wetland environments afforded protection in the State's protected area network of parks and reserves;
- a strong partnership between owners of wetlands on private land, catchment and coastal authorities and local and State government agencies that encourages wetland owners to use wetlands wisely and sustainably, restore degraded wetlands and protect wetland biodiversity;
- an increased awareness and appreciation of wetlands by the community leading to a higher level of active participation in wetland conservation and monitoring.

The most significant challenges in managing wetlands for biodiversity relate to tackling the major issues such as wetland drainage, changes to water regimes and salinisation. These are particular problems on privately owned agricultural land and a co-operative effort between land owners, Catchment Management Authorities and local government is required to address them effectively. A whole-of-catchment approach is critical for addressing threats such as salinity, excess nutrient runoff, sedimentation and rising water tables, which result from catchment-wide practices such as land clearing, overstocking, and injudicious use of fertilisers and irrigation waters.

Changes in wetland water regimes can be tackled at the local level by individual land owners. At a regional level this issue is best addressed by Catchment Management Authorities via the implementation of salinity plans, wetland management plans and watering strategies. Water authorities and irrigators are also important stakeholders. The bulk water entitlement processes are a key to addressing water regime issues in floodplain wetlands. Along the coast, the Victorian Coastal Council and Regional Coastal Boards will play a leading role in co-ordinating the actions of the many stakeholders and agencies in implementing strategies to protect coastal wetlands such as estuaries and intertidal areas.

The priority management responses for land and water managers and planners are to:

- Work in conjunction with the Commonwealth and other States and Territories to implement the Ramsar Convention and to secure the best possible outcomes for wetland biodiversity through the Natural Heritage Trust and forums such as ANZECC and the Murray-Darling Basin Ministerial Council.
- Complete integrated management planning for the ten Ramsar sites in Victoria and investigate potential new sites.
- Protect important habitat of migratory waders and species listed on JAMBA and CAMBA with a focus on investigating the addition of significant sites to the East Asian–Australasian Shorebird Reserve Network.
- Ensure wetland water regimes are considered in the bulk water entitlement conversion and new allocation processes. As part of the Government's water reform package, investigate new strategies for the effective use of environmental water on floodplains, use savings in irrigation systems for environmental purposes and improve and maintain habitat where environmental water is provided.
- Develop management agreements to encourage water authorities to take account of the environmental values of those wetlands that are part of the water distribution system.
- Implement the State Environmental Protection Policy Waters of Victoria as it relates to water quality in wetlands.

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- Phase out the use of lead shot for duck hunting, in consultation with hunting organisations.
- Complete the process of identifying important and representative wetlands in Victoria and contribute to a third edition of A Directory of Important Wetlands in Australia and a national wetlands inventory.
- Promote recognition of important wetlands and encourage actions leading to their improved management.
- Promote World Wetlands Day and World Wetlands Week in Victoria as a focus for increasing community awareness of the importance of wetlands.
- In conjunction with the Commonwealth Asia-Pacific Wetlands Management Training Program, develop and implement a training program for wetland managers.
- Make information about wetlands more accessible to the community, wetland managers, students and planners through Land for Wildlife and other extension programs and by establishing a Victorian Wetlands Home Page on the internet and promoting useful publications and interpretive material.
- Improve environmental monitoring programs in wetlands with particular emphasis on Ramsar sites and encourage the community to adopt new wetland sites for monitoring through the Waterwatch Program.

### **Rivers and Streams** **Bioregion: All Terrestrial**

#### Relationships with the Landscape

Freshwater ecosystems are a prominent feature of the landscape in most bioregions. They include a diversity of forms, ranging from permanently flowing rivers and streams, permanent large and small lakes and swamps, through to temporary flowing rivers and streams and small or large temporary wetlands. Biodiversity and conservation considerations for in-stream habitats are discussed here and wetlands (lakes and swamps) are dealt with in the previous section.

There are 3820 named watercourses in Victoria, with a total length of 56 000 kilometres. In addition there are numerous un-named streams, mainly smaller tributaries of named watercourses.

Unlike the relatively discrete terrestrial bioregions already described, there is no clear regionalisation for Victorian rivers and streams. On a simple topographic basis, Victoria can be divided into 29 river basins. However, many of these basins are interconnected, through the Murray River (for north flowing rivers, part of the major Murray-Darling Drainage Division) and, to an extent, through Bass Strait and the historical land bridge to Tasmania (for south flowing rivers, part of the South-East Coast Drainage Division). The differences between the two drainage basins have had major influences on the types and distribution of some of the aquatic flora and fauna, particularly fish, throughout the State.

A single river system can flow through a number of different bioregions. Most of the major river systems in Victoria rise in the high country of the Victorian Alps or the Victorian Midlands, and flow down through the foothills and onto the plains of various bioregions.

For example, the Goulburn River rises in the Alps, descends through the South Eastern Highlands and the Victorian Midlands and finally joins the Murray River in the Riverina.

Across bioregions, there are certain similarities in form (and probably ecological processes) between rivers, depending on the location in the landscape. In a broad sense, these can be divided into mountain, valley and plains segments of rivers. Mountain streams tend to be small, high gradient erosional systems with rocky stream beds and with relatively high flows compared to runoff. Further downslope, as headwater streams join to form the larger valley streams, the gradient is lower and flows are more variable. On the plains, rivers are much larger with low gradients and highly variable flows. While the river changes in width, depth, flow rate and water quality along its length in line with these different landforms, it remains a single linear entity. Its biodiversity characteristics are determined by a complex combination of geography (drainage basin, mountain, valley or plains) and local physical factors (stream size, stream bed form, water, in-stream habitat and riparian quality), floodplain characteristics and management activities, including those both upstream and downstream of any point.

The water, bed and banks of all watercourses in Victoria are deemed to be public land. In 1881, a Crown frontage of between 20 and 60 metres was permanently reserved for public purposes across all water courses in the State, except those areas which had already been alienated. Consequently, the bed and banks of most watercourses in Victoria are deemed to be public land. In many cases, the reserved Crown frontage has been used by the adjacent landowner under licence, and has been subjected to extensive changes in vegetation cover and condition.

It is proposed that the management of these Crown frontages and waterways will be the responsibility of the relevant Catchment Management Authority. Legal entitlements to use of the water are also held by Water Authorities and individual landholders.

Some of the river length is located in national and State parks. Eighteen river segments with special scenic, recreational, cultural or ecological values have been declared Heritage Rivers under the Heritage Rivers Act 1992.

#### The Natural Capital of Rivers and Streams

Rivers and streams support a wide variety of flora and fauna species and communities. Along with two largely aquatic mammals, the Platypus and the Water Rat, there are 38 extant species of essentially freshwater fish (plus one presumed extinct species). Of these, 29 are considered threatened in Victoria.

Within the fish fauna, there is a distinction between species located north and south of the Great Dividing Range. Thirteen species are located only in the Murray Darling Drainage Division while 18 species are found solely south of the Divide. Only six species have distributions on both sides of the Divide.

North of the divide four species are known to be migratory, moving upstream or downstream to spawn at particular times of the year. Murray Cod have recently been discovered to move more than 100 kilometres upstream each year to spawn, before returning to the same section of river. South of the Divide, 13 of the 18 species are known to migrate.



## Rivers and Streams

Some, such as the Freshwater Herring, move downstream to estuaries to spawn, while others including the Spotted Galaxias spawn upstream with larvae washed downstream to the sea and the juveniles making an upstream migration. The migration behaviour of many of the freshwater fish species is unknown.

The total number of invertebrate species in rivers and streams remains unknown but would far exceed the diversity of the vertebrate fauna. There is much less distinction between north and south of the Divide, but distinct invertebrate faunas have been identified from a number of areas such as streams in the Grampians. There are data to suggest that different macroinvertebrate assemblages exist in alpine, mountain, valley and plain segments. Fourteen insects and 19 crustacean species (including 11 of the 42 known decapod species) have been identified as threatened, although this is likely to be an underestimate of the true conservation status of macroinvertebrates.

Similarly, the biodiversity of plants in rivers and streams has not been adequately evaluated. Larger macrophytes such as reeds are fairly well known, but smaller vascular plants and algae are in need of monitoring and taxonomic research. Many frogs spend the tadpole phase of their life cycle in streams. As adults, they rely on the moist microclimate in the riparian zones to avoid desiccation, returning to the stream to breed and lay eggs. Many frog populations throughout the world are declining and 10 species are considered endangered in Victoria.

Water birds including ducks, cormorants, spoonbills, ibis, herons and grebes are dependent on aquatic ecosystems for food and breeding. At least 12 species of birds associated with rivers and streams are considered threatened in Victoria. At least one bat species, the Large-footed Myotis, which is rare in Victoria, also depends on rivers for food.

### Management Themes

Because of the vital nature of freshwater supplies for agriculture, industry and urban living, many factors and issues influence biodiversity outcomes in rivers and streams.

The variable nature of Victorian climate and rainfall lead to a dependence on stored water for agricultural, domestic and industrial purposes. Consequently, many Victorian rivers have been impounded. Extraction of water for domestic or industrial use has reduced overall flows significantly in many places. About 55 per cent of all divertable streamflow is extracted. Large releases of water for irrigation often occur during summer, when natural flows are low. The quality of water released from impoundments is often altered, commonly being far colder than normal. These changes to volume, seasonality and water quality reduce the suitability of rivers and streams for aquatic species. Storage during high flow periods has reduced inundation of the floodplain, which may have been a factor in the reduction of some fish, bird and plant species.

Impoundments create barriers to the migration of fish, restricting the available habitat. Even small structures such as weirs or poorly constructed road crossings, or channelisation, can create barriers to fish movement.

Changing land use has altered the quality of water in rivers and streams. Clearing of native vegetation, particularly in association with irrigation, has led to increased stream salinity, while degradation of stream bank condition through grazing and other activities has increased turbidity levels in some streams. Agricultural practices and domestic and industrial discharges have increased the levels of various toxic chemicals and nutrients in streams.

Many bird, invertebrate and fish species rely on woody debris for resting or breeding. Removing snags for navigation, and during flood and erosion mitigation works, has reduced the habitat quality of many rivers for native fauna.

Increased sedimentation that fills either interstices in the stream bed or deep pools also reduces the available habitat in many waterways.

Several species of introduced fish and invertebrates have caused declines in populations of a range of native species.

Exotic plants such as willows and blackberries dominate many riparian streamsides. These can change the ecology of rivers and streams, making them less suitable for native biota. Aquatic weeds, including Cord-grass, can also be serious problems where they become abundant.

### Biodiversity Condition

In 1986, a state-wide survey was conducted of the environmental condition of Victorian rivers and streams. Sites were evaluated for 10 factors likely to be important to aquatic biota, including stream bed condition, bank vegetation, flow, depth and erosion. Results showed that 60 per cent of all streams were classified as being in good or excellent condition, 13 per cent were in moderate condition and 27 per cent were in poor or very poor condition.

The overall state figures included all streams in upland forest areas including national park and State forest.

A high proportion of minor streams were in good or excellent condition (69 per cent), compared with far fewer main streams (21 per cent) and tributaries (36 per cent). The figures for streams in cleared areas were significantly different, with only 5 per cent of streams in good or excellent condition, 30 per cent in moderate condition and 65 per cent in poor or very poor condition.

Stream condition varies throughout the State. Rivers in the east, including the East Gippsland, Tambo, Snowy, Mitchell and Thomson catchments are generally in good condition, with over 90 per cent of the stream length in good

## Rivers and Streams

or excellent condition. Rivers in the drier west, including the Corangamite, Avoca, Hopkins and Campaspe catchments are in generally poor condition with over 95 per cent of stream length in moderate to very poor condition.

The composition of aquatic macroinvertebrate assemblages in rivers and streams has been used as an indicator of biological health. In general, mountain streams are in better health than valley and plain rivers. Over 90 per cent of mountain stream segments are rated as in excellent or good health based on the macroinvertebrate fauna compared to just over 10 per cent of plains river segments. However, data for 50 per cent of plain segments and 65 per cent of valley streams are insufficient to determine biological health.

Flows below points of water extraction in rivers have been evaluated for their suitability for fish. The diversion of water for domestic purposes has placed moderate to high stress on 104 rivers and streams (67 small streams and 37 larger rivers) during the normal low flow periods in summer or autumn. Only 69 rivers and streams from which water is diverted for domestic purposes release sufficient water to prevent downstream stress during low flow periods.

Of 88 diversions on larger rivers that store water for irrigation, 29 have a significant impact on flows during summer and 59 have flow rates that cause minimum amounts of stress.

The condition of riparian vegetation declines markedly from the upland to the plains segments of rivers. Good quality riparian vegetation, where there is a dominance of native species, width greater than 30 metres and with more than 80 per cent continuous length intact, is uncommon in plains, with 80 per cent of plains segments in poor or degraded condition.

The poor condition of many rivers and streams has resulted in a significant degradation of the native aquatic fauna. Over 65 per cent of Victorian fish species are rated as threatened and 20 of these have been listed under the Flora and Fauna Guarantee Act 1988. Five amphibians are also listed, but fewer aquatic and riparian plants and invertebrates have been listed. Action statements have been prepared for seven of the listed fish, frog and invertebrate species. Ten potentially threatening processes dealing directly with rivers have been listed, but as yet none of these have Action Statements.

### Management Responses

The low number of streams in good or better condition in cleared agricultural land means that a major improvement effort must be made. Improvements will rely heavily on Catchment Management Authorities, local councils and landowners. The emphasis will be on working with land and water managers to incorporate protection and restoration of rivers and streams into management plans, primarily through the amelioration of threatening processes. It is opportune for strategic actions to be directed towards on-ground works. There is already considerable interest within the community in protecting and restoring rivers and streams, particularly through fencing and revegetating riparian zones. The importance of clean water for domestic, agricultural and environmental use is also well recognised and becoming more important to the community.

Continued research and monitoring will improve our knowledge about the biodiversity of rivers and streams, particularly of plants and invertebrates. It will also identify critical areas for protection and restoration, and assist in determining the appropriate management approaches.

In upland streams, emphasis will be on working with land managers to incorporate protection and restoration of rivers and streams into management plans, through the development and implementation of scientifically-based codes of practice for activities such as roading, timber harvesting and recreation.

The priority management responses for land and water managers and planners are the following:

- Incorporate the approved LCC recommendations for Rivers and Streams into relevant plans and strategies.
- Develop an in-stream and riparian strategy for Victoria, which will help achieve better river management and restoration outcomes, particularly to increase community and landholder custodianship in the rural landscape.
- Ensure that biodiversity information on the in-stream and riparian environments is used effectively in the bulk water entitlements process.
- Promote the adoption of aquatic biodiversity information and conservation management into Regional Forest Agreements, Regional Catchment Management Strategies, and Heritage River, Streamflow, Nutrient and Salinity management plans.
- Promote instream and riparian vegetation protection and restoration as a key environmental outcome for the Natural Heritage Trust program and co-ordinate the strategic restoration of Victorian streams to maximise biodiversity outcomes on the ground.
- Promote the use of fishways over selected barriers with priority given to threatened species and sites that maximise the available upstream habitat.
- Incorporate the importance and benefits of protecting and enhancing native vegetation in the instream and riparian environments in extension and voluntary programs to landholders and the community; these include Land for Wildlife, Farm\$mart and Waterwatch.

## Rivers and Streams

- Ensure that ‘best practice’ in restoration of riparian vegetation is continually developed and communicated to natural resource managers and landholders and is included in relevant codes of practice.
- In conjunction with other agencies, including the Murray-Darling Basin Commission and adjacent state governments, continue strategic and co-ordinated investigations into the ecology and management of freshwater environments.

### Bays, Inlets and Estuaries

#### Relationships with the Land and Seascape

Bays, inlets and estuaries are semi-coastal waters where freshwater inputs from catchments blend to varying extents with marine waters. In Victoria, these features are found from the Glenelg River estuary in the west to Mallacoota Inlet in the east. They have biophysical characteristics that distinguish them from riverine and oceanic areas and together they form one of Victoria's significant bioregions. They have a range of salinity from virtually fresh water to fully marine, lower wave energy than the open coast, restricted water exchange patterns and their floors are generally covered in soft sediments. A number of habitats occur within these systems including sand flats, mud flats and associated drainage channels, seagrass beds, and mangroves. Larger embayments also contain sandy beaches, rocky reefs and islands. Mangroves and intertidal flats only occur within the bays, inlets and estuaries.

There are pronounced differences between the various estuaries, inlets and bays depending on their topography and hydrology. The largest Victorian marine embayment is Port Phillip Bay, which covers 1950 square kilometres and has 250 kilometres of coastline. Sand covers the sea floor along the eastern, western and southern sides, with a large mud area in the middle. Intertidal flats and seagrass beds occur predominantly along the western shore from Altona to Swan Bay. The southern section near Port Phillip Heads has more oceanic characteristics. Western Port covers 680 square kilometres, has two entrances and contains several large islands. It is also a large tidal bay with extensive mudflats and seagrass beds occurring in the north and south-east. Corner Inlet and the Nooramunga are marine barrier island inlets with extensive tidal mudflats, seagrass beds and the southern-most occurrence of the White Mangrove, *Avicennia marina*, in the world. The Gippsland Lakes, Victoria's largest estuary, are a series of interconnected lagoons that drain several catchments. A permanent artificial entrance to the estuary was created in 1889.

#### The Natural Capital of Bays, Inlets and Estuaries

The flora and fauna vary according to the biophysical characteristics of each bay or inlet. The benthic assemblages in the muddy central region of Port Phillip Bay are distinct from those in adjoining sandy areas to the west and east. The turbid conditions in Western Port allow many subtidal animals to live in shallower water than is usual. A highly diverse intertidal community has developed on the soft basalt reefs near San Remo.

In Port Phillip Bay and Western Port the dominant seagrasses are *Zostera muelleri* and *Heterozostera tasmanica*. *Posidonia australis* occurs in Corner Inlet and the Nooramunga. The small riverine estuaries in western Victoria have an impoverished benthic fauna compared to the larger estuaries with wind-mixed lagoons and lakes in the east. The estuaries of far eastern Victoria are also distinguished by the presence of several warm temperate species, for example peneid prawns and the seagrass *Zostera capricorni*.

The bays and inlets support a rich invertebrate, fish and bird fauna. For example over a hundred species of fish have been recorded from Victorian bays, inlets and estuaries. Some fish, such as Black Bream, are normally found only in bays, inlets and estuaries, whereas other

fish only use these areas during part of their life cycle. Bays, inlets and estuaries are important breeding and nursery areas for several fish of commercial and recreational importance. Islands within the bays support important breeding colonies for species of birds and seals. Intertidal flats and adjacent shorelines provide feeding areas and sheltered roost sites that are needed by large numbers of migratory and resident wading birds and waterfowl. Many of the wetlands are of international significance for migratory birds and nationally important for Australian waterfowl species.

Of the threatened species and ecological communities in this bioregion there are:

- two listed opisthobranchs, neither of which has an Action Statement;
- one listed community has an Action Statement.

#### Management Themes

The living resources of our bays, inlets and estuaries were first utilised by indigenous peoples who collected shellfish and trapped fish. Fish and shellfish also nourished the early European settlers. Flat oysters were the target of an early dredge fishery and were over-exploited in many areas. Near shore, fish were caught with hand-hauled seine nets. Commercial fishing expanded with the increasing population and the development of ferry and rail links. By 1890 there was a thriving industry in all major Victorian bays and inlets. Catch levels of these fisheries have been quite variable over this century, with peaks and declines occurring at different times in different inlets. Fishing effort has shifted towards more profitable species as market preferences have changed. Dredging for scallops started in Port Phillip Bay in 1963 but ceased in 1996 due to concerns about the environmental effects of this technique. The main commercial fishing methods currently used in bays and inlets include haul seining, purse seining, mesh (gill) netting, long-lining and hand collection of various invertebrates by divers.

## Bays, Inlets and Estuaries

Approximately 14 per cent of Victorians over the age of 14 currently fish for recreation in the major bays and inlets at least once a year. The participation rate has declined in recent years; however, continued improvements in fishing technology and knowledge have probably led to an increase in the overall fish catching capacity. The recreational catch of a number of bay and inlet species (flathead, whiting, garfish, calamari squid, snapper, bream) is potentially equal to or greater than the commercial catch. Illegal harvesting and/or sale of shellfish and illegal netting are thought to be major problems in some of our bays and estuaries.

The farming of blue mussels is the major current significant aquaculture development in the bays. Culture of abalone, flounder and scallops is being developed but attempts to cultivate flat oysters and other species have not so far been as successful as hoped. Aquaculture is expected to increase with improved technology. Environmental impacts from poorly managed aquaculture can include nutrient enrichment at the local to regional scale, pollution from the use of pesticides and therapeutic chemicals, the establishment of feral populations of exotic species, and interference with seabirds and mammals.

Other uses of the bays and inlets include tourism, recreational diving, boating and other water sports and ports and shipping. Ecology based tourism operators offer a range of wildlife watching experiences, particularly in southern Port Phillip Bay. It is likely that tourists will increasingly seek out the experiences of our diverse biodiversity assets and new industries will evolve. Boat ownership in Victoria has doubled in the last 20 years. The effect of boating on sensitive habitats or water quality has not been quantified.

There are four major ports and numerous minor ports and jetties along the Victorian coast, many of which are contained within the bays and inlets. Environmental impacts from shipping and related activities include dredging of the sea floor to maintain channels, the discharge of dredge spoils, the use of toxic antifouling paints, the accidental release of hydrocarbons, the cleaning of fouled ship hulls, and the disposal of ballast water. Shipping activities have introduced numerous species from foreign ports, from hull fouling and the release of ballast water. Over 90 introduced marine plants and animals are now known from Port Phillip Bay, some of which have become pest species. The use of the toxic antifouling paint tributyl-tin has been banned on vessels less than 25 metres long. The in-water cleaning of ship hulls within Victorian ports has also been banned recently.

The major sewerage discharge into our bays is from the Werribee treatment complex into Port Phillip Bay which handles 65 per cent of the domestic sewage from Melbourne. Industrial discharges also occur from several outfalls into Port Phillip Bay and Western Port. There is also runoff pollution from unsewered urban areas, stormwater drains and inappropriate land use practices. High toxicant levels in the sediments of several sites around Port Phillip Bay are a legacy of past industrial pollution. These are likely to decrease with time.

Inadequate management of the associated catchments has compromised the health of our inlets and estuaries. Increased levels of nutrient from sewerage and agricultural practices have led to eutrophication in some areas. Sediment from erosion and urban development has been washed down the rivers and streams to smother seagrass and alter the natural topography. The hydrological regime has been altered in many estuaries by the creation of entrances to the sea through the outer sand bars and the diversion of water from the catchment rivers to agriculture and urban centres. This has led to increased salinity levels and decreased the natural flushing of the inlets. The spread of introduced pests (e.g. Carp, marine fanworms) and weeds (Spartina, Broccoli Weed) have compounded these problems. Poor environmental conditions pose a major threat to the biodiversity of these systems. The large bays appear better able to absorb the increased input of nutrients, although a progressive decrease in nitrogen levels has been recently recommended for Port Phillip Bay.

The bays and inlets are largely in public ownership. Alienated sea floor is confined to areas around some ports and marinas. Leases, licences and similar arrangements cover a range of commercial activities, such as aquaculture, fishing and shipping channel maintenance. Areas have been reserved or proclaimed as Protected Areas in Port Phillip Bay, Shallow and Corner Inlets and the Nooramunga. Fishing is permitted throughout all bays, inlets and estuaries except in the tiny Popes Eye reserve in southern Port Phillip Bay. Current reserves are not comprehensive, adequate or representative of bay and inlet habitats. In recognition of their wetland values, extensive areas in Port Phillip Bay, Western Port and Corner Inlet and the Nooramunga are listed for protection under international agreements such as the Ramsar Convention.

Natural habitats have been modified in many areas. Fringing mangrove and saltmarsh habitats have been cleared. There have been significant declines of various seagrasses in Swan Bay, Western Port, Corner Inlet and the Nooramunga. Soft sediment habitats were extensively disturbed in the past by dredging for scallops and oysters. Localised areas are also affected by dredging and spoil disposal for navigation and beach nourishment purposes.

Management Responses

## Bays, Inlets and Estuaries

Victoria's bays, inlets and estuaries support a rich diversity of flora and fauna. The public ownership of most of the area allows for the strategy of maintaining the essentially intact ecological processes in these areas. The Victorian Coastal Strategy (1997) provides the framework for management of this bioregion, and the Environment Conservation Council's investigation will make recommendations on marine park reservation and a range of activities that affect the area.

Like aquatic systems on land, these near-shore areas are affected by the use of land in the catchments that empty into them. Therefore a key management approach is to improve the quality of water that enters the sea from land.

Catchment management is as important for these marine areas as it is for the terrestrial bioregions in which it occurs. There is a strong focus on research into the distribution, conservation status and management requirements of the species and ecological communities that rely on these environments, as they are not as well understood as most terrestrial systems. The recent four year scientific study of Port Phillip Bay is the most comprehensive investigation carried out in this bioregion to date. As such information is gathered, environmental management plans and guidelines for the ecologically sustainable use of the areas and the natural resources they support can be improved.

The early detection and control of introduced plants and animals is a key threat management activity in this bioregion, as it is almost impossible to control infestations in such areas. Efforts to prevent the introduction of exotic organisms through the release of ballast water are also significant in this respect.

The priority management responses for land and water managers and planners are the following:

- Restore the health of our inlets and estuaries through improved catchment management.
- Prevent the establishment and control the presence of noxious marine species.
- Reduce theft and illegal fishing methods through education and enforcement.
- Increase understanding, protection and monitoring of vulnerable habitats, particularly seagrass, mangroves and saltmarsh.
- Promote ecologically sensitive tourism that is based on maintaining the long-term health of the biological assets and minimising disruption to populations (e.g. dolphin watching).
- Increase the understanding and protection of vulnerable and threatened species, and significant sites such as seabird breeding locations.
- Ensure the ecologically sustainable harvesting and management of fisheries resources.
- Encourage the non-extractive use of our living marine resources
- Plan for oil spill contingencies in all bays and inlets
- Improve the environmental quality of the bays and inlets by minimising industrial waste and progressively improving sewage treatment standards.
- Progressively improve dredging and spoil disposal.
- Encourage sustainable and environmentally sensitive aquaculture.

### Open Coasts

#### The Bioregional Seascape

Open coastal waters under Victorian jurisdiction extend 5.5 kilometres from the shore and cover almost 7000 square kilometres. They range from waters of the Southern Ocean in the west, through Bass Strait, to the edge of the Tasman Sea in the far east. Four IMCRA regions have been identified along the open coast: Otway, Central Victoria, Flinders and Twofold Shelf. The habitats in these waters range from the intertidal beaches and rock platforms to those of the sea floor, which off East Gippsland is almost 120 metres deep. It also includes the pelagic habitat formed by the water column. There are numerous offshore islands from Lawrence Rocks in the west to Gabo Island in the east. Sediments in offshore waters change from carbonate sands in the west, through the muds of central Bass Strait to quartz sands in the east. Subtidal rocky areas are scattered throughout but predominate off much of the western coast and south of Wilsons Promontory. Low limestone reefs representing old shorelines occur offshore in various places. Western Victoria is mainly influenced by cool sub-Antarctic water while the east is influenced by the warm Eastern Australian Current that originates in the tropical north. The sea surface temperature is approximately three degrees higher in eastern Victoria than in the west.

#### The Natural Capital of Open Coasts

The Victorian open coast supports a diverse temperate fauna and flora that is largely endemic to southern Australia. Rock platforms and shallow subtidal reefs are dominated by kelps and other algae. Deeper reefs are covered in a diverse range of sessile invertebrates such as sponges, bryozoans, and gorgonians. Amphibolis seagrass beds are common in sand adjacent to shallow rocky reefs. A rich fauna also occurs in unvegetated subtidal sand and mud habitats. The diversity of marine invertebrates in the subtidal sands off East Gippsland is significantly higher than that found in similar habitats elsewhere in the world. Many cool temperate species have their eastern distribution limit within central Victoria, particularly between Bunurong and Wilsons Promontory. A number of New South Wales species persist into eastern Victoria including the Sydney Rock Oyster and the Black Sea Urchin.

The living resources of the Victorian open waters have never been quantified but probably include over 500 species of fish and almost 1000 species of algae. Seals, penguins and Short-tailed Shearwaters breed on offshore islands. Offshore islands and the near-shore waters are also used by a large number of migrant, non-breeding species of birds and mammals. For some species, these islands support the only breeding and roosting colonies in Victoria and therefore are recognised as significant at the national level.

Several whale species visit our shores, and three of these are threatened with extinction. Most endangered of these is the Southern Right Whale, which calves off Warrnambool. As a result of whaling activity, the population of this species fell from tens of thousands to only about 1000, and is now recovering very slowly. This species has been listed under the Flora and Fauna Guarantee Act 1988 and an Action Statement is being prepared. Management of the calving and nursery

grounds and migration routes used by Southern Right

Whales focuses on maximising the reproductive potential of the species.

#### Management Themes

The living resources of our open coast were first utilised by indigenous peoples who collected the abundant shellfish and ate the occasional seal or beached whale. Sealing and whaling were the first two industries established by Europeans within Victoria. These animals were rapidly over-exploited. Commercial fishing was at first limited to inshore areas where barracouta and lobster were taken by boats under sail. Other fisheries gradually became established with improved technology and new discoveries: a shark fishery in the late 1930s, a mixed trawl fishery out of Lakes Entrance in the late 1940s; abalone in the early 1960s and an eastern Bass Strait scallop fishery in the early 1970s. Recent fisheries include wrasse, king crabs, and aquarium fish. Offshore recreational fishing has also expanded with improved technology. Line fishers target various species including snapper and sharks. Divers take abalone, lobster and various reef fish. Intertidal shellfish and bait collecting is also an important recreational pursuit. Aquaculture in Victorian offshore waters is currently limited to abalone ranching.

Although commercial fishing is recognised as a beneficial use of resources, it is recognised that there are some impacts that vary with each fishery. Sea floor habitats can be damaged by scallop dredging and bottom trawling with Danish seines and otter trawls. Long-lived habitat-forming animals such as sponges and bryozoans are particularly vulnerable. Trawl fisheries catch a diverse mix of species including long-lived fish with low levels of fertility which are more vulnerable to over-exploitation. Some sharks, lobster, reef fish and intertidal shellfish are either over-exploited or vulnerable to over-exploitation by commercial or recreational fishers. Other uses along the open coast include recreational diving, surfing, boating and other water sports, ecotourism, shipping, oil and gas exploration and

## Open Coasts

production, waste disposal from outfalls, sea floor cables and pipelines. Current oil and gas production is outside Victorian waters, however the as yet undeveloped Otway basin includes nearshore areas. Potential environmental impacts arise through discharges such as drilling muds and cuttings, formation waters, outfalls and from removal of installations at the end of their effective life. There are seventeen waste outfalls along the Victorian open coast. Sewage treatment varies, not all sewerage treating is to a secondary level.

The seabed is almost totally under public ownership. Potential long-term lessors include the aquaculture and petroleum industry. There are two major oil and gas basins off Victoria's coast, and exploration continues in these areas. Marine reserves include areas off Point Nepean, Bunurong and Wilsons Promontory. Current reserves are not comprehensive, adequate or representative of the Victorian open coast. Only the sanctuary zone within the Bunurong Marine and Coastal Park is totally protected from extractive use.

Natural habitat cover has been modified in several areas. Constant bottom trawling and scallop dredging in eastern Bass Strait may have removed the larger epibenthos species such as sponges, bryozoans and corals. The effect and scale of this habitat loss is unknown.

There is anecdotal evidence that the Giant Southern Kelps have declined in south-eastern Australia over the past 25 years, which is possibly related to above average sea-water temperatures. Few introduced species currently occur along the open coast; none are considered pest species.

The islands, many of which are wildlife reserves, are managed primarily to protect the biodiversity assets, some of which are of national significance, for example those on Lady Julia Percy Island. Some species may breed in tens of thousands while others have much lower numbers. Rabbits and cats have been an historical problem on some islands. Maintaining fox free status and ensuring human disturbance is controlled, both on the islands and adjacent waters, is critical for the maintenance of these breeding colonies and other biological assets.

### Management Responses

Victoria's open coast bioregions are, like the bay and inlet environments described in the previous section, largely intact and under public ownership. Like those partially enclosed waters, open coasts are affected by catchment management practices on adjacent lands, as well as by the marine industries, shipping and recreational activities. Hence the key management approaches for open coast bioregions echo those established for bays and inlets.

The priority management responses for land and water managers and planners are the following:

- Ensure the ecologically sustainable harvest of fisheries.
- Encourage and assist the fishing industry to adopt technologies and develop codes of practice to minimise damage to sea floor habitats and impact on non-target species.
- Increase understanding, protection and monitoring of vulnerable habitats, particularly kelp and epibenthic communities affected by trawling or dredging.
- Establish a comprehensive, adequate and representative system of marine reserves.
- Increase the understanding and protection of vulnerable and threatened species and their habitats, particularly those that communally breed or roost on islands.
- Encourage the non-extractive use of our living marine resources.
- Plan for oil spill contingencies from shipping or fixed installations in open waters.
- Encourage sustainable and environmentally sensitive aquaculture.
- Minimise the environmental impacts of exploration and extraction of earth resources, particularly oil and gas.
- Improve understanding of offshore areas through mapping marine habitats and developing an inventory of the biological resources.



## Appendix 1

# The National Strategy for the Conservation of Australia's Biological Diversity: Objectives

Conservation of biological diversity across Australia.

Identify important biological diversity components and threatening processes.

Manage biological diversity on a regional basis, using natural boundaries to facilitate the integration of conservation and production-oriented management.

Improve the standards of management and protection of Australia's biological diversity by encouraging the implementation of integrated management techniques.

Establish and manage a comprehensive, adequate and representative system of protected areas covering Australia's biological diversity.

Strengthen off-reserve conservation of biological diversity.

Ensure the maintenance of, and where necessary strengthen, existing arrangements to conserve Australia's native wildlife (flora and fauna).

Enable Australia's species and ecological communities threatened with extinction to survive and thrive in their natural habitats and to retain their genetic diversity and potential for evolutionary development, and prevent additional species and ecological communities from becoming threatened.

Recognise and ensure the continuity of the contribution of the ethnobiological knowledge of Australia's indigenous peoples to the conservation of Australia's biological diversity.

To complement in-situ measures, establish and maintain facilities for ex-situ research into and conservation of plants, animals and microorganisms, particularly those identified by action taken in accordance with [the first objective in this section].

Integrating biological diversity conservation and natural resource management.

Develop and implement national integrated policies for the ecologically sustainable use of biological resources.

Achieve the conservation of biological diversity through the adoption of ecologically sustainable agricultural and pastoral management practices.

Achieve the conservation of biological diversity through the adoption of ecologically sustainable fisheries management practices.

Achieve the conservation of biological diversity through the adoption of ecologically sustainable forestry management practices.

Manage water resources in accordance with biological diversity conservation objectives and to satisfy economic, social and community needs.

Achieve the conservation of biological diversity through the adoption of ecologically sustainable management practices for tourism and recreation.

Achieve the conservation of biological diversity through the adoption of ecologically sustainable wildlife (flora and fauna) management practices.

Ensure that the social and economic benefits of the use of genetic material and products derived from Australia's biological diversity accrue to Australia.

Managing threatening processes.

Monitor, regulate and minimise processes and categories of activities that have or are likely to have significant adverse impacts on the conservation of biological diversity and be able to respond appropriately to emergency situations.

Ensure effective measures are in place to retain and manage native vegetation, including controls on clearing.

Control the introduction and spread of alien species and genetically modified organisms and manage the deliberate spread of native species outside their historically natural range.

Minimise and control the impacts of pollution on biological diversity.

Reduce the adverse impacts of fire regimes on biological diversity.

Plan to minimise the potential impacts of human-induced climate change on biological diversity.

Repair and rehabilitate areas to restore their biological diversity.

Ensure that the potential impacts of any projects, programs and policies on biological diversity are assessed and reflected in planning processes, with a view to minimising or avoiding such impacts.

## Appendix 1

Improving our knowledge.

Provide the knowledge and understanding of Australia's biological diversity essential for its effective conservation and management.

Involving the community.

Increase public awareness of and involvement in the conservation of biological diversity.

Expand biological diversity studies in educational curricula.

Australia's international role.

Support and encourage the development of and Australia's participation in international agreements for the conservation of biological diversity.

Seek to ensure that the activities of Australians outside Australia are consistent with the conservation of biological diversity.

Ensure continued and effective international cooperation in the conservation of biological diversity, directly between governments or through relevant international governmental and non-government organisations.

Implementation.

Implement the [National] Strategy through priority actions within established time frames.

Ensure that appropriate arrangements are established to implement the National Strategy for the Conservation of Australia's Biological Diversity and monitor its effectiveness.

Ensure that the National Strategy is complemented by State and Territory and bioregional strategies, supported by effective legislation where necessary.

Ensure that the costs of biological diversity protection are equitably shared, such that they reflect contributions to degradation and benefits from protection or use.

## Appendix 2

### Further Sources of Information

#### Legislation

Catchment and Land Protection Act 1994  
Coastal Management Act 1995  
Conservation, Forests and Lands Act 1987  
Crown Lands (Reserves) Act 1978  
Environmental Protection Act 1970  
Fisheries Act 1995  
Flora and Fauna Guarantee Act 1988  
Forests (Timber Harvesting) Act 1958  
Heritage Act 1995  
Heritage Rivers Act 1992  
National Parks Act 1975  
Planning and Environment (Planning Schemes) Act 1996  
Water Act 1989  
Wildlife Act 1975

#### Strategies, Management Plans and Reports

Commonwealth of Australia (1996). The National Strategy for the Conservation of Australia's Biological Diversity. DEST. Available at <http://www.erin.gov.au/net/biostrat.html>  
Commonwealth of Australia (1997). Nationally Agreed Criteria for the Establishment of a Comprehensive, Adequate and Representative Reserve System for Forests in Australia. A report by the Joint ANZECC/MCFFA National Forest Policy statement Implementation Sub-committee. Available at <http://www.environment.gov.au/land/forests/documents/janis/contents.html>  
CSIRO (1996). Port Phillip Bay Environmental Study: Final Report. CSIRO: Canberra.  
Government of Victoria (1997). Victoria's Biodiversity – Our Living Wealth. NRE  
Government of Victoria (1997). Victoria's Biodiversity – Sustaining Our Living Wealth. NRE  
Government of Victoria (1997). Victorian Coastal Strategy. NRE  
Interim Scientific Guidelines for Establishing the National Reserve System (1997). Version 5.0. Environment Australia. Available at <http://www.biodiversity.environment.gov.au/protecte/nrs/document/scigui.htm>  
Interim Marine and Coastal Regionalisation of Australia (IMCRA). Currently in draft form. Further details are available at <http://www.biodiversity.environment.gov.au/protecte/nrs/marine.htm>  
NRE. Forest Management Plans - East Gippsland, Otways, Midlands, Central Highlands  
NRE. Flora and Fauna Guarantee Action Statements  
No. 1-74. Available at <http://www.nre.vic.gov.au/plntanml/native/actstats/actstats.htm>  
Parks Victoria. Park Management Plans.  
Contact NRE Information Centre (03) 9637 8080  
Regional Catchment Strategies. There are nine strategies.  
Key elements are available at <http://www.vic.gov.au/catchmnt/partner/index.htm>  
Regional Forest Agreement - East Gippsland.  
Available at <http://www.erin.gov.au/land/forests/rfa.html>  
Thackway, R. and Cresswell, I.D. (Eds) 1995. An Interim Biogeographic Regionalisation for Australia: A framework for setting priorities in the National Reserves System Cooperative Program. Australian Nature Conservation Agency: Canberra.

#### Websites

Australian Conservation Foundation  
<http://www.peg.apc.org/~acfenv>

## Appendix 2

Banksia Environmental Foundation  
<http://www.banksia-foundation.com.au>  
Birds Australia  
<http://yarra.vicnet.net.au/~birdsau/>  
Bird Observers Club of Australia  
<http://www.anbg.gov.au/esu/boca.html>  
Birds on farms  
<http://www.vicnet.net.au/~raou/projects/bof.html#top>  
Creswick Landcare Centre  
<http://users.netconnect.com.au/~gpark>  
Department of Natural Resources and Environment (NRE)  
<http://www.nre.vic.gov.au>  
Department of Primary Industries and Energy Network (PIENet)  
<http://www.dpie.gov.au/dpie/home.html>  
Earthwatch  
<http://www.creativeaccess.com.au/earth/index.html>  
Environmental Resources Information Network  
<http://kaos.erin.gov.au:80/erin.html>  
Flora and Fauna Guarantee Action Statements  
<http://www.nre.vic.gov.au/plntanml/native/actstats/actstats.htm>  
Greening Australia Limited  
<http://www.greeningaustralia.com.au>  
Indigenous Flora and Fauna Association  
<http://www.vicnet.net.au/~iffa/welcome.htm>  
International Standard ISO 14000  
<http://www.dircon.co.uk/quality/iso14000.htm>  
NRE Information Centre  
<http://www.nre.vic.gov.au/sales/infocntr/infocntr.htm>  
Parks Victoria  
<http://www.parks.vic.gov.au>  
Regional Forest Agreements  
<http://www.erin.gov.au/land/forests/rfa/rfa.html>  
Society for Growing Australian Plants  
<http://www.ozemail.com.au/~sgap/index.html>  
Waterwatch Victoria  
<http://www.vic.waterwatch.org.au>  
Wetlands Ramsar Bureau  
<http://w3.iprolink.ch/iucnlib/themes/ramsar/index.html>  
Whale Information Network  
<http://chopper.macmedia.com.au/whales/whales3.html>  
Wilderness Society  
<http://www.peg.apc.org/~twsnat/>

## Appendix 3

### Local Government Authorities and Associated Victorian Bioregions

#### Port Phillip Area

<i>Shire</i>	<i>VP</i>	<i>CVU</i>	<i>HS</i>	<i>HN</i>	<i>OP</i>	<i>GP</i>
Banyule			✓			✓
Bass Coast			✓			✓
Bayside						✓
Boroondara						✓
Brimbank	✓					
Casey			✓			✓
Darebin	✓					✓
Frankston						✓
French Island						✓
Glen Eira						✓
Greater Dandenong						✓
Greater Geelong	✓	✓			✓	
Hobson Bay	✓					✓
Hume	✓	✓				
Kingston						✓
Knox			✓			✓
Manningham			✓			✓
Maribyrnong						✓
Maroondah			✓			✓
Melbourne						✓
Melton		✓				
Monash						✓
Moonee Valley	✓					✓
Moreland	✓					✓
Mornington Peninsula						✓
Nillumbik			✓	✓		
Port Phillip						✓
Queenscliffe					✓	
Stonnington						✓
Whitehorse			✓			✓
Whittlesea	✓		✓	✓		
Wyndham	✓				✓	
Yarra	✓					✓

## Appendix 3

### Eastern Half of Victoria

<i>Shire</i>	<i>VP</i>	<i>GO</i>	<i>CVU</i>	<i>NIS</i>	<i>VR</i>	<i>VA</i>	<i>HS</i>	<i>HN</i>	<i>GP</i>	<i>WPR</i>	<i>EGU</i>	<i>EGL</i>
Alpine				✓		✓	✓	✓				
Baw Baw						✓	✓		✓			
Cardinia							✓		✓			
Delatite			✓	✓	✓	✓	✓	✓				
East Gippsland						✓	✓	✓	✓		✓	✓
Greater Shepparton		✓		✓	✓							
Indigo				✓	✓			✓				
La Trobe							✓		✓			
Mitchell	✓	✓	✓		✓		✓					
Moirā				✓	✓							
Murrindindi			✓			✓	✓	✓				
South Gippsland							✓		✓	✓		
Strathbogie		✓	✓	✓	✓			✓				
Towong				✓		✓		✓				
Milawa			✓	✓	✓	✓		✓				
Wellington						✓	✓		✓		✓	✓
Wodonga				✓	✓			✓				
Yallourn Works Area							✓		✓			
Yarra Ranges						✓	✓	✓				

### Legend for Victorian Bioregions

LM	-	Lowan Mallee	VA	-	Victorian Alps
MM	-	Murray Mallee	HS	-	Highlands - Southern Fall
WI	-	Wimmera	HN	-	Highlands - Northern Fall
VP	-	Victorian Volcanic Plain	OR	-	Otway Ranges
GLP	-	Glenelg Plain	WP	-	Warrnambool Plain
DT	-	Dundas Tablelands	OP	-	Otway Plain
GG	-	Greater Grampians	GP	-	Gippsland Plain
GO	-	Goldfields	WPR	-	Wilsons Promontory
CVU	-	Central Victorian Uplands	EGU	-	East Gippsland Uplands
NIS	-	Northern Inland Slopes	EGL	-	East Gippsland Lowlands
VR	-	Victorian Riverina			

## Appendix 3

### Western Half of Victoria

<i>Shire</i>	<i>LM</i>	<i>MM</i>	<i>WI</i>	<i>VP</i>	<i>GLP</i>	<i>DT</i>	<i>GG</i>	<i>GO</i>	<i>CVU</i>	<i>NIS</i>	<i>VR</i>	<i>OR</i>	<i>WP</i>	<i>OP</i>
Ararat							✓	✓	✓					
Ballarat				✓					✓					
Buloke		✓						✓			✓			
Campaspe								✓		✓	✓			
Central Goldfields								✓						
Colac Otway				✓								✓	✓	✓
Corangamite				✓								✓	✓	✓
Gannawarra		✓									✓			
Glenelg				✓	✓	✓							✓	
Golden Plains				✓					✓					
Greater Bendigo											✓			
Hepburn									✓					
Hindmarsh	✓	✓												
Horsham	✓		✓			✓	✓							
Loddon		✓						✓		✓	✓			
Macedon Ranges				✓					✓					
Mildura	✓	✓												
Moorabool				✓					✓					
Mount Alexander											✓			
Moyne				✓									✓	
Northern Grampians		✓	✓			✓	✓	✓						
Pyrenees				✓					✓					
Southern Grampians				✓		✓	✓	✓						
Surf Coast												✓		✓
Swan Hill		✓									✓			
Warrnambool				✓									✓	
West Wimmera	✓		✓		✓	✓								
Yarriambiack	✓	✓												

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Inside front and back covers: Dragonfly *Hemianax papuensis*: David Meagher.



## Further Information

### Further Information

Additional copies of 'Victoria's Biodiversity – Directions in Management' and the complementary documents 'Victoria's Biodiversity – Our Living Wealth' and 'Victoria's Biodiversity – Sustaining Our Living Wealth' may be obtained from:

NRE Information Centre  
8 Nicholson Street  
East Melbourne, 3002  
(03) 9637 8080

Information Victoria  
356 Collins Street  
Melbourne, 3000  
(03) 9603 9938

Regional offices  
of the Department of Natural Resources and Environment

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