# Biodiversity Assessment

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## *Foreword*

This report provides details of the biodiversity assessment component of the Gippsland Comprehensive Regional Assessment (CRA). A summary version of this document has been published as part of a Gippsland CRA report, obtainable from the address given above.

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# 1 INTRODUCTION

## 1.1 Background

The National Forest Policy Statement (NFPS) establishes the concept of the Comprehensive Regional Assessment (CRA) process, and lists the protection of biological diversity under *The Convention on Biological Diversity* as one of the Commonwealth obligations to be included in the assessment. Strategies for conserving biodiversity, as outlined under the NFPS, are:

- establishment of a dedicated forest reserve system on public land based on the principles of comprehensiveness, adequacy and representativeness;
- complementary management of public native forests outside conservation reserves which assists biodiversity conservation; and
- promotion of the management of private forests in sympathy with nature conservation goals (Commonwealth of Australia 1992).

The NFPS identifies the following objectives of biodiversity conservation:

- to maintain ecological processes and the dynamics of forest ecosystems in their landscape context;
- to maintain viable examples of forest ecosystems throughout their natural ranges;
- to maintain viable populations of native forest species throughout their natural ranges; and
- to maintain the genetic diversity of native forest species.

To achieve these objectives, a set of national criteria has been developed to guide the establishment of a Comprehensive, Adequate and Representative (CAR) forest reserve system (JANIS 1997). The criteria relating specifically to biodiversity are outlined in Box 1.

**Box 1 Summary of the JANIS biodiversity criteria**

1. As a general criterion, 15% 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.
2. Where forest ecosystems are recognised as vulnerable, (eg. approaching a reduction in areal extent of 70% within a bioregional context or subject to continuing and significant threatening processes), then at least 60% of their remaining extent should be reserved. (Vulnerable ecosystems include those where threatening processes have caused significant changes in species composition, loss or significant decline in species that play a major role within the ecosystem, or significant alteration to ecosystem processes.)
3. All remaining occurrences of rare and endangered forest ecosystems should be reserved or protected by other means as far as is practicable.
4. 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.
5. 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.

6. Reserves should be large enough to sustain the viability, quality and integrity of populations.
7. 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.
8. In fragmented landscapes, remnants that contribute to sampling the full range of biodiversity are vital parts of a forest reserve system. The areas should be identified and protected as part of the development of integrated regional conservation strategies.

The Scoping Agreement for the Victoria–Commonwealth Regional Forest Agreement requires that elements of biodiversity at the species and ecosystem levels be identified and threatening processes be reviewed.

The results of this assessment are to be used in identifying a comprehensive, adequate and representative (CAR) reserve system that protects forest biodiversity in accordance with nationally agreed criteria. The strategy for conserving biodiversity relies not just on a CAR reserve system, but also on the application of ecologically sustainable forest

management practices in off-reserve areas. The assessment provides a benchmark for monitoring the efficacy of these practices.

## 1.2 Elements of biodiversity

Biological diversity is usually considered at three levels:

- 'Genetic diversity' refers to the variety of genetic information contained in all individual plants, animals and micro-organisms. It occurs within and between populations of species as well as between species.
- 'Species diversity' refers to the variety of living species.
- 'Ecosystem diversity' refers to the variety of habitats, biotic communities and ecological processes, as well as the diversity present between and within ecosystems.

### *1.2.1 Genetic diversity*

Empirical data on genetic variation within and between species is sparse and generally restricted to a small number of species, primarily vertebrates and vascular plants. The time and cost of analyses to incorporate a full consideration of genetic variation is beyond the scope of the CRA process.

The national criteria state that "The reserve system should seek to maximise the area of high quality habitat for all known elements of biodiversity "(criterion 5). The agreed approach to address the genetic component of this diversity in the assessment has been to analyse the spatial and environmental spread in the representation of vegetation classes and species populations within the Region. Threatened species or groups of species that require targeted assessments to ensure their survival *in situ* will have a particular dependence on the maintenance of genetic variation.

As knowledge of intra-specific variation and techniques for assessing it improve, it will be necessary to review the strategies for ensuring preservation of genetic variation.

### *1.2.2 Species diversity*

Under the National Forest Policy Statement (Commonwealth of Australia 1992a), Australian governments agreed to manage for the conservation of all species of Australia's indigenous forest fauna and flora throughout those species' ranges and to maintain the native forest cover where a reduction in this cover would compromise regional conservation objectives, consistent with ecologically sustainable management. The national forest reserve criteria, jointly agreed by the Commonwealth and the States, identify objectives in relation to species conservation (see Box 1 above, point 5).

In particular, assessment of species-level biodiversity in Gippsland forests for the CRA required a review of the conservation status of threatened taxa, their susceptibility to decline and extinction and an evaluation of the effects of disturbance on each of these taxa. Existing or proposed management actions are also addressed.

### *1.2.3 Ecosystem diversity*

Ecosystem diversity encompasses the broad differences between and within ecosystem types in relation to the diversity of habitats and ecological processes. It is more difficult to define than species or genetic diversity because the 'boundaries' of communities (associations of species) and ecosystems are often indistinct. The ecosystem concept is dynamic and thus variable, and it can also be applied at different scales.

Forest ecosystems are defined in the nationally agreed criteria for a CAR reserve system for forests and in Victoria it has been agreed that Ecological Vegetation Classes (EVCs) are equivalent to forest ecosystems for the purposes of the CRA assessments. This assumes a correlation between the occurrence of entities defined by certain structural, floristic and environmental features and the occurrence of particular suites of fauna.

## 1.3 Conservation of biodiversity

### *1.3.1 National and State obligations and actions*

The Commonwealth and Victorian governments have a number of legislative and international responsibilities in connection with the conservation of biodiversity. Of particular relevance are the Convention on Biological Diversity, the Commonwealth *Endangered Species Protection Act* 1992 and Victorian *Flora and Fauna Guarantee Act* 1988.

#### *The Convention on Biological Diversity*

Conservation of biodiversity is a foundation of ecologically sustainable development and one of the three principal objectives of the National Strategy for Ecologically Sustainable Development (Commonwealth of Australia 1992b).

The Convention on Biological Diversity, ratified by Australia on 18 June 1993, deals at a global level with the full range of the conservation of biological diversity, its sustainable use, and the fair and equitable sharing of the benefits arising from this use. The National Strategy for the Conservation of Australia's Biological Diversity, signed by the Commonwealth and all State and Territory governments, provides the framework for giving effect to Australia's international obligations (Commonwealth of Australia 1996). Under the Strategy, governments in Australia have

undertaken to identify the terrestrial, marine and other aquatic components of biodiversity that are important for biodiversity conservation and ecologically sustainable use.

### *Commonwealth Endangered Species Protection Act*

Under the *Endangered Species Protection Act* 1992, the Commonwealth is responsible for identifying endangered species and their habitats for the purpose of analysis of threats and potential for recovery and for developing measures to ensure their future viability.

The primary purpose of the Act is to promote the recovery of species and ecological communities that are endangered or vulnerable and to prevent other species and communities from becoming endangered or vulnerable. The Act aims to reduce conflict in land management, to provide for public involvement and better understanding, and to encourage cooperative management for the conservation of endangered species and communities.

Provision is made under the Act for a scientifically based listing process that identifies nationally endangered and vulnerable species, endangered ecological communities and key threatening processes of national importance. Those species, communities and threatening processes are listed in Schedules to the Act.

The Act promotes the use of 'Recovery Plans', to help in the recovery of endangered species and ecological communities, and 'threat-abatement plans', for reducing the impact of threatening processes.

Note: The objects of the *Environment Protection and Biodiversity Conservation Act 1999* are met through the Regional Forest Agreement process for each region. Accordingly, the Act does not apply to forestry operations in RFA regions except where such operations are in a property included in the World Heritage list or in a wetland designated under the Ramsar Convention or are incidental to a purpose other than forestry.

### *Victorian Flora and Fauna Guarantee Act*

The *Flora and Fauna Guarantee Act* 1988 provides a framework for the legal protection of Victoria's flora and flora, and for a major program of State Government and community action. The aim is to ensure that Victoria's native flora and fauna survive, flourish and retain their potential for evolutionary development.

The Act provides for native species or biological communities, which have been identified as being threatened, to be listed in one of its schedules.

It also allows for the listing of threatening processes which may affect the long term survival and evolutionary development of flora and fauna.

When a listing occurs, an Action Statement must be prepared as soon as possible detailing what measures are needed for the management of the listed species, biological community or potentially threatening process. Action Statements take into account social and economic considerations.

Interim Conservation Orders (ICOs) can also be made in cases where the threat to the critical habitat of a listed species or biological community is considered so urgent that immediate action is required.

#### Victoria's Biodiversity Strategy

In December 1997 Victoria published its Biodiversity Strategy which sets a strategic framework to enable the Victorian community to better understand, value and protect its biodiversity assets. The Strategy embraces broad-based responsibility for action within an adaptive management framework, and outlines priorities for action, monitoring and reporting at a bioregional scale. In addition, the Strategy fulfils a legislative requirement under the *Flora and Fauna Guarantee Act* 1988 to produce a Flora and Fauna Guarantee Strategy.

### *Victorian National Parks Act*

The *National Parks Act* 1975 provides for the establishment, protection, management and use of National, State, and Wilderness Parks, as well as other parks and reserves. Under the Act, the Director is required to ensure that each National, State and Wilderness Park is controlled and managed in a manner that will preserve and protect the natural condition of the park and its indigenous flora and fauna. The Act requires a management plan to be prepared for each park.

### *Forest Management*

Forest management plans are prepared in accord with the relevant legislation such as the *Flora and Fauna Guarantee Act* 1998 to address the full range of values and uses in State forest. These management plans provide protection of environmental, cultural and resource values at the regional level and for the long term.

In accordance with the Code of Forest Practices for Timber Production (Code), forest management plans and associated local prescriptions consider:

- representative conservation and minimum levels of protection of all forest ecosystems;
- special protection for communities of limited distribution;
- strategies for conserving rare and threatened plant and animal species;

- protection and provision for recruitment of old trees;
- protection of old-growth forest; and
- strategies for maintaining a mosaic of corridors, regrowth stages and zones which incorporate high flora and fauna value so as to enhance conservation values and biodiversity.

A forest management plan for the Gippsland Region is currently in preparation.

The purpose of the Code is to ensure that commercial timber growing and timber harvesting activities are carried out in such a way that promotes an internationally competitive forest industry, is compatible with the conservation of the wide range of environmental values, and ecological sustainable forest management. The Code provides Statewide goals, guidelines and minimum standards to be applied to timber production operations.

Other relevant legislation includes the *Forests Act* 1958, *Crown Land (Reserves) Act* 1978 and the *Heritage Rivers Act* 1992.

A list and description of key Commonwealth and State legislation relating to RFAs in Victoria is provided in Appendix 1 of the Gippsland CRA Report (VicRFASC 1999) and in the statewide assessment of Ecologically Sustainable Forest Management (VicRFASC 1997).

## 1.4 Biodiversity assessment methods

### *1.4.1 Methodological approaches: an overview*

The Comprehensive Regional Assessment (CRA) provides information about individual flora and fauna species and their habitats, forest ecosystems and communities, and threatening processes. It reviews existing information and the results of additional studies of priority taxa and communities.

The review of existing information has two main elements: an audit of biological records data so as to identify any major gaps in biodiversity information; and a review of information on species and forest ecosystems, the effects of threatening processes and existing or proposed management actions which address these. Chapter 3 discusses the approach to the data audit that was undertaken.

A major, systematic program of fauna survey has been undertaken during the preparation of this CRA. This survey was considered necessary because of the lack of fauna survey data, which was revealed in an initial data audit. A data audit following this survey is also included in the CRA for comparison.

Analysis of data involves the following:

- information identifying survey intensity for flora and selected fauna groups in relation to different environmental strata across the Region;
- generation of maps of the current distribution of Ecological Vegetation Classes (EVCs) in the Gippsland and analysis of their reservation status in relation to modelled pre-1750 distributions and current tenures; and
- analysis of species and ecosystem responses to disturbance.

The CRA has focused primarily on the ecosystem and species levels of biodiversity because information about genetic variation within species is limited. Ecosystem biodiversity has been dealt with for flora only, because there is, at present, no well-developed understanding of faunal ecosystems. Floristic ecosystems are dealt with in detail in the EVC mapping component of the CRA (see Chapter 3).

The biodiversity information presented here is intended to reflect the best understanding of the available information, including information obtained through data audit, expert scientific opinion, and analysis of available data. It also points to deficiencies in existing information.

The data presented will be used in the development of the Gippsland RFA, including configuration of the CAR forest reserve system, and in the formulation of management recommendations.

### *1.4.2 Limits to reliability of information*

The utility of all scientific information is constrained by the reliability inherent in the method of its collection. The limitations imposed by incompleteness and/or a lack of replication of biological data sets are largely unavoidable, but their impact can be minimised if deficiencies are acknowledged and well circumscribed. The Chapter on data audit deals with a number of these issues. The following are other important factors relating to the reliability of assessment of biodiversity in the Gippsland CRA. Many are generally applicable to forested regions of Australia as a whole:

For species assessments,

- A lack of data of the biology, population and life history characteristics of taxa can lead to uncertainty in identifying the status of specific threatening processes and identifying remedial action.

- The dearth of knowledge about the distribution and characteristics of invertebrate and non-vascular plant species, many of which remain undescribed, means that assessments are necessarily weighted towards the less cryptic elements of flora and fauna (ie. vascular flora and vertebrate fauna).

For Ecological Vegetation Class (EVC) mapping,

- The digital coverages were produced at a scale of 1:100 000. The minimum polygon size defined is approximately 0.25 hectares.
- Vegetation associations tend to merge along a continuum, so that a line on the vegetation map often represents an ecotone rather than a discrete boundary. Discrete boundaries do, however, occur in some situations; for example, the boundary between closed forest and sedgelands.
- Most of the vegetation boundaries can be clearly derived from aerial photo interpretation based on canopy height and cover. Dominant floristics are attributed to each polygon on the basis of the site data present, expert knowledge, aerial photo-interpretation of forest types, and extensive field validation.
- The pre-1750 vegetation reconstruction was conducted using the best available environmental modelling, remnant site data, reference to historical information, and expert knowledge. This component of the assessment was, however, impossible to validate in the field in most places.

# 2 AUDIT OF EXISTING BIOLOGICAL DATA

## 2.1 Introduction

Biodiversity assessment relies on having adequate information about the distribution of species. It is important to know whether or not surveys undertaken for species or groups of species have been adequately distributed across the range of environments represented within the region. As part of this assessment, analyses were undertaken to determine where surveys for flora and fauna had been carried out in the Gippsland region, which species were targeted, and whether survey sites are reasonably distributed to detect most species in most geographic or environmental components. The results of these analyses will highlight gaps in information and identify those areas that still require further survey work. Some gaps were identified early in the assessment and revealed the need for further fauna survey work. This work has been carried out during the preparation of the CRA. It covered 169 sites with the exception of diurnal birds, which were surveyed at 242 sites, and it has resulted in a more complete distribution of vertebrate fauna information for the Gippsland region. The survey, which is reported on in Chapter 5, also collected an amount of invertebrate fauna information.

Site selection for the fauna survey was developed through a process of using statewide environmental stratification to ensure an even spread of sites across the region. Sites were also stratified across three sub-regions (Tambo catchment, Central South Gippsland, and Central Gippsland), and throughout the altitudinal range within these sub-regions. A separate regional stratification has been developed to verify the site selection for fauna survey and assess the adequacy of flora survey. The data review process involves systematically working through databases to determine the adequacy of existing site-based biological data for identifying priority areas and data gaps to be filled through additional survey work. The data review relies on expert knowledge and professional judgment but is supplemented by explicit analyses where appropriate.

The first step in the data review process is to select only those survey data that meet required standards of accuracy, precision and reliability. This allows a degree of confidence when analysing the distribution of species.

The next step is to stratify the region. This enables an assessment of the environmental and geographic representation by sites from accredited data sets. A regional environmental stratification should be based on variables that either directly or indirectly influence the spatial distribution of species. These include solar radiation, temperature, terrain wetness, nutrient status, ground water, rainfall, elevation, slope, aspect and geology. The strata developed may represent either classes of single variables, such as temperature or rainfall, or may consist of environmental units developed from the integration of variables using objective or intuitive multivariate classification analyses.

The distribution of flora and fauna survey sites among strata can initially be analysed in terms of the size of each stratum and its geographic distribution. The density of survey sites in each stratum is calculated and strata with no sites or low site densities are identified as possibly requiring future field work. Ideally, the density of survey sites in each stratum should be a function of the stratum's total species richness and spatial heterogeneity. These parameters can be examined by using species data from existing sites to derive species accumulation curves and associated statistics for each stratum. Species accumulation curves are frequently used to assess sampling adequacy in a given area by graphically illustrating the rate of addition of new species to a sampling unit with repeated sampling events. Curves that show an asymptote indicate the full complement of species in the area being investigated has been sampled, assuming an unbiased distribution of adequately sampled sites.

Because most, if not all, strata will be made up of numerous geographically discrete areas (substrata), it is necessary to also examine the distribution of sites between substrata within strata. Sites should be replicated across the geographic extent of each stratum. Where this is not the case, a geographically representative sample of substrata may be identified for further survey work (Cocks & Baird 1991). In the case of very large substrata, the distribution of existing flora and fauna survey sites should be examined for spatial biases resulting from the design and objectives of the original surveys and logistical constraints (for example, sampling along roads).

### *2.1.1 Methods*

A data audit methodology tool kit was developed by the Environment Forest Group within Environment Australia to assist assessment of the quality of data to be used in regional biodiversity assessments. The tool kit has been developed as an ARC/INFO geographic information system application with a menu interface that incorporates ARC/INFO advanced macro language scripts menus and functions, in addition to system scripts and other programs. The methodology helps users to:

- ascertain the resolution and reliability of species site-survey records,
- identify spatial, environmental and temporal biases in the survey data, and
- ascertain sampling adequacy for species groups within a region.

The tool kit is designed to perform the following tasks:

- develop a regional environmental stratification;
- create ARC/INFO point coverages from site text files and add species attributes;
- intersect sites with a regional environmental stratification and calculate statistics;

- generate cumulative species curves and predicted species richness statistics;
- create a histogram showing the proportion of total land area and the proportion of total sites of each stratum;
- produce maps of the regional environmental stratification and survey intensity; and view and print graphs and maps.

### *Process of developing the stratification*

Environmental variables suitable for developing stratifications for CRA data audits in Victoria were identified in a joint State-Commonwealth Workshop involving both flora and fauna specialists. These variables include 35 climatic attributes and one substrate attribute (lithology). The stratification process works best when a small number of environmental attributes, which most accurately reflect the environmental gradients across the region, are combined to produce environmental strata. As more variables are combined to develop the stratification, the process becomes more complex and the output becomes more difficult to interpret. It is therefore important to select variables that provide the best surrogates for the range of factors influencing species distribution. The stratification of the Gippsland region was based on three climatic variables, which best reflect the range, seasonality and extremes of climate of the region. A fourth variable, lithology, provides an acceptable surrogate for variations in fertility, drainage and landform which are key factors influencing vegetation distribution. The sources and derivation of these data are outlined below.

#### Climate

Methods have been developed to estimate climate at any point in a landscape, given the availability of topographic and meteorological data. 'Climate surfaces' fitted to a Digital Elevation Model provide spatially reliable estimates of mean monthly climate attributes derived from long-term meteorological station records for any given longitude, latitude and elevation (Hutchinson and Bischof, 1983; Hutchinson *et al*., 1984; Hutchinson, 1989, 1991a, 1991b). Currently, the estimated standard errors are $0.5^{o}$ Celsius for monthly mean temperature and less than 10% for mean monthly precipitation (Hutchinson, 1984; Hutchinson *et al*., 1992).

Key climatic attributes which describe the range, seasonality and extremes of climate (temperature, precipitation and radiation) of Victoria have been calculated for each cell in the nine second elevation grid using the software package ANUCLIM (McMahon *et al*., 1995). Of the climatic variables available for the Gippsland region, mean annual precipitation (with a range of 464 to 2353 mm), mean maximum temperature of the warmest month (17 to $28^{o}$C) and mean minimum temperature of the coldest month (- 5.1 to + 7.1C) were selected for use in the stratification of the region. These variables were used to develop the stratification in the Central Highlands and North East RFA regions and were considered the most appropriate group of environmental variables for the Gippsland stratification. Each of these climatic variables was then divided into intervals that most accurately reflect the bioclimatic variation within the Gippsland region (Table 2.1).

**Table 2.1 Climatic attributes and classes used in the Gippsland environmental stratification**

| Variable | Classes |
|---|---|
| **mean annual precipitation**<br>Gippsland range =464 to 2353 mm | Low =464 - 700mm<br>Moderate =701 - 1000mm<br>High = 1001 - 2353mm |
| **mean minimum temperature of coldest month**<br>Gippsland range = minus 5.1 to 7.1°C | Low = minus 5.1- 0°C<br>Moderate = 0.1 - 2.0°C<br>High = 2.0 - 7.1°C |
| **mean maximum temperature of warmest month**<br>Gippsland range = 17 to 28°C | Low = 17 - 20°C<br>Moderate = 20 .1- 23°C<br>High = 23.1 - 26°C<br>Very High = 26.1 - 28°C |

#### Lithology (rock type)

Lithology influences soil fertility, drainage and landform, which in turn influence vegetation distribution. Lithology (rock type) has been mapped for Victoria at 1:250,000 scale and was considered to be the most suitable surrogate for these variables in the stratification process. Of the 26 lithological types described in the Land Systems coverage of Victoria at a 1:250,000 scale, 14 are represented in Gippsland. From these 14 types, 9 generalised classes of lithology were derived by aggregating lithology classes with similar characteristics (Table 2.2). These classes were used to derive an environmental stratification.

**Table 2.2 Aggregations of lithology types used in the Gippsland environmental stratification**

| Class | Lithology types |
|---|---|
| 1 | • undescribed |
| 2 | • coarsely textured unconsolidated deposits: low fertility |
| 3 | • coarsely textured unconsolidated deposits/finely textured unconsolidated deposits: low fertility |
| 4 | • finely textured unconsolidated deposits: highest fertility |
| 5 | • finely textured unconsolidated deposits/coarsely textured unconsolidated deposits: moderate fertility |
| 6 | • granites and gneisses moderate to low fertility |

| | |
|---|---|
| 7 | • limestone<br>• limestone/ coarsely textured unconsolidated deposits |
| 8 | • sedimentary rock - low fertility (except where rainfall is high)<br>• sedimentary/ granites and gneisses - low fertility<br>• sedimentary/ volcanic rock - low/moderate fertility<br>• sedimentary/ limestone rock -<br>• volcanic/ sedimentary rock - high fertility |
| 9 | • volcanic rock - low fertility |

### *Deriving the regional stratification*

The environmental stratification was based on the three climatic attributes and lithology as described above, and estimated for each 250 x 250 metre grid cell. A total of 324 individual units or strata are possible when the three classes of annual precipitation, three classes of minimum temperature of the coldest month, four classes of maximum temperature of the warmest month and nine classes of lithology are combined. Clipping strata classes with an overlay of a forest/non-forest classified coverage (TREE 100 tree cover of Victoria) reduced the number of forested strata that occurred in Gippsland to 104 ranging in size from 279,557 to 6 ha. Thirty-seven strata were less than 500 ha, and for the purpose of this analysis, these strata (comprising only 0.3 % of the forest cover) were not evaluated. The spatial arrangement of strata across the Region is shown in Map 1. This environmental stratification was subsequently used for the analyses of flora and fauna databases presented here.

Of the 104 strata represented in the area under forest cover (1,579,461 ha) the 33 largest strata (>10,000 ha) occupied 90% of the forested land area. Fifty-eight strata were smaller than 5,000 hectares. These small strata (63,582 ha) represented only 4% of the forested land and were generally scattered throughout the fragmented landscape of the private land/public land interface.

## 2.2 Flora survey data review

### *2.2.1 Methods*

For flora, the site-based biological data sets used in this assessment were drawn from the Flora Information System of Victoria. The flora core data fields extracted were: reference (quadrat) number; date; latitude longitude; and species code. The latitude/longitude is accurate to 100 metres. Flora survey intensity was evaluated both for the total area of the Gippsland Region (including non- forested areas) and separately for the area under forest cover.

4112 sites (quadrats) have been sampled for vascular plants in Gippsland. Of these sites, 3196 are on forested land and 916 are non forest sites. The sites sampled have been collected in a consistent manner as part of a range of studies including: region-wide studies; intensive sampling of experimental areas (eg. and other studies based on targeted sampling of particular habitats, such as alpine areas). The quadrat sampling has been largely undertaken by NRE for the purpose of classifying and describing the variation in native vegetation.

Summary information for each stratum, along with figures relating to the flora site density analysis discussed below, is presented in Appendix A. The flora survey intensity is shown in Map 4 and is discussed below in relation to the environmental strata of the region (Map 1).

Of the 104 strata generated from the stratification, the 37 strata that occupied less than 500 hectares have not been evaluated in the following discussion. The remaining 67 strata were classified on the basis of flora survey intensity (none, low, moderate, high - see Map 4). The geographic locations referred to in the discussion below relate primarily to the Geographic Representation Units (GRUs) identified in the region.

### *2.2.2 Results and discussion*

#### *Strata under forest cover with high flora survey site density (> 40 sites per 10,000 hectares)*

Fifteen strata in Gippsland fell into this category. These strata occupy 185,193 hectares or 12% of the total forested land area. Five of these strata, 86, 18, 78, 81, and 95, are large. Strata 86, 78, 95 and 81 are located mostly in the Mullungdung Coastal, Strzelecki Foothills, Latrobe Valley, Wilsons Promontory, and Taylor Foothills geographic units. Stratum 18 is a fragmented stratum with the majority of its area in the Wellington Mountains, Upper Murray Mountains, Cobungra Mountains and Dargo Mountains GRUs.

#### *Strata under forest cover with moderate flora survey site density (10-40 sites per 10,000 hectares)*

Strata with moderate site densities comprise 699,061 hectares or 44% of the total forested land area. Sixteen of the 29 strata in this group, 13, 62, 17, 16, 8, 9, 60, 68, 87, 41, 76, 19, 2, 7, 57 and 84, are large and comprise 623,791 hectares. Stratum 13, 123,946 hectares, is the second largest stratum in the region. This stratum spans a number of geographic units with the majority located in mountainous GRUs including the Upper Murray, Cobungra, Dargo and Macalister Mountains geographic units.

### *Strata under forest cover with low flora survey site density (>0-10 sites per 10,000 hectares)*

Strata with low site densities comprise 684,671 hectares or 43% of the forested area of the region. Of the 19 strata in this category, 12 are large including stratum 56 (the largest stratum in the region). This stratum covers 279,557 hectares of mainly foothill GRUs including the Taylor, Avon and Aberfeldy Foothills geographic units.

### *Strata without flora survey sites*

Four strata greater than 500 hectares do not contain flora survey sites. These strata, 85, 64, 24 and 52, comprise 5,311 hectares or 0.34% of the total forested land area. These strata are generally small and scattered, and are located in the Dargo, Upper Murray and Wellington Mountains GRUs in the more remote parts of the region, or in the fragmented landscape of the private land/public land interface of the Latrobe Valley, Mullungdung Coastal and Wellington Coastal Plains GRUs.

### *Cumulative species curves*

The results of the cumulative species curve analysis were expressed as a probability that the next species encountered for a stratum would not have already been encountered. A high probability therefore generally reflected relatively low sampling densities, while a low probability generally reflected relatively high sampling densities.

Although the results of the cumulative species curve analysis tended to mirror those of the site density analysis, the probability also strongly reflected the absolute number of samples collected. Thus a relatively small (in area) stratum with high sampling density but only a small number of samples would be likely to have a higher probability that the next species would be new than a large stratum with the same sampling density but many more samples. Unevenness in sampling of extensive and/or floristically diverse strata is also likely to produce higher probabilities.

| Probability that next species is new (%) | Percentage of Area included (%) | Number of strata included |
|---|---|---|
| Sample too small to calculate | 3 | 14 |
| < 10 | 59% | 14 |
| 10 – 20 | 25% | 19 |

The results obtained in the cumulative species curve analysis suggest more adequate survey effort than the survey intensity analysis with 59% of the forested area of the region (14 strata) having probabilities of <10% that the next species is new. If this threshold is raised to 20%, then 84% of the region (33 strata) is included.

### *Summary*

Approximately equal proportions of the forested land in the Gippsland region have either a low (43%) or moderate (44%) survey intensity. Twelve per cent of the forested land of the region has been surveyed with a high survey intensity. When a cumulative species curve analysis is carried out, 84% of the region has a probability of $\leq$ 20% that the next species recorded will be new.

## 2.3 Fauna survey data review

### *2.3.1 Methods*

In Victoria, much of the existing site data for fauna has come from individual records from a range of sources supplemented by information from systematic surveys. A lack of species records in certain strata does not necessarily mean that the strata have not been sampled; but that the information might not have been appropriate for use in this analysis. All biological records over an area as large and diverse as Gippsland are to some extent artefacts of differential collecting effort and subject to the sampling bias arising from the relative ease with which the occurrence of certain groups (such as birds) can be scored. A lack of systematic survey for specific faunal groups weakens the power of the audit tool to expose under-sampled environmental strata for those groups, but it is not without value.

To ensure an adequate database of systematic survey records for terrestrial fauna, a general survey covering 169 sites was undertaken in the Gippsland region. The records from this survey were entered onto the Atlas of Victorian Wildlife to supplement the existing data sets.

The site-based biological data sets used in the fauna assessment were drawn from the Atlas of Victorian Wildlife and the Victorian Freshwater and Estuarine Fish Database.

The fauna core data fields extracted were: reference number, date, latitude, longitude, survey method, survey effort and species code.

The Atlas of Victorian Wildlife covers birds, mammals, reptiles, amphibians, threatened invertebrates and threatened fish. Of these, the following groups were excluded from the study: marine birds, waders (except Latham's Snipe), marine mammals and marine reptiles. Records with less geographic precision (ie. greater than two minutes of latitude or longitude), were also excluded. Invertebrate fauna were also not included in the review.

The data audit only includes data from formal surveys, incidental records were excluded from the analysis. The fauna data audit only includes strata under forest cover (the flora data analysis was undertaken across the entire region including non-forested areas).

In preparation for further analysis, the data were collated into discrete data sets to cover the following species groups:

- Arboreal mammals
- Large mammals
- Small ground mammals
- Bats
- Diurnal birds
- Nocturnal birds
- Large forest owls
- Reptiles
- Amphibians

As was done for flora information, the distribution and density of survey site records were used to evaluate the adequacy of sampling of the environmental variation in the region. Strata and large polygons with low densities of sites were identified. The probability of the next species recorded for a particular stratum being new (ie. not previously recorded in surveys for that fauna group in that stratum) was used as an indication of the adequacy of sampling effort. The analysis was mostly confined to the 33 most extensive strata (>10,000 ha.), totalling 90 % of the forested area.

### *2.3.2 Results and discussion*

The results of the survey site analysis for each fauna functional group are shown in Table 2.3. Maps 5-13 and in Appendix B. Incidental records were not included in the analysis but are shown on the maps referred to above.

#### *Arboreal Mammal Surveys*

A total of 1003 sites in 58 strata have been surveyed for arboreal mammals. With the exception of stratum 95, a 10,103 ha stratum located wholly in the Wilsons Promontory GRU, all the most extensive strata (> 10,000 ha) have been surveyed. Of these 32 large strata, 13 have a low (≤ 5%) probability of a new species being detected. Survey intensity is low (1-5 sites per 10,000 ha) for 56% (18 strata) of the largest strata and moderate ( 5-10 sites per 10,000 ha) for 38% (12 strata) of these strata. Strata 2 and 60 have a high survey intensity (10-20 sites per 10, 000 ha) and a 5% and 0% probability respectively of detecting new species with further survey. Eight strata (87, 76, 19, 7, 35, 88, 84, 39) had too few samples for accurate calculation of a probability statistic. These poorly surveyed strata are widely distributed across the region and include coastal plains GRUs in the south (eg. Mullungdung Coastal, Wellington and King Coastal Plains), foothill GRUs (Avon and Taylor Foothills) and mountainous GRUs in the east (Haunted Mountains and Nunniong Mountains) and north-east (Upper Murray and Cobungra Mountains GRUs) of the region.

#### *Large Mammal Surveys*

A total of 1510 sites in 58 strata have been surveyed for large mammals in Gippsland. Of the 33 most extensive strata, 32 have been surveyed and include 89% of all Gippsland survey sites. The unsurveyed large stratum is 95. Most large strata had either a moderate (5-10 sites per 10,000 ha, 17 strata) or high (10-20 sites per 10,000 ha, 8 strata) survey intensity. The most intensely surveyed large stratum is 2, a 13,974 ha stratum located mostly in the Nunniong Mountains, Cobungra Mountains and Upper Murray Mountains geographic units. This stratum has 31 sites per 10,000 ha and a 20% probability of the next species detected being new. Four large strata (56, 13, 62, 78) had low (≤ 5%) probabilities of new species being detected with further survey, while five strata (19, 35, 88, 84, 39) had too few sites to calculate probabilities. Eight strata (68, 37, 41, 40, 55, 53, 42, 7) had 100% probabilities of detecting new species with further survey.

#### *Small Ground Mammal Surveys*

Small ground mammals have been surveyed at 952 sites in 52 strata in Gippsland. Twenty-nine of the 33 largest strata have been surveyed and include 87% of all survey sites. The four unsurveyed large strata, 60, 42, 40, and 39, total 81,303 ha and include 5% of the forested land of the region. Survey intensity is low (1-5 sites per 10, 000 ha) for 13 of the largest strata, and moderate (5-10 sites per 10,000 ha) for 6 of the largest strata. Ten of the largest strata have a low probability (≤ 5%) of the next species detected being new. Strata 87 and 76 have a very high survey intensity with 42 and 27 sites per 10,000 ha respectively. Both strata have a 0% probability of detecting a new species by further survey. Together these strata are located in the Mullungdung Coastal, Wellington Coastal Plains, King Coastal Plains, Avon Foothills and Taylor Foothills GRUs. Strata 14, 41, 55 and 35 have been poorly surveyed with insufficient survey sites to calculate probability statistics. These poorly surveyed strata constitute 88,168 ha or 6% of the total forested land in the region and, with the exception of strata 55 and 41 which are partly located in the foothill GRUs (Aberfeldy and Avon), are all located in mountainous GRUs.

**Table 2.3 Terrestrial vertebrate fauna survey data, by species group**

| Faunal group | Arb-oreal Mamm | Large Mamm. | Small Ground Mamm. | Bats | Diurnal Birds | Noc-turnal Birds | Large Forest Owls | Rep-tiles | Amph-Ibians |
|---|---|---|---|---|---|---|---|---|---|
| Number of the 104 strata with survey sites | 58 | 58 | 52 | 46 | 46 | 53 | 54 | 41 | 42 |
| Number of the 33 largest strata with survey sites | 32 | 32 | 29 | 27 | 27 | 31 | 31 | 26 | 26 |
| Number of the largest strata with low probability (≤5%) of new species in next survey | 13 | 4 | 10 | 10 | 8 | 11 | 9 | 3 | 2 |

### *Bat Surveys*

A total of 487 sites have been surveyed for bats. Of the 33 large strata, 27 have survey sites. These 27 strata include 85% of the forested land of the Gippsland region. The six large unsurveyed strata, 55, 19, 42, 7, 39 and 95, comprise 81,789 ha or 5% of the forested land in Gippsland. Fifteen of the largest strata have a low survey intensity (1-5 sites per 10, 000 ha), and six strata have a moderate survey intensity (5-10 sites per 10,000 ha). Stratum 84, a highly fragmented stratum located mostly in the Mullungdung Coastal and Wellington Coastal Plains GRUs, has a very high surveyed intensity with 32 sites per 10,000 ha and a 1% probability of further survey detecting new species. Ten of the large strata surveyed have low probabilities (≤ 5%) that the next species detected is new.

### *Diurnal Birds*

A total of 686 sites in forty-six strata have been surveyed for diurnal birds in the Gippsland region. Of the 33 largest strata, 27 have been surveyed and include 85% of all survey sites. The majority of these strata (63%) have a low survey intensity (1-5 sites per 10, 000 ha). Eight of the large surveyed strata have a low probability (≤ 5%) of the next species detected being new. The six unsurveyed large strata: 14, 76, 19, 42, 84 and 95, comprise 91,242 ha, 6% of the forested land of the region. With the exception of stratum 76 with 43% of its area in the Avon Foothills and Taylor Foothills GRUs, these strata are located in either coastal GRUs, Wilsons Promontory, Mullungdung Coastal and King and Wellington Coastal Plains GRUs, in the south of the region, or mountainous GRUs, Cobungra, Nunniong Upper Murray, and Haunted Mountains GRUs, in the north-east of the region.

### *Nocturnal Birds*

Nocturnal birds have been surveyed at 610 sites in 53 strata in Gippsland. The majority of survey sites (89%) are located in large strata. Thirty-one of the 33 largest strata have been surveyed although the majority of these (77%, 24 strata) have a low survey intensity (1-5 sites per 10, 000 ha). The two unsurveyed large strata, 19 and 95 totalling 24,293 ha, are located mostly in the Wilsons Promontory (stratum 95) and Cobungra Mountains and Upper Murray Mountains GRUs (stratum 19). Of the large strata, 11 have low probabilities (≤ 5%) of detecting a new species with further survey. Strata 87 and 40 have very low survey intensities (0-1 sites per 10,000 ha). The majority of stratum 87 is located in the Mullungdung Coastal and Wellington Coastal Plains GRUs. Stratum 40 is a highly fragmented stratum, the majority of its area falls in the Haunted Mountains and Dargo Mountains GRUs. Small fragments of this stratum are also located in the Nunniong Mountains. Eight large strata had too few survey sites to calculate probabilities.

### **Large Forest Owls**

A total of 969 sites in 54 strata have been surveyed for large forest owls. Thirty-one of the 33 largest strata have been surveyed for this faunal group and include 87% of all owl survey sites. The unsurveyed large strata, 84 and 95, total 20, 890 ha. The majority of surveyed large strata have either a low (1-5 sites per 10, 000 ha, 14 strata) or moderate (5-10 sites per 10,000 ha) survey intensity. Nine strata have low probabilities (≤ 5%) that the next species recorded is new. Thirteen of the largest strata have a 100% chance of the next species detected being new. Five large strata (87, 76, 7, 35, 88) had too few survey sites to calculate probabilities.

### *Reptiles*

A total of 469 sites in 41 strata have been surveyed for reptiles. Twenty-six of the 33 large strata have been surveyed, but only three of these (56, 27, 2) have been surveyed sufficiently to reduce the probability of detecting a new species to 5% or less. These three strata include the largest stratum (56) and total 384,404 ha, 24% of the forested area of the region. Most of the area of stratum 56 falls in the Taylor, Avon and Aberfeldy Foothills GRUs. The majority of surveyed large strata have a low survey intensity (1-5 sites per 10,000 ha, 17 strata). Strata 8, 9, 76 and 57 have very low survey intensities (<1 site per 10,000 ha). Strata 57 and 76 are fragmented strata located mostly on the edge of cleared land of the foothills and coastal plains, while fragments of stratum 9, also a highly fragmented stratum, are located in many of the mountainous GRUs. Stratum 8 is mostly located in the Upper Murray Mountains GRU. These four strata, together with the unsurveyed large strata, cover 221,794 ha, 14% of the forested area of the region. Twelve large strata, 14, 19, 35, 39, 41, 42, 53, 60, 68, 81, 87, 95, have ≥ 93% probabilities of further survey detecting new species.

### *Amphibians*

Amphibians have been surveyed at 489 sites in 42 strata in Gippsland. Amphibian survey sites are present in 26 of the 33 largest strata. For most of these large strata, survey intensity is low (1-5 sites per 10,000 ha, 18 strata). Three strata (8, 9, 57) have a very low survey intensity (<1 site per 10,000 ha). Strata 56 and 20 are the only two of the largest strata with a low probability (≤ 5%) of the next species recorded being new. Eight of the surveyed large strata have a ≥ 95% probability of further survey detecting new species, and 10 strata had too few sites to calculate a probability statistic. The unsurveyed large strata (14, 53, 19, 42, 35, 39, 95) cover 116,904 ha of the region and are widely distributed across the region, occurring in most of the mountainous GRUs as well as the Wilsons Promontory GRU (stratum 95) and Aberfeldy Foothills (21% of stratum 53).

### *2.3.3 Summary*

Of the largest strata generated by the stratification of the Gippsland region, the majority have been surveyed for each of the fauna groups considered although, for most groups, survey intensity is generally low. Strata 95 (eight of the nine faunal groups remain unsurveyed) and 42 (five of the nine faunal groups remain unsurveyed) are the most poorly surveyed large strata. Arboreal mammals and nocturnal birds are the groups most comprehensively surveyed across the region, based on them having the most large strata with low probabilities of new species being detected. Small ground mammals, bats and diurnal birds have been moderately well surveyed with approximately 30% of the large strata surveyed having a low probability of detecting new species. For the majority of the largest strata, future surveys for reptiles, amphibians and large mammals are most likely to detect species not previously recorded in formal surveys.

# 3 FOREST ECOSYSTEM ASSESSMENT

## 3.1 Introduction

The forest ecosystem assessment provides an analysis of information to determine whether viable examples of forest ecosystems are maintained throughout their natural ranges, and whether ecological processes and the dynamics of forest ecosystems are provided for in their landscape context. The assessment contributes to an evaluation against the national reserve criteria, particularly criteria (1), (2), (3), (4), (5) and (7), and complementary off-reserve management as part of ecologically sustainable forest management (ESFM).

To meet these objectives the following assessment outputs are required:

- maps of both the current and pre-1750 distributions of forest ecosystems;
- determination of the current reservation status for forest ecosystems;
- a description of forest ecosystems which are endangered, vulnerable or rare; and
- a description of disturbances and management actions relevant to forest ecosystems.

### *3.1.1 Ecological Vegetation Classes*

Ecological vegetation classes (EVCs) are the basic mapping unit used for forest ecosystem assessments, biodiversity planning and conservation management at the regional scale in Victoria. The concept of ecological vegetation classes (EVCs) was introduced and used in the *Old growth study of East Gippsland* (Woodgate *et al.* 1994).

EVCs are derived from underlying large-scale forest type and floristic community mapping. Floristic, structural, and environmental attributes are used to define EVCs. The relationship of each EVC to floristic vegetation communities and floristic sub-communities and forest types (Land Conservation Council studies) is discussed in Woodgate *et al.* 1994.

A description of the methodology used to derive EVCs can be found in Commonwealth and NRE (1996), Appendix G.

Descriptions of EVCs occurring in Gippsland are given in Appendix C. On the adjacent footslopes of the Great Dividing Range and on the plains beyond, only the less fertile habitats have remained substantially intact.

## 3.2 Pre-1750 extent of Ecological Vegetation Classes

EVCs have been mapped on all public land in the Gippsland region at a scale of 1:100 000 (Map 2). For the purposes of this assessment the pre-1750 extent of each EVC on both private and public land has been mapped to allow a comparison of the extant distribution and area of each EVC with that estimated prior to European settlement within the region (Map 3).

EVCs which were not recorded in the public land vegetation mapping of the study area (Appendix C) occur either on lowland, riverine, and coastal plains or rolling hills and in estuaries which have been largely cleared for agriculture, or occur on less fertile areas that have been cleared for urban development on the fringes of the larger towns.

### *3.2.1 Methods*

#### *Mapping*

In cleared or heavily disturbed areas, existing remnant vegetation, and a variety of physical environmental attributes were employed to map the estimated pre-1750 extent of EVCs. This process relied heavily on subjective assessments by experts with extensive field knowledge of the area surveyed and the vegetation mapped. The attributes used to predict presence were specific to each EVC being mapped.

Table 3.1 shows the attributes used for those EVCs that occur on private land in the region, listed in their order of importance for each EVC. Further EVC attributes are presented in Appendix C.

Where indigenous vegetation currently exists in the region it was assumed that the pre-1750 vegetation type and extent is the same as the existing vegetation. The exceptions to this are the floodplain around Lake Wellington which is now Estuarine Wetland but was Swamp Scrub prior to European occupation, and some areas of Plains Grassy Woodland on the Gippsland plain which were previously Plains Grassland.

**Table 3.1 Physical attributes used to model and map the pre-1750 extent of EVCs in Gippsland**

| EVC No. | Ecological Vegetation Class | Attributes |
|---|---|---|
| 1 | Coastal Dune Scrub Mosaic | Exposure, soils, landform, landsystems |
| 2 | Coast Banksia Woodland | Exposure, soils, landform, landsystems |
| 3 | Damp Sands Herb-rich Woodland | Soils, geology, hydrology, geography, topography, elevation |
| 6 | Sand Heathland | Landsystems, soils, elevation |
| 8 | Wet Heathland | Hydrology, soils, landsystems, |
| 10 | Estuarine Wetland | Hydrology, salinity, landform |
| 15 | Limestone Box Forest | Geology, soils, topography, aspect |

| EVC No. | Ecological Vegetation Class | Attributes |
|---|---|---|
| 16 | Lowland Forest | Geology, landsystems, elevation, rainfall |
| 18 | Riparian Forest | Topography, hydrology, soils, rainfall, elevation |
| 19 | Riparian Shrubland | Soils, flood severity, hydrology, topography |
| 20 | Heathy Dry Forest | Geology, aspect, elevation, slope, rainfall |
| 21 | Shrubby Dry Forest | Geology, aspect, elevation, rainfall |
| 22 | Grassy Dry Forest | Geology, aspect, elevation, slope, rainfall |
| 23 | Herb-rich Foothill Forest | Aspect, rainfall, elevation, topography |
| 27 | Blackthorn Scrub | Slope, aspect, geology, rainfall |
| 29 | Damp Forest | Aspect, rainfall, elevation, topography |
| 30 | Wet Forest | Aspect, rainfall, elevation, topography |
| 31 | Cool Temperate Rainforest | Topography, aspect, fire frequency, rainfall, elevation |
| 32 | Warm Temperate Rainforest | Topography, aspect, fire frequency, rainfall, elevation, soils |
| 34 | Dry Rainforest | Landform, aspect, rainfall, elevation |
| 36 | Montane Dry Woodland | Aspect, elevation, geology |
| 37 | Montane Grassy Woodland | Geology, aspect, elevation |
| 38 | Montane Damp Forest | Aspect, elevation, rainfall |
| 39 | Montane Wet Forest | Aspect, elevation, rainfall |
| 40 | Montane Riparian Woodland | Elevation, landform, hydrology1` |
| 43 | Sub-alpine Woodland | Elevation, topography, geology |
| 45 | Shrubby Foothill Forest | Topography, rainfall, elevation |
| 47 | Valley Grassy Forest | Geology, hydrology, landsystems, rainfall |
| 48 | Heathy Woodland | Landsystems, landform, geology, soils, topography |
| 53 | Swamp Scrub | Hydrology, soils, floodplain morphology, landsystems |
| 55 | Plains Grassy Woodland | Landsystems, topography, rainfall |
| 56 | Floodplain Riparian Woodland | Floodplain morphology, topography, inundation regime |
| 61 | Box Ironbark Forest | Landsystems, geology, rainfall, topography |
| 82 | Riverine Escarpment Scrub | Topography, aspect, slope, rainfall |
| 83 | Swampy Riparian Woodland | Topography, hydrology, rainfall |
| 107 | Lake Bed Herbland | Topography, hydrology, inundation regime |
| 125 | Plains Grassy Wetland | Hydrology, landsystems, geology, rainfall |
| 126 | Swampy Riparian Complex | Topography, inundation regime, elevation, gradient, geology |
| 127 | Valley Heathy Forest | Soil, slope, rainfall |
| 128 | Grassy Forest | Topography, geology, rainfall, elevation |
| 132 | Plains Grassland | Soils, landsystems, topography, rainfall, elevation |
| 133 | Limestone Pomaderris Shrubland | Geology, slope, aspect, soils, topography |
| 135 | Gallery Rainforest | Flood severity, stream order, topography, rainfall |
| 136 | Sedge Wetland | Hydrology, soils, landsystems, geology |
| 141 | Sandy Flood Scrub | Soils, landsystems, hydrology, geology |
| 151 | Plains Grassy Forest | Landsystems, soils, geology, rainfall |
| 161 | Coastal Headland Scrub | Landform, exposure, slope, rainfall |
| 163 | Coastal Tussock Grassland | Landform, exposure, topography |
| 164 | Creekline Herb-rich Woodland | Stream order, soils, gradient, topography |
| 169 | Dry Valley Forest | Rainfall, soils, topography, hydrology, elevation, landsystems |
| 175 | Grassy Woodland | Geology, rainfall, topography, slope |
| 177 | Valley Slopes Dry Forest | Slope, topography, aspect |
| 191 | Riparian Scrub | Hydrology, landsystems, soils |
| 195 | Seasonally Inundated Shrubby Woodland | Floodplain morphology, hydrology, elevation, topography |
| 206 | Sub-alpine Grassland | Elevation, soils, topography, geology |
| 207 | Montane Grassy Shrubland | Elevation, soils, topography, geology |
| 210 | Sub-alpine Wet Heathland | Elevation, soils, hydrology, topography |
| 309 | Calcareous Swale Grassland | Landform, soils, geology, topography |
| 316 | Shrubby Damp Forest | Aspect, rainfall, elevation, topography |
| 318 | Montane Swamp | Elevation, hydrology, geology |
| 319 | Montane Herb-rich Woodland | Elevation, aspect, topography, rainfall |
| 334 | Billabong Wetland | Floodplain morphology, inundation regime |
| 681 | Deep Freshwater Marsh | Landsystems, geology |
| 686 | Wet Heathland/Damp Heathland Mosaic | Landsystems, soils, topography |
| 689 | Gippsland Plains Grassy Woodland/Gilgai Wetland Mosaic | Landsystems, topography, geology |
| 691 | Aquatic Herbland/Plains Sedgy Wetland Mosaic | Landsystems, topography, hydrology |
| 700 | Swamp Scrub/Plains Sedgy Wetland Mosaic | Landsystems, hydrology, topography |
| 702 | Montane Grassland | Elevation, soils, topography, geology |
| 795 | Lowland Forest/Damp Sands Herb-rich Woodland Mosaic | Landsystems, geology, soils |
| 863 | Floodplain Reedbed | Floodplain morphology, salinity, inundation regime, soils |
| 877 | Lowland Herb-rich Forest | Soils, topography, geology, rainfall |

### *Mapping Reliability*

The inherent reliability of mapping at 1:100 000 scale using current technology is adequate for the assessment. The certainty and reliability of this mapping is related to the quality and understanding of the underlying data sets used to define the vegetation types, the extent of ground-truthing undertaken and the quality of extant vegetation visited during that ground-truthing. This reliability pertains to both the identity (label) and the boundaries of the vegetation types mapped.

The reliability of pre-1750 mapping was determined using four components: ground truthing, remnants (quality and observation), EVC determination and the linkage of EVCs to, and quality of, available environmental data sets. Table 3.2

lists these components and the characteristics that define them. Pre-1750 mapping reliability ratings were determined for all pre-1750 mapping and will be stored in the Departmental Corporate Geographic Data Library to be accessed by 1:100 000 map sheet.

**Table 3.2 Components used to determine mapping reliability and their characteristics**

| Component | Characteristics |
|---|---|
| Ground truthing | • density of tracks available<br>• proportion of tracks driven during ground-truthing<br>• applies to EVC identity only (not to line work or EVC boundary) |
| Remnants | • number of remnants or sites visited that contain an EVC, this will limit the ability to characterise and determine the EVC<br>• vegetation quality/level of disturbance within those remnants visited, this will limit the ability to characterise and determine the EVC<br>• applies to EVC label only (not to line work or EVC boundary) |
| EVC determination | • quality of the definition and description, this limits the ability to accurately determine and EVC (components include the number of samples taken, quality and type of floristic analyses and floristic vegetation and habitat description and characterisation)<br>• applies to EVC label and to line work or boundary of EVC |
| Environmental data sets - attributes for modelling | • quality, scale and availability of environmental information available (geology, soils and topography mapping, rainfall data, aerial photographs etc)<br>• environmental correlation of an EVC to these perameters, ie. how useful are the perameters as environmental surrogates for the determination of EVC type and boundary<br>• applies to EVC label and to line work or boundary of EVC |

### *3.2.2 Results*

The results of the Pre-1750 EVC analysis are presented in Table 3.3. These data have also been used to ascertain the rarity and threatened status of EVCs within the study area.

The extent of representation of EVCs in conservation reserves and other land tenures is shown in Table 3.3.

Conservation reserves include National Parks, State Parks, Wilderness Parks, Regional Parks (where timber harvesting does not occur), Flora Reserves, Flora and Fauna Reserves, Natural Features Reserves, Heritage Rivers and Essentially Natural Catchments established under the Heritage Rivers Act, and Remote and Natural Areas not available for timber harvesting.

## Table 3.3 Representative conservation (percentage reservation status) of EVCs in the Gippsland region based on pre-1750 vegetation mapping

| EVC No. | EVC Name | Area (ha) | | Percent Remaining | Percent of EVC (pre-1750 extent) in each land category | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | pre-1750 | Current | | Conservation Reserves | State Forest | Other Parks & Reserves | Commonwealth Land | Other Public Land | Private Land | Water Bodies |
| 1 | Coastal Dune Scrub Mosaic | 11200 | 8925 | 79.7 | 59.3 | 0.0 | 0.0 | 0.0 | 2.4 | 17.8 | 0.2 |
| 2 | Coast Banksia Woodland | 3475 | 1382 | 39.8 | 23.1 | 0.0 | 0.0 | 0.0 | 0.3 | 16.4 | 0.0 |
| 3 | Damp Sands Herb-rich Woodland | 40883 | 14306 | 35.0 | 19.3 | 0.0 | 0.0 | 0.0 | 1.1 | 14.5 | 0.1 |
| 5 | Coastal Sand Heathland | 23 | 23 | 100.0 | 73.2 | 0.0 | 0.0 | 26.8 | 0.0 | 0.0 | 0.0 |
| 6 | Sand Heathland | 8289 | 7402 | 89.3 | 82.0 | 0.0 | 0.0 | 0.0 | 3.6 | 3.7 | 0.0 |
| 7 | Clay Heathland | 683 | 685 | 100.3 | 46.7 | 42.0 | 0.0 | 0.0 | 0.0 | 11.6 | 0.0 |
| 8 | Wet Heathland | 14390 | 7408 | 51.5 | 44.7 | 2.0 | 0.0 | 0.0 | 0.4 | 4.4 | 0.0 |
| 9 | Coastal Saltmarsh | 7710 | 7059 | 91.6 | 57.0 | 0.0 | 0.0 | 0.0 | 2.7 | 27.3 | 4.6 |
| 10 | Estuarine Wetland | 8377 | 12266 | 146.4 | 79.3 | 0.0 | 0.0 | 0.0 | 6.5 | 57.5 | 3.2 |
| 11 | Coastal Lagoon Wetland | 59 | 59 | 100.0 | 100.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 12 | Wet Swale Herbland | 171 | 193 | 112.5 | 112.5 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 15 | Limestone Box Forest | 1430 | 746 | 52.1 | 9.2 | 10.4 | 5.9 | 0.0 | 0.7 | 25.3 | 0.7 |
| 16 | Lowland Forest | 258999 | 116680 | 45.1 | 5.4 | 22.4 | 1.8 | 0.0 | 0.6 | 14.9 | 0.0 |
| 17 | Riparian Scrub Complex | 0 | 5 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 18 | Riparian Forest | 9687 | 9014 | 93.0 | 36.0 | 44.8 | 3.3 | 0.0 | 3.2 | 5.3 | 0.4 |
| 19 | Riparian Shrubland | 4375 | 1660 | 37.9 | 8.9 | 8.4 | 0.0 | 0.0 | 5.3 | 2.5 | 12.8 |
| 20 | Heathy Dry Forest | 88161 | 85017 | 96.4 | 44.9 | 43.7 | 2.0 | 0.0 | 0.2 | 5.5 | 0.1 |
| 21 | Shrubby Dry Forest | 272744 | 263826 | 96.7 | 24.3 | 66.6 | 1.6 | 0.0 | 0.0 | 4.2 | 0.0 |
| 22 | Grassy Dry Forest | 39824 | 33368 | 83.8 | 20.2 | 39.1 | 2.9 | 0.0 | 0.3 | 21.2 | 0.0 |
| 23 | Herb-rich Foothill Forest | 130909 | 116606 | 89.1 | 43.1 | 37.9 | 1.6 | 0.0 | 0.3 | 6.1 | 0.0 |
| 27 | Blackthorn Scrub | 7429 | 7378 | 99.3 | 16.5 | 81.0 | 0.0 | 0.0 | 0.0 | 1.8 | 0.0 |
| 28 | Rocky Outcrop Shrubland | 1816 | 1807 | 99.5 | 36.3 | 60.2 | 0.0 | 0.0 | 0.3 | 2.5 | 0.2 |
| 29 | Damp Forest | 183397 | 106062 | 57.8 | 6.5 | 43.9 | 1.4 | 0.0 | 0.2 | 5.8 | 0.0 |
| 30 | Wet Forest | 111093 | 68453 | 61.6 | 7.2 | 20.3 | 0.3 | 0.0 | 0.8 | 32.9 | 0.0 |
| 31 | Cool Temperate Rainforest | 2207 | 893 | 40.5 | 15.3 | 8.1 | 0.0 | 0.0 | 0.0 | 17.0 | 0.0 |
| 32 | Warm Temperate Rainforest | 6078 | 2513 | 41.4 | 21.8 | 15.7 | 0.0 | 0.0 | 0.4 | 3.3 | 0.1 |
| 34 | Dry Rainforest | 31 | 13 | 41.2 | 9.6 | 21.3 | 0.0 | 0.0 | 0.0 | 10.3 | 0.0 |
| 35 | Tableland Damp Forest | 11034 | 11031 | 100.0 | 12.8 | 87.1 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 |
| 36 | Montane Dry Woodland | 139459 | 131619 | 94.4 | 42.2 | 47.6 | 0.8 | 0.0 | 0.2 | 3.6 | 0.0 |
| 37 | Montane Grassy Woodland | 58302 | 29952 | 51.4 | 5.1 | 31.9 | 0.3 | 0.0 | 0.8 | 13.2 | 0.0 |
| 38 | Montane Damp Forest | 105672 | 104135 | 98.5 | 40.0 | 56.9 | 0.7 | 0.0 | 0.4 | 0.6 | 0.0 |
| 39 | Montane Wet Forest | 11694 | 11613 | 99.3 | 37.6 | 61.1 | 0.3 | 0.0 | 0.0 | 0.3 | 0.0 |
| 40 | Montane Riparian Woodland | 7476 | 2759 | 36.9 | 13.2 | 7.0 | 0.0 | 0.0 | 8.0 | 8.7 | 0.0 |
| 41 | Montane Riparian Thicket | 2631 | 2654 | 100.9 | 15.4 | 82.7 | 1.2 | 0.0 | 0.7 | 0.8 | 0.0 |
| 42 | Sub-alpine Shrubland | 111 | 111 | 100.0 | 96.7 | 3.3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 43 | Sub-alpine Woodland | 38468 | 38388 | 99.8 | 72.6 | 24.6 | 0.0 | 0.0 | 2.0 | 0.6 | 0.0 |
| 44 | Treeless Sub-alpine Mosaic | 167 | 167 | 100.0 | 100.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 45 | Shrubby Foothill Forest | 133917 | 36887 | 27.5 | 4.7 | 20.1 | 1.2 | 0.0 | 0.1 | 1.5 | 0.0 |
| 47 | Valley Grassy Forest | 11697 | 3118 | 26.7 | 4.8 | 4.3 | 1.2 | 0.0 | 0.3 | 16.1 | 0.0 |
| 48 | Heathy Woodland | 44049 | 34506 | 78.3 | 38.2 | 17.1 | 0.0 | 0.0 | 6.4 | 16.6 | 0.0 |
| 53 | Swamp Scrub | 82570 | 4180 | 5.1 | 2.0 | 0.8 | 0.0 | 0.0 | 0.1 | 2.2 | 0.0 |
| 55 | Plains Grassy Woodland | 134044 | 3112 | 2.3 | 0.5 | 0.1 | 0.1 | 0.0 | 0.2 | 1.5 | 0.0 |
| 56 | Floodplain Riparian Woodland | 17817 | 1080 | 6.1 | 0.0 | 0.0 | 0.0 | 0.0 | 1.7 | 4.1 | 0.2 |
| 61 | Box Ironbark Forest | 7503 | 2497 | 33.3 | 2.6 | 8.7 | 8.0 | 0.0 | 0.4 | 13.6 | 0.1 |
| 72 | Granitic Hills Woodland | 3979 | 3979 | 100.0 | 100.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 73 | Rocky Outcrop Shrubland/Herbland Mosaic | 9383 | 9394 | 100.1 | 73.5 | 22.4 | 3.6 | 0.0 | 0.0 | 0.6 | 0.0 |
| 74 | Wetland Formation | 580 | 1871 | 322.4 | 164.3 | 21.0 | 0.0 | 0.0 | 3.6 | 73.1 | 60.4 |

| EVC No. | EVC Name | Area (ha) | | Percent Remaining | Percent of EVC (pre-1750 extent) in each land category | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | pre-1750 | Current | | Conservation Reserves | State Forest | Other Parks & Reserves | Commonwealth Land | Other Public Land | Private Land | Water Bodies |
| 82 | Riverine Escarpment Scrub | 9231 | 8637 | 93.6 | 30.2 | 58.1 | 0.0 | 0.0 | 0.1 | 5.1 | 0.1 |
| 83 | Swampy Riparian Woodland | 15630 | 97 | 0.6 | 0.1 | 0.3 | 0.0 | 0.0 | 0.1 | 0.1 | 0.0 |
| 84 | Riparian Forest/Swampy Riparian Woodland/Riparian Shrubland/Riverine Escarpment Scrub/Disturbed Mosaic | 105 | 7 | 6.7 | 0.0 | 2.2 | 0.0 | 0.0 | 0.0 | 3.0 | 1.6 |
| 107 | Lake Bed Herbland | 605 | 712 | 117.7 | 117.7 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 123 | Riparian Forest/Warm Temperate Rainforest Mosaic | 2023 | 0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 125 | Plains Grassy Wetland | 1093 | 0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 126 | Swampy Riparian Complex | 8549 | 667 | 7.8 | 0.0 | 0.1 | 0.0 | 0.0 | 2.1 | 5.6 | 0.0 |
| 127 | Valley Heathy Forest | 1242 | 1130 | 91.0 | 0.0 | 85.5 | 0.0 | 0.0 | 0.0 | 5.5 | 0.0 |
| 128 | Grassy Forest | 1794 | 7 | 0.4 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.4 | 0.0 |
| 132 | Plains Grassland | 37284 | 291 | 0.8 | 0.8 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 133 | Limestone Pomaderris Shrubland | 174 | 74 | 42.3 | 0.1 | 32.1 | 0.0 | 0.0 | 0.0 | 9.9 | 0.3 |
| 135 | Gallery Rainforest | 269 | 46 | 17.2 | 4.4 | 0.0 | 0.0 | 0.0 | 0.0 | 11.0 | 1.8 |
| 136 | Sedge Wetland | 2215 | 965 | 43.6 | 17.0 | 1.5 | 0.0 | 0.0 | 4.3 | 20.9 | 0.0 |
| 140 | Mangrove Shrubland | 2933 | 3074 | 104.8 | 85.6 | 0.0 | 0.0 | 0.0 | 1.6 | 8.1 | 9.6 |
| 141 | Sandy Flood Scrub | 2456 | 394 | 16.1 | 4.1 | 0.0 | 0.0 | 0.0 | 6.6 | 4.9 | 0.4 |
| 143 | Estuarine Wetland/Coastal Saltmarsh Mosaic | 0 | 642 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 144 | Coast Banksia Woodland/ East Gippsland Coastal Warm Temperate Rainforest Mosaic | 13 | 13 | 100.0 | 93.8 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 6.2 |
| 151 | Plains Grassy Forest | 88017 | 19781 | 22.5 | 1.6 | 15.0 | 0.0 | 0.0 | 0.4 | 5.5 | 0.0 |
| 154 | Bird Colony Shrubland | 50 | 50 | 100.0 | 100.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 159 | Clay Heathland/Wet Heathland/Riparian Scrub Mosaic | 55 | 42 | 76.8 | 0.0 | 68.1 | 0.0 | 0.0 | 0.0 | 8.7 | 0.0 |
| 160 | Coastal Dune Scrub | 31 | 31 | 100.0 | 100.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 161 | Coastal Headland Scrub | 1110 | 949 | 85.4 | 67.0 | 0.0 | 0.0 | 1.4 | 0.0 | 17.1 | 0.0 |
| 163 | Coastal Tussock Grassland | 1348 | 1231 | 91.3 | 70.4 | 0.0 | 0.0 | 0.0 | 0.0 | 13.9 | 7.0 |
| 164 | Creekline Herb-rich Woodland | 1009 | 0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 169 | Dry Valley Forest | 24999 | 18851 | 75.4 | 10.2 | 53.0 | 0.0 | 0.0 | 4.5 | 7.6 | 0.1 |
| 175 | Grassy Woodland | 48592 | 13981 | 28.8 | 11.1 | 2.9 | 0.6 | 0.0 | 0.6 | 13.6 | 0.0 |
| 177 | Valley Slopes Dry Forest | 1996 | 1840 | 92.2 | 26.7 | 51.7 | 0.0 | 0.0 | 0.6 | 11.2 | 1.9 |
| 191 | Riparian Scrub | 13549 | 3903 | 28.8 | 18.5 | 4.0 | 0.0 | 0.0 | 1.4 | 4.9 | 0.0 |
| 192 | Montane Rocky Shrubland | 3259 | 3259 | 100.0 | 92.0 | 8.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 195 | Seasonally Inundated Shrubby Woodland | 131 | 0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 201 | Shrubby Wet Forest | 2250 | 2250 | 100.0 | 0.9 | 94.4 | 4.7 | 0.0 | 0.0 | 0.0 | 0.0 |
| 206 | Sub-alpine Grassland | 15827 | 15386 | 97.2 | 88.3 | 5.4 | 0.0 | 0.0 | 1.2 | 2.3 | 0.0 |
| 207 | Montane Grassy Shrubland | 88 | 29 | 32.3 | 0.0 | 0.7 | 3.5 | 0.0 | 0.0 | 28.0 | 0.0 |
| 210 | Sub-alpine Wet Heathland | 2106 | 1224 | 58.1 | 22.2 | 34.5 | 0.0 | 0.0 | 0.0 | 1.4 | 0.0 |
| 233 | Wet Sand Thicket | 65 | 0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 265 | Valley Grassy Forest/Grassy Dry Forest Mosaic | 7 | 2 | 26.7 | 0.0 | 26.4 | 0.0 | 0.0 | 0.0 | 0.3 | 0.0 |
| 307 | Sand Heathland/Wet Heathland Mosaic | 3440 | 3719 | 108.1 | 107.9 | 0.0 | 0.0 | 0.0 | 0.0 | 0.3 | 0.0 |
| 309 | Calcareous Swale Grassland | 552 | 305 | 55.3 | 55.3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 310 | Wet Rocky Outcrop Scrub | 521 | 521 | 100.0 | 100.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 315 | Shrubby Foothill Forest/Damp Forest Complex | 7995 | 7707 | 96.4 | 2.8 | 89.3 | 1.0 | 0.0 | 0.0 | 3.4 | 0.0 |
| 316 | Shrubby Damp Forest | 68783 | 68161 | 99.1 | 16.0 | 81.1 | 0.6 | 0.0 | 0.0 | 1.4 | 0.0 |

| EVC No. | EVC Name | Area (ha) | | Percent Remaining | Percent of EVC (pre-1750 extent) in each land category | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | pre-1750 | Current | | Conservation Reserves | State Forest | Other Parks & Reserves | Commonwealth Land | Other Public Land | Private Land | Water Bodies |
| 317 | Sub-alpine Wet Heathland/Sub-alpine Grassland Mosaic | 3654 | 3413 | 93.4 | 37.5 | 46.7 | 0.1 | 0.0 | 0.0 | 9.1 | 0.0 |
| 318 | Montane Swamp | 702 | 219 | 31.2 | 2.8 | 0.0 | 0.0 | 0.0 | 26.5 | 1.9 | 0.0 |
| 319 | Montane Herb-rich Woodland | 24766 | 22421 | 90.5 | 31.4 | 51.4 | 0.5 | 0.0 | 2.0 | 5.1 | 0.0 |
| 320 | Grassy Dry Forest/Heathy Dry Forest Complex | 529 | 503 | 95.1 | 95.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 322 | Dry Rainforest/Warm Temperate Rainforest/Gallery Rainforest/Riparian Shrubland Mosaic | 185 | 198 | 106.7 | 0.9 | 1.9 | 0.0 | 0.0 | 10.0 | 4.3 | 89.7 |
| 334 | Billabong Wetland | 851 | 12 | 1.4 | 0.0 | 0.0 | 0.0 | 0.0 | 0.2 | 1.2 | 0.0 |
| 342 | Rocky Outcrop Shrubland/Herbland Mosaic/Shrubby Foothill Forest Complex | 3 | 3 | 100.0 | 0.0 | 31.1 | 0.0 | 0.0 | 0.0 | 68.9 | 0.0 |
| 637 | Swampy Scrub/Damp Sands Herb-rich Woodland/ Wet Heathland Mosaic | 4 | 0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 638 | Swamp Scrub/Wet Heathland Mosaic | 1128 | | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 639 | Swamp Scrub/Plains Grassy Forest Mosaic | 4280 | 164 | 3.8 | 0.0 | 3.6 | 0.0 | 0.0 | 0.0 | 0.3 | 0.0 |
| 681 | Deep Freshwater Marsh | 8173 | 3982 | 48.7 | 14.7 | 0.0 | 0.0 | 0.0 | 0.0 | 31.5 | 2.5 |
| 686 | Wet Heathland/Damp Heathland Mosaic | 7085 | 0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 687 | Swamp Scrub/Plains Grassland Mosaic | 22233 | 0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 688 | Swampy Riparian Woodland/Swamp Scrub Mosaic | 4112 | 0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 689 | Gippsland Plains Grassy Woodland/Gilgai Wetland Mosaic | 31018 | 73 | 0.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.2 | 0.0 |
| 690 | Floodplain Riparian Woodland/Billabong Wetland Mosaic | 3057 | 0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 691 | Aquatic Herbland/Plains Sedgy Wetland Mosaic | 1153 | 0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 695 | Dry Valley Forest/Swamp Scrub/Warm Temperate Rainforest Mosaic | 4938 | 18 | 0.4 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.2 | 0.0 |
| 698 | Lowland Forest/Heathy Woodland Mosaic | 9638 | 0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 699 | Valley Grassy Forest/Swamp Scrub Mosaic | 222 | 0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 700 | Swamp Scrub/Plains Sedgy Wetland Mosaic | 26 | 0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 701 | Swamp Scrub/Warm Temperate Rainforest/Billabong Wetland Mosiac | 1814 | 4 | 0.2 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 |
| 702 | Montane Grassland | 2013 | 69 | 3.4 | 1.0 | 0.0 | 0.0 | 0.0 | 1.9 | 0.5 | 0.0 |
| 703 | Montane Grassy Woodland/Montane Grassland Mosaic | 1867 | 71 | 3.8 | 0.1 | 0.1 | 0.0 | 0.0 | 3.6 | 0.0 | 0.0 |
| 795 | *Gippsland Plains* Lowland Forest/Damp Sands Herb-rich Woodland Mosaic | 24958 | 0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 858 | Calcarenite Dune Woodland | 3568 | 3831 | 107.4 | 107.3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 863 | Floodplain Reedbed | 1623 | | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 875 | Blocked Coastal Stream Swamp | 29 | 32 | 110.8 | 110.8 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 876 | Spray-zone Coastal Shrubland | 47 | 47 | 100.0 | 100.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 877 | Lowland Herb-rich Forest | 36051 | 20444 | 56.7 | 3.7 | 29.7 | 0.4 | 0.0 | 0.5 | 22.5 | 0.0 |
| 878 | Damp Sands Herb-rich Woodland/Swamp Scrub Complex | 5103 | 157 | 3.1 | 2.9 | 0.0 | 0.0 | 0.0 | 0.0 | 0.2 | 0.0 |
| 879 | Coastal Dune Grassland | 34 | 34 | 100.0 | 97.6 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 2.4 |
| 985 | Sandy Beach | 1209 | 1345 | 111.3 | 111.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

| EVC No. | EVC Name | Area (ha) | | Percent Remaining | Percent of EVC (pre-1750 extent) in each land category | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | pre-1750 | Current | | Conservation Reserves | State Forest | Other Parks & Reserves | Commonwealth Land | Other Public Land | Private Land | Water Bodies |
| 986 | Rocky Shore | 356 | 359 | 100.8 | 96.9 | 0.0 | 0.0 | 3.9 | 0.0 | 0.0 | 0.0 |
| 993 | Bare Rock/Ground. | 60 | 60 | 101.3 | 101.3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 995 | Ocean | 16747 | | | | | | | | | |
| 997 | Non-vegetated/Non-treed | 332 | 982564 | | | | | | | | |
| 998 | Water Body – Natural or man made | 47321 | 52962 | | | | | | | | |
| 999 | Unknown/Unclassified | 0 | 16 | | | | | | | | |
| | | 2676284 | 2676284 | | | | | | | | |

**Note:** A vegetation *mosaic* consists of discrete floristic entities (EVCs) which were unable to be distinguished in the mapping due to the scale used (i.e. 1:100 000).

A vegetation *complex* occurs where floristic entities are unable to be distinguished in an area but are known to exist discretely elsewhere.

Plantations are based on records of overstorey plantings. Both overstorey and understorey vary between native and non-native species.

## 3.3 Reservation status of Ecological Vegetation Classes

Information on the current reservation status of EVCs for Gippsland is provided in Table 3.3. The reservation level of each EVC can be assessed against the national reserve criteria. For those EVCs that are not endangered, vulnerable or rare, the criteria establish a reservation target of 15 per cent of the pre-1750 extent. If an EVC is vulnerable, then 60 per cent of its remaining extent should be reserved. All remaining occurrences of rare and endangered EVCs should be protected.

Table 3.3 shows the distribution of EVCs across all land tenures in Gippsland. Descriptions of some of the land tenure categories represented in the table are as follows:

**Conservation Reserves:** includes National Parks, State Parks, Wilderness Parks, Reference Areas, Regional Parks (where timber harvesting does not occur), Flora and Fauna Reserves, Flora Reserves, Natural Features Reserves, Heritage Rivers and Natural Catchment Areas established under the Heritage Rivers Act, and Remote and Natural Areas not available for timber harvesting.

**Other Parks and Reserves:** includes Regional Parks, historic and cultural features reserves where timber harvesting may be permitted.

**Other Public Land:** includes Bushland Reserves and land managed by water supply authorities.

**Private Land:** includes freehold land and land leased or licensed for plantation purposes.

There are 103 EVCs currently occurring in the Gippsland region. Of these, one is a vegetation formation and 22 are vegetation mosaics or complexes. Twelve mosaics and five EVCs (Plains Grassy Wetland, Creekline Herb-rich Woodland, Seasonally Inundated Shrubby Woodland, Wet Sand Thicket and Floodplain Reedbed) were not recorded in the public land vegetation mapping of the study area. These occur either on lowland, riverine and coastal plains or rolling hills and in estuaries which have been largely cleared for agriculture, or on less fertile areas that have been cleared for urban development on the fringes of the larger towns.

Fourteen EVCs occur predominantly on private land, with the remaining 89 occurring mainly on public land. For those EVCs that are not endangered, vulnerable or rare, the national reserve criteria reservation target of 15 per cent of the pre-1750 extent has been met for all EVCs except Lowland Forest, Damp Forest, Wet Forest, Tableland Damp Forest, Montane Grassy Woodland, Dry Valley Forest, Shrubby Wet Forest, Shrubby Foothill Forest/Damp Forest Complex, and Lowland Herb-rich Forest.

For many of the EVCs which are endangered, vulnerable or rare as a result of depletion (Table 3.3), the only occurrence outside conservation reserves is on private land or in State forest. This reflects the effects of disturbances discussed in Chapter 6. Table 6.1 lists threatening processes associated with EVCs determined to be endangered, vulnerable or rare.

### *3.3.1 Sub-regional reservation of Ecological Vegetation Classes*

Twenty-one Geographic Representation Units (GRUs) have been identified across Gippsland which reflect the landscape scale variation across the region (See Map 1 of the Comprehensive Regional Assessment Report). These are based on similar land form, geology, vegetation and climate. Table 3.4 lists the GRUs and the attributes that characterise them.

The overall reservation status of each EVC was undertaken by overlaying the reserve system with the EVC coverage using a Geographic Information System (GIS). The results of this analysis are presented in Table 3.5.

**Table 3.4 Geographic Representation Units in the Gippsland region**

| Geographic Representation Unit (GRU) | Description |
|---|---|
| Aberfeldy Foothills | Steeply dissected ranges of Palaeozoic sedimentary and metamorphic rocks in the rainshadow of the Baw Baw massif. Rainfall moderate. |
| Avon Foothills | Dissected foothills of Ordovician sandstones. Rainfall moderate. |
| Bunyip Foothills | Rolling hills and small ranges in moderate to high rainfall zones south of the Great Dividing Range (only a small portion occurs in this Region) |
| Cobungra Mountains | Palaeozoic granitic mountain ranges of the Great Divide, includes southern slopes of Mount Hotham. Rainfall moderate to high. |
| Dargo Mountains | Foothills and dissected ranges of Ordovician sandstones and older Volcanics around Dargo. Rainfall moderate. |
| Fish Creek Coastal | Gently undulating erosional and depositional plains of Cainozoic marine sedimentary and continental deposits. Rainfall moderate. |
| Haunted Mountains | Dissected foothills and ranges of Ordovician sediments and metamorphics. Rainfall low to moderate. |
| King Coastal Plains | Flat Quaternary Alluvial Plain below 100m. Includes Lakes Victoria and King. Rainfall low. |
| Latrobe Foothills | Foothills country of varied geology (sediments, outwash, alluviums and basalts) south of the Great Divide on the margins of the Latrobe Valley. Moderate to high rainfall. |
| Latrobe Valley | Broad erosional and alluvial plains, in part overlying extensive Tertiary brown coal deposits. Rainfall moderate. |
| Macalister Mountains | Alpine to montane uplands of Palaeozoic sediments and older volcanics. Rainfall |

| Geographic Representation Unit (GRU) | Description |
|---|---|
| | moderate to high. |
| Matlock Mountains | Steeply dissected ranges south of the Great Dividing Range, consisting of Devonian and Silurian sediments in low to moderate rainfall areas. |
| Mullungdung Coastal | Relatively flat coastal plain underlain by marine Tertiary rocks. Coastline is characterized by Quaternary depositional features and includes the islands east of Corner Inlet. Rainfall low to moderate. |
| Nunniong Mountains | Montane ranges above 400m of predominantly Ordovician sediments and metamorphics. Rainfall moderate. |
| Strzelecki Foothills | Ranges of mainly mesozoic sandstones with widespread older volcanic basalts. Rainfall high to very high. |
| Taylor Foothills | Steeply dissected foothills of Ordovician sandstone north of Bairnsdale. Rainfall low to moderate. |
| Upper Murray Mountains | Alpine to montane ranges of varied geology (Palaeozoic sediments, metamorphics and volcanics) comprising the headwaters of the Murray River. Rainfall moderate to high. |
| Wellington Coastal Plains | Broad alluvial plains at the western edge of the Gippsland Lakes. Includes Lake Wellington and Quaternery depositional barrier features around Loch Sport . Rainfall low. |
| Wellington Mountains | High alpine plains of Mesozoic and Palaeozoic sediments. Rainfall moderate to high. |
| West Gippsland Foothills | Rolling foothills (predominantly cleared) at the western edge of the Strzelecki Ranges, formed of mesozoic sandstones and mudstones. Rainfall moderate. |
| Wilsons Promontory | Granitic massif linked to the mainland by a narrow neck of dunes. Peaks rise to 750m. Rainfall moderate |

**Note:** Rainfall is classified as low (<700mm), moderate (700-1000mm), high (1000-1200m) or very high (>1200mm).

## Table 3.5 Representative conservation ( per cent reservation status) of EVCs in the Gippsland region by Geographic Representation Unit

| | EVC | Pre-1750 Extent | Abernethy Foothills | | Avon Foothills | | Bunyip Foothills | | Cobungra Mountains | | Dargo Mountains | | Fitch Creek Coastal | | Haunted Mountains | | King Coastal Plains | | Latrobe Foothills | | Latrobe Valley | | Macalister Mountains | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Area (ha) | Prot % | Area (ha) | Prot % | Area (ha) | Prot % | Area (ha) | Prot % | Area (ha) | Prot % | Area (ha) | Prot % | Area (ha) | Prot % | Area (ha) | Prot % | Area (ha) | Prot % | Area (ha) | Prot % | Area (ha) | Prot % |
| 1 | Coastal Dune Scrub Mosaic | 11,200 | | | | | | | | | | | 4,727 | 48 | | | 412 | 62 | | | | | | |
| 2 | Coast Banksia Woodland | 3,475 | 4 | | 42 | | | | | | 20 | | 1,220 | 7 | | | 22 | 47 | | | | | | |
| 3 | Damp Sands Herb-rich Woodland | 40,922 | 9 | | | | | | 60 | | | | 5,969 | | | | 3,899 | 49 | | | 140 | | | |
| 5 | Coastal Sand Heathland | 22 | | | | | | | | | | | | | | | | | | | | | | |
| 6 | Sand Heathland | 9,399 | | | | | | | | | | | | | | | 7 | | | | | | | |
| 7 | Clay Heathland | 693 | | | | | | | | | | | | | | | | | | | | | | |
| 8 | Wet Heathland | 14,390 | | | | | | | | | | | 7,477 | 8 | | | | | | | | | | |
| 9 | Coastal Saltmarsh | 7,710 | | | | | | | | | | | 819 | 43 | | | 572 | 69 | | | | | | |
| 10 | Estuarine Wetland | 8,377 | | | | | | | | | | | 1,117 | 45 | | | | | | | | | | |
| 11 | Coastal Lagoon Wetland | 58 | | | | | | | | | | | | | | | | | | | | | | |
| 12 | Wet Swale Herbland | 171 | | | | | | | | | | | | | | | | | | | | | | |
| 15 | Limestone Box Forest | 1,430 | | | | | | | | | 2 | | | | | | 91 | | | | | | | |
| 16 | Lowland Forest | 258,999 | 12,377 | 4 | 16,757 | 9 | 1,480 | | | | 6 | | 42,331 | 3 | 1,698 | | 4,739 | 5 | 14,983 | 2 | 16,686 | 4 | 8 | 57 |
| 18 | Riparian Forest | 9,667 | 1,398 | 28 | 862 | 55 | | | 494 | 68 | 1,181 | 28 | | | 299 | | | | 587 | 10 | 82 | | 1,119 | 77 |
| 19 | Riparian Shrubland | 4,375 | 85 | 25 | 1,809 | 7 | | | 209 | 4 | 81 | 53 | | | 104 | | 148 | 36 | 17 | | 199 | | 179 | 39 |
| 20 | Heathy Dry Forest | 85,161 | 8,893 | 28 | 6,252 | 46 | | | 22,096 | 68 | 1,940 | 22 | | | 5,302 | | | | 90 | 91 | | | 4,861 | 69 |
| 21 | Shrubby Dry Forest | 272,744 | 33,839 | 28 | 62,829 | 28 | | | 8,609 | 27 | 42,797 | 18 | | | 17,809 | | | | 822 | 11 | 289 | | 25,837 | 98 |
| 22 | Grassy Dry Forest | 39,824 | 1,003 | 28 | 6,560 | 54 | | | 1,666 | 1 | 6,321 | 24 | | | 6,933 | | | | 684 | 6 | | | 3,217 | 60 |
| 23 | Herb-rich Foothill Forest | 130,809 | 9,346 | 27 | 1,301 | 75 | | | 17,957 | 58 | 16,290 | 21 | 115 | | 4,651 | | | | | | | | 16,508 | 69 |
| 27 | Blackthorn Scrub | 7,429 | | | 413 | 34 | | | | | 1,569 | 29 | | | 1,512 | | | | | | | | | |
| 28 | Rocky Outcrop Shrubland | 1,815 | 4 | | | | | | 681 | 48 | 99 | 27 | | | 22 | | | | | | | | 104 | 66 |
| 29 | Damp Forest | 183,397 | 20,599 | 5 | 8,026 | 35 | 1,312 | | 2,044 | 66 | 1,795 | 3 | 18,314 | 3 | 17,804 | | | | 7,344 | 2 | 1,735 | 6 | 5,456 | 12 |
| 30 | Wet Forest | 111,093 | 3,958 | 3 | 1,104 | 34 | | | 18 | 100 | 3,149 | 4 | 5,165 | 3 | 5,571 | | | | 233 | | 82 | | 1,768 | 6 |
| 31 | Cool Temperate Rainforest | 2,207 | 29 | | 19 | 3 | | | | | | | 5 | 95 | 16 | | | | | | | | 4 | |
| 32 | Warm Temperate Rainforest | 6,076 | | | 23 | 27 | | | | | | | 784 | | 135 | | 4 | | | | | | | |
| 34 | Dry Rainforest | 31 | | | | | | | | | | | | | 3 | | | | | | | | | |
| 35 | Tableland Damp Forest | 11,034 | 527 | 11 | 1,863 | 55 | | | 33 | 100 | 641 | | | | 3,618 | | | | | | | | 472 | 10 |
| 36 | Montane Dry Woodland | 139,459 | 1,932 | 17 | 2,926 | 83 | | | 25,627 | 38 | 17,783 | 24 | | | 11,628 | 3 | | | | | | | 10,445 | 68 |
| 37 | Montane Grassy Woodland | 58,302 | | | 229 | 85 | | | 33,273 | 5 | 809 | 4 | | | 7,449 | 1 | | | | | | | 15 | 100 |
| 38 | Montane Damp Forest | 105,672 | 2,759 | 5 | 1,445 | 54 | | | 16,238 | 54 | 9,411 | 24 | | | 9,852 | 1 | | | | | | | 5,700 | 57 |
| 39 | Montane Wet Forest | 11,694 | 951 | 2 | 27 | 86 | | | 3,631 | 91 | 7 | | | | 1,849 | | | | | | | | 112 | 2 |
| 40 | Montane Riparian Woodland | 7,475 | | | 1 | 7 | | | 2,594 | 8 | 0 | 100 | | | 936 | | | | | | | | | |
| 41 | Montane Riparian Thicket | 2,631 | 1 | 100 | | | | | 567 | 21 | 35 | | | | 659 | 0 | | | | | | | 32 | 94 |
| 42 | Sub-alpine Shrubland | 111 | | | | | | | | | | | | | | | | | | | | | 24 | 100 |
| 43 | Sub-alpine Woodland | 39,468 | 930 | 6 | 961 | 89 | | | 10,040 | 62 | 4,060 | 48 | | | 247 | 5 | | | | | | | 1,699 | 99 |
| 44 | Treeless Sub-alpine Mosaic | 107 | | | | | | | | | | | | | | | | | | | | | 104 | 100 |
| 45 | Shrubby Foothill Forest | 133,917 | 6,938 | 3 | 3,331 | 39 | | | 334 | 68 | 3,268 | 6 | 37,615 | | 7,003 | | 13 | | 3,117 | 2 | 386 | | 2,210 | 7 |
| 47 | Valley Grassy Forest | 11,697 | 928 | 1 | 667 | 31 | | | 27 | | 1,933 | 1 | | | 1,906 | | 633 | 1 | | | | | 606 | 73 |
| 48 | Heathy Woodland | 44,049 | | | | | | | | | | | 1,420 | 1 | | | 2,396 | 32 | 86 | | 282 | | | |
| 53 | Swamp Scrub | 82,570 | 742 | 18 | 2 | 42 | | | | | | | 22,361 | 1 | | | 5,513 | 37 | 319 | | 3,887 | | | |
| 55 | Plains Grassy Woodland | 134,044 | 1,174 | | 8,276 | | | | | | | | | | | | 27,816 | 2 | 1,589 | | 52,693 | | | |
| 56 | Floodplain Riparian Woodland | 17,817 | 1,096 | | | | | | | | | | | | | | | | 223 | | 10,686 | | | |
| 61 | Box Ironbark Forest | 7,503 | 5,468 | 1 | 88 | 89 | | | | | | | | | | | | | 93 | | 1,889 | | | |
| 72 | Granitic Hills Woodland | 3,979 | | | | | | | | | | | | | | | | | | | | | | |
| 73 | Rocky Outcrop Shrubland-Heathland Mosaic | 9,383 | 245 | 23 | 1,876 | 84 | | | 62 | 68 | 2,774 | 45 | | | 39 | | | | 6 | 100 | | | 2,057 | 88 |
| 74 | Wetland Formation | 680 | | | | | | | | | | | 9 | 100 | | | | | | | | | | |
| 82 | Riverine Escarpment Scrub | 9,231 | 1,975 | 26 | 2,160 | 36 | | | 45 | 92 | 751 | 18 | | | 511 | | | | 293 | 34 | 2 | | 117 | 87 |
| 83 | Swampy Riparian Woodland | 15,630 | | | 16 | | | | | | 61 | | 4,904 | 1 | | | | | 57 | | 3,484 | | | |
| 84 | Riparian Forest/Swampy Riparian Woodland/Riparian Shrubland/Riverine Escarpment | 105 | | | 7 | | | | 67 | | | | | | | | | | | | | | | |
| 107 | Lake Bed Herbland | 605 | | | | | | | 600 | 100 | | | | | | | | | | | | | | |
| 123 | Riparian Forest/Warm Temperate Rainforest Mosaic | 2,023 | | | | | | | | | | | 114 | | | | | | | | | | | |
| 125 | Plains Grassy Wetland | 1,003 | | | 43 | | | | | | | | | | | | 76 | | | | 799 | | | |
| 126 | Swampy Riparian Complex | 8,549 | | | | | 1,182 | 1 | | | | | | | | | | | | | | | | |
| 127 | Valley Heathy Forest | 1,242 | | | 115 | | | | | | | | | | | | | | | | | | 139 | |
| 128 | Grassy Forest | 1,794 | | | | | 311 | | | | | | | | | | | | | | | | | |
| 132 | Plains Grassland | 37,284 | 518 | | 2,172 | | | | | | | | | | | | | | | | 17,189 | | | |
| 133 | Limestone Pomaderris Shrubland | 174 | | | | | | | | | | | | | | | 21 | | | | | | | |
| 135 | Gallery Rainforest | 269 | | | | | | | | | | | | | | | 64 | 35 | | | | | | |
| 136 | Sedge Wetland | 2,215 | | | | | | | | | | | | | | | 417 | 5 | | | 14 | | | |
| 140 | Mangrove Shrubland | 2,933 | | | | | | | | | | | 1,045 | 53 | | | | | | | | | | |
| 141 | Sandy Flood Scrub | 2,456 | | | 135 | | | | | | | | | | | | 374 | | | | | | | |
| 144 | Coast Banksia Woodland/ East Gippsland Coastal Warm Temperate Rainforest Mosaic | 13 | | | | | | | | | | | | | | | 13 | 94 | | | | | | |
| 151 | Plains Grassy Forest | 66,017 | 3,210 | | 2,932 | | | | | | | | | | | | 9,597 | | 1,884 | | 9,080 | | | |
| 154 | Bird Colony Shrubland | 50 | | | | | | | | | | | | | | | | | | | | | | |
| 159 | Clay Heathland/Wet Heathland/Riparian Scrub Mosaic | 55 | | | | | | | | | | | | | | | | | 55 | | | | | |
| 160 | Coastal Dune Scrub | 21 | | | | | | | | | | | | | | | | | | | | | | |
| 161 | Coastal Headland Scrub | 1,110 | | | | | | | | | | | 710 | 45 | | | | | | | | | | |
| 163 | Coastal Tussock Grassland | 1,368 | | | | | | | | | | | 339 | 31 | | | | | | | | | | |
| 164 | Creekline Herb-rich Woodland | 1,009 | | | | | | | | | | | | | | | | | | | | | | |
| 169 | Dry Valley Forest | 24,999 | 2,998 | 18 | 4,562 | 36 | | | 28 | 91 | 1,673 | 8 | | | 2,511 | | 92 | | 45 | 66 | 0 | | 2,079 | 21 |
| 175 | Grassy Woodland | 48,592 | 1,510 | | 2,008 | 31 | | | 1,308 | 75 | 4,894 | 9 | | | 9,833 | | 93 | | | | | | 3,192 | 23 |
| 177 | Valley Slopes Dry Forest | 1,996 | 997 | 28 | 318 | 22 | | | 47 | 11 | 275 | 19 | | | 12 | | | | 93 | 79 | | | 186 | 8 |
| 181 | Riparian Scrub | 13,949 | | | | | | | | | | | 368 | | | | | | 245 | | | | | |
| 182 | Montane Rocky Shrubland | 3,259 | | | 474 | 100 | | | | | 91 | 58 | | | | | | | | | | | 613 | 91 |
| 195 | Seasonally Inundated Shrubby Woodland | 131 | | | | | | | | | | | | | | | | | | | | | | |
| 201 | Shrubby Wet Forest | 2,250 | 1,042 | | 38 | 12 | | | | | 496 | | | | 327 | | | | | | | | 272 | 2 |
| 206 | Sub-alpine Grassland | 15,827 | | | 11 | 100 | | | 1,466 | 68 | 1,394 | 54 | | | 7 | | | | | | | | 125 | 100 |
| 207 | Montane Grassy Shrubland | 66 | | | | | | | 66 | | | | | | | | | | | | | | | |
| 210 | Sub-alpine Wet Heathland | 2,106 | | | 1 | 100 | | | 644 | 28 | 0 | 100 | | | 137 | | | | | | | | | |
| 233 | Wet Sand Thicket | 66 | | | | | | | | | | | | | | | | | | | | | | |
| 265 | Valley Grassy Forest/Grassy Dry Forest Mosaic | 7 | | | | | | | | | | | | | | | | | | | | | | |
| 307 | Sand Heathland/Wet Heathland Mosaic | 3,440 | | | | | | | | | | | 66 | 97 | | | | | | | | | | |
| 309 | Calcareous Swale Grassland | 652 | | | | | | | | | | | | | | | | | | | | | | |
| 310 | Wet Rocky Outcrop Scrub | 521 | | | | | | | | | | | | | | | | | | | | | | |
| 315 | Shrubby Foothill Forest/Damp Forest Complex | 7,995 | 7,364 | 3 | 50 | 33 | | | | | | | | | | | | | 317 | 4 | | | 364 | 16 |
| 316 | Shrubby Damp Forest | 68,753 | 8,164 | 21 | 15,140 | 25 | | | 38 | 100 | 1,729 | 8 | | | 12,378 | | 1 | | | | | | 3,920 | 52 |
| 317 | Sub-alpine Wet Heathland/Sub-alpine Grassland Mosaic | 3,654 | | | | | | | 1,051 | 3 | | | | | | | | | | | | | | |
| 318 | Montane Swamp | 702 | | | | | | | 200 | | | | | | | | | | | | | | | |
| 319 | Montane Herb-rich Woodland | 34,755 | | | | | | | 4,398 | 38 | 213 | 3 | | | | | | | | | | | | |
| 320 | Grassy Dry Forest/Heathy Dry Forest Complex | 529 | | | | | | | | | | | | | | | | | | | | | 130 | 100 |
| 322 | Dry Rainforest/Warm Temperate Rainforest/Gallery Rainforest/Riparian Shrubland Mosaic | 185 | | | | | | | | | | | | | | | | | | | | | | |
| 334 | Billabong Wetland | 851 | 26 | | | | | | | | | | | | | | 183 | 14 | | | 141 | | | |
| 342 | Rocky Outcrop Shrubland/Herbland Mosaic/Shrubby Foothill Forest Complex | 3 | | | | | | | | | | | | | | | | | | | | | | |
| 607 | Swampy Scrub/Damp Sands Herb-rich Woodland/Wet Heath | 4 | | | | | | | | | | | 4 | | | | | | | | | | | |
| 608 | Swamp Scrub/Wet Heathland Mosaic | 1,129 | | | | | | | | | | | 1,129 | 3 | | | | | | | | | | |
| 609 | Swamp Scrub/Plains Grassy Forest Mosaic | 4,200 | | | | | 192 | | | | | | 0 | | | | | | | | | | | |
| 681 | Deep Freshwater Marsh | 9,172 | | | | | | | | | | | | | | | 839 | 72 | | | 1,217 | | | |
| 686 | Wet Heathland/Damp Heathland Mosaic | 7,995 | | | | | | | | | | | 6,006 | 1 | | | | | | | | | | |
| 687 | Swamp Scrub/Plains Grassland Mosaic | 22,233 | | | | | | | | | | | 810 | | | | | | | | | | | |
| 688 | Swampy Riparian Woodland/Swamp Scrub Mosaic | 4,112 | | | | | | | | | | | | | | | | | | | | | | |
| 689 | Gippsland Plains Grassy Woodland/Gilgai Wetland Mosaic | 31,018 | 1,140 | | 1,334 | | | | | | | | | | | | 11,670 | | 648 | | 12,598 | | | |
| 690 | Floodplain Riparian Woodland/Billabong Wetland Mosaic | 3,057 | 86 | | | | | | | | | | | | | | | | | | 2,110 | | | |
| 691 | Aquatic Herbland/Plains Sedgey Wetland Mosaic | 1,153 | | | | | | | | | | | | | | | 134 | | | | 99 | | | |
| 686 | Dry Valley Forest/Swamp Scrub/Warm Temperate Rainforest Mosaic | 4,938 | | | | | | | | | | | | | | | 1,745 | 7 | | | | | | |
| 688 | Lowland Forest/Heathy Woodland Mosaic | 9,638 | | | | | | | | | | | | | | | | | | | | | | |
| 689 | Valley Grassy Forest/Swamp Scrub Mosaic | 222 | | | | | | | | | | | | | | | 222 | | | | | | | |
| 700 | Swamp Scrub/Plains Sedgey Wetland Mosaic | 26 | | | | | | | | | | | | | | | 4 | | | | | | | |
| 701 | Swamp Scrub/Warm Temperate Rainforest/Billabong Wetland Mosaic | 1,814 | | | | | | | | | | | | | | | 666 | 1 | | | | | | |
| 702 | Montane Grassland | 2,013 | | | | | | | 402 | 18 | | | | | | | | | | | | | | |
| 703 | Montane Grassy Woodland/Montane Grassland Mosaic | 1,857 | | | | | | | 1,814 | | | | | | | | | | | | | | | |
| 705 | Lowland Forest/Damp Sands | 24,958 | | | 620 | | | | | | | | | | | | 14,336 | 3 | | | | | | |
| 858 | Casuarina Dune Woodland | 3,558 | | | | | | | | | | | 1 | | | | | | | | | | | |
| 863 | Floodplain Reedbed | 1,625 | | | | | | | | | | | | | | | 865 | 5 | | | 31 | | | |
| 875 | Blocked Coastal Stream Swamp | 29 | | | | | | | | | | | | | | | | | | | | | | |
| 876 | Spray-zone Coastal Shrubland | 47 | | | | | | | | | | | | | | | | | | | | | | |
| 877 | Lowland Herb-rich Forest | 35,051 | 2,401 | 5 | 1,760 | 7 | | | | | | | | | 413 | | 1,890 | | | | 0 | | | |
| 878 | Damp Sands Herb-rich Woodland/Swamp Scrub Complex | 5,103 | | | | | | | | | | | 4,947 | 4 | | | | | | | | | | |
| 879 | Coastal Dune Grassland | 34 | | | | | | | | | | | | | | | | | | | | | | |
| 985 | Sands/ Beach | 1,209 | | | | | | | | | | | 149 | 56 | | | | | | | | | | |
| 986 | Rocky Shore | 356 | | | | | | | | | | | | | | | | | | | | | | |
| 990 | Bare Rock/Ground | 50 | | | | | | | | | | | | | | | | | | | | | | |
| 995 | Ocean | 15,747 | | | | | | | | | | | 1 | | | | | | | | | | | |
| 997 | Non-vegetated/Ice-treed | 332 | 40 | | | | | | | | | | | | | | 20 | 65 | 35 | | | | | |
| 998 | Water Body - Natural or man made | 47,321 | 21 | | | | | | | | | | 12 | 99 | | | 22,417 | 1 | | | 0 | | | |
| | | 2,970,204 | 144,195 | | 172,367 | | 4,440 | | 190,526 | | 139,992 | | 159,467 | | 134,095 | | 111,391 | | 20,580 | | 140,264 | | 96,927 | |

## Table 3.5: continued

| | EVC | Pre-1750 Extent | Wallaci Mountains | | Mullungdung Coastal | | Nunniong Mountains | | Strzelecki Foothills | | Taylor Foothills | | Upper Murray Mountains | | Wellington Coastal Plains | | Wellington Mountains | | West Gippsland Foothills | | Westernport Coastal | | Wilsons Promontory | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Area (ha) | Prot % | Area (ha) | Prot % | Area (ha) | Prot % | Area (ha) | Prot % | Area (ha) | Prot % | Area (ha) | Prot % | Area (ha) | Prot % | Area (ha) | Prot % | Area (ha) | Prot % | Area (ha) | Prot % | Area (ha) | Prot % |
| 1 | Coastal Dune Scrub Mosaic | 11,280 | | | 3,453 | 16 | | | | | | | | | 1,567 | 62 | | | | | | | 2,019 | 100 |
| 2 | Coast Banksia Woodland | 3,475 | | | 622 | 13 | | | | | | | | | 619 | 16 | | | | | | | 657 | 100 |
| 3 | Damp Sands Herb-rich Woodland | 40,883 | | | 25,394 | 13 | | | | | 448 | | | | 4,809 | 31 | | | | | | | 927 | 100 |
| 5 | Coastal Sand Heathland | 33 | | | | | | | | | | | | | | | | | | | | | 23 | 73 |
| 6 | Sand Heathland | 9,289 | | | 346 | 69 | | | | | | | | | 7,175 | 65 | | | | | | | 769 | 100 |
| 7 | Clay Heathland | 683 | | | 646 | 50 | | | | | 37 | | | | | | | | | | | | | |
| 8 | Wet Heathland | 14,380 | | | 857 | 32 | | | | | 36 | | | | | | | | 35 | | | | 5,966 | 100 |
| 9 | Coastal Saltmarsh | 7,710 | | | 4,511 | 98 | | | | | | | | | 1,994 | 97 | | | | | | | 150 | 100 |
| 10 | Estuarine Wetland | 8,307 | | | 3,674 | 34 | | | | | | | | | 1,177 | 81 | | | | | | | 348 | 100 |
| 11 | Coastal Lagoon Wetland | 69 | | | | | | | | | | | | | | | | | | | | | 69 | 100 |
| 12 | Wet Swale Herbland | 171 | | | | | | | | | | | | | | | | | | | | | 171 | 100 |
| 15 | Limestone Box Forest | 1,430 | | | | | 47 | | | | 1,298 | 6 | | | | | | | | | | | | |
| 16 | Lowland Forest | 268,669 | | | 41,475 | 7 | 2,758 | 5 | 16,276 | | 52,801 | 5 | | | 2,120 | 2 | | | 29,831 | | | | 3,672 | 100 |
| 18 | Riparian Forest | 9,687 | 100 | | 644 | 8 | 684 | | 99 | | 658 | 14 | 39 | 100 | | | 888 | 91 | 994 | | | | 44 | 100 |
| 19 | Riparian Shrubland | 4,205 | | | | | 186 | 1 | | | 518 | 69 | 0 | 21 | 1,101 | | 91 | 100 | | | | | | |
| 20 | Healthy Dry Forest | 60,181 | 1,502 | | | | 9,165 | 0 | | | 692 | 0 | 27,054 | 99 | | | 2,362 | 69 | | | | | | |
| 21 | Shrubby Dry Forest | 272,744 | 4,798 | | | | 19,488 | 4 | | | 41,538 | 13 | 428 | | | | 13,453 | 91 | | | | | | |
| 22 | Grassy Dry Forest | 39,834 | 5 | | | | 9,976 | | | | 424 | 3 | 297 | | | | 586 | 100 | | | | | | |
| 23 | Herb-rich Foothill Forest | 130,569 | 5,420 | | | | 8,783 | 4 | 9,895 | 1 | | | 14,880 | 97 | | | 16,372 | 68 | | | | | | |
| 27 | Blackthorn Scrub | 7,439 | | | | | 2,641 | 8 | | | 1,194 | 51 | | | | | | | | | | | | |
| 28 | Rocky Outcrop Shrubland | 1,919 | | | | | 115 | 79 | | | | | 791 | 39 | | | | | | | | | | |
| 29 | Damp Forest | 163,387 | 2,388 | | 1,243 | 9 | 12,047 | 4 | 31,935 | 1 | 8,948 | 2 | 596 | 70 | | | 277 | 17 | 31,895 | | | | 3,671 | 100 |
| 30 | Wet Forest | 111,083 | 1,391 | | 155 | | 4,145 | 10 | 58,791 | 3 | 147 | | 82 | | | | 42 | 100 | 19,293 | 6 | | | 3,948 | 100 |
| 31 | Cool Temperate Rainforest | 2,287 | | | | | 112 | | 1,991 | 23 | | | | | | | | | | | | | 141 | 100 |
| 32 | Warm Temperate Rainforest | 8,038 | | | 20 | | 269 | 5 | 1,313 | 2 | 1,252 | 26 | | | | | | | 999 | | | | 1,108 | 100 |
| 34 | Dry Rainforest | 31 | | | | | 6 | | | | 16 | 69 | | | 6 | 100 | | | | | | | | |
| 35 | Tableland Damp Forest | 11,034 | 20 | | | | 3,640 | 2 | | | | | 130 | 100 | | | 69 | 38 | | | | | | |
| 36 | Montane Dry Woodland | 139,459 | 4,456 | 2 | | | 9,816 | 19 | | | | | 33,721 | 42 | | | 21,125 | 62 | | | | | | |
| 37 | Montane Grassy Woodland | 58,362 | | | | | 364 | 7 | | | | | 13,858 | 2 | | | 2,306 | 52 | | | | | | |
| 38 | Montane Damp Forest | 105,872 | 3,036 | 2 | | | 5,872 | 1 | | | 7 | | 38,204 | 48 | | | 16,148 | 68 | | | | | | |
| 39 | Montane Wet Forest | 11,684 | 126 | | | | 1,827 | | | | | | 3,042 | 12 | | | 121 | 53 | | | | | | |
| 40 | Montane Riparian Woodland | 7,479 | | | | | 21 | 42 | | | | | 3,899 | 17 | | | 269 | 78 | | | | | | |
| 41 | Montane Riparian Thicket | 2,631 | | | | | 80 | | | | | | 853 | 6 | | | 364 | 43 | | | | | | |
| 42 | Sub-alpine Shrubland | 111 | | | | | | | | | | | 14 | 73 | | | 73 | 100 | | | | | | |
| 43 | Sub-alpine Woodland | 38,469 | 636 | 53 | | | 640 | 15 | | | | | 8,410 | 74 | | | 11,266 | 78 | | | | | | |
| 44 | Treeless Sub-alpine Mosaic | 187 | | | | | | | | | | | | | | | 63 | 100 | | | | | | |
| 45 | Shrubby Foothill Forest | 122,917 | 90 | | 369 | | 9,269 | 9 | 39,809 | | 774 | | | | | | 129 | | 31,662 | | | | 3,780 | 100 |
| 47 | Valley Grassy Forest | 11,697 | | | | | 4,937 | | | | 528 | | | | 152 | | | | | | | | | |
| 48 | Healthy Woodland | 44,049 | | | 33,020 | 32 | | | 815 | | 82 | | | | 3,003 | 39 | | | | | | | 3,292 | 100 |
| 53 | Swamp Scrub | 62,570 | | | 12,806 | 2 | | | 5,407 | | 528 | 4 | | | 15,614 | 31 | | | 9,882 | | | | 372 | 100 |
| 55 | Plains Grassy Woodland | 134,044 | | | 1,840 | | | | 3,376 | | 3,088 | | | | 94,261 | 2 | | | | | | | | |
| 56 | Floodplain Riparian Woodland | 17,817 | | | 1,951 | 1 | | | 395 | | | | | | 3,514 | 1 | | | | | | | | |
| 61 | Box Ironbark Forest | 7,583 | | | | | | | | | | | | | | | | | | | | | | |
| 72 | Granitic Hills Woodland | 3,979 | | | | | | | | | | | | | | | | | | | | | 3,979 | 100 |
| 73 | Rocky Outcrop Shrubland/Herbland Mosaic | 9,383 | | | | | 14 | | | | 184 | 96 | 135 | | | | 1,775 | 98 | | | | | 215 | 100 |
| 74 | Wetland Formation | 580 | | | 223 | 78 | | | | | | | | | 272 | 65 | | | | | | | 77 | 100 |
| 82 | Riverine Escarpment Scrub | 9,231 | | | | | 1,780 | 9 | 70 | | 1,484 | 64 | 104 | 82 | | | | | | | | | | |
| 83 | Swampy Riparian Woodland | 15,630 | | | 699 | | 35 | | 3,149 | | | | | | | | 15 | 100 | 3,699 | | | | | |
| 84 | Riparian Forest/Swampy Riparian Woodland/Riparian Shrubland/Riverine Escarpment | 185 | | | | | | | | | | | 1 | | | | | | | | | | | |
| 107 | Lake Bed Herbland | 685 | | | | | | | | | | | 4 | 100 | | | | | | | | | | |
| 123 | Riparian Forest/Warm Temperate Rainforest Mosaic | 2,003 | | | | | | | 1,183 | | | | | | | | | | 746 | | | | | |
| 125 | Plains Grassy Wetland | 1,083 | | | 78 | | | | | | 11 | | | | 126 | | | | | | | | | |
| 126 | Swampy Riparian Complex | 9,049 | | | | | | | 3,192 | | | | | | | | | | 3,799 | | 428 | | | |
| 127 | Valley Healthy Forest | 1,242 | | | | | 838 | | | | | | 90 | 84 | | | | | | | | | | |
| 128 | Grassy Forest | 1,754 | | | | | | | 903 | | | | | | | | | | 1,179 | 1 | | | | |
| 132 | Plains Grassland | 37,284 | | | 1,947 | 15 | | | | | | | | | 15,536 | 1 | | | | | | | | |
| 133 | Limestone Poa sieberiana Shrubland | 174 | | | | | 57 | | | | 92 | | | | | | | | | | | | | |
| 135 | Gallery Rainforest | 369 | | | | | | | | | 206 | 17 | | | | | | | | | | | | |
| 136 | Sedge Wetland | 2,215 | | | 1,344 | 16 | | | | | 4 | | | | 369 | 35 | | | | | | | 68 | 100 |
| 140 | Mangrove Shrubland | 2,903 | | | 1,865 | 93 | | | | | | | | | | | | | | | | | 22 | 100 |
| 141 | Sandy Flood Scrub | 2,466 | | | | | | | | | 11 | | | | 1,935 | 17 | | | | | | | | |
| 144 | Coast Banksia Woodland/ East Gippsland Coastal Warm Temperate Rainforest Mosaic | 13 | | | | | | | | | | | | | | | | | | | | | | |
| 151 | Plains Grassy Forest | 89,017 | | | 37,300 | 2 | | | 9,756 | | 12,174 | 1 | | | 3,094 | 1 | | | | | | | | |
| 154 | Bird Colony Shrubland | 30 | | | | | | | | | | | | | | | | | | | | | 58 | 100 |
| 159 | Clay Heathland/Wet Heathland/Riparian Scrub Mosaic | 55 | | | | | | | | | | | | | | | | | | | | | | |
| 160 | Coastal Dune Scrub | 31 | | | 31 | 100 | | | | | | | | | | | | | | | | | | |
| 161 | Coastal Headland Scrub | 1,170 | | | | | | | | | | | | | | | | | | | | | 408 | 99 |
| 163 | Coastal Tussock Grassland | 1,348 | | | 916 | 79 | | | | | | | | | | | | | | | | | 304 | 100 |
| 164 | Coastline Herb-rich Woodland | 1,089 | | | 1,009 | 19 | | | | | | | | | | | | | | | | | | |
| 169 | Dry Valley Forest | 24,989 | 7 | | | | 3,314 | | | | 5,447 | 3 | 27 | 6 | | | 1,217 | 108 | | | | | | |
| 175 | Grassy Woodland | 48,552 | | | | | 21,484 | | | | 528 | 2 | 3,214 | 62 | | | 458 | 108 | | | | | | |
| 177 | Valley Slopes Dry Forest | 1,086 | | | | | 17 | | | | 82 | 75 | | | | | | | | | | | | |
| 191 | Riparian Scrub | 13,549 | | | 10,401 | 15 | | | 1 | | 156 | | | | 6 | | | | | | | | 2,338 | 100 |
| 160 | Montane Rocky Shrubland | 9,269 | | | | | | | | | | | 106 | | | | 1,861 | 97 | | | | | 114 | 100 |
| 195 | Seasonally Inundated Shrubby Woodland | 131 | | | | | | | | | | | | | 131 | | | | | | | | | |
| 201 | Shrubby Wet Forest | 2,250 | 115 | | | | | | | | | | | | | | 20 | 53 | | | | | | |
| 206 | Sub-alpine Grassland | 15,827 | | | | | 886 | 61 | | | | | 3,097 | | | | 8,950 | 96 | | | | | | |
| 207 | Montane Grassy Shrubland | 88 | | | | | | | | | | | | | | | | | | | | | | |
| 210 | Sub-alpine Wet Heathland | 2,186 | | | | | 126 | 80 | | | | | 986 | 8 | | | 162 | 92 | | | | | | |
| 223 | Wet Sand Thicket | 65 | | | | | | | 65 | | | | | | | | | | | | | | | |
| 265 | Valley Grassy Forest/Grassy Dry Forest Mosaic | 7 | | | | | | | | | 7 | | | | | | | | | | | | | |
| 307 | Sand Heathland/Wet Heathland Mosaic | 3,440 | | | | | | | | | | | | | | | | | | | | | 3,354 | 100 |
| 309 | Calcareous Swale Grassland | 662 | | | | | | | | | | | | | | | | | | | | | 662 | 100 |
| 310 | Wet Rocky Outcrop Scrub | 521 | | | | | | | | | | | | | | | | | | | | | 521 | 100 |
| 315 | Shrubby Foothill Forest/Damp Forest Complex | 7,986 | | | | | | | | | | | | | | | | | | | | | | |
| 316 | Shrubby Damp Forest | 66,783 | | | | | 5,552 | 4 | | | 14,226 | 9 | | | | | 1,030 | 68 | | | | | | |
| 317 | Sub-alpine Wet Heathland/Sub-alpine Grassland Mosaic | 3,654 | | | | | | | | | | | 2,592 | 52 | | | | | | | | | | |
| 318 | Montane Swamp | 782 | | | | | | | | | | | 502 | 4 | | | | | | | | | | |
| 319 | Montane Herb-rich Woodland | 24,786 | | | | | 2,873 | 21 | | | | | 17,252 | 34 | | | | | | | | | | |
| 320 | Grassy Dry Forest/Healthy Dry Forest Complex | 539 | | | | | | | | | | | 326 | 100 | | | | | | | | | | |
| 322 | Dry Rainforest/Warm Temperate Rainforest/Gallery Rainforest/Riparian Shrubland Mosaic | 185 | | | | | 7 | | | | 178 | 1 | | | | | | | | | | | | |
| 334 | Billabong Wetland | 661 | | | 16 | | | | 3 | | 191 | | | | 290 | | | | | | | | | |
| 342 | Rocky Outcrop Shrubland/Herbland Mosaic/Shrubby Foothill Forest Complex | 3 | | | | | | | | | 3 | | | | | | | | | | | | | |
| 607 | Swampy Scrub/Damp Sands Herb-rich Woodland/Wet Heath | 8 | | | | | | | | | | | | | | | | | | | | | | |
| 630 | Swamp Scrub/Wet Heathland Mosaic | 1,120 | | | | | | | | | | | | | | | | | | | | | | |
| 639 | Swamp Scrub/Plains Grassy Forest Mosaic | 4,280 | | | | | | | 1,430 | | | | | | | | | | 3,887 | 2 | | | | |
| 661 | Deep Freshwater Marsh | 8,173 | | | | | | | | | 147 | | | | 5,871 | 22 | | | | | | | | |
| 666 | Wet Heathland/Deep Heathland Mosaic | 7,065 | | | 1,041 | | | | | | | | | | | | | | | | | | 37 | 100 |
| 667 | Swamp Scrub/Plains Grassland Mosaic | 22,233 | | | 13,094 | | | | 8,339 | | | | | | | | | | | | | | | |
| 669 | Swampy Riparian Woodland/Swamp Scrub Mosaic | 4,112 | | | 741 | | | | 3,371 | | | | | | | | | | | | | | | |
| 689 | Gippsland Plains Grassy Woodland/Sedge Wetland Mosaic | 31,018 | | | 357 | | | | | | 481 | | | | 2,829 | | | | | | | | | |
| 690 | Floodplain Riparian Woodland/Billabong Wetland Mosaic | 3,067 | | | | | | | | | | | | | 861 | | | | | | | | | |
| 691 | Aquatic Herbland/Plains Sedgey Wetland Mosaic | 1,153 | | | | | | | | | 38 | | | | 913 | 21 | | | | | | | | |
| 695 | Dry Valley Forest/Swamp Scrub/Warm Temperate Rainforest Mosaic | 4,939 | | | | | | | | | 3,193 | 1 | | | | | | | | | | | | |
| 699 | Lowland Forest/Healthy Woodland Mosaic | 9,030 | | | 9,030 | 1 | | | | | | | | | | | | | | | | | | |
| 699 | Valley Grassy Forest/Swamp Scrub Mosaic | 222 | | | | | | | | | | | | | | | | | | | | | | |
| 700 | Swamp Scrub/Plains Sedgey Wetland Mosaic | 36 | | | | | | | | | 23 | | | | | | | | | | | | | |
| 701 | Swamp Scrub/Warm Temperate Rainforest/Billabong Wetland Mosaic | 1,814 | | | | | | | | | 1,148 | 2 | | | | | | | | | | | | |
| 702 | Montane Grassland | 2,013 | | | | | | | | | | | 1,690 | 2 | | | | | | | | | | |
| 703 | Montane Grassy Woodland/Montane Grassland Mosaic | 1,667 | | | | | | | | | | | 53 | 3 | | | | | | | | | | |
| 705 | Lowland Forest/Damp Sands | 24,958 | | | | | | | | | 64 | | | | 9,739 | 6 | | | | | | | | |
| 858 | Calcareous Dune Woodland | 3,580 | | | | | | | | | | | | | | | | | | | | | 3,567 | 100 |
| 963 | Floodplain Riparian Woodland | 1,623 | | | 58 | | | | | | 88 | | | | 488 | | | | | | | | | |
| 975 | Grassy Sedge Wetland | 39 | | | | | | | | | | | | | | | | | | | | | 39 | 100 |
| 976 | Spray-zone Coastal Shrubland | 47 | | | | | | | | | | | | | | | | | | | | | 47 | 100 |
| 977 | Lowland Herb-rich Forest | 36,051 | | | | | 1,716 | | | | 21,148 | 3 | | | 960 | | | | | | | | | |
| 979 | Damp Sands Herb-rich Woodland/Swamp Scrub Complex | 5,163 | | | 157 | 95 | | | | | | | | | | | | | | | | | | |
| 979 | Coastal Dune Grassland | 34 | | | 34 | 98 | | | | | | | | | | | | | | | | | | |
| 985 | Sandy Beach | 1,289 | | | 6 | 100 | | | | | | | | | | | | | | | | | 1,055 | 100 |
| 986 | Rocky Shore | 269 | | | | | | | | | | | | | | | | | | | | | 269 | 96 |
| 993 | Bare Rock/Ground | 80 | | | | | | | | | | | | | | | | | | | | | 58 | 100 |
| 995 | Ocean | 15,747 | | | 15,729 | 2 | | | | | | | | | | | | | | | | | 17 | 73 |
| 997 | Non-vegetated/Non-treed | 302 | | | 200 | 62 | 2 | 71 | | | | | 6 | 76 | 2 | 11 | | | 9 | | | | | |
| 998 | Water Body - Natural or dam inside | 47,321 | | | 4,033 | 97 | | | | | 864 | | | | 20,272 | 2 | | | | | | | 11 | 100 |
| | | 3,676,284 | 34,062 | | 295,927 | | 143,689 | | 199,845 | | 179,376 | | 173,651 | | 140,914 | | 102,169 | | 139,480 | | 428 | | 69,964 | |

### *3.3.2 Representation within reserves of floristic variation across EVCs*

A preliminary floristic analysis was carried out to inform the EVC mapping process, however the analysis does not allow an examination of floristic communities within EVCs identified for the Gippsland region because of recent revisions and additions to the mapping. Floristic variation within EVCs is strongly correlated with regional and sub-regional variation, and it is expected that attention to reservation of EVCs across the range of GRUs will also result in sufficient protection for the range of floristic variation within EVCs.

### *3.3.3 Reservation status of Ecological Vegetation Class growth stages*

In addition to the representation of EVCs and old growth forest in reserves, representation of the range of different forest growth stages in each EVC has been assessed. Such an analysis enables an evaluation of the reservation status of the various successional stages in the forest at the present time. Appropriate representation of a range of age-classes in reserves improves the likelihood that a greater suite of associated biodiversity will be protected and reduces the risk of stochastic events (such as wildfire) eliminating all recruitment to older growth stages for extended periods.

The following forest disturbance class growth stages are based on Woodgate *et al*. (1994) and used for this assessment.

1. **Old-growth Forest** - Forest which contains significant amounts of its oldest growth stage in the upper stratum – usually senescing trees – and has been subject to any disturbance, the effect of which is now negligible.
2. **Negligibly Disturbed Forest** - Forest which has less than 10% of the oldest trees (senescing) growth stage and less than 10% of its youngest (regrowth) growth stage in the upper stratum, and where the effects of any disturbance are negligible or non-existent;
3. **Significantly Disturbed Forest** - Forest which has greater than 10% of its youngest (regrowth) growth stage in the upper stratum and has been subject to natural disturbances (ie. wildfire), and forests which have been subjected to un-natural disturbances thought to have had a significant effect on their naturalness;
4. **Other Forest** -Forests or non-forest areas which have not been assessed for old growth.

The data used in the assessment derive from Gippsland public land mapping EVC coverage, Gippsland old growth forest study, and land tenure data layers held by the Department of Natural Resources and Environment.

The area by EVC of old-growth forest, negligibly and significantly disturbed forest and other forest is presented in Table 3.6. The area figures in Table 3.6 represent the total area of each forest category on public land for each EVC. The corresponding percent protection figure refers to the proportion of the total area protected in conservation reserves.

**Table 3.6 Extent and level of disturbance for different forest growth stages and disturbance categories in the Gippsland region.**

| EVC No | Ecological Vegetation Class | Old-growth Forest | | Negligibly Disturbed | | Significantly Disturbed | | Other Forest | |
|---|---|---|---|---|---|---|---|---|---|
| | | Total (ha) | % Prot. | Total (ha) | % Prot. | Total (ha) | % Prot. | Total (ha) | % Prot. |
| 1 | Coastal Dune Scrub Mosaic | 11 | 100 | | | 11 | 100 | 6,768 | 95 |
| 2 | Coast Banksia Woodland | 35 | 100 | | | 33 | 100 | 762 | 94 |
| 3 | Damp Sands Herb-rich Woodland | 13 | 71 | 8 | 100 | 2,394 | 97 | 5,992 | 91 |
| 5 | Coastal Sand Heathland | | | | | 0 | | 22 | 73 |
| 6 | Sand Heathland | 7 | 85 | 4 | 100 | 27 | 100 | 7,332 | 92 |
| 7 | Clay Heathland | 10 | 83 | 1 | 100 | 55 | 54 | 608 | 46 |
| 8 | Wet Heathland | 33 | 81 | 7 | 100 | 65 | 75 | 7,154 | 89 |
| 9 | Coastal Saltmarsh | | | | | 5 | 69 | 6,521 | 66 |
| 10 | Estuarine Wetland | 5 | 100 | 2 | 100 | 35 | 96 | 11,595 | 56 |
| 11 | Coastal Lagoon Wetland | | | | | 0 | | 59 | 100 |
| 12 | Wet Swale Herbland | 6 | 100 | | | 1 | 100 | 185 | 100 |
| 15 | Limestone Box Forest | 44 | 0 | 5 | 0 | 250 | 35 | 72 | 54 |
| 16 | Lowland Forest | 2,263 | 52 | 3,385 | 64 | 67,264 | 13 | 5,523 | 32 |
| 17 | Riparian Scrub Complex | | | | | 0 | | 0 | |
| 18 | Riparian Forest | 324 | 48 | 366 | 23 | 6,845 | 44 | 941 | 25 |
| 19 | Riparian Shrubland | 52 | 25 | 14 | 87 | 176 | 42 | 1,269 | 23 |
| 20 | Heathy Dry Forest | 20,676 | 38 | 8,284 | 39 | 32,926 | 49 | 18,220 | 69 |
| 21 | Shrubby Dry Forest | 78,118 | 35 | 3,153 | 22 | 143,560 | 22 | 27,476 | 26 |
| 22 | Grassy Dry Forest | 7,907 | 43 | 1,487 | 37 | 12,587 | 24 | 2,917 | 38 |
| 23 | Herb-rich Foothill Forest | 12,616 | 64 | 24,248 | 54 | 59,176 | 49 | 12,521 | 50 |
| 27 | Blackthorn Scrub | 2,703 | 21 | 53 | 0 | 1,181 | 11 | 3,305 | 16 |
| 28 | Rocky Outcrop Shrubland | 709 | 34 | 19 | 64 | 471 | 52 | 557 | 28 |
| 29 | Damp Forest | 15,412 | 18 | 21,511 | 13 | 48,612 | 7 | 9,951 | 25 |
| 30 | Wet Forest | 4,901 | 29 | 4,441 | 27 | 14,463 | 13 | 8,178 | 42 |
| 31 | Cool Temperate Rainforest | 48 | 65 | 17 | 40 | 77 | 58 | 372 | 68 |
| 32 | Warm Temperate Rainforest | 88 | 53 | 70 | 93 | 308 | 20 | 1,837 | 62 |
| 34 | Dry Rainforest | | | 2 | 0 | 0 | | 3 | 0 |

| EVC No | Ecological Vegetation Class | Old-growth Forest | | Negligibly Disturbed | | Significantly Disturbed | | Other Forest | |
|---|---|---|---|---|---|---|---|---|---|
| | | Total (ha) | % Prot. | Total (ha) | % Prot. | Total (ha) | % Prot. | Total (ha) | % Prot. |
| 35 | Tableland Damp Forest | 1,068 | 13 | 1,191 | 37 | 7,558 | 6 | 1,212 | 29 |
| 36 | Montane Dry Woodland | 16,776 | 57 | 10,319 | 46 | 81,862 | 43 | 17,629 | 51 |
| 37 | Montane Grassy Woodland | 2,076 | 18 | 811 | 25 | 16,546 | 13 | 2,695 | 9 |
| 38 | Montane Damp Forest | 7,625 | 51 | 10,596 | 46 | 68,890 | 37 | 16,419 | 49 |
| 39 | Montane Wet Forest | 2,210 | 58 | 1,779 | 41 | 5,626 | 25 | 1,959 | 49 |
| 40 | Montane Riparian Woodland | 32 | 63 | 19 | 33 | 1,361 | 67 | 648 | 7 |
| 41 | Montane Riparian Thicket | 350 | 13 | 640 | 12 | 969 | 13 | 670 | 23 |
| 42 | Sub-alpine Shrubland | | | | | 9 | 100 | 100 | 97 |
| 43 | Sub-alpine Woodland | 6,798 | 82 | 2,238 | 83 | 23,313 | 69 | 5,810 | 78 |
| 44 | Treeless Sub-alpine Mosaic | | | 2 | 100 | 0 | | 164 | 100 |
| 45 | Shrubby Foothill Forest | 2,888 | 18 | 6,609 | 21 | 18,192 | 7 | 7,117 | 43 |
| 47 | Valley Grassy Forest | 57 | 64 | 36 | 46 | 956 | 51 | 179 | 12 |
| 48 | Heathy Woodland | 8,321 | 63 | 170 | 79 | 9,911 | 57 | 8,768 | 65 |
| 53 | Swamp Scrub | 46 | 43 | | | 153 | 10 | 3,107 | 52 |
| 55 | Plains Grassy Woodland | 2 | 0 | 1 | 100 | 895 | 72 | 189 | 20 |
| 56 | Floodplain Riparian Woodland | | | | | 0 | | 342 | 1 |
| 58 | Cleared Severely Disturbed | 54 | 25 | 40 | 68 | 479 | 17 | 7,293 | 35 |
| 61 | Box Ironbark Forest | | | | | 1,151 | 12 | 142 | 41 |
| 72 | Granitic Hills Woodland | 1,256 | 100 | 857 | 100 | 110 | 100 | 1,753 | 100 |
| 73 | Rocky Outcrop Shrubland/Herbland Mosaic | 515 | 84 | 145 | 78 | 619 | 68 | 8,077 | 73 |
| 74 | Wetland Formation | 5 | 40 | | | 30 | 75 | 1,757 | 52 |
| 82 | Riverine Escarpment Scrub | 307 | 29 | 49 | 36 | 749 | 25 | 7,084 | 35 |
| 83 | Swampy Riparian Woodland | | | | | 53 | 26 | 26 | 0 |
| 84 | Riparian Forest/Swampy Riparian Woodland/Riparian Shrubland/Riverine Escarpment | | | | | | | 3 | 0 |
| 107 | Lake Bed Herbland | | | | | 0 | | 0 | |
| 126 | Swampy Riparian Complex | | | | | 5 | 0 | 178 | 1 |
| 127 | Valley Heathy Forest | 444 | 0 | 9 | 0 | 500 | 0 | 109 | 0 |
| 128 | Grassy Forest | | | | | 0 | | 0 | |
| 132 | Plains Grassland | | | | | 0 | | 290 | 99 |
| 133 | Limestone Pomaderris Shrubland | 1 | 0 | | | 0 | | 53 | 0 |
| 135 | Gallery Rainforest | | | | | 0 | | 13 | 63 |
| 136 | Sedge Wetland | 44 | 93 | 2 | 100 | 104 | 81 | 640 | 38 |
| 140 | Mangrove Shrubland | | | | | 0 | | 2,658 | 89 |
| 141 | Sandy Flood Scrub | 15 | 79 | | | 9 | 100 | 318 | 24 |
| 143 | Estuarine Wetland/Coastal Saltmarsh | | | | | 0 | | 631 | 18 |
| 144 | Coast Banksia Woodland/ East Gippsland Coastal Warm Temperate Rainforest Mosaic | | | | | | | 12 | 100 |
| 149 | Plantation (Softwood and Weedy Hardwood) | 4 | 0 | | | 64 | 14 | 982 | 16 |
| 151 | Plains Grassy Forest | 1,224 | 22 | 651 | 61 | 11,794 | 3 | 1,329 | 28 |
| 154 | Bird Colony Shrubland | | | | | 0 | | 49 | 100 |
| 159 | Clay Heathland/Wet Heathland/Riparian Scrub Mosaic | | | | | 5 | 0 | 32 | 0 |
| 160 | Coastal Dune Scrub | | | | | 0 | | 31 | 100 |
| 161 | Coastal Headland Scrub | 1 | 100 | 9 | 100 | 1 | 100 | 901 | 80 |
| 163 | Coastal Tussock Grassland | | | | | 0 | | 1,089 | 84 |
| 169 | Dry Valley Forest | 821 | 20 | 315 | 19 | 13,809 | 15 | 1,917 | 11 |
| 175 | Grassy Woodland | 200 | 55 | 333 | 77 | 5,696 | 78 | 1,098 | 50 |
| 177 | Valley Slopes Dry Forest | 657 | 34 | 11 | 48 | 726 | 35 | 215 | 24 |
| 191 | Riparian Scrub | 163 | 56 | 37 | 97 | 374 | 18 | 2,657 | 87 |
| 192 | Montane Rocky Shrubland | 174 | 96 | 51 | 94 | 212 | 92 | 2,821 | 92 |
| 201 | Shrubby Wet Forest | 260 | 1 | 280 | 1 | 1,524 | 1 | 184 | 0 |
| 206 | Sub-alpine Grassland | 42 | 73 | 34 | 69 | 532 | 72 | 14,465 | 94 |
| 207 | Montane Grassy Shrubland | | | | | 0 | | 2 | 0 |
| 210 | Sub-alpine Wet Heathland | 15 | 74 | 4 | 100 | 303 | 21 | 869 | 45 |
| 265 | Valley Grassy Forest/Grassy Dry Forest Mosaic | | | | | 0 | | 2 | 0 |
| 307 | Sand Heathland/Wet Heathland Mosaic | 31 | 100 | 27 | 100 | 31 | 100 | 3,627 | 100 |
| 309 | Calcareous Swale Grassland | | | | | 0 | | 305 | 100 |
| 310 | Wet Rocky Outcrop Scrub | 2 | 100 | 12 | 100 | 0 | | 506 | 100 |
| 315 | Shrubby Foothill Forest/Damp Forest Complex | 238 | 7 | 562 | 9 | 6,327 | 2 | 304 | 2 |
| 316 | Shrubby Damp Forest | 9,637 | 22 | 11,853 | 19 | 41,711 | 15 | 4,005 | 14 |
| 317 | Sub-alpine Wet Heathland/Sub-alpine Grassland Mosaic | 5 | 0 | 7 | 29 | 186 | 37 | 2,898 | 45 |
| 318 | Montane Swamp | | | | | 0 | | 194 | 10 |
| 319 | Montane Herb-rich Woodland | 2,031 | 41 | 1,239 | 33 | 16,844 | 37 | 1,015 | 25 |
| 320 | Grassy Dry Forest/Heathy Dry Forest Complex | 20 | 100 | 3 | 100 | 324 | 100 | 154 | 100 |

| EVC No | Ecological Vegetation Class | Old-growth Forest | | Negligibly Disturbed | | Significantly Disturbed | | Other Forest | |
|---|---|---|---|---|---|---|---|---|---|
| | | Total (ha) | % Prot. | Total (ha) | % Prot. | Total (ha) | % Prot. | Total (ha) | % Prot. |
| 322 | Dry Rainforest/Warm Temperate Rainforest/Gallery Rainforest/Riparian Shrubland Mosaic | 5 | 0 | | | 24 | 0 | 155 | 0 |
| 334 | Billabong Wetland | | | | | 0 | | 2 | 0 |
| 342 | Rocky Outcrop Shrubland/Herbland Mosaic/Shrubby Foothill Forest Complex | | | | | | | 0 | |
| 639 | Swamp Scrub/Plains Grassy Forest Mosaic | | | | | 148 | 0 | 2 | 0 |
| 681 | Deep Freshwater Marsh | | | | | 0 | | 3,944 | 30 |
| 689 | Gippsland Plains Grassy Woodland/Gilgai Wetland Mosaic | | | | | 0 | | 0 | |
| 695 | Dry Valley Forest/Swamp Scrub/Warm Temperate Rainforest Mosaic | | | | | 0 | | 8 | 57 |
| 701 | Swamp Scrub/Warm Temperate Rainforest/Billabong Wetland Mosiac | | | | | 0 | | 2 | 100 |
| 702 | Montane Grassland | | | | | 0 | | 36 | 7 |
| 703 | Montane Grassy Woodland/Montane Grassland Mosaic | | | | | 0 | | 67 | 0 |
| 858 | Calcarenite Dune Woodland | | | | | 0 | | 3,829 | 100 |
| 875 | Blocked Coastal Stream Swamp | | | | | 0 | | 32 | 100 |
| 876 | Spray-zone Coastal Shrubland | | | | | 0 | | 41 | 100 |
| 877 | Lowland Herb-rich Forest | 381 | 7 | 318 | 4 | 11,816 | 11 | 444 | 7 |
| 878 | Damp Sands Herb-rich Woodland/Swamp Scrub Complex | | | | | 0 | | 149 | 100 |
| 879 | Coastal Dune Grassland | | | | | 0 | | 33 | 100 |
| 985 | Bare Sand | 3 | 100 | 10 | 100 | 0 | | 1,290 | 100 |
| 986 | Rocky Shore | | | 11 | 100 | 0 | | 261 | 96 |
| 993 | Bare Rock/Ground | | | 8 | 100 | 0 | | 44 | 100 |
| 997 | Non-vegetated/Non-treed | 38 | 55 | 24 | 31 | 353 | 32 | 30,402 | 20 |
| 998 | Water Body - Natural or man made | 1 | 100 | | | 17 | 49 | 13,705 | 20 |
| 999 | Unknown/Unclassified | | | | | 0 | | 6 | 80 |
| | Total | 212,825 | 41 | 118,390 | 36 | 743,395 | | 334,290 | 51 |

### *3.3.4 Endangered, vulnerable and rare forest ecosystems*

The conservation status of EVCs in the region has been assessed against a number of national reserve criteria (JANIS 1997). The criteria have been applied to ecological vegetation classes as the appropriate level of resolution for forest ecosystems.

EVCs which are classified as rare, vulnerable or endangered according to the national reserve criteria are presented in Table 3.8. This assessment is relevant to Criteria 2 and 3 which specify reservation targets for EVCs classified as endangered, vulnerable or rare. As outlined previously, all remaining occurrences of rare and endangered EVCs should be reserved or protected by other means as far as is practicable, and at least 60 percent of the remaining extent of vulnerable EVCs should be reserved.

**Table 3.7 The National Forest Reserve (JANIS) criteria used to assess the conservation status of EVCs**

| Status of EVC | Criteria |
|---|---|
| Rare | R1. Total range generally less than 10,000 ha.<br>R2. Total area generally less than 1,000 ha.<br>R3. Patch sizes generally less than 100 ha. |
| Vulnerable | V1. Approaching greater than 70 per cent lost (depletion) and remains subject to threatening processes.<br>V2. Includes EVCs where threatening processes have caused:<br>• Significant changes in species composition,<br>• loss or significant decline in species that play a major role within the ecosystem, or<br>• significant alteration to ecosystem processes.<br>V3. Not depleted but subject to continuing threatening processes which may reduce its extent. |
| Endangered | E1. Distribution has contracted to less than 10 per cent of original range.<br>E2. Less than 10 per cent of original area remaining.<br>E3. 90 per cent of area is in small patches subject to threatening processes and unlikely to persist. |

Many of the EVCs listed in Table 3.8 are largely confined to private land in the region (see also Section 3.2)

**Table 3.8 Endangered, vulnerable and rare Ecological Vegetation Classes in Gippsland, their percent reservation in the region, and threatening processes**

| EVC No. | EVC Name | Criteria | % Res.[1] | Threatening Processes[2] |
|---|---|---|---|---|
| 2 | Coast Banksia Woodland | V2, V3 | 23.1 | Recreation, clearing, inappropriate fire regimes, residential and commercial development |
| 3 | Damp Sands Herb-rich Woodland | V1, V2, V3, E3 | 19.3 | Grazing, weed invasion, inappropriate fire regimes, clearing, agriculture, plantation development |
| 5 | Coastal Sand Heathland | R1, R2, R3, V3 | 73.2 | Recreation |
| 7 | Clay Heathland | R2 | 46.7 | |
| 9 | Coastal Saltmarsh | R2, E3, V2, V3 | 57.0 | Alteration of drainage patterns and flooding regimes, recreation, clearing, residential and commercial development |
| 10 | Estuarine Wetland | V2, V3, E3 | 79.3 | Residential and commercial development, alteration of drainage patterns and flooding regimes, recreation |
| 11 | Coastal Lagoon Wetland | R1, R2, R3 | 100.0 | |
| 12 | Wet Swale Herbland | R2, R3 | 112.5 | |
| 15 | Limestone Box Forest | R1, R2, V2, V3 | 9.2 | Grazing, clearing, minor forest produce, weed invasion, habitat loss, timber harvesting, fragmentation, inappropriate fire regimes |
| 18 | Riparian Forest | V2, V3 | 36.0 | Weed invasion, grazing, recreation, mining, clearing, fire, indirect impacts of road construction and maintenance and timber harvesting |
| 19 | Riparian Shrubland | R3 | 8.9 | Weed invasion |
| 28 | Rocky Outcrop Shrubland | R3 | 36.3 | Weed invasion, inappropriate fire regimes |
| 31 | Cool Temperate Rainforest | R2, R3, E3, V2, V3 | 15.3 | Fire, clearing, indirect effects of timber harvesting and of road construction and maintenance |
| 32 | Warm Temperate Rainforest | R3, E3,V2 | 21.8 | Fire, clearing, indirect effects of timber harvesting and of road construction and maintenance |
| 34 | Dry Rainforest | R1, R2, R3, V2, V3, E3 | 9.6 | Fire |
| 40 | Montane Riparian Woodland | E3 | 13.2 | Weed invasion, grazing, indirect impacts of road construction and maintenance, inappropriate fire regimes |
| 41 | Montane Riparian Thicket | R3 | 15.4 | Indirect impacts of road construction and maintenance, indirect impacts of timber harvesting |
| 42 | Sub-alpine Shrubland | R2, R3,E3 | 96.7 | Recreation |
| 44 | Treeless Sub-alpine Mosaic | R2, R3, E3, V2, V3 | 100.0 | Grazing, recreation, weed invasion |
| 45 | Shrubby Foothill Forest | V1 | 4.7 | Minor forest produce, timber harvesting, inappropriate fire regimes |
| 47 | Valley Grassy Forest | V1, V2, V3 | 4.8 | Weed invasion, grazing, clearing, minor forest produce, agriculture, minor forest produce |
| 53 | Swamp Scrub | E2, E3 | 2.0 | Grazing |

| EVC No. | EVC Name | Criteria | % Res.[1] | Threatening Processes[2] |
|---|---|---|---|---|
| 55 | Plains Grassy Woodland | R3, E2, E3, V2, V3 | 0.5 | Habitat loss, clearing, agriculture, fragmentation, grazing, weed invasion, road construction and maintenance, minor forest produce, timber harvesting, inappropriate fire regimes |
| 56 | Floodplain Riparian Woodland | R2, E2, E3, V2, V3 | 0.0 | Habitat loss, clearing, agriculture, fragmentation, timber harvesting, minor forest produce, alteration of drainage patterns and flooding regimes, grazing, weed invasion, indirect impacts of road construction and maintenance, agriculture |
| 61 | Box Ironbark Forest | R1, V1, V2, V3 | 2.6 | Timber harvesting, firewood and post and pole production, mining, habitat loss, fragmentation, weed invasion, clearing, inappropriate fire regimes |
| 83 | Swampy Riparian Woodland | R2, R3, V3, E2, E3 | 0.1 | Clearing for agriculture, grazing, weed invasion, alteration of drainage patterns and flooding regimes, indirect impacts of road construction and maintenance |
| 107 | Lake Bed Herbland | R1, R2, E3, V2, V3 | 117.7 | Grazing, alteration of drainage patterns and flooding regimes, weed invasion |
| 126 | Swampy Riparian Complex | R2, E2, V3 | 0.0 | Clearing for agriculture, grazing, weed invasion, alteration of drainage patterns and flooding regimes, indirect impacts of road construction and maintenance |
| 127 | Valley Heathy Forest | R2, R3, V2 | 0.0 | Clearing, agriculture, habitat loss, weed invasion, inappropriate fire regimes |
| 128 | Grassy Forest | R1, R2, R3, E2, E3, V2, V3 | 0.0 | Grazing, weed invasion, clearing, agriculture, timber harvesting, minor forest produce |
| 132 | Plains Grassland | R2, R3, E2, E3, V2, V3 | 0.8 | Inappropriate grazing regime, clearing, agriculture, habitat loss, fragmentation, weed invasion, road construction and maintenance, inappropriate fire regimes |
| 133 | Limestone Pomaderris Shrubland | R2, R3, V2, V3, E3 | 0.1 | Grazing, weed invasion, mining |
| 135 | Gallery Rainforest | R2, R3, V1, V2, V3, E3 | 4.4 | Fire, clearing, indirect effects of timber harvesting and of road construction and maintenance, |
| 136 | Sedge Wetland | R2, R3, V3, E3 | 17.0 | Grazing, alteration of drainage patterns and flooding regimes, weed invasion |
| 140 | Mangrove Shrubland | E3, V2, V3 | 85.6 | Alteration of drainage patterns and flooding regimes, recreation, earthworks and construction associated with development |
| 141 | Sandy Flood Scrub | R1, R2, V1 | 4.1 | Inappropriate fire regimes |
| 143 | Estuarine Wetland/Coastal Saltmarsh Mosaic | R1, R2, V2, V3 | - | Alteration of drainage patterns and flooding regimes, recreation |
| 151 | Plains Grassy Forest | V1, V2, V3 | 1.6 | Grazing, minor forest produce, agriculture, clearing, weed invasion, timber harvesting |
| 154 | Bird Colony Shrubland | R2, R3 | 100.0 | Soil erosion |
| 160 | Coastal Dune Scrub | R2, R3 | 100.0 | |
| 161 | Coastal Headland Scrub | R1, R2, R3, V3, E3 | 67.0 | Recreation, soil erosion, weed invasion, residential development, clearing |
| 163 | Coastal Tussock Grassland | R3 | 70.4 | Soil erosion |
| 175 | Grassy Woodland | V1, E3, V2, V3 | 11.1 | Grazing, weed invasion, habitat loss, fragmentation, clearing, agriculture, timber harvesting, minor forest produce |
| 177 | Valley Slopes Dry Forest | R1, R3 | 26.7 | Soil erosion, weed invasion |
| 191 | Riparian Scrub | R1, R3, V1, V3 | 18.5 | Clearing, weed invasion, recreation, alteration of drainage patterns and flooding regimes |
| 192 | Montane Rocky Shrubland | R1, R3 | 92.0 | Inappropriate fire regimes, weed invasion |
| 207 | Montane Grassy Shrubland | R2, R3, V1, V2, V3 | 0.0 | Grazing, weed invasion |
| 210 | Sub-alpine Wet Heathland | R1, R3, V2, V3 | 22.2 | Grazing, fire, recreation |
| 309 | Calcareous Swale Grassland | R1, R2, R3 | 55.3 | |
| 310 | Wet Rocky Outcrop Scrub | R1, R2, R3 | 100.0 | |
| 318 | Montane Swamp | R2, R3, V1, V2, V3, E3 | 2.8 | Grazing, alteration of drainage patterns and flooding regimes, weed invasion |
| 334 | Billabong Wetland | R2, R3, V2, V3, E2, E3 | 0.0 | Grazing, altered water/drainage regimes, weed invasion, habitat loss, salination, clearing, agriculture |
| 681 | Deep Freshwater Marsh | E3, V2, V3 | 14.7 | Alteration of drainage patterns and flooding regimes, weed invasion |

| EVC No. | EVC Name | Criteria | % Res.[1] | Threatening Processes[2] |
|---|---|---|---|---|
| 689 | *Gippsland Plains* Grassy Woodland/Gilgai Wetland Mosaic | R2, R3, E2, E3, V2, V3 | 0.0 | Altered drainage patterns and flooding regimes, weed invasion, clearing, agriculture, grazing, minor forest produce, fragmentation, habitat loss, road construction and maintenance |
| 702 | Montane Grassland | V1, R1, R2, R3, E2, E3, V2, V3 | 1.0 | Grazing, weed invasion |
| 858 | Calcarenite Dune Woodland | R1 | 107.3 | Recreation |
| 875 | Blocked Coastal Stream Swamp | R1, R2, R3, | 110.8 | Alteration of drainage patterns and flooding regimes |
| 876 | Spray-zone Coastal Shrubland | R2, R3, | 100.0 | Soil erosion |
| 879 | Coastal Dune Grassland | R1, R2, R3, V3, E3 | 97.6 | Recreation, soil erosion |

**Notes:** [1.] Percent Reservation in Conservation Parks and Reserves is based on pre-1750 extent.
[2.] Threatening processes are those which have occurred in the past, and may or may not be current threatening processes for these EVCs. Minor forest produce includes produce harvested other than sawlogs or residual logs. It is often collected by small operators or individuals and includes products such as sleepers, posts and poles, craftwood, firewood, and honey.
[3.] Extinct EVCs and EVC mosaics of small extent which are artefacts of mapping methods have not been included.

Management mechanisms currently available to address the threatening processes tabulated above include: the Code of Practice for Fire Management on Public Land, Native Vegetation Retention Controls, Weed Control, Fencing, and the Land for Wildlife scheme. Further details are included in Chapter 6.

Several relatively common EVCs are subject to a variety of threatening processes but are not currently judged to be impacted to a sufficiently significant degree (i.e. in extent and/or severity) to be considered endangered, vulnerable or rare in accordance with the JANIS criteria. For example, EVCs with heathy understories (Heathy Dry Forest, Heathy Woodland, Granitic Hills Woodland) are particularly sensitive to altered fire regimes and the resultant reduced diversity is commonly identified across the study area. The understorey composition of mountain forest EVCs (Damp Forest, Wet Forest, Montane Wet Forest, Shrubby Damp Forest, Shrubby Wet Forest), particularly old individuals of some prominent understorey species (e.g. tree ferns), is significantly impacted by mechanical disturbance associated with timber harvesting. Open fertile EVCs (Montane Grassy Woodland, Sub-alpine Grassland) are favoured for grazing and are relatively more prone to weed invasion. The conservation status of these EVCs is analogous to the "near threatened" category that is applied to some species. Stabilising the status of these EVCs relies on a range of management strategies aimed at minimising any long-term impacts.

# 4 VASCULAR FLORA ASSESSMENT

## 4.1 Introduction

Assessment of the Gippsland flora has involved an analysis of the distribution and viability of individual taxa and their populations within the region. The purpose of this assessment is to assist in determining whether:

- viable populations of all terrestrial and aquatic plant taxa are maintained throughout their natural range in the region;
- representative populations of each taxon are included in the reserve system; and
- populations and their habitats both within and outside the reserve system are subject to management appropriate for their long-term maintenance.

A total of approximately 2,500 vascular plant taxa have been recorded for the Gippsland region, including 348 taxa of conservation significance and approximately 600 exotic taxa.

### *4.1.1 Priority flora*

The focus of this assessment of the flora occurring in the Gippsland region has been on those taxa which have been identified as being at risk because of rarity, depletion or the continued action of threatening processes. Rare or threatened plants are often at the forefront of the debate regarding the balance between conservation and resource utilisation. They are significant because of their intrinsic value as unique forms of life and the higher likelihood of their permanent loss. In addition, the fate of rare or threatened plants may also indicate the health of the ecosystems, and communities on which they depend, and the direct or indirect impact of human activities on these ecosystems and communities.

Rare or threatened plants exhibit a range of life histories, life forms, reproductive strategies, distribution patterns and ecological dependencies. Included among the plants considered rare or threatened in the Gippsland region are:

- 164 (47%) short-lived (1-5 yrs) herbs and 138 (40%) long-lived (5-10 yrs) herbs or shrubs;
- 7 (2%) annuals and 17 (5%) extremely long-lived (>50 yrs) trees;
- 129 (37%) herbs, 98 (28%) shrubs, 42 (12%) grasses, 22 (6%) sedges, 18 (5%) trees, 14 (4%) ferns, 6 (2%) epiphytes and 3 (1%) climbers.
- 174 (35%) perennial taxa that do not disperse over long distances and persist in an area by virtue of a substantial soil seedbank.
- 49 (14%) orchids and ferns that produce large quantities of short-lived seed or spores that are dispersed by wind over large distances.
- endemics which may be locally abundant but occur in a restricted area and those which occur over a large area but are rarely common;
- taxa which are naturally rare but appear stable; and
- sub-alpine, lowland, swamp and coastal taxa;

This review of the conservation of rare or threatened taxa in the Gippsland region addresses:

- plants listed as threatened under the Victorian *Flora and Fauna Guarantee Act* 1988 (FFG Act),
- plants listed as endangered or vulnerable under the Commonwealth *Endangered Species Protection Act* 1992 (ESP Act),
- plants included in the Victorian Rare or Threatened Species list for plants (VROTS),
- plants included in the national list of Rare or Threatened Australian Plants (ROTAP) (Briggs and Leigh 1995), and
- any other threatened plants recommended for addition to the ROTAP list by the Australian & New Zealand Environment and Conservation Council (ANZECC).

Non-vascular plants have not been considered in this assessment, nor have those taxa where their continuing occurrence within the Gippsland region could not be confirmed because of (a) difficulties in confirming identification or location, or (b) the absence of recent (post-1950) records, or (c) where they are hybrids. The full list of 348 priority taxa is listed in Table 4.1.

## 4.2 Life history and population parameters for priority flora

### *4.2.1 Assessment methods*

For each of the plants evaluated in this review, questions relating to the following topics were answered using the best information available from the databases maintained by NRE, expert opinion and the available literature:

- the conservation status of each taxon;

- the regional distribution and demographic attributes of each taxon;
- the habitat attributes of each taxon;
- the life history attributes of each taxon, and;
- the response of each taxon to various forms of disturbance or common environmental conditions found in different land-use categories or management regimes.

The greatest effort went into compiling information on the distribution, abundance and demography of all priority taxa so that a detailed assessment of the reservation status and vulnerability of each taxon could be conducted. Some of the more important information collated included:

- the approximate proportion of each taxon's Australian distribution, or population where this is known, that occurs within the Gippsland region;
- the reservation status of known populations within the Gippsland region.
- the number of populations and/or individuals known to occur in the Gippsland region;
- the number of populations and/or individuals known to occur in protected areas or land free from processes causing sudden and irreversible loss of habitat within the Gippsland region;
- the area of occupancy and/or the extent of occurrence of each taxon within the Gippsland region; and
- any trends which may be apparent in the demography of each taxon;
- any trends which may be apparent or threats to the habitat of each species

Some of these data are presented inTable 4.1. More details for plants listed under the *Flora and Fauna Guarantee Act* 1988 or *Endangered Species Protection Act* 1992 can be found in Appendix E.

### *4.2.2 Patterns of abundance, distribution and habitat*

Spatial analysis of the distribution and abundance of priority taxa and review of their habitat identified six groups of plants that appeared to correlate with particular regions or habitats present throughout the region. These include (1) plants of sub-alpine habitats, (2) plants of riparian or wetland habitats, (3) plants of coastal regions, (4) plants of Wilsons Promontory, (5) plants of the Strzelecki Ranges, and (6) plants of the Gippsland Plains. Each habitat or region and the plants associated with them are discussed in the sections below.

#### *Plants of restricted, highly localised and naturally rare habitat types*

**Sub-alpine habitats**

In Australia sub-alpine environments are relictual, their distribution having contracted over time due to climate change since the end of the last ice age. These environments, therefore, represent very small areas of a unique habitat within the Australian context (NRE 1997) and act as refugia for plants confined to the narrow range of environmental variables typical of such environments.

In the Gippsland region, sub-alpine habitats are restricted to areas in and around the Alpine National Park between the mountains north of the Avon Wilderness Area through to Cowombat Flat near Mount Cobberas No. 2. Most of these areas occur within conservation reserves except for sections of the High Plains leased for cattle grazing and State Forest east of Bindi (e.g. Nunniong Plains). Two distinct EVCs dominate these regions: Sub-alpine Woodland (dominated by Snowgum *Eucalyptus pauciflora* over varied shrub and field layers) and Treeless Sub-alpine Mosaic (existing as a complex range of floristic communities including wet heathlands, grasslands, shrublands, bogs and frost hollows). Both EVCs are restricted to altitudes between 1200 to 1830 metres ASL. Montane forest and woodlands dominated by Alpine Ash *Eucalyptus delegatensis* are also common above altitudes of 900 metres ASL and frequently grow in close proximity to Snow Gum *Eucalyptus pauciflora* Woodlands or become ecotonal with it.

Sixteen percent of all the rare or threatened plants found within the Gippsland region grow primarily at high altitudes (>1000m A.S.L.) in sub-alpine habitats. Due to the restricted nature of their habitat, their usually low population numbers, and occurrence in the Alpine National Park, the bulk of these taxa are considered rare, but not threatened. Out of the 55 plants confined to sub-alpine habitats, 12 are considered threatened in Victoria. These are Snow Aciphyll *Aciphylla glacialis*, Mountain Water-fern *Blechnum vulcanicum*, Mountain Daisy *Brachyscome tenuiscapa*, Archer's Sedge *Carex archeri*, Dwarf Sedge *Carex paupera*, Slender Gingidia *Gingidia harveyana*, Matted Brooklime *Gratiola nana*, Silver Carraway *Oreomyrrhis argentea*, Mountain Geebung *Persoonia asperula*, Harsh Phebalium *Phebalium squameum* ssp. *coriaceum*, Tasmanian Bladderwort *Utricularia monanthos* and Fairy Bluebell *Wahlenbergia densiflora*.

**Riparian or wetland habitats**

Although widespread, riparian vegetation has a narrow range of habitat requirements and as such is restricted in extent. The dominant EVC associated with the larger rivers and streams throughout the Gippsland region is Riparian Forest. This vegetation type is predominantly found between the elevations of 200 and 900 metres ASL and is dominated throughout most of the region by Manna Gum *Eucalyptus viminalis*, Swamp Gum *Eucalyptus ovata*, Silver Wattle *Acacia dealbata*, Blackwood *Acacia melanoxylon*, Soft Tree-fern *Dicksonia antarctica* and Hazel Pomaderris *Pomaderris aspera*. The

only exception to this within the Gippsland region is around the Tambo River where the vegetation has elements of the East Gippsland flora dominated by Blackwood *Acacia melanoxylon*, Fishbone Water-fern *Blechnum nudum*, Prickly Currant-bush *Coprosma quadrifida*, Hazel Pomaderris *Pomaderris aspera*, Austral Bracken *Pteridium esculentum* and Kanooka *Tristaniopsis laurina*.

In the plains and coastal districts of the Gippsland region Estuarine Wetland, Freshwater Marsh, Swamp Scrub, Riparian Scrub and Sedge Wetland EVCs dominate slow-moving streams or freshwater swamps. Wetlands in these areas have, in the past, been extensively cleared and drained so that the land could be used for agriculture. Consequently, these habitats are very localised and heavily disturbed.

At higher altitudes in sub-alpine areas, bog communities dominated by Peat Moss *Sphagnum*, occur in permanently wet drainage lines and the upper reaches of streams. The dominant species in wetter areas within these bogs is Peat Moss *Sphagnum novozelandicum* whereas Peat Moss *Sphagnum cristatum* dominates in the drier areas. Associated with these bryophytes is a wide range of vascular plants that are usually confined to the slightly drier hummocks of the bog. Two sub-alpine 'wetland' communities, viz. Alpine Bog Community and Fen (Bog Pool) Community, have been listed on the *Flora & Fauna Guarantee Act* 1998.

Twelve percent of all the rare or threatened plants found within the Gippsland region grow primarily in riparian or wetland habitats. Out of these 43 plants, 16 are considered threatened and two of these, Bog Willow-herb *Epilobium brunnescens* ssp. *beaugleholei* and Native Wintercress *Barbarea grayi*, are currently considered to be threatened at a national level (Bog Willow-herb *Epilobium brunnescens* ssp. *beaugleholei* although not having a ROTP status is listed as vulnerable under the *Endangered Species Protection Act* 1992). Although Enigmatic Greenhood *Pterostylis aenigma* and Winged Everlasting *Ozothamnus adnatus* are suspected of being threatened at a national level, further survey is required to better document their distribution and identify any potential threats. The other 12 taxa threatened at a state level are Filmy Maidenhair *Adiantum diaphanum*, Brickmakers' Saw-sedge *Gahnia grandis*, Prickly Tree-fern *Cyathea leichhardtiana*, Star Cucumber *Sicyos australis*, Water Parsnip *Berula? erecta*, Mountain Water-fern *Blechnum vulcanicum*, Shining Anchor Plant *Discaria nitida*, Showy Willow-herb *Epilobium pallidiflorum*, Gippsland Red Gum *Eucalyptus tereticornis*, Slender Gingidia *Gingidia harveyana*, Blue-tongued Greenhood *Pterostylis dubia* and Slender Mud-grass *Pseudoraphis paradoxa*. Enigmatic Greenhood *Pterostylis aenigma* is endemic to the Gippsland region.

### Coastal habitats

The dominant land system throughout the coastal regions of this study area is the Gippsland Plain. This land system is characterised by gently sloping terrain south of the Eastern Highlands to the Victorian Coast. Along the coastline a typical series of vegetation types dominate the littoral zone, calcareous dune systems and immediate hinterland. The dominant EVCs in this area are Coast Banksia Woodland, Coastal Dune Scrub, Coastal Tussock Grassland, Coastal Saltmarsh and Mangrove Shrubland. All are commonly found along the Victorian Coast, including the recent Quaternary deposits that can be found around the mountainous granitic outcrop that forms Wilsons Promontory.

Only three plants of all the rare or threatened plants found within the Gippsland region grow primarily in coastal habitats. These are Coast Fescue *Austrofestuca littoralis*, Coast Stackhousia *Stackhousia spathulata* and White Mangrove *Avicennia marina* ssp *australasica*. Coast Fescue *Austrofestuca littoralis* is considered to be vulnerable in Victoria. Other priority taxa that occur within coastal habitats are Gilgai Blown-grass *Agrostis billardierei* var. *filifolia*, Marsh Saltbush *Atriplex paludosa*, Ribbed Thryptomene *Thryptomene micrantha* and Tiny Arrow-grass *Triglochin minuitissimum*.

## *Plants localised to natural regions of the Gippsland region*

### Wilsons Promontory

Wilsons Promontory is a mountainous granitic mass connected to the mainland by the Yanakie Isthmus. Geologically this range represents the most northerly point of a formation extending from north-eastern and eastern Tasmania. Although geologically distinct within Victoria the vegetation in this region is similar to the nearby Gippsland Highlands. Consequently only 1 plant of all the rare or threatened plants found within the Gippsland region, viz. Broad-leaved Prickly Moses *Acacia verticillata* var. *latifolia*, is endemic to Wilsons Promontory. Other threatened taxa that occur within Wilsons Promontory are Crimson Berry *Cyathodes juniperina*, Bushy Peppercress *Lepidium desvauxii*, Coast Bitter-bush *Adriana quadripartita* (pubescent form), Brickmakers' Saw-sedge *Gahnia grandis*, Beech Finger-fern *Grammitis magellanica* ssp. *nothofageti*, Long Clubmoss *Huperzia varia*, Promontory Daisy-bush *Olearia allenderae*, Prawn Greenhood *Pterostylis pedoglossa* and Tunstall's Greenhood *Pterostylis tunstallii*.

### Strzelecki Ranges

The Strzelecki Ranges are an isolated series of mountains in the southern section of the Gippsland region that are surrounded by the Gippsland Plain. Previously covered in tall forests, most of this vegetation was progressively cleared for settlement or logged for timber. Today there are significant areas of native forest in the Strzeleckis interspersed with native and exotic species plantations managed for timber production. The principal EVCs remaining in this area include Cool Temperate Rainforest, Warm Temperate Rainforest, Damp Forest, Wet Forest, Herb-rich Foothill Forest, Lowland Forest and Shrubby Foothill Forest. Some of the priority taxa common in the Strzelecki Ranges are Filmy Maidenhair

*Adiantum diaphanum*, Strzelecki Gum *Eucalyptus strzeleckii*, Slender Tree-fern *Cyathea cunninghamii* and Sticky Wattle *Acacia howittii*.

### Gippsland Plains

The Gippsland Plains are extensive coastal plains that extend across the southern section of the Gippsland region. The vegetation in this area is both structurally and floristically diverse, resulting in a wide range of ecological vegetation classes. Some of the main EVCs include Coast Banksia Woodland, Coastal Dune Scrub, Damp Sands Herb-rich Woodland, Lowland Forest, Heathy Woodland, Plains Grassy Woodland, (only isolated remnants remaining) and Plains Grassy Forest.

Threatened taxa known to occur on the Gippsland Plains include Gilgai Blown Grass *Agrostis billardierei* var. *filifolia*, Wavy Swamp Wallaby-grass *Amphibromus sinuatus*, Swamp Everlasting *Bracteantha palustris*, Purple Diuris *Diuris punctata* var. *punctata*, Gippsland Red Gum *Eucalyptus tereticornis*, Prostrate Cone-bush *Isopogon prostratus*, Woolly Waterlily *Philydrum lanuginosum*, Gaping Leek-orchid *Prasophyllum correctum*, Maroon Leek-orchid *Prasophyllum frenchii*, Holey Plains Mint-bush *Prostanthera* sp. aff. *linearis* (Holey Plains), Dwarf Kerrawang *Rulingia prostrata* and Metallic Sun-orchid *Thelymitra epipactoides*. Holey Plains Mint-bush *Prostanthera* sp. aff. *linearis* (Holey Plains) and Dwarf Kerrawang *Rulingia prostrata* are endemic to the Gippsland region.

## *Plants endemic to the Gippsland region*

Nine priority taxa are endemic to the Gippsland region. Two taxa are considered threatened nationally, viz. Marble Daisy-bush *Olearia astroloba* and Dwarf Kerrawang *Rulingia prostrata*, and another four considered threatened in Victoria, viz. Lemon-scented Boronia *Boronia citrata*, Aniseed Boronia *Boronia galbraithiae*, Leafy Phebalium *Phebalium frondosum* and Enigmatic Greenhood *Pterostylis aenigma*. The other endemic taxa not considered threatened are Promontory Peppermint *Eucalyptus willisii* ssp. *willisii* s.s. (Prom), Mount Elizabeth Hovea *Hovea pannosa* (Mount Elizabeth form) and Holey Plains Mint-bush *Prostanthera* sp. aff. *linearis* (Holey Plains).

## Table 4.1 Conservation Status and Distribution of Rare or Threatened Plants in the Gippsland Regional Forest Agreement region.

(a) **Plants listed (or recommended for listing) as threatened under the Commonwealth *Endangered Species Protection Act* 1992 and the *Flora and Fauna Guarantee Act* 1988.**

| Species Name | Common Name | Conservation Status | | | | % of Australian Range | Tenure | | |
|---|---|---|---|---|---|---|---|---|---|
| | | ESP | ROTAP | FFG | VROTS | | cr (%) | opl (%) | pri (%) |
| *Acacia caerulescens* | Limestone Blue Wattle | V | V | - | v | 0-25% | - | 10 | 90 |
| *Adiantum diaphanum* | Filmy Maidenhair | - | - | listed | e | 0-25% | - | 90 | 10 |
| *Adriana quadripartita* (pubescent form) | Coast Bitter-bush | - | - | listed | v | unknown | 100 | - | - |
| *Adriana quadripartita* s.s. (glabrous form) | Rare Bitter-bush | - | - | listed | e | 0-25% | - | - | 100 |
| *Agrostis billardierei* var. *filifolia* | Gilgai Blown-grass | - | - | listed | v | 26-50% | 50 | - | 50 |
| *Almaleea capitata* | Slender Parrot-pea | - | R | listed | r | 0-25% | 100 | - | - |
| *Amphibromus fluitans* | River Swamp Wallaby-grass | V | V | rejected | k | 0-25% | - | - | 100 |
| *Asplenium hookerianum* | Maidenhair Spleenwort | V | V | final rec | e | 26-50% | 100 | - | - |
| *Asplenium obtusatum* | Shore Spleenwort | V | E | - | v | 0-25% | 100 | - | - |
| *Boronia galbraithiae* | Aniseed Boronia | - | R | listed | v | 76-100% | 100 | - | - |
| *Brachyscome tenuiscapa* | Mountain Daisy | - | - | listed | v | 26-50% | 80 | 10 | 10 |
| *Bracteantha palustris* | Swamp Everlasting | - | - | listed | v | unknown | 30 | 70 | - |
| *Caladenia fragrantissima* ssp. *orientalis* | Eastern Spider-orchid | E | E | listed | e | 0-25% | k | k | k |
| *Carex paupera* | Dwarf Sedge | - | R | listed | v | 51-75% | 100 | - | - |
| *Celmisia sericophylla* | Silky Daisy | - | R | listed | r | 0-25% | - | 100 | - |
| *Cyathea cunninghamii* | Slender Tree-fern | - | R | listed | v | 0-25% | 70 | 10 | 20 |
| *Cyathea leichhardtiana* | Prickly Tree-fern | - | - | listed | v | 0-25% | 100 | - | - |
| *Discaria nitida* | Shining Anchor Plant | - | R | listed | e | 51-75% | 10 | 80 | 10 |
| *Discaria pubescens* | Hairy Anchor Plant | - | R | listed | v | 26-50% | - | 60 | 40 |
| *Diuris ochroma* | Pale Golden Moths | V | V | - | v | 76-100% | 100 | - | - |
| *Diuris punctata* var. *punctata* | Purple Diuris | - | - | listed | v | 0-25% | - | 10 | 90 |
| *Drabastrum alpestre* | Mountain Cress | - | R | listed | v | 26-50% | 100 | - | - |
| *Epilobium brunnescens* ssp. *beaugleholei* | Bog Willow-herb | V | - | - | v | 76-100% | 100 | - | - |
| *Epilobium willisii* | Carpet Willow-herb | - | R | listed | x | 0-25% | 100 | - | - |
| *Eucalyptus strzeleckii* | Strzelecki Gum | V | V | - | e | 76-100% | - | 50 | 50 |
| *Euphrasia collina* ssp. *muelleri* | Purple Eyebright | E | - | - | e | 0-25% | - | 100 | - |
| *Euphrasia scabra* | Rough Eyebright | - | K | listed | e | 26-50% | 80 | 20 | - |
| *Glycine latrobeana* | Clover Glycine | V | V | listed | v | 0-25% | 100 | - | - |
| *Isopogon prostratus* | Prostrate Cone-bush | - | - | listed | e | 0-25% | 100 | - | - |
| *Lepidium aschersonii* | Spiny Pepper-cress | V | V | listed | e | 0-25% | - | 100 | - |
| *Olearia astroloba* | Marble Daisy-bush | V | V | listed | v | 76-100% | - | 100 | - |
| *Poa saxicola* | Rock Poa | - | - | listed | v | 26-50% | 100 | - | - |
| *Prasophyllum correctum* | Gaping Leek-orchid | E | E | listed | e | 76-100% | - | 100 | - |
| *Prasophyllum frenchii* | Maroon Leek-orchid | V | V | final rec | e | 26-50% | 20 | - | 80 |
| *Pseudoraphis paradoxa* | Slender Mud Grass | - | - | final rec | e | 0-25% | 100 | - | - |
| *Pterostylis cucullata* | Leafy Greenhood | V | V | listed | v | 26-50% | 90 | - | 10 |
| *Pterostylis tenuissima* | Swamp Greenhood | V | V | - | v | 0-25% | 100 | - | - |
| *Rulingia prostrata* | Dwarf Kerrawang | E | E | listed | e | 76-100% | - | 30 | 70 |
| *Thelymitra epipactoides* | Metallic Sun-orchid | E | E | listed | e | 0-25% | 90 | 10 | - |
| *Thelymitra matthewsii* | Spiral Sun-orchid | V | V | listed | v | 0-25% | - | 100 | - |
| *Thesium australe* | Austral Toad-flax | V | V | listed | e | 0-25% | 100 | - | - |
| *Wahlenbergia densifolia* | Fairy Bluebell | - | - | listed | v | 51-75% | 80 | 10 | 10 |

**(b) Other Victorian Rare or Threatened Plants**

| Species Name | Common Name | Conservation Status | | | | % of Australian Range | Tenure | | |
|---|---|---|---|---|---|---|---|---|---|
| | | ESP | AROTS | FFG | VROTS | | cr (%) | opl (%) | pri (%) |
| *Acacia alpina* | Alpine Wattle | - | - | - | r | 51-75% | 30 | 70 | - |
| *Acacia howittii* | Sticky Wattle | - | R | - | r | 76-100% | 40 | 30 | 30 |
| *Acacia retinodes* var. *uncifolia* | Coast Wirilda | - | - | - | r | 0-25% | 100 | - | - |
| *Acacia verticillata* var. *latifolia* | Broad-leaf Prickly Moses | - | - | - | r | 51-75% | 100 | - | - |
| *Aciphylla glacialis* | Snow Aciphyll | - | - | - | v | 51-75% | 60 | 40 | - |
| *Aciphylla simplicifolia* | Mountain Aciphyll | - | - | - | r | 51-75% | 30 | 70 | - |
| *Acronychia oblongifolia* | Yellowwood | - | - | - | r | 0-25% | 30 | 10 | 60 |
| *Acrotriche leucocarpa* | Tall Ground-berry | - | - | - | r | 26-50% | 20 | 80 | - |
| *Adiantum hispidulum* var. *hispidulum* | Rough Maidenhair | - | - | - | r | 0-25% | - | 10 | 90 |
| *Adriana tomentosa* var. *tomentosa* | Eastern Bitter-bush | - | - | - | r | unknown | - | - | 100 |
| *Agrostis aemula* var. *setifolia* | Gilgai Blown-grass | - | - | - | v | 0-25% | 50 | - | 50 |
| *Agrostis australiensis* | Tiny Bent | - | - | - | r | 26-50% | 80 | 10 | 10 |
| *Agrostis avenacea* var. *perennis* | Wetland Blown-grass | - | - | - | k | 26-50% | 10 | 50 | 40 |
| *Agrostis meionectes* | Alpine Bent | - | R | - | r | 26-50% | 100 | - | - |
| *Agrostis muelleriana* | Mueller's Bent | - | - | - | r | 26-50% | 40 | 50 | 10 |
| *Agrostis rudis* | Ruddy Bent | - | - | - | r | 0-25% | 80 | 10 | 10 |
| *Alchemilla* sp. 1 | Lady's Mantle | - | - | - | r | 0-25% | 100 | - | - |
| *Amphibromus sinuatus* | Wavy Swamp Wallaby-grass | - | - | - | v | 0-25% | k | k | k |
| *Aristida calycina* var. *calycina* | Dark Wire-grass | - | - | - | r | 0-25% | - | 100 | - |
| *Arthropodium* sp. 1 *(robust glaucous)* | Tall Vanilla-lily | - | - | - | r | 26-50% | - | 100 | - |
| *Arthropodium* sp. 3 (aff. *strictum)* | Small Chocolate-lily | - | - | - | k | 0-25% | - | - | 100 |
| *Asplenium trichomanes* | Common Spleenwort | - | - | - | r | 0-25% | 100 | - | - |
| *Asplenium trichomanes* ssp. *quadrivalens* | Common Spleenwort | - | - | - | r | unknown | 100 | - | - |
| *Asplenium trichomanes* ssp. *trichomanes* | Common Spleenwort | - | - | - | r | unknown | 100 | - | - |
| *Astrotricha linearis* | Narrow-leaf Star-hair | - | - | - | r | 0-25% | 100 | - | - |
| *Astrotricha parvifolia* | Small-leaf Star-hair | - | R | - | r | 76-100% | k | k | k |
| *Atriplex australasica* | Native Orache | - | - | - | k | 0-25% | 60 | - | 40 |
| *Atriplex paludosa* ssp. *paludosa* | Marsh Saltbush | - | - | - | k | 0-25% | 60 | - | 40 |
| *Australina pusilla* ssp. *pusilla* | Small Shade-nettle | - | - | - | r | 0-25% | 100 | - | - |
| *Australopyrum retrofractum* | Comb Wheat-grass | - | - | - | r | 0-25% | - | 100 | - |
| *Australopyrum velutinum* | Mountain Wheat-grass | - | - | - | r | 26-50% | 50 | 30 | 20 |
| *Austrodanthonia induta* | Shiny Wallaby-grass | - | - | - | k | 0-25% | - | 30 | 70 |
| *Austrodanthonia pilosa* var. *paleacea* | Large Velvet Wallaby-grass | - | - | - | r | 0-25% | - | - | 100 |
| *Austrodanthonia* sp. *(syn. Danthonia procera)* | Tall Wallaby-grass | - | - | - | k | 0-25% | - | - | 100 |
| *Austrofestuca eriopoda* | Lanky Fescue | - | - | - | r | 26-50% | 10 | 80 | 10 |
| *Austrofestuca littoralis* | Coast Fescue | - | - | - | v | 0-25% | 80 | - | 20 |
| *Avicennia marina* ssp. *australasica* | White Mangrove | - | - | - | r | 0-25% | 100 | - | - |
| *Banksia saxicola* | Rock Banksia | - | - | - | r | 26-50% | 100 | - | - |
| *Barbarea grayi* | Native Wintercress | - | E | - | v | 26-50% | 100 | - | - |
| *Baumea laxa* | Lax Twig-sedge | - | - | - | r | 0-25% | 100 | - | - |
| *Bertya cunninghamii* | Sticky Bertya | - | - | - | r | 0-25% | 60 | 40 | - |
| *Bertya findlayi* | Mountain Bertya | - | R | - | v | 0-25% | 100 | - | - |
| *Berula ? erecta* | Water Parsnip | - | - | - | k | unknown | k | - | - |
| *Beyeria lasiocarpa* | Wallaby-bush | - | - | - | r | 0-25% | - | 90 | 10 |
| *Beyeria viscosa* | Pinkwood | - | - | - | r | 0-25% | 30 | 50 | 20 |

| Species Name | Common Name | Conservation Status | | | | % of Australian Range | Tenure | | |
|---|---|---|---|---|---|---|---|---|---|
| | | ESP | AROTS | FFG | VROTS | | cr (%) | opl (%) | pri (%) |
| *Billardiera scandens* var. *brachyantha* | Velvet Apple-berry | - | - | - | r | unknown | - | 100 | - |
| *Blechnum vulcanicum* | Mountain Water-fern | - | - | - | e | 26-50% | 100 | - | - |
| *Boronia anemonifolia* ssp. B (Wilsons Promontory) | Sticky Boronia | - | - | - | k | 76-100% | 100 | - | - |
| *Boronia citrata* | Lemon-scented Boronia | - | R | rejected | v | 76-100% | 100 | - | - |
| *Boronia ledifolia* | Showy Boronia | - | - | - | v | 0-25% | 100 | - | - |
| *Bossiaea bracteosa* | Mountain Leafless Bossiaea | - | - | - | r | 26-50% | 80 | 20 | - |
| *Bossiaea heterophylla* | Variable Bossiaea | - | - | - | r | 0-25% | 50 | 10 | 40 |
| *Botrychium australe* | Austral Moonwort | - | - | - | v | 26-50% | 70 | - | 30 |
| *Brachyscome* aff. *formosa* Entity 1 | Elegant Daisy | - | - | - | k | 26-50% | k | k | k |
| *Brachyscome obovata* | Baw Baw Daisy | - | - | - | r | 26-50% | 100 | - | - |
| *Brachyscome petrophila* | Rock Daisy | - | R | - | r | 0-25% | 30 | 70 | - |
| *Brachyscome radicans* | Marsh Daisy | - | - | - | r | 0-25% | 30 | 70 | - |
| *Brachyscome tadgellii* | Tadgell's Daisy | - | - | - | r | 76-100% | 100 | - | - |
| *Caladenia aurantiaca* | Orange-tip Caladenia | - | - | - | r | 0-25% | k | k | k |
| *Caladenia australis* | Southern Spider-orchid | - | - | - | k | 0-25% | 100 | - | - |
| *Caladenia dilatata* s.s. | Green-comb Spider-orchid | - | - | - | k | 0-25% | k | k | k |
| *Caladenia hildae* | Honey Caladenia | - | - | - | r | 76-100% | 50 | 50 | - |
| *Callitriche palustris* | Swamp Water-starwort | - | - | - | k | 0-25% | k | k | k |
| *Calochilus gracillimus* | Slender Beard-orchid | - | - | - | k | 0-25% | 100 | - | - |
| *Cardamine lilacina* s.s. | Lilac Bitter-cress | - | - | - | k | unknown | k | k | k |
| *Cardamine tenuifolia* | Slender Bitter-cress | - | - | - | k | 0-25% | 30 | 40 | 30 |
| *Carex archeri* | Archer's Sedge | - | - | - | v | 51-75% | 100 | - | - |
| *Carex capillacea* | Hair Sedge | - | R | rejected | r | 26-50% | 60 | 30 | 10 |
| *Carex echinata* | Star Sedge | - | - | - | v | 26-50% | 100 | - | - |
| *Carex iynx* | Sedge | - | - | - | k | 0-25% | 100 | - | - |
| *Carex raleighii* | Raleigh Sedge | - | R | rejected | r | 26-50% | 60 | 30 | 10 |
| *Chionogentias cunninghamii* | Cunningham's Snow-gentian | - | - | - | k | 0-25% | k | k | k |
| *Chionogentias cunninghamii* ssp. *major* | Tall Snow-gentian | - | K | - | k | 26-50% | k | k | k |
| *Clematis microphylla* var. *leptophylla* | Skeleton Vine | - | - | - | k | 26-50% | 80 | 10 | 10 |
| *Colobanthus affinis* | Alpine Colobanth | - | - | - | r | 0-25% | 60 | 40 | - |
| *Coprosma moorei* | Turquoise Coprosma | - | - | - | r | 0-25% | 100 | - | - |
| *Coprosma nivalis* | Snow Coprosma | - | - | - | r | 26-50% | 60 | 30 | 10 |
| *Correa reflexa* var. *cardinalis* | South Gippsland Correa | - | - | - | r | 26-50% | 100 | - | - |
| *Corybas aconitiflorus* | Spurred Helmet-orchid | - | - | - | r | 0-25% | k | k | k |
| *Corybas fimbriatus* | Fringed Helmet-orchid | - | - | - | r | 0-25% | k | k | k |
| *Corybas fordhamii* | Swamp Helmet-orchid | - | - | - | r | 0-25% | k | k | k |
| *Corybas* sp. aff. *diemenicus* (Coastal) | Late Helmet-orchid | - | - | - | e | 76-100% | 100 | - | - |
| *Craspedia alba* | White Billy-buttons | - | R | - | k | 0-25% | 80 | 10 | 10 |
| *Craspedia* sp. (Mt Stirling) | Mt Stirling Billy-buttons | - | - | - | v | 26-50% | - | - | 100 |
| *Cryptandra amara* var. *longiflora* | Bitter Cryptandra | - | - | - | r | 0-25% | 100 | - | - |
| *Cuscuta tasmanica* | Golden Dodder | - | - | - | k | 0-25% | 100 | - | - |
| *Cyathodes juniperina* | Crimson Berry | - | - | - | v | 0-25% | 100 | - | - |
| *Cymbonotus lawsonianus* | Bear's-ears | - | - | - | r | 0-25% | k | k | k |
| *Cyphanthera anthocercidea* | Large-leaf Ray-flower | - | R | - | r | 51-75% | - | 100 | - |
| *Cystopteris tasmanica* | Brittle Bladder-fern | - | R | - | r | 26-50% | 100 | - | - |
| *Dampiera purpurea* | Mountain Dampiera | - | - | - | r | 0-25% | k | k | k |

| Species Name | Common Name | Conservation Status | | | | % of Australian Range | Tenure | | |
|---|---|---|---|---|---|---|---|---|---|
| | | ESP | AROTS | FFG | VROTS | | cr (%) | opl (%) | pri (%) |
| *Daviesia genistifolia* | Broom Bitter-pea | - | - | - | r | 0-25% | 100 | - | - |
| *Dendrobium striolatum* | Streaked Rock-orchid | - | - | - | r | 0-25% | 50 | 30 | 20 |
| *Deschampsia caespitosa* | Tufted Hair-grass | - | - | - | r | 0-25% | 100 | - | - |
| *Desmodium varians* | Slender Tick-trefoil | - | - | - | k | 0-25% | 10 | 50 | 40 |
| *Deyeuxia contracta* | Compact Bent-grass | - | - | - | r | 0-25% | 20 | 80 | - |
| *Deyeuxia crassiuscula* | Thick Bent-grass | - | - | - | r | 0-25% | 60 | 40 | - |
| *Deyeuxia decipiens* | Devious Bent-grass | - | - | - | v | 0-25% | - | 100 | - |
| *Dillwynia sieberi* | Parrot-pea | - | - | - | r | 76-100% | k | k | k |
| *Diplaspis nivis* | Snow Pennywort | - | - | - | r | 76-100% | 100 | - | - |
| *Dodonaea boroniifolia* | Hairy Hop-bush | - | - | - | r | 0-25% | 100 | - | - |
| *Echinopogon caespitosus* | Bushy Hedgehog-grass | - | - | - | e | 0-25% | 50 | - | 50 |
| *Elymus multiflorus* | Short-awned Wheat-grass | - | - | - | k | 0-25% | 60 | 40 | - |
| *Entolasia stricta* | Upright Panic | - | - | - | k | 0-25% | 40 | 20 | 40 |
| *Epacris glacialis* | Reddish Bog Heath | - | - | - | r | 0-25% | 100 | - | - |
| *Epacris microphylla* s.s. | Coral Heath | - | - | - | r | 0-25% | 80 | 20 | - |
| *Epacris microphylla* var. *microphylla* | Coast Coral Heath | - | - | - | v | 0-25% | 100 | - | - |
| *Epacris microphylla* var. *rhombifolia* | Mountain Coral Heath | - | - | - | r | 26-50% | 50 | 50 | - |
| *Epilobium pallidiflorum* | Showy Willow-herb | - | - | - | v | 0-25% | 20 | 30 | 50 |
| *Eragrostis benthamii* | Bentham's Love-grass | - | - | - | k | unknown | k | k | k |
| *Eragrostis leptostachya* | Paddock Love-grass | - | - | - | k | 0-25% | 30 | 50 | 20 |
| *Eragrostis trachycarpa* | Rough-grain Love-grass | - | - | delisted | v | 0-25% | 10 | 10 | 80 |
| *Eucalyptus bosistoana* | Coast Grey-box | - | - | - | r | 0-25% | 10 | 10 | 80 |
| *Eucalyptus elaeophloia* | Olive Mallee | - | R | - | v | 0-25% | k | k | k |
| *Eucalyptus glaucescens* | Tingaringy Gum | - | - | - | r | 0-25% | 100 | - | - |
| *Eucalyptus globulus* ssp. *globulus* | Southern Blue Gum | - | - | - | r | 26-50% | 80 | - | 20 |
| *Eucalyptus globulus* ssp. *maidenii* | Maiden's Gum | - | - | - | r | 0-25% | k | k | k |
| *Eucalyptus kitsoniana* | Bog Gum | - | R | - | r | 51-75% | 30 | - | 70 |
| *Eucalyptus kybeanensis* | Mallee Ash | - | - | - | r | 51-75% | 80 | 20 | - |
| *Eucalyptus mackintii* | Gippsland Stringybark | - | - | - | r | 0-25% | 20 | 80 | - |
| *Eucalyptus neglecta* | Omeo Gum | - | R | - | r | 51-75% | 50 | 50 | - |
| *Eucalyptus perriniana* | Spinning Gum | - | - | - | r | 26-50% | 80 | 20 | - |
| *Eucalyptus tereticornis* | Gippsland Red-gum | - | - | - | v | 0-25% | 30 | 20 | 50 |
| *Eucalyptus willisii* ssp. *willisii* s.s. (Prom*)* | Promontory Peppermint | - | - | - | r | 26-50% | k | k | k |
| *Eucalyptus yarraensis* | Yarra Gum | - | R | rejected | k | 0-25% | - | - | 100 |
| *Euchiton umbricolus* | Cliff Cudweed | - | - | - | r | 26-50% | 70 | 30 | - |
| *Euphrasia caudata* | Tailed Eyebright | - | - | - | r | 26-50% | 60 | 40 | - |
| *Euphrasia collina* ssp. aff. *diversicolor(*Cobberas) | Purple Eyebright | - | - | - | v | 76-100% | 100 | - | - |
| *Euphrasia collina* ssp. *diversicolor* | Purple Eyebright | - | - | - | x | 0-25% | k | k | k |
| *Exocarpos syrticola* | Coast Ballart | - | - | - | r | 0-25% | 80 | - | 20 |
| *Gahnia grandis* | Brickmakers' Saw-sedge | - | - | - | v | 0-25% | 100 | - | - |
| *Gahnia microstachya* | Slender Saw-sedge | - | - | - | r | 0-25% | 20 | 80 | - |
| *Genoplesium arrectum* | Erect Midge-orchid | - | R | - | r | 51-75% | k | k | k |
| *Genoplesium despectans* | Sharp Midge-orchid | - | K | - | - | 26-50% | k | k | k |
| *Genoplesium nudiscapum* | Dense Midge-orchid | - | - | - | v | 76-100% | k | k | k |
| *Genoplesium nudum* | Tiny Midge-orchid | - | - | - | r | 0-25% | k | k | k |
| *Geranium obtusisepalum* | Kosciusko Cranesbill | - | - | - | k | 0-25% | - | 100 | - |

| Species Name | Common Name | Conservation Status | | | | % of Australian Range | Tenure | | |
|---|---|---|---|---|---|---|---|---|---|
| | | ESP | AROTS | FFG | VROTS | | cr (%) | opl (%) | pri (%) |
| *Geranium sessiliflorum* ssp. *brevicaule* | Alpine Cranesbill | - | - | - | r | 0-25% | 20 | 20 | 60 |
| *Gingidia harveyana* | Slender Gingidia | - | - | - | v | 0-25% | 70 | 30 | - |
| *Glossodia minor* | Small Wax-lip Orchid | - | - | - | r | 0-25% | 100 | - | - |
| *Goodenia macmillanii* | Pinnate Goodenia | - | - | - | r | 26-50% | 30 | 70 | - |
| *Grammitis magellanica* ssp. *nothofageti* | Beech Finger-fern | - | - | - | v | 0-25% | 100 | - | - |
| *Gratiola nana* | Matted Brooklime | - | - | - | v | 0-25% | 80 | 20 | - |
| *Grevillea celata* | Colquhoun Grevillea | - | - | - | v | 76-100% | - | 100 | - |
| *Grevillea chrysophaea* | Golden Grevillea | - | - | - | r | 51-75% | 60 | 20 | 20 |
| *Grevillea miqueliana* | Oval-leaf Grevillea | - | - | - | r | 51-75% | 100 | - | - |
| *Grevillea willisii* | Rock Grevillea | - | R | - | r | 76-100% | 70 | 20 | 10 |
| *Gynatrix macrophylla* | Gippsland Hemp Bush | - | - | - | r | 76-100% | 50 | 50 | - |
| *Herpolirion novae-zelandiae* | Sky Lily | - | - | - | r | 26-50% | k | k | k |
| *Hibbertia diffusa* | Wedge Guinea-flower | - | - | - | r | 0-25% | 60 | 40 | - |
| *Hibbertia hermanniifolia* | Outcrop Guinea-flower | - | R | - | r | 26-50% | 60 | 40 | - |
| *Hibbertia pedunculata* | Stalked Guinea-flower | - | - | - | r | 0-25% | 90 | 10 | - |
| *Hovea pannosa* (Mount Elizabeth form) | Mt Elizabeth Hovea | - | - | - | r | 76-100% | 100 | - | - |
| *Hovea pannosa* (rheophytic Omeo form) | Mountain Hovea | - | - | - | r | 76-100% | k | k | k |
| *Huperzia australiana* | Fir Clubmoss | - | - | - | r | 0-25% | 60 | 40 | - |
| *Huperzia varia* | Long Clubmoss | - | - | - | v | 0-25% | 100 | - | - |
| *Hybanthus monopetalus* | Slender Violet-bush | - | - | - | r | 0-25% | k | k | k |
| *Hypsela tridens* | Hypsela | - | - | - | k | 26-50% | k | k | k |
| *Irenepharsus magicus* | Elusive Cress | - | R | - | r | 26-50% | - | 100 | - |
| *Isolepis gaudichaudiana* | Benambra Club-sedge | - | - | - | v | 0-25% | k | k | k |
| *Isolepis montivaga* | Fog Club-sedge | - | - | - | r | 26-50% | 40 | 10 | 50 |
| *Isolepis wakefieldiana* | Tufted Club-sedge | - | - | - | r | 0-25% | k | k | k |
| *Juncus falcatus* | Sickle-leaf Rush | - | - | - | r | 26-50% | 60 | 40 | - |
| *Juncus phaeanthus* | Dark-flower Rush | - | - | - | r | 26-50% | 20 | 80 | - |
| *Juncus revolutus* | Creeping Rush | - | - | - | r | 0-25% | 80 | 20 | - |
| *Koeleria cristata* | Crested Hair-grass | - | - | - | r | 0-25% | 70 | 30 | - |
| *Korthalsella rubra* ssp. *rubra* | Jointed Mistletoe | - | - | - | v | 0-25% | 100 | - | - |
| *Laxmannia gracilis* | Slender Wire-lily | - | - | - | r | 0-25% | 30 | 10 | 60 |
| *Lepidium desvauxii* | Bushy Pepper-cress | - | - | - | r | 0-25% | 100 | - | - |
| *Lepidium pseudohyssopifolium* | Native Pepper-cress | - | - | - | k | 0-25% | - | 50 | 50 |
| *Lepidosperma canescens* | Hoary Rapier-sedge | - | - | - | r | 0-25% | 100 | - | - |
| *Lepidosperma gunnii* | Slender Sword-sedge | - | - | - | k | 0-25% | 30 | 70 | - |
| *Lepilaena marina* | Sea Water-mat | - | - | - | v | 0-25% | 100 | - | - |
| *Leptorhynchos elongatus* | Lanky Buttons | - | - | - | e | 0-25% | 30 | 70 | - |
| *Leptospermum emarginatum* | Twin-flower Tea-tree | - | - | - | r | 26-50% | k | k | k |
| *Lespedeza juncea* ssp. *sericea* | Chinese Lespedeza | - | - | - | r | 0-25% | k | k | k |
| *Leucopogon attenuatus* | Grey Beard-heath | - | - | - | r | 0-25% | 10 | 90 | - |
| *Leucopogon juniperinus* | Long-flower Beard-heath | - | - | - | k | 0-25% | 20 | 70 | 10 |
| *Leucopogon montanus* | Snow Beard-heath | - | - | - | r | 0-25% | 100 | - | - |
| *Leucopogon pilifer* | Trailing Beard-heath | - | - | - | r | 26-50% | 90 | 10 | - |
| *Limonium australe* | Yellow Sea-lavender | - | - | - | r | 0-25% | 100 | - | - |
| *Lomandra glauca* s.s. | Blue Mat-rush | - | - | - | k | 0-25% | k | k | k |
| *Lotus australis* | Austral Trefoil | - | - | - | k | 0-25% | 70 | 20 | 10 |

| Species Name | Common Name | Conservation Status | | | | % of Australian Range | Tenure | | |
|---|---|---|---|---|---|---|---|---|---|
| | | ESP | AROTS | FFG | VROTS | | cr (%) | opl (%) | pri (%) |
| *Luzula acutifolia* ssp. *acutifolia* | Sharp-leaf Woodrush | - | - | - | r | 26-50% | 100 | - | - |
| *Luzula alpestris* | Tussock Woodrush | - | - | - | r | 26-50% | 70 | - | 30 |
| *Macroglena caudata* | Jungle Bristle-fern | - | - | - | r | 0-25% | 100 | - | - |
| *Marsdenia flavescens* | Yellow Milk-vine | - | - | - | r | 0-25% | 20 | 10 | 70 |
| *Melaleuca armillaris* ssp. *armillaris* | Giant Honey-myrtle | - | - | - | r | 0-25% | - | - | 100 |
| *Microtis orbicularis* | Dark Mignonette-orchid | - | - | - | v | 0-25% | 100 | - | - |
| *Monotoca glauca* | Currant-wood | - | - | - | r | 26-50% | 100 | - | - |
| *Monotoca oreophila* | Mountain Broom-heath | - | R | - | r | 26-50% | 100 | - | - |
| *Muehlenbeckia axillaris* | Matted Lignum | - | - | - | r | 26-50% | 100 | - | - |
| *Muellerina celastroides* | Coast Mistletoe | - | - | - | r | 0-25% | k | k | k |
| *Myriophyllum alpinum* | Alpine Water-milfoil | - | - | - | r | 0-25% | 20 | 80 | - |
| *Nymphoides geminata* | Open Marshwort | - | - | - | r | 0-25% | k | k | k |
| *Olearia adenophora* | Scented Daisy-bush | - | R | - | r | 51-75% | 70 | 20 | 10 |
| *Olearia aglossa* | Alpine Daisy-bush | - | K | - | k | 0-25% | 100 | - | - |
| *Olearia allenderae* | Promontory Daisy-bush | - | R | - | v | 26-50% | 100 | - | - |
| *Olearia frostii* | Bogong Daisy-bush | - | R | - | r | 0-25% | 30 | 70 | - |
| *Olearia stellulata* | Starry Daisy-bush | - | - | - | k | 0-25% | 100 | - | - |
| *Olearia tenuifolia* | Thin-leaf Daisy-bush | - | - | - | v | 0-25% | 100 | - | - |
| *Olearia viscosa* | Viscid Daisy-bush | - | - | - | r | 0-25% | 20 | 10 | 70 |
| *Ophioglossum petiolatum* | Stalked Adder's-tongue | - | - | - | r | 0-25% | k | k | k |
| *Oreobolus oxycarpus* ssp. *oxycarpus* | Tuft-rush | - | - | - | r | 26-50% | 20 | 80 | - |
| *Oreobolus pumilio* ssp. *pumilio* | Alpine Tuft-rush | - | - | - | r | 0-25% | 100 | - | - |
| *Oreomyrrhis argentea* | Silver Carraway | - | - | rejected | v | 0-25% | 100 | - | - |
| *Oschatzia cuneifolia* | Wedge Oschatzia | - | R | - | r | 26-50% | 80 | 20 | - |
| *Ozothamnus adnatus* | Winged Everlasting | - | K | - | v | 0-25% | - | 100 | - |
| *Ozothamnus argophyllus* | Spicy Everlasting | - | - | - | r | 0-25% | - | 50 | 50 |
| *Ozothamnus rogersianus* | Nunniong Everlasting | - | - | - | r | 26-50% | k | k | k |
| *Pelargonium* aff. *rodneyanum* (Lake Omeo) | Omeo Stork's-bill | - | - | - | v | unknown | k | k | k |
| *Persoonia asperula* | Mountain Geebung | - | - | - | e | 0-25% | 100 | - | - |
| *Phebalium frondosum* | Leafy Phebalium | - | R | - | v | 76-100% | 100 | - | - |
| *Phebalium squameum* ssp. *coriaceum* | Harsh Phebalium | - | - | - | v | 76-100% | 100 | - | - |
| *Philydrum lanuginosum* | Woolly Waterlily | - | - | - | v | 0-25% | 100 | - | - |
| *Pimelea axiflora* ssp. *alpina* | Alpine Bootlace Bush | - | - | - | r | 26-50% | 100 | 100 | - |
| *Pimelea biflora* | Matted Rice-flower | - | - | - | r | 26-50% | 80 | - | 20 |
| *Pimelea flava* ssp. *dichotoma* | Diosma Rice-flower | - | - | - | r | 0-25% | - | 100 | - |
| *Pimelea pauciflora* | Poison Rice-flower | - | - | - | r | 26-50% | 40 | 40 | 20 |
| *Platylobium triangulare* | Ivy Flat-pea | - | - | - | k | 0-25% | k | k | k |
| *Platysace ericoides* | Heath Platysace | - | - | - | r | 0-25% | 10 | 90 | - |
| *Poa clivicola* | Fine-leaf Snow-grass | - | - | - | r | 51-75% | 50 | 50 | - |
| *Poa fordeana* | Forde Poa | - | - | - | k | 0-25% | 50 | - | 50 |
| *Poa gunnii* | Avon Tussock-grass | - | - | - | r | 26-50% | 70 | 20 | 10 |
| *Poa hookeri* | Hooker's Tussock-grass | - | - | - | r | 0-25% | 100 | - | - |
| *Poa labillardierei* var. *acris* | Sharp Mountain Tussock-grass | - | - | - | v | 51-75% | 40 | 20 | 40 |
| *Poa meionectes* | Fine-leaf Tussock-grass | - | - | - | r | 0-25% | - | 80 | 20 |
| *Poa petrophila* | Rock Tussock-grass | - | - | - | v | 26-50% | 80 | - | 20 |
| *Poa poiformis* var. *ramifer* | Trailing Coast Poa | - | - | - | r | 0-25% | 100 | - | - |

| Species Name | Common Name | Conservation Status | | | | % of Australian Range | Tenure | | |
|---|---|---|---|---|---|---|---|---|---|
| | | ESP | AROTS | FFG | VROTS | | cr (%) | opl (%) | pri (%) |
| *Poa sieberiana* var. *cyanophylla* | Blue-leaf Tussock-grass | - | - | - | r | 26-50% | 50 | 50 | - |
| *Poa* sp. aff. *tenera* (Hairy) | Soft Slender Tussock-grass | - | - | - | r | 0-25% | - | 100 | - |
| *Polygala japonica* | Dwarf Milkwort | - | - | - | v | 0-25% | 50 | 10 | 40 |
| *Polystichum formosum* | Broad Shield-fern | - | - | - | r | 0-25% | - | 100 | - |
| *Pomaderris aurea* | Golden Pomaderris | - | - | - | r | 51-75% | 20 | 70 | 10 |
| *Pomaderris discolor* | Eastern Pomaderris | - | - | - | r | 0-25% | - | 100 | - |
| *Pomaderris oraria* | Coast Pomaderris | - | R | - | r | 51-75% | 50 | 50 | - |
| *Pomaderris oraria* ssp. *calcicola* | Limestone Pomaderris | - | R | - | r | 76-100% | - | 80 | 20 |
| *Pomaderris oraria* ssp. *oraria* | Coast Pomaderris | - | R | - | r | 51-75% | 100 | - | - |
| *Potamogeton australiensis* | Thin Pondweed | - | - | - | k | 0-25% | 100 | - | - |
| *Prasophyllum lindleyanum* | Green Leek-orchid | - | - | rejected | v | 0-25% | 100 | - | - |
| *Prasophyllum patens* | Broad-lip Leek-orchid | - | - | - | r | 0-25% | k | k | k |
| *Prasophyllum pyriforme* s.s. | Silurian Leek-orchid | - | - | - | k | 0-25% | 30 | - | 70 |
| *Prasophyllum rogersii* | Marsh Leek-orchid | - | - | - | v | 0-25% | 100 | - | - |
| *Prostanthera decussata* | Dense Mint-bush | - | - | - | r | 0-25% | 20 | 80 | - |
| *Prostanthera rhombea* | Sparkling Mint-bush | - | - | - | v | 0-25% | 100 | - | - |
| *Prostanthera* sp. aff. *linearis* (Holey Plains) | Holey Plains Mint-bush | - | - | - | v | 76-100% | 90 | - | 10 |
| *Prostanthera walteri* | Monkey Mint-bush | - | R | - | r | 0-25% | 90 | 10 | - |
| *Pseudanthus divaricatissimus* | Tangled Pseudanthus | - | R | - | r | 26-50% | 60 | 40 | - |
| *Pterostylis aenigma* | Enigmatic Greenhood | - | K | - | e | 76-100% | 100 | - | - |
| *Pterostylis aestiva* | Long-tongue Summer Greenhood | - | - | - | r | 0-25% | 50 | 50 | - |
| *Pterostylis alveata* | Gippsland Greenhood | - | - | - | v | 0-25% | k | k | k |
| *Pterostylis dubia* | Blue-tongue Greenhood | - | - | - | e | 26-50% | 20 | 80 | - |
| *Pterostylis fischii* | Fisch's Greenhood | - | - | - | r | 0-25% | 70 | 30 | - |
| *Pterostylis grandiflora* | Cobra Greenhood | - | - | - | r | 0-25% | - | 100 | - |
| *Pterostylis pedoglossa* | Prawn Greenhood | - | - | - | v | 0-25% | 100 | - | - |
| *Pterostylis tunstallii* | Tunstall's Greenhood | - | - | - | v | 0-25% | 100 | - | - |
| *Pultenaea fasciculata* | Alpine Bush-pea | - | - | - | r | 26-50% | 40 | 60 | - |
| *Pultenaea foliolosa* | Small-leaf Bush-pea | - | - | - | r | 0-25% | - | 100 | - |
| *Pultenaea tenella* | Delicate Bush-pea | - | - | - | r | 51-75% | 70 | 30 | - |
| *Pultenaea williamsonii* | Highland Bush-pea | - | K | - | r | 0-25% | 100 | - | - |
| *Ranunculus collinus* | Strawberry Buttercup | - | - | - | r | 26-50% | 70 | 30 | - |
| *Ranunculus eichlerianus* | Eichler's Buttercup | - | R | rejected | r | 26-50% | 70 | 20 | 10 |
| *Ranunculus gunnianus* | Gunn's Alpine Buttercup | - | - | - | r | 26-50% | 100 | - | - |
| *Ranunculus millanii* | Dwarf Buttercup | - | - | - | r | 51-75% | 80 | 10 | 10 |
| *Ranunculus papulentus* | Large River Buttercup | - | - | - | k | 0-25% | k | k | k |
| *Ranunculus victoriensis* | Victorian Buttercup | - | - | - | r | 51-75% | 100 | - | - |
| *Rytidosperma nivicolum* | Snow Wallaby-grass | - | - | - | r | 0-25% | 100 | - | - |
| *Sagina namadgi* | Native Pearlwort | - | - | - | k | 0-25% | 50 | 50 | - |
| *Samolus valerandii* | Water Pimpernel | - | - | - | r | 0-25% | - | 100 | - |
| *Schizacme montana* var. *montana* | Mountain Mitrewort | - | - | - | r | 0-25% | 100 | - | - |
| *Schizeilema fragoseum* | Alpine Pennywort | - | - | - | v | 0-25% | 100 | - | - |
| *Schoenus carsei* | Wiry Bog-sedge | - | - | - | r | 0-25% | 100 | - | - |
| *Schoenus imberbis* | Beardless Bog-sedge | - | - | - | r | 0-25% | k | k | k |
| *Scirpus polystachyus* | Large-head Club-sedge | - | - | - | r | 0-25% | 10 | 30 | 60 |
| *Scleranthus diander* | Tufted Knawel | - | - | - | r | 51-75% | 90 | - | 10 |

| Species Name | Common Name | Conservation Status | | | | % of Australian Range | Tenure | | |
|---|---|---|---|---|---|---|---|---|---|
| | | ESP | AROTS | FFG | VROTS | | cr (%) | opl (%) | pri (%) |
| *Scleranthus fasciculatus* | Spreading Knawel | - | - | - | r | 0-25% | 80 | 10 | 10 |
| *Scleranthus singuliflorus* | Mossy Knawel | - | - | - | r | 0-25% | - | 100 | - |
| *Senecio diaschides* | Shingle Fireweed | - | - | - | r | 0-25% | 90 | 10 | - |
| *Senecio pectinatus* var. *major* | Alpine Groundsel | - | - | - | r | 0-25% | 80 | 20 | - |
| *Senna aciphylla* | Sprawling Cassia | - | - | - | r | 0-25% | - | 100 | - |
| *Sicyos australis* | Star Cucumber | - | - | - | v | 0-25% | 100 | - | - |
| *Solanum linearifolium* | Mountain Kangaroo Apple | - | - | - | r | 0-25% | - | 100 | - |
| *Sorghum leiocladum* | Wild Sorghum | - | - | - | v | 0-25% | - | 100 | - |
| *Sowerbaea juncea* | Rush Lily | - | - | - | r | 0-25% | 100 | - | - |
| *Spiranthes sinensis* | Austral Ladies' Tresses | - | - | - | v | 0-25% | 100 | - | - |
| *Stackhousia pulvinaris* | Alpine Stackhousia | - | - | - | r | 0-25% | 100 | - | - |
| *Stackhousia spathulata* | Coast Stackhousia | - | - | - | k | 0-25% | k | k | k |
| *Swainsona behriana* | Southern Swainson-pea | - | - | - | r | 0-25% | - | 100 | - |
| *Taraxacum aristum* | Austral Dandelion | - | R | rejected | r | 51-75% | 80 | 20 | - |
| *Tetratheca subaphylla* | Leafless Pink-bells | - | - | - | r | 0-25% | 50 | 50 | - |
| *Thelymitra mucida* | Plum Orchid | - | - | - | v | 0-25% | 100 | - | - |
| *Thomasia petalocalyx* | Paper Flower | - | - | - | r | 0-25% | 100 | - | - |
| *Thryptomene micrantha* | Ribbed Thryptomene | - | - | - | r | 26-50% | 100 | - | - |
| *Tmesipteris elongata* ssp. *elongata* | Slender Fork-fern | - | - | - | v | 26-50% | 30 | - | 70 |
| *Tmesipteris ovata* | Oval Fork-fern | - | - | - | r | 26-50% | 100 | - | - |
| *Triglochin minutissimum* | Tiny Arrow-grass | - | - | - | r | 0-25% | 100 | - | - |
| *Trochocarpa clarkei* | Lilac Berry | - | - | - | r | 51-75% | 80 | 20 | - |
| *Uncinia nemoralis* | River Hook-sedge | - | - | - | r | 0-25% | 10 | 90 | - |
| *Utricularia monanthos* | Tasmanian Bladderwort | - | - | - | v | 0-25% | 100 | - | - |
| *Viola fuscoviolacea* | Dusky Violet | - | - | - | r | 0-25% | 100 | - | - |
| *Viola improcera* | Dwarf Violet | - | R | - | k | 26-50% | 100 | - | - |
| *Vittadinia tenuissima* | Delicate New Holland Daisy | - | - | - | v | 0-25% | 50 | 50 | - |
| *Zieria cytisoides* | Dwarf Zieria | - | - | - | r | 0-25% | 100 | - | - |
| *Zieria robusta* | Robust Zieria | - | - | - | r | 0-25% | 100 | - | - |
| *Zieria smithii* | Sandfly Zieria | - | - | - | r | 0-25% | - | 100 | - |
| *Zieria veronicea* | Pink Zieria | - | - | - | r | 0-25% | - | 100 | - |

**ESP**, *Endangered Species Protection Act* 1992 (E = endangered, V = vulnerable). **ROTAP**, Rare or Threatened Australian Plant (E = endangered, V = vulnerable, R = rare). **FFG**, *Flora & Fauna Guarantee Act* 1988 (listed = taxon listed under Schedule 2 of the FFG Act, final rec = taxon has received the Scientific Advisory Committees final recommendation to be listed under Schedule 2 of the FFG Act, rejected = taxon nominated but rejected by the Scientific Advisory Committee, delisted = taxon delisted from FFG Act). **VROTS**, Victorian Rare or Threatened Species (x = extinct, e = endangered, v = vulnerable, r = rare, k = unknown). **Tenure**, Tenure of Gippsland Populations (cr = % of regional population occurring in conservation reserves, opl = % of regional population occurring in other public land, pri = % of regional population occurring in private land, k=unknown).

## 4.3 Review of the reservation status of priority flora

### *4.3.1 Assessment methods*

The purpose of this review is to examine the tenure of rare or threatened plant populations within the Gippsland region.

The approach used in this review was to intersect plant location data from statewide flora databases and the National Herbarium of Victoria with land tenure using a geographic information system (GIS). This data was then updated and augmented with current knowledge of the historical and contemporary distribution and abundance of each taxon.

The land tenure categories used are conservation reserves (National Parks, State Parks, Reference Areas, Wilderness Parks, Flora Reserves, Flora and Fauna Reserves, Wildlife Reserves), other public land (State forest, uncommitted Crown land, and public land reserved for other purposes), and private land. It should be noted that these land tenure categories differ from those used in other analyses in this report.

This review is based on a qualitative rather than quantitative analysis, due to the lack of accurate, verified information on the current size and location of populations. It relies on a combination of recent records and judgement by experts. Each taxon was evaluated according to the proportion of its Australian distribution that occurs within the Gippsland region (0-25%, 25-50%, 50-75%, 75-100%), and the proportion, to the nearest decile, that occurs in conservation reserves, other public land and private property. Results are presented in Table 4.1.

#### *Plants for which their regional occurrence forms a major part of their distribution*

Of the 348 rare or threatened plant species in the Gippsland region, 130 (37%) have more than 25% of their geographic range within the region. For 55 (42%) of these taxa over half their known distribution occurs within the Gippsland region and conservation within this area is critical for their long-term survival.

Of the 130 taxa, 78 have the highest proportion and 11 an equal highest proportion of their Gippsland population occurring within conservation reserves. Six of the 9 taxa endemic to the Gippsland region fall into this category (Lemon-scented Boronia *Boronia citrata*, Aniseed Boronia *Boronia galbraithiae*, Mount Elizabeth Hovea *Hovea pannosa* (Mount Elizabeth form), Leafy Phebalium *Phebalium frondosum*, Holey Plains Mint-bush *Prostanthera* sp. aff. *linearis* (Holey Plains) and Enigmatic Greenhood *Pterostylis aenigma)*. Three taxa – Pale Golden Moths *Diuris ochroma*, Maidenhair Spleenwort *Asplenium hookerianum* and Leafy Greenhood *Pterostylis cucullata* – are listed as vulnerable on the *Endangered Species Protection Act* 1992. Gilgai Blown-grass *Agrostis billardierei* ssp. *filifolia*, Aniseed Boronia *Boronia galbraithiae*, Mountain Daisy *Brachyscome tenuiscapa*, Dwarf Sedge *Carex paupera*, Mountain Cress *Drabastrum alpestre*, Rough Eyebright *Euphrasia scabra*, Rock Poa *Poa saxicola* and Fairy Bluebell *Wahlenbergia densiflora* are all listed on the Flora & Fauna Guarantee Act 1988.

Of the remaining 41 taxa, 21 have the highest proportion and one an equal highest proportion of their Gippsland population occurring on other public land. One of these taxa – Marble Daisy-bush *Olearia astroloba* – is endemic to the region. This species, together with Gaping Leak-orchid *Prasophyllum correctum* and Strzelecki Gum *Eucalyptus strzeleckii* are listed on the *Endangered Species Protection Act* 1992. Marble Daisy-bush *Olearia astroloba* has only one known population of ~1000 individuals dispersed over 40 hectares. Originally threatened by a proposed marble mine the species and its unique habitat – Limestone Pomaderris Shrubland Community – were listed on the *Flora & Fauna Guarantee Act* 1988. The main threats now relate to the small population size and its susceptibility to stochastic events. Strzelecki Gum *Eucalyptus strzeleckii*, unlike the localised Marble Daisy-bush *Olearia astroloba*, is widespread throughout the Strzelecki Ranges and adjacent foothills. This species, which grows throughout the Ranges on the lower slopes of gullies and along side the main rivers, has been cleared from most of its former habitat. None of the remnant stands of this species occur within conservation reserves and little or no recruitment has been recorded in any of its populations. Without immediate attention, this species will have a continuing decline in the overall number of plants, number of populations and extent of occurrence. Gaping Leak-orchid *Prasophyllum correctum* is only known for certainty from a single location from a rail reserve where it is threatened by invading pasture grasses, roaming stock, herbicide spraying and the movements of heavy vehicles. Hairy Anchor-plant *Discaria pubescens* and Shining Anchor Plant *Discaria nitida*, two species listed on the *Flora & Fauna Guarantee Act* 1988, also have the largest proportion of their Gippsland population on other public land.

Six taxa have the largest proportion of their Gippsland population occurring on private land. Out of these, one taxon – Mt Stirling Billy-buttons *Craspedia* sp. (Mt Stirling) – is only known to occur on public land. Maroon Leek-orchid *Prasophyllum frenchii* and Dwarf Kerrawang *Rulingia prostrata* are both listed on the *Endangered Species Protection Act* 1992 and the *Flora & Fauna Guarantee Act* 1988. Despite previously being described as 'locally rather common' the Maroon Leek-orchid *Prasophyllum frenchii* is currently only known from a handful of disturbed sites throughout the state. Although recorded from one population in the Lakes National Park on the edge of a track, all of the other populations are confined to private property. Dwarf Kerrawang *Rulinga prostrata* is a prostrate shrub that grows on disturbed soil along the edges of swamps. All extant populations exist in disturbed and modified environments. The only relatively secure population occurs on uncommitted Crown land that is being invaded by Burgan *Kunzea ericoides*.

## 4.4 Vulnerability analysis of priority flora

### *4.4.1 Assessment methods*

The vulnerability assessment is designed to identify those rare or threatened plant species that are at greatest risk of further significant decline and potential extinction as a result of activities, ongoing threatening processes and catastrophic events in the Gippsland region. Note that this assessment is confined to each taxon's Gippsland distribution, and does not necessarily accord with its overall vulnerability, which is generally reflected by its status at a national or statewide level (see Table 4.1).

Quantitative criteria such as those endorsed by the IUCN (IUCN 1994) provide a recognised and internationally accepted set of criteria with which to assess the risk of extinction. The criteria are most appropriately applied to taxa at a global scale but can be used at a regional or national scale. For rating as Critically Endangered (CR), Endangered (EN) or Vulnerable (VU) there is a range of quantitative criteria: RULES A to E (IUCN 1994). Meeting any one of these criteria qualifies a taxon for rating at that level of threat. The different criteria are derived from a wide review aimed at detecting risk factors across the broad range of organisms and the diverse life histories they exhibit. A taxon is considered Lower Risk (LR) when it has been evaluated but does not satisfy the criteria for any of the Critically Endangered, Endangered or Vulnerable categories. A taxon is considered Data Deficient (DD) when there is inadequate information to make a direct or indirect assessment of its risk of extinction based on its distribution and/or population status (IUCN 1994).

The IUCN criteria were developed primarily for fauna and there are several difficulties in applying them to flora (IUCN 1994). Recently Keith (1998) critically reviewed the IUCN Red List criteria and suggested modifications, developing a system called 'RARE' (Rules for the Assessment of the Risk of Extinction in vascular plants). The modifications included smaller distributional thresholds appropriate to sessile organisms, inclusion of life-history and land-based attributes, an amendment to account for skewed metapopulation structure, and inclusion of an additional rule (RULE F) to address number of populations and qualitatively define classes of threatening processes. For the Gippsland vulnerability assessment the vulnerability for priority taxa was evaluated using both the IUCN and RARE rule sets. Precedence is given to the IUCN rating in this assessment as RARE has just recently been published and has not been discussed within the broader scientific community.

As a means of improving the efficiency of evaluating a large number of plant species for both the IUCN and RARE rule sets, the rules were re-interpreted as a series of explicit questions to avoid collecting the same data twice and a series of decision trees developed so that each rule could be evaluated using a computer. A software package, called ConStat98, was then developed to allow large data sets to be imported, analysed and presented quickly. Data output was in two forms: Taxon Assessment Sheets or a summary table. Taxon Assessment Sheet lists a taxon's overall rating, the rating for each rule and the sub-criteria used to establish the overall rating for both the IUCN and RARE rule sets. A modified version of the summary table is presented in Table 4.1.

### *4.4.2 Overview of vulnerability analysis*

Of the 348 rare or threatened plant species considered in this study, sufficient information was available to analyse 301 (87%) taxa. Sixty-two taxa were rated as Critically Endangered, 58 rated as Endangered and 179 rated as Vulnerable (Table 4.2). Rating using the IUCN rule set (IUCN 1994) was primarily based on satisfying RULES D, B, A and C in that order. Rating using the RARE rule set (Keith 1998) was based on satisfying RULES D, F, B, A and C in that order. All plants were rated as Data Deficient for RULE E with both rule sets, as there was insufficient information available to satisfy any one of the criteria.

RULE D rates taxa based on the estimated number of mature individuals alone, RULE B rates taxa based on a combination of extent of occurrence or area of occupancy with indicators of population variability, RULE A rates taxa based on an observed, estimated, inferred or suspected past or future reduction in the regional population, RULE C rates taxa based on the estimated number of mature individuals in combination with estimates of continuing decline in numbers of mature individuals, and RULE F rates taxa based on how concentrated the populations of a species are and their exposure to different forms of threat.

For taxa rated as Critically Endangered or Endangered their overall rating was based primarily on satisfying RULE B (IUCN 1994). This contrasts significantly from the Vulnerable taxa for which the overall rating was based almost exclusively on satisfying RULE D. For further details on the categorisation of threatened taxa using the IUCN or RARE rule sets see IUCN (1994) and Keith (1998).

### *4.4.3 Plants rated 'Critically Endangered' in the Gippsland region*

The 'Critically Endangered' category signifies the highest risk of extinction in the wild. Sixty-two of the rare or threatened plant taxa evaluated during this assessment were categorised as Critically Endangered according to the IUCN Red List Criteria (IUCN 1994). Most of these have been rated Critically Endangered based on their very small extent of occurrence or area of occupancy and fragmented population or continuing decline in habitat.

Twelve of the 62 taxa rated Critically Endangered have more than 25% of their geographic range within Gippsland, which forms an important part of their distribution. These are Rock Banksia *Banksia saxicola,* Bog Willow-herb *Epilobium brunnescens* ssp. *beaugleholei,* Marble Daisy-bush *Olearia astroloba,* Gaping Leek-orchid *Prasophyllum correctum,* Shining Anchor Plant *Discaria nitida,* Rough Eyebright *Euphrasia scabra,* Elusive Cress *Irenepharsus magicus,* Dwarf Kerrawang *Rulingia prostrata,* Alpine Bent *Agrostis meionectes,* Colquhoun Grevillea *Grevillea celata,* Rock Poa *Poa saxicola* and Slender Fork-fern *Tmesipteris elongata* ssp. *elongata.*

### *4.4.4 Plants rated 'Endangered' in the Gippsland region*

The 'Endangered' category signifies that a taxon is facing a very high risk of extinction in the wild. Fifty-eight of the rare or threatened plant taxa evaluated during this assessment were categorised as Endangered according to the IUCN Red List Criteria (1994). Most of these taxa have been rated Endangered based on their low population numbers or their low extent of occurrence with a continuing decline in habitat.

Twenty-seven of the 58 taxa rated as Endangered have more than 25% of their geographic range within Gippsland, which forms an important part of their distribution. These are Golden Pomaderris *Pomaderris aurea,* Dwarf Sedge *Carex paupera,* Mountain Cress *Drabastrum alpestre,* Bog Gum *Eucalyptus kitsoniana,* Pinnate Goodenia *Goodenia macmillanii,* Oval-leaf Grevillea *Grevillea miqueliana,* Hypsela *Hypsela tridens,* Dark-flower Rush *Juncus phaeanthus,* Currant-wood *Monotoca glauca,* Poison Rice-flower *Pimelea pauciflora,* Mueller's Bent *Agrostis muelleriana,* Mountain Wheat-grass *Australopyrum velutinum,* Sky Lily *Herpolirion novae-zelandiae,* Strawberry Buttercup *Ranunculus collinus,* Dwarf Buttercup *Ranunculus millanii,* Mountain Aciphyll *Aciphylla simplicifolia,* Native Wintercress *Barbarea grayi,* Austral Moonwort *Botrychium australe,* Star Sedge *Carex echinata,* Southern Blue Gum *Eucalyptus globulus* ssp. *globulus,* Tailed Eyebright *Euphrasia caudata,* Purple Eyebright *Euphrasia collina* ssp. aff. *diversicolor* (Cobberas), Sharp-leaf Woodrush *Luzula acutifolia* ssp. *acutifolia,* Tuft-rush *Oreobolus oxycarpus* ssp. *oxycarpus,* Maroon Leek-orchid *Prasophyllum frenchii,* Tangled Pseudanthus *Pseudanthus divaricatissimus* and Blue-tongue Greenhood *Pterostylis dubia.*

### *4.4.5 Plants rated as 'Vulnerable' in the Gippsland region*

The 'Vulnerable' category signifies that a taxon is facing a high risk of extinction in the wild in the medium-term future. One hundred and seventy-nine of the rare or threatened plant species evaluated during this assessment were categorised as Vulnerable according to the IUCN Red List Criteria (1994). Most of these have been rated as Vulnerable based on their low population numbers or their low area of occupancy.

Seventy-five of the 179 taxa rated as Vulnerable have more than 25% of their geographic range within Gippsland, which forms an important part of their distribution. These are Tall Ground-berry *Acrotriche leucocarpa,* Tall Vanilla-lily *Arthropodium* sp. *1 (robust glaucous),* Raleigh Sedge *Carex raleighii,* Snow Coprosma *Coprosma nivalis,* Parrot-pea *Dillwynia sieberi,* Trailing Beard-heath *Leucopogon pilifer,* Matted Rice-flower *Pimelea biflora,* Strzelecki Gum *Eucalyptus strzeleckii,* Broad-leaf Prickly Moses *Acacia verticillata* var. *latifolia,* Tiny Bent *Agrostis australiensis,* Wetland Blown-grass *Agrostis avenacea* var. *perennis,* Lemon-scented Boronia *Boronia citrata,* Mountain Leafless Bossiaea *Bossiaea bracteosa,* Baw Baw Daisy *Brachyscome obovata,* Mountain Daisy *Brachyscome tenuiscapa,* Skeleton Vine *Clematis microphylla* var. *leptophylla,* Brittle Bladder-fern *Cystopteris tasmanica,* Pale Golden Moths *Diuris ochroma,* Spinning Gum *Eucalyptus perriniana,* Cliff Cudweed *Euchiton umbricolus,* Golden Grevillea *Grevillea chrysophaea,* Fog Club-sedge *Isolepis montivaga,* Tussock Woodrush *Luzula alpestris,* Scented Daisy-bush *Olearia adenophora,* Promontory Daisy-bush *Olearia allenderae,* Wedge Oschatzia *Oschatzia cuneifolia,* Fine-leaf Snow-grass *Poa clivicola,* Avon Tussock-grass *Poa gunnii,* Holey Plains Mint-bush *Prostanthera* sp. aff. *linearis* (Holey Plains), Leafy Greenhood *Pterostylis cucullata,* Delicate Bush-pea *Pultenaea tenella,* Eichler's Buttercup *Ranunculus eichlerianus,* Gunn's Alpine Buttercup *Ranunculus gunnianus,* Victorian Buttercup *Ranunculus victoriensis,* Tufted Knawel *Scleranthus diander,* Fairy Bluebell *Wahlenbergia densifolia,* Alpine Wattle *Acacia alpina,* Snow Aciphyll *Aciphylla glacialis,* Gilgai Blown-grass *Agrostis billardierei* var. *filifolia,* Maidenhair Spleenwort *Asplenium hookerianum,* Lanky Fescue *Austrofestuca eriopoda,* Mountain Water-fern *Blechnum vulcanicum,* Aniseed Boronia *Boronia galbraithiae,* Tadgell's Daisy *Brachyscome tadgellii,* Honey Caladenia *Caladenia hildae,* Archer's Sedge *Carex archeri,* Hair Sedge *Carex capillacea,* South Gippsland Correa *Correa reflexa* var. *cardinalis,* Large-leaf Ray-flower *Cyphanthera anthocercidea,* Snow Pennywort *Diplaspis nivis,* Hairy Anchor Plant *Discaria pubescens,* Mountain Coral Heath *Epacris microphylla* var. *rhombifolia,* Mallee Ash *Eucalyptus kybeanensis,* Omeo Gum *Eucalyptus neglecta,* Rock Grevillea *Grevillea willisii,* Gippsland Hemp Bush *Gynatrix macrophylla,* Outcrop Guinea-flower *Hibbertia hermanniifolia,* Mt Elizabeth Hovea *Hovea pannosa* (Mount Elizabeth form), Mountain Broom-heath *Monotoca oreophila,* Matted Lignum *Muehlenbeckia axillaris,* Leafy Phebalium *Phebalium frondosum,* Harsh Phebalium *Phebalium squameum* ssp. *coriaceum,* Alpine Bootlace Bush *Pimelea axiflora* ssp. *alpina,* Sharp Mountain Tussock-grass *Poa labillardierei* var. *acris,* Rock Tussock-grass *Poa petrophila,* Coast Pomaderris *Pomaderris oraria,* Limestone Pomaderris *Pomaderris oraria* ssp. *calcicola,* Coast Pomaderris *Pomaderris oraria* ssp. *oraria,* Enigmatic Greenhood *Pterostylis aenigma,* Alpine Bush-pea *Pultenaea fasciculata,* Austral Dandelion *Taraxacum aristum,* Ribbed Thryptomene *Thryptomene micrantha,* Oval Fork-fern *Tmesipteris ovata,* Lilac Berry *Trochocarpa clarkei* and Dwarf Violet *Viola improcera.*

## Table 4.2 The results of the vulnerability analysis carried out by ConStat 98.

**(a) Plants rated as Critically Endangered in the Gippsland region according to the IUCN Red List Categories (IUCN 1994).**

| TAXON | IUCN | RARE |
|---|---|---|
| *Acacia caerulescens* | CR | CR |
| *Adiantum diaphanum* | CR | CR |
| *Adriana quadripartita* s.s. (glabrous form) | CR | EN |
| *Adriana tomentosa* var. *tomentosa* | CR | CR |
| *Agrostis meionectes* | CR | VU |
| *Amphibromus sinuatus* | CR | VU |
| *Aristida calycina* var. *calycina* | CR | EN |
| *Atriplex paludosa* ssp. *paludosa* | CR | VU |
| *Austrofestuca littoralis* | CR | CR |
| *Banksia saxicola* | CR | CR |
| *Berula ? erecta* | CR | DD |
| *Bracteantha palustris* | CR | EN |
| *Celmisia sericophylla* | CR | CR |
| *Cyathea leichhardtiana* | CR | EN |
| *Discaria nitida* | CR | EN |
| *Epilobium brunnescens* ssp. *beaugleholei* | CR | CR |
| *Epilobium willisii* | CR | CR |
| *Eucalyptus bosistoana* | CR | CR |
| *Eucalyptus yarraensis* | CR | VU |
| *Euphrasia collina* ssp. *muelleri* | CR | CR |
| *Euphrasia scabra* | CR | EN |
| *Geranium obtusisepalum* | CR | CR |
| *Glycine latrobeana* | CR | VU |
| *Grammitis magellanica* ssp. *nothofageti* | CR | VU |
| *Gratiola nana* | CR | VU |
| *Grevillea celata* | CR | VU |
| *Irenepharsus magicus* | CR | EN |
| *Lepidium aschersonii* | CR | CR |
| *Lepidium pseudohyssopifolium* | CR | CR |
| *Leptorhynchos elongatus* | CR | VU |
| *Lotus australis* | CR | CR |

| TAXON | IUCN | RARE |
|---|---|---|
| *Microtis orbicularis* | CR | EN |
| *Olearia astroloba* | CR | CR |
| *Olearia viscosa* | CR | CR |
| *Oreobolus pumilio* ssp. *pumilio* | CR | EN |
| *Ozothamnus argophyllus* | CR | EN |
| *Persoonia asperula* | CR | CR |
| *Poa fordeana* | CR | VU |
| *Poa saxicola* | CR | VU |
| *Polystichum formosum* | CR | CR |
| *Pomaderris discolor* | CR | VU |
| *Prasophyllum correctum* | CR | CR |
| *Prasophyllum patens* | CR | CR |
| *Prasophyllum rogersii* | CR | EN |
| *Prostanthera rhombea* | CR | CR |
| *Pseudoraphis paradoxa* | CR | EN |
| *Pterostylis aestiva* | CR | VU |
| *Pterostylis tenuissima* | CR | EN |
| *Pultenaea foliolosa* | CR | CR |
| *Rulingia prostrata* | CR | EN |
| *Rytidosperma nivicolum* | CR | VU |
| *Schizeilema fragoseum* | CR | EN |
| *Solanum linearifolium* | CR | VU |
| *Sorghum leiocladum* | CR | CR |
| *Tetratheca subaphylla* | CR | VU |
| *Thelymitra epipactoides* | CR | EN |
| *Thelymitra matthewsii* | CR | CR |
| *Thelymitra mucida* | CR | EN |
| *Thesium australe* | CR | CR |
| *Tmesipteris elongata* ssp. *elongata* | CR | VU |
| *Utricularia monanthos* | CR | EN |
| *Viola fuscoviolacea* | CR | EN |

**(b) Plants rated as Endangered in the Gippsland region according to the IUCN Red List Categories (IUCN 1994).**

| TAXON | IUCN | RARE |
|---|---|---|
| *Aciphylla simplicifolia* | EN | VU |
| *Agrostis muelleriana* | EN | LR |
| *Almaleea capitata* | EN | EN |
| *Amphibromus fluitans* | EN | VU |
| *Asplenium obtusatum* | EN | VU |
| *Australopyrum velutinum* | EN | LR |
| *Austrodanthonia* sp. (syn. *Danthonia procera)* | EN | VU |
| *Barbarea grayi* | EN | VU |
| *Botrychium australe* | EN | VU |
| *Brachyscome petrophila* | EN | VU |
| *Brachyscome radicans* | EN | VU |
| *Carex echinata* | EN | VU |
| *Carex paupera* | EN | EN |
| *Desmodium varians* | EN | VU |
| *Drabastrum alpestre* | EN | EN |
| *Epilobium pallidiflorum* | EN | VU |
| *Eucalyptus globulus* ssp. *globulus* | EN | VU |
| *Eucalyptus kitsoniana* | EN | EN |
| *Euphrasia caudata* | EN | VU |
| *Euphrasia collina* ssp. aff. *diversicolor* (Cobberas) | EN | VU |
| *Geranium sessiliflorum* ssp. *brevicaule* | EN | VU |
| *Gingidia harveyana* | EN | VU |
| *Goodenia macmillanii* | EN | EN |
| *Grevillea miqueliana* | EN | EN |
| *Herpolirion novae-zelandiae* | EN | LR |
| *Hypsela tridens* | EN | EN |
| *Juncus phaeanthus* | EN | EN |
| *Lepidium desvauxii* | EN | EN |
| *Leucopogon juniperinus* | EN | EN |

| TAXON | IUCN | RARE |
|---|---|---|
| *Luzula acutifolia* ssp. *Acutifolia* | EN | VU |
| *Monotoca glauca* | EN | EN |
| *Myriophyllum alpinum* | EN | VU |
| *Nymphoides geminata* | EN | LR |
| *Olearia frostii* | EN | EN |
| *Olearia stellulata* | EN | EN |
| *Olearia tenuifolia* | EN | EN |
| *Oreobolus oxycarpus* ssp. *oxycarpus* | EN | VU |
| *Oreomyrrhis argentea* | EN | VU |
| *Ozothamnus adnatus* | EN | EN |
| *Pimelea pauciflora* | EN | EN |
| *Platysace ericoides* | EN | EN |
| *Polygala japonica* | EN | VU |
| *Pomaderris aurea* | EN | DD |
| *Prasophyllum frenchii* | EN | VU |
| *Prostanthera decussata* | EN | EN |
| *Pseudanthus divaricatissimus* | EN | VU |
| *Pterostylis alveata* | EN | DD |
| *Pterostylis dubia* | EN | VU |
| *Pterostylis grandiflora* | EN | VU |
| *Ranunculus collinus* | EN | LR |
| *Ranunculus millanii* | EN | LR |
| *Sagina namadgi* | EN | DD |
| *Samolus valerandii* | EN | VU |
| *Scleranthus singuliflorus* | EN | EN |
| *Senecio pectinatus* var. *major* | EN | EN |
| *Senna aciphylla* | EN | VU |
| *Spiranthes sinensis* | EN | VU |
| *Uncinia nemoralis* | EN | EN |

**(c) Plants rated as vulnerable in the Gippsland region according to the IUCN Red List Categories (IUCN 1994).**

| TAXON | IUCN | RARE |
|---|---|---|
| *Acacia alpina* | VU | VU |
| *Acacia verticillata* var. *latifolia* | VU | LR |
| *Aciphylla glacialis* | VU | VU |
| *Acronychia oblongifolia* | VU | LR |
| *Acrotriche leucocarpa* | VU | CR |
| *Adiantum hispidulum* var. *hispidulum* | VU | DD |
| *Adriana quadripartita (pubescent form)* | VU | VU |
| *Agrostis aemula* var. *setifolia* | VU | VU |
| *Agrostis australiensis* | VU | LR |
| *Agrostis avenacea* var. *perennis* | VU | LR |
| *Agrostis billardierei* var. *filifolia* | VU | VU |
| *Agrostis rudis* | VU | LR |
| *Alchemilla* sp. 1 | VU | VU |
| *Arthropodium* sp. 1 (robust glaucous) | VU | CR |
| *Arthropodium* sp. 3 (aff. *strictum)* | VU | DD |
| *Asplenium hookerianum* | VU | VU |
| *Asplenium trichomanes* | VU | LR |
| *Asplenium trichomanes* ssp. *quadrivalens* | VU | VU |
| *Astrotricha linearis* | VU | VU |
| *Atriplex australasica* | VU | VU |
| *Australina pusilla* ssp. *pusilla* | VU | VU |
| *Australopyrum retrofractum* | VU | CR |
| *Austrodanthonia induta* | VU | EN |
| *Austrodanthonia pilosa* var. *paleacea* | VU | CR |
| *Austrofestuca eriopoda* | VU | VU |
| *Avicennia marina* ssp. *australasica* | VU | VU |
| *Baumea laxa* | VU | VU |
| *Bertya cunninghamii* | VU | VU |
| *Bertya findlayi* | VU | VU |
| *Beyeria lasiocarpa* | VU | DD |
| *Beyeria viscosa* | VU | DD |
| *Billardiera scandens* var. *brachyantha* | VU | CR |
| *Blechnum vulcanicum* | VU | VU |
| *Boronia citrata* | VU | LR |
| *Boronia galbraithiae* | VU | VU |
| *Boronia ledifolia* | VU | VU |
| *Bossiaea bracteosa* | VU | LR |
| *Bossiaea heterophylla* | VU | VU |
| *Brachyscome obovata* | VU | LR |
| *Epacris microphylla* var. *rhombifolia* | VU | VU |
| *Eragrostis leptostachya* | VU | VU |
| *Eragrostis trachycarpa* | VU | DD |
| *Eucalyptus glaucescens* | VU | VU |
| *Eucalyptus kybeanensis* | VU | VU |
| *Eucalyptus mackintii* | VU | DD |
| *Eucalyptus neglecta* | VU | VU |
| *Eucalyptus perriniana* | VU | LR |
| *Eucalyptus strzeleckii* | VU | EN |
| *Euchiton umbricolus* | VU | LR |
| *Euphrasia collina* ssp. *diversicolor* | VU | EN |
| *Exocarpos syrticola* | VU | EN |
| *Gahnia grandis* | VU | VU |
| *Gahnia microstachya* | VU | VU |
| *Glossodia minor* | VU | VU |
| *Grevillea chrysophaea* | VU | LR |
| *Grevillea willisii* | VU | VU |
| *Gynatrix macrophylla* | VU | VU |
| *Hibbertia diffusa* | VU | VU |
| *Hibbertia hermanniifolia* | VU | VU |
| *Hibbertia pedunculata* | VU | LR |
| *Hovea pannosa* (Mount Elizabeth form) | VU | VU |
| *Huperzia australiana* | VU | VU |
| *Huperzia varia* | VU | VU |
| *Isolepis gaudichaudiana* | VU | VU |
| *Isolepis montivaga* | VU | LR |
| *Isopogon prostratus* | VU | EN |
| *Juncus revolutus* | VU | VU |
| *Koeleria cristata* | VU | LR |
| *Korthalsella rubra* ssp. *rubra* | VU | VU |
| *Laxmannia gracilis* | VU | DD |
| *Lepidosperma gunnii* | VU | VU |

| TAXON | IUCN | RARE |
|---|---|---|
| *Brachyscome tadgellii* | VU | VU |
| *Brachyscome tenuiscapa* | VU | LR |
| *Caladenia aurantiaca* | VU | VU |
| *Caladenia australis* | VU | VU |
| *Caladenia fragrantissima* ssp. *orientalis* | VU | CR |
| *Caladenia hildae* | VU | VU |
| *Calochilus gracillimus* | VU | VU |
| *Cardamine tenuifolia* | VU | DD |
| *Carex archeri* | VU | VU |
| *Carex capillacea* | VU | VU |
| *Carex raleighii* | VU | DD |
| *Clematis microphylla* var. *leptophylla* | VU | LR |
| *Colobanthus affinis* | VU | LR |
| *Coprosma moorei* | VU | VU |
| *Coprosma nivalis* | VU | DD |
| *Correa reflexa* var. *cardinalis* | VU | VU |
| *Craspedia alba* | VU | LR |
| *Cryptandra amara* var. *longiflora* | VU | VU |
| *Cuscuta tasmanica* | VU | VU |
| *Cyathea cunninghamii* | VU | VU |
| *Cyphanthera anthocercidea* | VU | VU |
| *Cystopteris tasmanica* | VU | LR |
| *Daviesia genistifolia* | VU | VU |
| *Dendrobium striolatum* | VU | VU |
| *Deschampsia caespitosa* | VU | LR |
| *Deyeuxia contracta* | VU | VU |
| *Deyeuxia crassiuscula* | VU | LR |
| *Deyeuxia decipiens* | VU | CR |
| *Dillwynia sieberi* | VU | DD |
| *Diplaspis nivis* | VU | VU |
| *Discaria pubescens* | VU | VU |
| *Diuris ochroma* | VU | LR |
| *Diuris punctata* var. *punctata* | VU | EN |
| *Dodonaea boroniifolia* | VU | VU |
| *Echinopogon caespitosus* | VU | VU |
| *Elymus multiflorus* | VU | VU |
| *Entolasia stricta* | VU | VU |
| *Epacris glacialis* | VU | VU |
| *Epacris microphylla* s.s. | VU | VU |
| *Luzula alpestris* | VU | LR |
| *Macroglena caudata* | VU | VU |
| *Marsdenia flavescens* | VU | DD |
| *Melaleuca armillaris* ssp. *armillaris* | VU | CR |
| *Monotoca oreophila* | VU | VU |
| *Muehlenbeckia axillaris* | VU | VU |
| *Olearia adenophora* | VU | LR |
| *Olearia aglossa* | VU | VU |
| *Olearia allenderae* | VU | LR |
| *Oschatzia cuneifolia* | VU | LR |
| *Phebalium frondosum* | VU | VU |
| *Phebalium squameum* ssp. *coriaceum* | VU | VU |
| *Philydrum lanuginosum* | VU | VU |
| *Pimelea axiflora* ssp. *Alpina* | VU | VU |
| *Pimelea biflora* | VU | DD |
| *Pimelea flava* ssp. *Dichotoma* | VU | CR |
| *Poa clivicola* | VU | LR |
| *Poa gunnii* | VU | LR |
| *Poa hookeri* | VU | LR |
| *Poa labillardierei* var. *acris* | VU | VU |
| *Poa meionectes* | VU | VU |
| *Poa petrophila* | VU | VU |
| *Poa poiformis* var. *ramifer* | VU | VU |
| *Poa* sp. aff. *tenera* (Hairy) | VU | CR |
| *Pomaderris oraria* | VU | VU |
| *Pomaderris oraria* ssp. *calcicola* | VU | VU |
| *Pomaderris oraria* ssp. *oraria* | VU | VU |
| *Prasophyllum lindleyanum* | VU | VU |
| *Prasophyllum pyriforme s.s.* | VU | VU |
| *Prostanthera* sp. aff. *linearis* (Holey Plains) | VU | LR |
| *Prostanthera walteri* | VU | LR |
| *Pterostylis aenigma* | VU | VU |

| TAXON | IUCN | RARE |
|---|---|---|
| *Lepilaena marina* | VU | VU |
| *Lespedeza juncea* ssp. *sericea* | VU | VU |
| *Leucopogon attenuatus* | VU | VU |
| *Leucopogon montanus* | VU | VU |
| *Leucopogon pilifer* | VU | DD |
| *Limonium australe* | VU | VU |
| *Ranunculus eichlerianus* | VU | LR |
| *Ranunculus gunnianus* | VU | LR |
| *Ranunculus victoriensis* | VU | LR |
| *Schizacme montana* var. *montana* | VU | VU |
| *Schoenus carsei* | VU | DD |
| *Scirpus polystachyus* | VU | VU |
| *Scleranthus diander* | VU | LR |
| *Scleranthus fasciculatus* | VU | LR |
| *Senecio diaschides* | VU | VU |
| *Sicyos australis* | VU | VU |
| *Sowerbaea juncea* | VU | LR |
| *Stackhousia pulvinaris* | VU | LR |
| *Swainsona behriana* | VU | VU |

| TAXON | IUCN | RARE |
|---|---|---|
| *Pterostylis cucullata* | VU | LR |
| *Pterostylis fischii* | VU | VU |
| *Pterostylis pedoglossa* | VU | VU |
| *Pterostylis tunstallii* | VU | VU |
| *Pultenaea fasciculata* | VU | VU |
| *Pultenaea tenella* | VU | LR |
| *Taraxacum aristum* | VU | VU |
| *Thryptomene micrantha* | VU | VU |
| *Tmesipteris ovata* | VU | VU |
| *Triglochin minutissimum* | VU | VU |
| *Trochocarpa clarkei* | VU | VU |
| *Viola improcera* | VU | VU |
| *Vittadinia tenuissima* | VU | VU |
| *Wahlenbergia densifolia* | VU | LR |
| *Zieria cytisoides* | VU | VU |
| *Zieria robusta* | VU | VU |
| *Zieria smithii* | VU | VU |
| *Zieria veronicea* | VU | VU |
| | | |

CR, Taxon rated as Critically Endangered by either the IUCN or the RARE rule sets (see overview of methodology). EN, Taxon rated as Endangered by either the IUCN or the RARE rule sets. VU, Taxon rated as vulnerable by either the IUCN or the RARE rule sets. LR, Taxon considered at Lower Risk by either the IUCN or the RARE rule sets. DD, Taxon has inadequate information available to make an assessment of its risk of extinction (Data Deficient).

Information regarding plants rated as Lower Risk and Data Deficient and plants for which there was insufficient information to rate, according the IUCN rule set, can be found in Appendix D.

## 4.5 Conclusion

Taxa with a high priority for management in the Gippsland region based on this vulnerability assessment are listed in Table 4.3. Taxa have been included in this list if the region represents a major part of their distribution and they have been rated Critically Endangered, Endangered, or Vulnerable in the region using the criteria published by the IUCN. In total, 114 plant species have been identified as having a high regional priority.

As shown in Table 4.1, 37 of these taxa occur solely within a conservation reserve and another 36 have more than half their regional distribution within a reserve. Important conservation reserves for these taxa, within the Gippsland region, are the Alpine National Park and Wilsons Promontory National Park. Four of these have been listed on the *Flora & Fauna Guarantee Act* 1988. None have Action Statements prepared. Three taxa, Bog Willow-herb *Epilobium brunnescens* ssp. *beaugleholei*, Maidenhair Spleenwort *Asplenium hookerianum* and Pale Golden Moths *Diuris ochroma*, are listed on the *Endangered Species Protection Act* 1992.

Six plant species are only known from other public land. These include Colquhoun Grevillea *Grevillea celata*, Elusive Cress *Irenepharsus magicus*, Marble Daisy-bush *Olearia astroloba*, Gaping Leek-orchid *Prasophyllum correctum*, Tall Vanilla-lily *Arthropodium* sp. 1 (robust glaucous) and Large-leaf Ray-flower *Cyphanthera anthocercidea*. Two of these taxa are listed on the *Flora & Fauna Guarantee Act* 1998 and *Endangered Species Protection Act* 1992, and have a published or near-published Action Statement. Thirteen other taxa have over half their regional distribution within other public land. These include Limestone Pomaderris *Pomaderris oraria* ssp. *calcicola*, Dark-flower Rush *Juncus phaeanthus*, Tuft-rush *Oreobolus oxycarpus* ssp. *oxycarpus*, Blue-tongue Greenhood *Pterostylis dubia*, Tall Ground-berry *Acrotriche leucocarpa*, Shining Anchor Plant *Discaria nitida*, Lanky Fescue *Austrofestuca eriopoda*, Mountain Aciphyll *Aciphylla simplicifolia*, Pinnate Goodenia *Goodenia macmillanii*, Alpine Wattle *Acacia alpina*, Golden Pomaderris *Pomaderris aurea*, Hairy Anchor Plant *Discaria pubescens* and Alpine Bush-pea *Pultenaea fasciculata*. Two of these species have been listed on the *Flora & Fauna Guarantee Act* 1998 but only one, Hairy Anchor Plant *Discaria pubescens*, has an Action Statement prepared.

Seven plant species have at least half their regional distribution occurring on private land. These include Maroon Leek-orchid *Prasophyllum frenchii*, Slender Fork-fern *Tmesipteris elongata* ssp. *elongata*, Bog Gum *Eucalyptus kitsoniana*, Dwarf Kerrawang *Rulingia prostrata*, Gilgai Blown-grass *Agrostis billardierei* var. *filifolia*, Strzelecki Gum *Eucalyptus strzeleckii* and Fog Club-sedge *Isolepis montivaga*. Dwarf Kerrawang *Rulingia prostrata* and Gilgai Blown-grass *Agrostis billardierei* var. *filifolia* have been listed on the *Flora & Fauna Guarantee Act* 1998 but neither have had an Action Statement prepared. Maroon Leek-orchid *Prasophyllum frenchii*, Dwarf Kerrawang *Rulingia prostrata* and Strzelecki Gum *Eucalyptus strzeleckii* are all listed on the *Endangered Species Protection Act* 1992.

Out of the 9 taxa endemic to the Gippsland region only one had insufficient information to be categorised. Six taxa – Lemon-scented Boronia *Boronia citrata*, Aniseed Boronia *Boronia galbraithiae*, Leafy Phebalium *Phebalium frondosum*, Enigmatic Greenhood *Pterostylis aenigma*, Mount Elizabeth Hovea *Hovea pannosa* (Mount Elizabeth form) and Holey Plains Mint-bush *Prostanthera* sp. aff. *linearis* (Holey Plains) – were ranked as Vulnerable, by virtue of their small population size. All these taxa had over 90% of their known population occurring within conservation reserves.

Two taxa were ranked as Critically Endangered, viz. Marble Daisy-bush *Olearia astroloba* and Dwarf Kerrawang *Rulingia prostrata*. Neither of these taxa has any known populations surviving within a conservation reserve. Both taxa are listed on the *Flora & Fauna Guarantee Act* 1988 and the *Endangered Species Protection Act* 1992. Action Statements are being prepared for both these taxa.

## 4.6 Management

Both the Commonwealth *Endangered Species Protection Act* 1992 (ESP Act) and the Victorian *Flora and Fauna Guarantee Act* 1988 (FFG Act) include provisions for the preparation of management plans for listed taxa. Recovery Plans and Action Statements outline the actions necessary to maximise the long-term prospects for survival of the taxon in the wild. It should be noted that the implementation of management actions is dependent on available resourcing and priorities within and between taxa.

The Department of Natural Resources and Environment has developed a simple monitoring form and database (VROTPop) for rare and threatened plants populations. It is envisaged that the use of this form and database will expand to the point where the major populations of all threatened plants will be regularly monitored. Active habitat management (environmental weed control, exclusion of predators or browsers, and ecological burning) is the most common form of management being implemented for taxa whose habitat is degrading or where direct external threats are operating. Where populations have declined to critical levels, active population management techniques (population reinforcement, reintroduction, translocation and artificial pollination) are sometimes recommended. Table 4.3 summarises the status of management planning for high priority listed taxa, further specific information on management planning, monitoring, and habitat and population management for these and other listed plant taxa is available in Appendix E.

**Table 4.3 Plant Taxa with high regional priority for management action**

| TAXON | IUCN | RARE | VROTS | FFG | Action Statement | ROTAP | ESP | Recovery Plan |
|---|---|---|---|---|---|---|---|---|
| *Banksia saxicola* | CR | CR | r | - | - | - | - | |
| *Epilobium brunnescens* ssp. *beaugleholei* | CR | CR | v | - | - | - | V | no |
| *Olearia astroloba* | CR | CR | v | Listed | in prep. | V | V | no |
| *Prasophyllum correctum* | CR | CR | e | Listed | yes | E | E | no |
| *Discaria nitida* | CR | EN | e | Listed | no | R | - | |
| *Euphrasia scabra* | CR | EN | e | Listed | yes | K | - | |
| *Irenepharsus magicus* | CR | EN | r | - | - | R | - | |
| *Rulingia prostrata* | CR | EN | e | Listed | in prep. | E | E | no |
| *Agrostis meionectes* | CR | VU | r | - | - | R | - | |
| *Grevillea celata* | CR | VU | v | - | - | - | - | |
| *Poa saxicola* | CR | VU | v | Listed | no | - | - | |
| *Tmesipteris elongata* ssp. *elongata* | CR | VU | v | - | - | - | - | |
| *Pomaderris aurea* | EN | DD | r | - | - | - | - | |
| *Carex paupera* | EN | EN | v | Listed | no | R | - | |
| *Drabastrum alpestre* | EN | EN | v | Listed | no | R | - | |
| *Eucalyptus kitsoniana* | EN | EN | r | - | - | R | - | |
| *Goodenia macmillanii* | EN | EN | r | - | - | - | - | |
| *Grevillea miqueliana* | EN | EN | r | - | - | - | - | |
| *Hypsela tridens* | EN | EN | k | - | - | - | - | |
| *Juncus phaeanthus* | EN | EN | r | - | - | - | - | |
| *Monotoca glauca* | EN | EN | r | - | - | - | - | |
| *Pimelea pauciflora* | EN | EN | r | - | - | - | - | |
| *Agrostis muelleriana* | EN | LR | r | - | - | - | - | |
| *Australopyrum velutinum* | EN | LR | r | - | - | - | - | |
| *Herpolirion novae-zelandiae* | EN | LR | r | - | - | - | - | |
| *Ranunculus collinus* | EN | LR | r | - | - | - | - | |
| *Ranunculus millanii* | EN | LR | r | - | - | - | - | |
| *Aciphylla simplicifolia* | EN | VU | r | - | - | - | - | |
| *Barbarea grayi* | EN | VU | v | - | - | E | - | |
| *Botrychium australe* | EN | VU | v | - | - | - | - | |
| *Carex echinata* | EN | VU | v | - | - | - | - | |
| *Eucalyptus globulus* ssp. *globulus* | EN | VU | r | - | - | - | - | |
| *Euphrasia caudata* | EN | VU | r | - | - | - | - | |
| *Euphrasia collina* ssp. aff. *diversicolor* (Cobberas) | EN | VU | v | - | - | - | - | |
| *Luzula acutifolia* ssp. *acutifolia* | EN | VU | r | - | - | - | - | |
| *Oreobolus oxycarpus* ssp. *oxycarpus* | EN | VU | r | - | - | - | - | |
| *Prasophyllum frenchii* | EN | VU | e | final rec | - | V | V | No |
| *Pseudanthus divaricatissimus* | EN | VU | r | - | - | R | - | |
| *Pterostylis dubia* | EN | VU | e | - | - | - | - | |
| *Acrotriche leucocarpa* | VU | CR | r | - | - | - | - | |

| TAXON | IUCN | RARE | VROTS | FFG | Action Statement | ROTAP | ESP | Recovery Plan |
|---|---|---|---|---|---|---|---|---|
| *Arthropodium* sp. 1 (robust glaucous) | VU | CR | r | - | - | - | - | |
| *Carex raleighii* | VU | DD | r | - | - | R | - | |
| *Coprosma nivalis* | VU | DD | r | - | - | - | - | |
| *Dillwynia sieberi* | VU | DD | r | - | - | - | - | |
| *Leucopogon pilifer* | VU | DD | r | - | - | - | - | |
| *Pimelea biflora* | VU | DD | r | - | - | - | - | |
| *Eucalyptus strzeleckii* | VU | EN | e | - | - | V | V | No |
| *Acacia verticillata* var. *latifolia* | VU | LR | r | - | - | - | - | |
| *Agrostis australiensis* | VU | LR | r | - | - | - | - | |
| *Agrostis avenacea* var. *perennis* | VU | LR | k | - | - | - | - | |
| *Boronia citrata* | VU | LR | v | - | - | R | - | |
| *Bossiaea bracteosa* | VU | LR | r | - | - | - | - | |
| *Brachyscome obovata* | VU | LR | r | - | - | - | - | |
| *Brachyscome tenuiscapa* | VU | LR | v | Listed | no | - | - | |
| *Clematis microphylla* var. *leptophylla* | VU | LR | k | - | - | - | - | |
| *Cystopteris tasmanica* | VU | LR | r | - | - | R | - | |
| *Diuris ochroma* | VU | LR | v | - | - | V | V | No |
| *Eucalyptus perriniana* | VU | LR | r | - | - | - | - | |
| *Euchiton umbricolus* | VU | LR | r | - | - | - | - | |
| *Grevillea chrysophaea* | VU | LR | r | - | - | - | - | |
| *Isolepis montivaga* | VU | LR | r | - | - | - | - | |
| *Luzula alpestris* | VU | LR | r | - | - | - | - | |
| *Olearia adenophora* | VU | LR | r | - | - | R | - | |
| *Olearia allenderae* | VU | LR | v | - | - | R | - | |
| *Oschatzia cuneifolia* | VU | LR | r | - | - | R | - | |
| *Poa clivicola* | VU | LR | r | - | - | - | - | |
| *Poa gunnii* | VU | LR | r | - | - | - | - | |
| *Prostanthera* sp. aff. *linearis* (Holey Plains) | VU | LR | v | - | - | - | - | |
| *Pterostylis cucullata* | VU | LR | v | Listed | yes | V | V | No |
| *Pultenaea tenella* | VU | LR | r | - | - | - | - | |
| *Ranunculus eichlerianus* | VU | LR | r | - | - | R | - | |
| *Ranunculus gunnianus* | VU | LR | r | - | - | - | - | |
| *Ranunculus victoriensis* | VU | LR | r | - | - | - | - | |
| *Scleranthus diander* | VU | LR | r | - | - | - | - | |
| *Wahlenbergia densifolia* | VU | LR | v | Listed | no | - | - | |
| *Acacia alpina* | VU | VU | r | - | - | - | - | |
| *Aciphylla glacialis* | VU | VU | v | - | - | - | - | |
| *Agrostis billardierei* var. *filifolia* | VU | VU | v | Listed | in prep. | - | - | |
| *Asplenium hookerianum* | VU | VU | e | final rec | - | V | V | Yes |
| *Austrofestuca eriopoda* | VU | VU | r | - | - | - | - | |
| *Blechnum vulcanicum* | VU | VU | e | - | - | - | - | |
| *Boronia galbraithiae* | VU | VU | v | Listed | no | R | - | |
| *Brachyscome tadgellii* | VU | VU | r | - | - | - | - | |
| *Caladenia hildae* | VU | VU | r | - | - | - | - | |
| *Carex archeri* | VU | VU | v | - | - | - | - | |
| *Carex capillacea* | VU | VU | r | - | - | R | - | |
| *Correa reflexa* var. *cardinalis* | VU | VU | r | - | - | - | - | |
| *Cyphanthera anthocercidea* | VU | VU | r | - | - | R | - | |
| *Diplaspis nivis* | VU | VU | r | - | - | - | - | |
| *Discaria pubescens* | VU | VU | v | Listed | yes | R | - | |
| *Epacris microphylla* var. *rhombifolia* | VU | VU | r | - | - | - | - | |
| *Eucalyptus kybeanensis* | VU | VU | r | - | - | - | - | |
| *Eucalyptus neglecta* | VU | VU | r | - | - | R | - | |
| *Grevillea willisii* | VU | VU | r | - | - | R | - | |
| *Gynatrix macrophylla* | VU | VU | r | - | - | - | - | |
| *Hibbertia hermanniifolia* | VU | VU | r | - | - | R | - | |
| *Hovea pannosa* (Mount Elizabeth form) | VU | VU | r | - | - | - | - | |
| *Monotoca oreophila* | VU | VU | r | - | - | R | - | |
| *Muehlenbeckia axillaris* | VU | VU | r | - | - | - | - | |
| *Phebalium frondosum* | VU | VU | v | - | - | R | - | |
| *Phebalium squameum* ssp. *coriaceum* | VU | VU | v | - | - | - | - | |
| *Pimelea axiflora* ssp. *alpina* | VU | VU | r | - | - | - | - | |
| *Poa labillardierei* var. *acris* | VU | VU | v | - | - | - | - | |
| *Poa petrophila* | VU | VU | v | - | - | - | - | |
| *Pomaderris oraria* | VU | VU | r | - | - | R | - | |
| *Pomaderris oraria* ssp. *calcicola* | VU | VU | r | - | - | R | - | |
| *Pomaderris oraria* ssp. *oraria* | VU | VU | r | - | - | R | - | |

| TAXON | IUCN | RARE | VROTS | FFG | Action Statement | ROTAP | ESP | Recovery Plan |
|---|---|---|---|---|---|---|---|---|
| *Pterostylis aenigma* | VU | VU | e | - | - | K | - | |
| *Pultenaea fasciculata* | VU | VU | r | - | - | - | - | |
| *Taraxacum aristum* | VU | VU | r | - | - | R | - | |
| *Thryptomene micrantha* | VU | VU | r | - | - | - | - | |
| *Tmesipteris ovata* | VU | VU | r | - | - | - | - | |
| *Trochocarpa clarkei* | VU | VU | r | - | - | - | - | |
| *Viola improcera* | VU | VU | k | - | - | R | - | |

**IUCN**, Regional conservation status based on IUCN rule set (CR=Critically Endangered, EN=Endangered, VU=vulnerable). **RARE**, Regional conservation status based on RARE rule set (CR=Critically Endangered, EN=Endnagered, VU=vulnerable). **VROTS**, Victorian Rare or Threatened Plant Species Conservation Status (e=endangered, v=vulnerable, r=rare, k=unknown). **FFG**, Taxon listed on Schedule 2 of the *Flora & Fauna Guarantee Act* 1988. **ROTAP**, Rare or Threatened Australian Plant Conservation Status (E=endangered, V=vulnerable, R=rare, K=unknown). **ESP**, Taxon listed on Schedule 1 of the *Endangered Species Protection Act* 1992 (E=endangered, V=vulnerable).

# 5 TERRESTRIAL FAUNA SPECIES ASSESSMENT

## 5.1 Introduction

Assessment of terrestrial fauna in Gippsland involved the collation of all relevant information on the distribution, biology and life history characteristics of priority species, the known threats to these species and current management actions that may affect them. This assessment will assist in determining the status of priority forest dependent fauna in the region and provide sufficient information to ensure the legislative and policy requirements for fauna conservation are met in the development of the Gippsland Regional Forest Agreement. Aquatic fauna are addressed in Chapter seven.

Data were gathered from an extensive search of the literature, existing data sets, experts and from new information generated by specialist projects including a broad scale regional survey of terrestrial fauna and a series of projects targeted at key threatened fauna (see sections 5.3 and 5.5 below). Critical life history attributes and population parameters were developed with the assistance of local and national experts in the field of population ecology. The information collected fell into two categories:

- life history attributes, population parameters and habitat components; and
- responses to disturbance.

This information is presented fully in Appendix F. It can be incorporated into databases and modelling tools to assist in predicting species' responses to various impacts and disturbances, allow appraisal and refinement of management action and the development of medium and long-term monitoring programs.

### *5.1.1 Priority species*

The assessment of fauna in Gippsland has focused on a selected group of priority species. These species are classified as threatened in Victoria and listed in *Threatened Vertebrate Fauna in Victoria* (NRE 1999a), listed under the Victorian *Flora and Fauna Guarantee Act* 1988 (FFG Act) and the Commonwealth *Endangered Species Protection Act* 1992 (ESP Act). The majority of these priority species are either forest dependent or require a component of their habitat to be within forest or woodland and may be affected by forestry or related activities.

To provide a broader assessment of the status of fauna in the region, a number of species were included because they are representative of taxa at risk from other management activities (not necessarily forestry related) on public or private land. A number of these species are either poorly known and their status in Gippsland is unclear, or are known to be declining.

The terrestrial species included in this assessment are shown in Table 5.1 with conservation status as classified in *Threatened Vertebrate Fauna in Victoria* (NRE 1999a), the existence of Action Statements (for species listed under the FFG Act) and Recovery Plans (for species listed under the ESP Act), and whether the species is secure based on other listings.

The categories and definitions used to describe the threatened status of fauna included on the list are largely based on those developed by the World Conservation Union (IUCN), and are defined as follows:

**Threatened**: a collective term used to denote taxa that are Critically Endangered, Endangered or Vulnerable. Additional categories used in this list are Lower Risk - near threatened and Data Deficient.

**(C) Critically Endangered:** A taxon is Critically Endangered when it is facing an extremely high risk of extinction in the wild in the immediate future.

**(E) Endangered**: A taxon is Endangered when it is not Critically Endangered but is facing a very high risk of extinction in the wild in the near future.

**(V) Vulnerable**: A Taxon is Vulnerable when it is not Critically Endangered or Endangered but is facing a high risk of extinction in the wild in the medium-term future.

**(R) Rare**: Taxa with small Victorian populations that are not at present Endangered or Vulnerable but are at risk. These taxa are usually localised within restricted geographical areas or habitats or are thinly distributed over a more extensive range.

**(LR)** Lower Risk - near threatened: A taxon is Lower Risk - near threatened when it has been evaluated, does not satisfy the criteria for any of the threatened categories, but which is close to qualifying for Vulnerable. In practice, these species are most likely to move into a threatened category should current declines continue or catastrophes befall the species.

(**D**) Data Deficient: A taxon is Data Deficient when there is inadequate information to make a direct or indirect assessment of its risk of extinction based on its distribution or population status. Listing of taxa in this category indicates that more information is required and acknowledges the possibility that future investigation will show that a threatened classification is appropriate.

In practice, these threat categories may include species whose populations are beginning to recover as a result of remedial action, but whose recovery is insufficient to justify their transfer to another category.

Other listings include the threatened species lists or legislated lists of all States and Territories, other than Victoria, where the species occur. Where species are not listed as threatened, rare, insufficiently known or restricted in these States/Territories, they are indicated as secure.

**Table 5.1 Terrestrial fauna species included in the assessment**

| Species Name | Common Name | TFV 1999 | FFG Status | Action Statement (Vic) | ESP Status | Recovery Plan (C'wlth) | Secure in Other States |
|---|---|---|---|---|---|---|---|
| **Mammals** | | | | | | | |
| *Dasyurus maculatus* | Spot-tailed Quoll | E | L | Yes | V | No | No |
| *Potorous longipes* | Long-footed Potoroo | E | L | Yes | E | In prep | No |
| *Mastacomys fuscus* | Broad-toothed Rat | LR | | | | | No |
| *Pseudomys fumeus* eastern form | Smoky Mouse | E | | | | | No |
| *Pseudomys novaehollandiae* | New Holland Mouse | C | L | Yes | | | Yes |
| *Canis familiaris dingo* | Dingo | D | | | | | Yes |
| *Rhinolophus megaphyllus* | Southern Horseshoe-bat | V | L | No | | | Yes |
| *Miniopteris schreibersii oceanensis* | Eastern Bent-wing Bat | V | L | In prep | | | Yes |
| ♦ *Perameles nastua* | Long-nosed Bandicoot | | | | | | |
| ♦ *Petaurus australis* | Yellow-bellied Glider | | | | | | |
| ♦ *Macropus rufogriseus* | Red-necked Wallaby | | | | | | |
| ♦ *Sminthopsis leucopus* | White-footed Dunnart | | | | | | |
| **Birds** | | | | | | | |
| *Lathamus discolor* | Swift Parrot | E | L | In prep | V | Yes | No |
| *Xanthomyza phrygia* | Regent Honeyeater | C | L | Yes | E | Yes | No |
| *Lophoictinia isura* | Square-tailed Kite | E | R | | | | No |
| *Accipiter novaehollandiae* | Grey Goshawk | LR | | | | | No |
| *Haliaeetus leucogaster* | White-bellied Sea-Eagle | E | L | Yes | | | No |
| *Ninox connivens* | Barking Owl | E | R | No | | | No |
| *Ninox strenua* | Powerful Owl | E | L | In prep | | | No |
| *Tyto novaehollandiae* | Masked Owl | E | L | In prep | | | No |
| *Tyto tenebricosa* | Sooty Owl | V | L | In prep | | | No |
| *Hylacola pyrrhopygia* | Chestnut-rumped Heathwren | D | | | | | No |
| ♦ *Callocephalon fimbriatum* | Gang-Gang Cockatoo | | | | | | |
| ♦ *Alecedo azurea* | Azure Kingfisher | | | | | | |
| ♦ *Petroica rodinagaster* | Pink Robin | | | | | | |
| ♦ *Melanodryas cucullata* | Hooded Robin | | | | | | |
| ♦ *Coracina tenuirostris* | Cicadabird | | | | | | |
| **Reptiles** | | | | | | | |
| *Pseudemoia rawlinsoni* | Glossy Grass Skink | LR | | | | | No |
| *Egernia coventryi* | Swamp Skink | V | | | | | No |
| *Varanus varius* | Lace Monitor | D | | | | | Yes |
| ♦ *Pseudemoia spenceri* | Spencer's Skink | | | | | | |
| **Amphibians** | | | | | | | |
| *Litoria spenceri* | Spotted Tree Frog | C | L | In prep | E | In prep | No |
| *Litoria verreauxii alpina* | Alpine Tree Frog | C | | | | | Yes |
| *Litoria littlejohni* | Large Brown Tree Frog | V | | | | | Yes |
| *Heleioporus australiacus* | Giant Burrowing Frog | V | L | Yes | | | No |
| *Uperleia martini* | Martin's Toadlet | D | | | | | Yes |
| *Uperleia tyleri* | Tyler's Toadlet | D | | | | | Yes |
| ♦ *Litoria citropa* | Blue Mountains Tree Frog | | | | | | |
| ♦ *Litoria phyllochroa* | Leaf Green Tree Frog | | | | | | |

**Notes**: Threatened Vertebrate Fauna in Victoria 1999 (NRE 1999a) – C-critically endangered, E-endangered, V-vulnerable, LR-lower risk, D-data deficient. **Victorian Flora and Fauna Guarantee Act (FFG):** L-listed, R-recommended for listing
**Commonwealth Endangered Species Protection Act (ESP):** E-endangered, V-vulnerable

♦ denotes indicator species

## 5.2 Life history and population parameters for priority fauna species

A number of biological characteristics may predispose a species or population to extinction. These are rarity, population dynamics, spatial dynamics, and life history parameters.

1. Rarity refers to the static qualities of a population: geographic range, abundance and habitat specificity. Species or populations most predisposed to extinction are those that have small geographic ranges, low abundance and narrow habitat specificity.

2. Population dynamics are the dynamic qualities of a population, that is, whether it is increasing, stable or decreasing in size.

3. Spatial dynamics, or metapopulation dynamics, is the interaction between colonisation and extinction of sub-populations that make up a population. The parameters that contribute to the potential risk of extinction of a species through metapopulation collapse are the variability in abundance of individual populations and dispersal ability.

4. Life history parameters are aspects of biology that may predispose a species to the threat of extinction under particular circumstances. The two most important parameters identified are reproductive output and longevity.

Each species listed in Table 5.1 was assigned a rating for the parameters associated with rarity, population dynamics, spatial dynamics, and life history, based on the scores for the contributing factors. A full explanation of the derivation of the parameters is contained in Dexter (1996). Each rating indicates the relative magnitude of the contribution of each parameter to the probability of extinction, as described below.

For the parameters associated with rarity, range size within Gippsland was classified for each species as large, medium or small, based on the geographic coverage of records within the region. Range size was large if the records were located over the majority of the region, medium if the area covered by the records was equal to or less than 50%, and small if records were clustered or confined within a limited area of the region. This parameter was designed to give an indication of the recorded geographic range size of the species within the region. Abundance within Gippsland was classified as high, medium or low, based the number of records on the Atlas of Victorian Wildlife and on expert opinion of the density of individuals within Gippsland. A species may have a large geographic range while at the same time have a low abundance if there is a low number of records spread over a large area of the region. Habitat specificity was classified as narrow or wide, based on expert opinion and literature studies of critical habitat components and/or habitat types likely to be used.

When considering the parameters associated with rarity, species or populations with small geographic range, low abundance and narrow habitat specificity are considered more predisposed to the threat of extinction than species with large geographic ranges, high abundance and wide habitat specificity.

Population dynamics were assessed by identifying those species whose numbers have been relatively stable or increased, and those which have declined over a recent time period (the last 10 years). Past population dynamics (since European settlement until 10 years ago) were also classified for all species as either having increased, declined or remained stable. Stable species and populations are considered to be at a lower risk of extinction than species and populations that are declining. It is also assumed that species that have declined in abundance since European settlement, but have had stable abundance in the last 10 years, would have a higher risk of extinction than species which have maintained a stable abundance since European settlement. Population trends since European settlement were classified by experts and from relevant literature, and were generally based on the change in the amount of each species' habitat within Gippsland.

Spatial dynamics describes the interaction between colonisation and extinction of sub-populations, and can be assessed using estimates of population variability and dispersal ability. Species were classified as having high or low population variability, based on measures or estimates of changes in abundance over time. Species that have high population variability are more likely to be under threat of extinction than species that have low population variability. Species were classified as having high or low dispersal ability, based on measured dispersal distances or inferences from anatomy (e.g. wings developed for flying long distances). Species with high mobility are more likely to colonise new patches of habitat and are less likely to be at risk of extinction than species that have low mobility.

The two life history parameters considered in this assessment were reproductive output and longevity. Species were classified as having high, medium or low reproductive output, based on measures or estimates of litter or clutch sizes or rates of increase, and as being long or short-lived based on measures or estimates of longevity or inferred from body size. Species that have high reproductive outputs are more likely to recover quickly from major declines in abundance than species with low reproductive outputs. Species that are long-lived tend to be less susceptible to extinction due to catastrophic events, such as fire and flooding. When abundance is low, species with low adult mortality are more likely to persist in an area than species with high adult mortality.

For some species the biological information available for a number of parameters was so limited, classifications could not be made. Parameters with no information were either classified as unknown, or a classification was assigned by experts, based on the most likely estimate.

**Results and Discussion**

Detailed information on the life history and population dynamics for each species are included in Appendix F. Summarised information for the species included in this review is presented in Table 5.2. The intention of this assessment is to provide a basis for prioritising those species requiring management action to improve the prospects for their long-term survival. This assessment should also be considered in conjunction with the information relating to threatening processes.

Species with a small geographic range are more vulnerable to regional extinction as a result of localised disturbance. Those species with small geographic ranges are the Southern Horseshoe Bat, Long-footed Potoroo, New Holland Mouse, Square-tailed Kite, Swamp Skink, Large Brown Tree Frog, Martin's Toadlet and Tyler's Toadlet (Table 5.2).

As expected for a group of species selected because there is some documented concern for their status, most species have a low abundance. Of the threatened species the Lace Monitor is the only exception; its abundance is classified as medium within Gippsland. Six threatened species recorded a low abundance with a large geographic range: the Eastern Bent-wing Bat, Dingo, Spot-tailed Quoll, Powerful Owl, Chestnut-rumped Heathwren and Swift Parrot. These species are generally represented by comparatively low numbers of records spread broadly over the Gippsland region. The Dingo has a very small number of existing records (three) all of which are from the same location. However, this is most likely a reflection of the difficulty in distinguishing pure bred animals from Dingo/Dog hybrids; when Dingo and wild Dog records are combined the number increases and they are scattered through-out the region, hence the probable large geographic range classification. The status and distribution of the Dingo within Gippsland is unknown and requires clarification. The Spot-tailed Quoll is represented by a low number of records (less than 35) which are widely scattered over Gippsland. This species was last recorded in 1991 (Atlas of Victorian Wildlife); its status in the region is also unclear.

A number of the non-threatened species covered by this review also have a low abundance: Azure Kingfisher, Cicadabird and Hooded Robin. The Hooded Robin is represented by a limited number of records, most of which are over 15 years old (Atlas of Victorian Wildlife). This species is declining in woodland and agricultural areas (Fitri and Ford 1997). A recent survey of the Gippsland region did not detect Azure Kingfisher, despite including several areas of suitable habitat. In contrast, the Cicadbird bird, an infrequently recorded species, was recorded more often than expected, particularly during summer counts (G. Appleby pers. comm. see section 5.3). It is not known how abundant the non-threatened reptile and amphibian species are in the region.

Many of the species covered by the review were rated as habitat specific. These species often depend on a combination of certain habitat components; the Sooty Owl needs large tree hollows for dens and prefers wet forests (Lumsden *et al.* 1991); the Regent Honeyeater appears to rely on nectar from a few key eucalypt species and needs this food source to be produced in copious amounts (Franklin *et al.* 1989); the Long-footed Potoroo requires sheltered sites with a dense understorey and moist soils (Jones and Johnson 1997). As a result, loss or reduction of a critical habitat component is likely to lead to population declines. Although some species rated a wide habitat specificity, due to their ability to inhabit a range of forest types, a number of these animals require particular components to be present to be able to survive. A number of species, for example, depend on tree hollows for dens such as the Yellow-bellied Glider and Powerful Owl. The Lace Monitor appears to depend largely on termite nests as egg-laying sites (P. Robertson pers. comm.).

A total of four species rate a small geographic range size, a low abundance and have narrow habitat requirements. These are: the Southern Horseshoe Bat, Long-footed Potoroo, New Holland Mouse and Swamp Skink. Consequently, of the species assessed, these are more predisposed to the threat of decline or extinction within Gippsland based on the rarity parameter. These species exist in small isolated populations making them particularly vulnerable to disturbances, especially stochastic events such as wildfire, which can cause local extinctions. Large populations with widespread distributions are better buffered against environmental changes (Bennett *et al.* 1991).

Factors limiting distribution of species can include habitat availability, which is especially important when a species has specific habitat requirements. Within the Gippsland region the Broad-toothed Rat and Alpine Tree Frog are largely found in alpine and sub-alpine areas. Alpine and sub-alpine habitats in Gippsland are critical to the survival of populations of these species. The Smoky Mouse is uncommonly recorded, the most recent record on the Atlas of Victorian Wildlife is from 1989, and its distribution is highly disjunct. This species is thought to depend on habitat that is strongly influenced by fire and successional changes may alter the suitability of particular areas of habitat (Menkhorst 1995c, SAC 1996). The Southern Horseshoe Bat requires caves or mineshafts of suitable warmth and humidity for roosting and usually does not venture far from these sites (Lumsden and Menkhorst 1995).

Species with high population variability and low powers of dispersal are more vulnerable to metapopulation collapse. Low powers of dispersal limits the ability of species to recolonise areas where local population extinctions have occurred. Species with low powers of dispersal and high population variability are Smoky Mouse and Spotted Tree Frog. A high population variability and low powers of dispersal in conjunction with either a low reproductive rate or low longevity increases the risk of decline. There are two species known to have a combination of these parameters; the Spotted Tree Frog exhibits a low reproductive rate, while the Smoky Mouse is a short-lived species. Species with a high reproductive rate can increase from low abundance following disturbances more rapidly than those with low reproductive outputs. Long-lived species are more buffered against sudden population declines than short-lived species as individuals with a longer lifespan are less likely to die due to age (Dexter 1996). The White-footed Dunnart has a very short lifespan (about 1 year) which is partially off-set by a high reproductive output (many young are born once a year) (Woolley and Ahern 1983). However, the short lifespan means it is particularly important that breeding is successful each year or local populations may become extinct. There are many species for which a number of these parameters are unknown, highlighting a lack of information and a need for species-specific research. Species such as Eastern Bent-wing Bat, Dingo, White-bellied Sea Eagle, Powerful Owl and Pink Robin have favourable spatial dynamic attributes that reduce the threat of extinction due to metapopulation collapse.

Population trends are the clearest indicators of a species' likelihood of extinction. The population trend since European settlement for each species is detailed in Appendix F. The majority of species covered by this review are thought to have declined in abundance since European settlement, usually as a result of loss of habitat through clearing for agriculture and urban development. The Spot-tailed Quoll has suffered a large reduction in range due to clearing of habitat (Mansergh

1995) while the Swift Parrot has lost substantial areas of overwintering habitat from the same cause (Webster in prep.). In contrast, the Eastern Bent-wing Bat and Southern Horseshoe Bat are thought to have increased since European settlement. Both species have narrow roost requirements and are dependent on a limited number of suitable sites. The construction of mineshafts has resulted in an increased number of suitable sites and may have led to an increase in these two species (L. Lumsden pers. comm.).

For a range of species, the population trend in the past 10 years could not be determined (Table 5.2). This highlights the need for further biological information and long term population monitoring. The effectiveness of species management requires an understanding of ecological requirements and long term records of population changes. Of the species whose population trend in the past 10 years could be determined, the majority have declined, including a number of the non-threatened species such as the Red-necked Wallaby, White-footed Dunnart, Yellow-bellied Glider, Hooded Robin and Leaf Green Tree Frog. Although Powerful Owl numbers are thought to have decreased since European settlement (see Appendix F), they appear to have become stable over the past 10 years.

When considering current knowledge of the life history and population parameters presented in Table 5.2, two species in particular; the Smoky Mouse and Spotted Tree Frog appear to be at higher risk of extinction. Both these species have declined in the last 10 years, have a medium geographic range, a low abundance and are habitat specific. Population variability is high and powers of dispersal low. The Smoky Mouse has a medium reproductive output and is short-lived, while the Spotted Tree Frog has a low reproductive output and is long-lived. These two species, based on these parameters, have a high priority for management in the Gippsland region. The Spotted Tree Frog has been the target of ongoing surveys and research which are still current. There is also an Action Statement and Recovery Plan in preparation for this species (Robertson and Gillespie in prep., Robertson *et al.* in prep.). Smoky Mouse is classified as Endangered in Victoria (NRE in prep.) and has been recommended for listing under the *Flora and Fauna Guarantee Act* 1988 (SAC 1996). Until a recent targeted survey conducted as part of the Gippsland CRA detected Smoky Mouse at five sites, the species was last recorded from the region in 1989 (Atlas of Victorian Wildlife).

Table 5.2 highlights the large number of gaps in published and expert knowledge of many ecological aspects of threatened and non-threatened species; many of the categories have been classified as 'unknown'. This lack of information is especially evident for the reptiles and amphibians. Without such data threat assessment is more difficult, which in turn hinders the development of appropriate management prescriptions for certain species.

Table 5.3 summarises the significance of a range of threats which were assessed for each species on a regional basis. The assessments were made recognising that the practices on public land follow minimum prescriptions required under the Code of Forest Practices for Timber Production (NRE 1996) and various State Acts and Regulations and that practices on private land are in accord with the *Planning and Environment Act* 1987 and the *Catchment and Land Protection Act* 1994. However, the assessments do not take account of additional protection afforded in various Action Statements, Park management plans, nor any additional measures that may be established in the Gippsland Forest Management Plan which is currently in preparation. Threats were rated as follows:

- Effect unknown;
0 Process not likely to be operating as a threat or there is no information to suggest that it is a threat;
1 Process is a minor threat, which by itself is unlikely to lead to broad scale decline of the species;
2 Process is a moderate threat, which is likely to lead to some declines of the species, especially if it operates in combination with other threatening processes; and
3 Process is a major threat, which if not checked poses a significant risk to the viability of the species in Gippsland.

## Table 5.2 Summary of life history and population dynamics information

| Species | Population trend in the last 10 years | Rarity Ratings | | | Spatial Dynamics Ratings | | Life History Parameter Ratings | |
|---|---|---|---|---|---|---|---|---|
| | | Geogra-phic Range | Abun-dance | Habitat Specificity | Population Variability | Powers of Dispersal | Reprod-uctive Output | Longevity |
| **Mammals** | | | | | | | | |
| Spot-tailed Quoll | declined | Large | low | wide | low | *high | medium | unknown |
| Long-footed Potoroo | unknown | Small | low | narrow | *low | low | low | long |
| Broad-toothed Rat | *declined | Medium | low | narrow | *low | unknown | low | long |
| Smoky Mouse | declined | Medium | low | narrow | high | *low | medium | short |
| New Holland Mouse | unknown | Small | low | narrow | high | unknown | high | short |
| Dingo | unknown | *large | low | wide | *low | high | low | long |
| Southern Horseshoe Bat | unknown | Small | low | narrow | low | low | low | long |
| Eastern Bent-wing Bat | unknown | Large | low | narrow | low | high | low | long |
| ♦ Long-nosed Bandicoot | *declined | Large | medium | wide | unknown | *high | high | *short |
| ♦ Yellow-bellied Glider | *declined | Large | medium | wide | low | high | low | long |
| ♦ Red-necked Wallaby | declined | Large | unknown | wide | *low | high | low | unknown |
| ♦ White-footed Dunnart | declined | Medium | unknown | wide | unknown | high | high | short |
| **Birds** | | | | | | | | |
| Swift Parrot | declined | Large | low | narrow | high | high | high | *long |

| Species | Population trend in the last 10 years | Rarity Ratings | | | Spatial Dynamics Ratings | | Life History Parameter Ratings | |
|---|---|---|---|---|---|---|---|---|
| | | Geographic Range | Abundance | Habitat Specificity | Population Variability | Powers of Dispersal | Reproductive Output | Longevity |
| Regent Honeyeater | declined | Medium | low | narrow | high | high | low | unknown |
| Square-tailed Kite | unknown | Small | low | wide | unknown | high | low | *long |
| Grey Goshawk | unknown | Medium | low | narrow | unknown | high | low | *long |
| White-bellied Sea-Eagle | unknown | Medium | low | wide | low | high | low | long |
| Barking Owl | unknown | Medium | low | narrow | low | high | low | *long |
| Powerful Owl | stable | Large | low | wide | low | high | low | long |
| Masked Owl | *declined | Medium | low | medium | unknown | high | low | long |
| Sooty Owl | *declined | Medium | low | narrow | low | high | low | long |
| Chestnut-rumped Heathwren | unknown | Large | low | narrow | unknown | low | low | short |
| ♦ Gang-gang Cockatoo | *declined | Large | medium | wide | *high | high | low | *long |
| ♦ Azure Kingfisher | unknown | Large | low | narrow | high | unknown | medium | *long |
| ♦ Pink Robin | stable | Large | medium | wide | low | high | low | short |
| ♦ Hooded Robin | declined | Medium | low | wide | *low | low | low | unknown |
| ♦ Cicadabird | unknown | Large | low | wide | unknown | high | low | long |
| **Reptiles** | | | | | | | | |
| Glossy Grass Skink | unknown | Medium | low | narrow | unknown | low | low | unknown |
| Swamp Skink | unknown | Small | low | narrow | unknown | low | low | long |
| Lace Monitor | unknown | Large | medium | wide | unknown | unknown | low | long |
| ♦ Spencer's Skink | unknown | Large | unknown | narrow | unknown | unknown | low | unknown |
| **Amphibians** | | | | | | | | |
| Spotted Tree Frog | declined | Medium | low | narrow | high | low | low | long |
| Alpine Tree Frog | declined | Medium | low | narrow | unknown | low | low | unknown |
| Large Brown Tree Frog | unknown | Small | low | wide | unknown | unknown | high | unknown |
| Giant Burrowing Frog | unknown | Medium | low | wide | unknown | unknown | unknown | unknown |
| Tyler's Toadlet | unknown | Small | unknown | narrow | unknown | unknown | unknown | unknown |
| Martin's Toadlet | unknown | Small | unknown | narrow | unknown | unknown | unknown | unknown |
| ♦ Blue Mountains Tree Frog | unknown | Medium | unknown | narrow | unknown | unknown | unknown | unknown |
| ♦ Leaf Green Tree Frog | declined | Large | unknown | narrow | unknown | unknown | high | unknown |

* denotes unknown, but most likely classification

♦ denotes indicator species

## Table 5.3 Summary of impacts of threatening processes on priority fauna species

| SPECIES | Clearing of Native Vegetation | Timber Harvesting | Fuel Reduction Burning | Firewood Collection | Unplanned Fire | Introduced Species | Grazing/Trampling | Pest Control | Road Construction and Maintenance | Mining/Quarrying | Tree Dieback | Recreation | Illegal Collecting/Harvesting Vandalism | Dams/Impoundments | Interspecific Competition | Climate Change | Genetic Dilution | Mineshaft Collapse | Draining of Wetland |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **MAMMALS** | | | | | | | | | | | | | | | | | | | |
| Broad-toothed Rat | 1 | 2 | 1 | 1 | 2 | 2 | 3 | 0 | 2 | 0 | 0 | 2 | 0 | 0 | 1 | | 2 | | |
| Dingo | 1 | 2 | 1 | 1 | 1 | 2 | 2 | 3 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | | | 2 | | |
| Long-footed Potoroo | 2 | 3 | 3 | - | 3 | 3 | 2 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | | | | | |
| Smoky Mouse | 2 | 3 | 3 | 1 | 2 | 2 | 2 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | | | | | |
| New Holland Mouse | 2 | 1 | 3 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | | | | | |
| Spot-tailed Quoll | 2 | 3 | 2 | 2 | 2 | 2 | 1 | 3 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | | | | | |
| Long-nosed Bandicoot | 2 | 2 | 2 | 1 | 2 | 3 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | | | |
| Red-necked Wallaby | 2 | 2 | 2 | 1 | 2 | 2 | 2 | - | 1 | 0 | 0 | - | 0 | - | 1 | | | | | |
| White-footed Dunnart | 2 | 2 | 2 | 0 | 2 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | | | |
| Yellow-bellied Glider | 2 | 2 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | | | | | |
| Common Bent-wing Bat | 1 | - | - | - | - | 2 | 0 | 2 | 0 | 2 | - | 2 | 1 | 3 | 0 | | | | 3 | |
| Eastern Horseshoe Bat | - | - | - | - | - | 2 | 0 | 2 | 0 | 2 | 0 | 2 | 0 | 3 | 0 | | | | 2 | |
| | | | | | | | | | | | | | | | | | | | | |
| **BIRDS** | | | | | | | | | | | | | | | | | | | | |
| Regent Honeyeater | 3 | 2 | - | 2 | 2 | 1 | 2 | - | 1 | - | 3 | - | 0 | - | 0 | 1 | | | | |
| Swift Parrot | 3 | 2 | - | 2 | - | 1 | 2 | - | 1 | - | 2 | - | - | - | 0 | - | | | | |
| Square-tailed Kite | 2 | 2 | 2 | 1 | 2 | 0 | 1 | - | 1 | - | 1 | - | 2 | 2 | 0 | | | | | |
| Grey Goshawk | 2 | 2 | 2 | 1 | 2 | 0 | 1 | 2 | 1 | - | 1 | 1 | - | 2 | 0 | | | | | |
| White-bellied Sea-Eagle | 3 | 2 | - | 2 | - | 0 | 2 | 2 | 2 | 2 | 2 | 3 | - | 2 | 0 | - | | | | |
| Barking Owl | - | - | - | - | - | - | - | - | - | - | - | 0 | 0 | 0 | 0 | | | | | |
| Powerful Owl | 1 | 3 | 2 | 1 | 2 | 0 | - | 1 | 1 | - | 1 | 0 | 0 | 0 | 0 | | | | | |
| Masked Owl | 2 | 2 | 3 | 2 | 2 | 1 | 1 | 3 | 1 | - | 1 | 0 | 0 | 0 | 0 | | | | | |
| Sooty Owl | 1 | 3 | 2 | 1 | 2 | 0 | - | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | | 2 | | | |
| Chestnut-rumped Heathwren | 2 | - | 2 | 2 | 2 | - | 1 | - | 0 | - | - | 0 | 0 | 0 | 1 | | | | | |

| SPECIES | Clearing of Native Vegetation | Timber Harvesting | Fuel Reduction Burning | Firewood Collection | Unplanned Fire | Introduced Species | Grazing/Trampling | Pest Control | Road Construction and Maintenance | Mining/Quarrying | Tree Dieback | Recreation | Illegal Collecting/Harvesting | Vandalism | Dams/Impoundments | Interspecific Competition | Climate Change | Genetic Dilution | Mineshaft Collapse | Draining of Wetland Habitat |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Azure Kingfisher | 2 | 1 | 0 | 0 | 0 | 2 | 1 | - | - | - | 0 | - | 0 | 0 | 3 | | | | | |
| Gang-gang Cockatoo | 2 | 2 | 1 | - | 2 | 0 | - | 0 | - | - | - | 0 | - | 0 | 0 | | | | | |
| Pink Robin | 1 | 2 | 1 | - | 1 | - | 1 | 0 | - | 0 | 2 | 0 | 0 | 0 | 0 | | 2 | | | |
| Hooded Robin | 2 | - | 2 | 2 | 2 | 3 | 2 | - | - | - | 2 | 0 | 0 | 0 | 0 | | | | | |
| Cicadabird | 2 | 2 | - | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | | | | | |
| **REPTILES** | | | | | | | | | | | | | | | | | | | | |
| Glossy Grass Skink | 3 | 2 | 1 | 0 | 1 | 2 | 2 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 2 | | | | | 3 |
| Spencer's Skink | 2 | 2 | 1 | 2 | 2 | 0 | 0 | 0 | 1 | 0 | 2 | 1 | 0 | 0 | 0 | | | | | |
| Swamp Skink | 3 | - | - | 1 | - | 2 | 2 | - | 1 | 0 | 0 | - | 0 | 0 | 2 | | | | | 2 |
| Lace Monitor | 3 | 3 | 2 | 2 | 2 | 2 | 1 | 2 | 1 | 1 | 2 | 1 | 1 | 1 | 0 | | | | | |
| | | | | | | | | | | | | | | | | | | | | |
| **AMPHIBIANS** | | | | | | | | | | | | | | | | | | | | |
| Giant Burrowing Frog | 2 | 3 | 2 | 1 | 2 | 2 | 2 | - | 2 | 2 | 0 | - | 0 | 0 | - | | | | | |
| Martin's Toadlet | - | 2 | 2 | - | 2 | - | - | - | 2 | - | - | - | - | - | - | | | | | |
| Tyler's Toadlet | - | 2 | 2 | - | 2 | - | - | - | 2 | - | - | - | -- | - | - | | | | | |
| Blue Mountains Tree Frog | 3 | 2 | - | - | - | - | - | - | 2 | - | - | - | - | - | - | | | | | |
| Large Brown Tree Frog | 1 | 2 | 2 | 1 | - | - | 1 | 1 | 1 | 1 | - | - | - | - | - | | | | | |
| Leaf Green Tree Frog | 3 | 2 | - | - | - | 2 | - | - | 2 | - | - | - | - | - | - | | | | | |
| Alpine Tree Frog | - | 0 | - | 0 | - | - | 3 | 1 | 1 | 1 | 0 | 2 | - | - | - | | 3 | | | |
| Spotted Tree Frog | 1 | 2 | - | 1 | -- | 3 | 2 | 2 | 2 | 3 | 0 | 2 | -- | - | 2 | | 2 | | | |
| | | | | | | | | | | | | | | | | | | | | |
| **TOTAL SCORE** | **68** | **69** | **49** | **31** | **50** | **44** | **43** | **26** | **36** | **18** | **23** | **18** | **5** | **13** | **15** | | | | | |
| **NO. OF SPECIES AFFECTED** | | | | | | | | | | | | | | | | | | | | |
| Major threat | 8 | 7 | 4 | 0 | 1 | 4 | 2 | 3 | 0 | 1 | 1 | 1 | 0 | 2 | 1 | | 1 | | 1 | 1 |
| Moderate threat | 18 | 23 | 15 | 9 | 21 | 14 | 14 | 6 | 9 | 4 | 6 | 5 | 1 | 3 | 3 | | 4 | 1 | 1 | 1 |
| Minor threat | 8 | 2 | 7 | 13 | 5 | 4 | 9 | 5 | 18 | 7 | 8 | 5 | 3 | 1 | 6 | 1 | | | | |
| Not a threat | 0 | 1 | 1 | 7 | 1 | 9 | 6 | 11 | 7 | 12 | 15 | 16 | 24 | 23 | 22 | | | | | |
| Unknown threat | 5 | 6 | 12 | 10 | 11 | 8 | 8 | 14 | 5 | 15 | 9 | 12 | 11 | 10 | 7 | 2 | | | | |
| **Total no. affected** | **34** | **32** | **26** | **22** | **27** | **22** | **25** | **14** | **27** | **12** | **15** | **11** | **4** | **6** | **10** | **1** | **5** | **1** | **2** | **2** |

## 5.3 Fauna survey

A major fauna survey of the Gippsland Region has been carried out in preparation for this CRA. A comprehensive report of the study is in preparation; it is reported on briefly here.

Objectives for the study included:

- to provide up-to-date and systematic information on distribution of terrestrial fauna (vertebrates and selected invertebrates), by conducting systematic and stratified surveys and producing a database that is suitable for habitat modelling and will facilitate informed management decisions on conservation of forest wildlife.
- to provide data on wildlife distribution and habitat for completion of Forest Management Plans and to facilitate the completion of Regional Forest Agreements.

### *5.3.1 Summary*

Field surveys for all major fauna groups were conducted within many Ecological Vegetation Classes throughout the Gippsland RFA region. A total of 169 survey sites were pre-selected in a randomised manner across the study area, which comprised over 1.6 million ha of forested land across all tenures. These surveys detected a total of 198 species of vertebrates (114 diurnal bird species, 32 reptile, 14 amphibian, 26 terrestrial mammal and 12 bat species), along with a further 127 species of ants, which were the primary invertebrate group investigated. Sites were surveyed intensively during the 1997-98 summer (late October to March), and diurnal birds were also assessed during the 1998 winter. Owls and arboreal mammals were surveyed at approximately 660 sites in Gippsland, over a longer period of time (1996-8). A more detailed report will be prepared on those groups, and they are not considered further here.

### *5.3.2 Site Selection*

Sites for fauna studies were selected using NRE's Geographical Information System (GIS). A small number of climatic and lithographic domains were used to ensure an even spread of sites across the region. These domains were created using the Data Audit Methodology toolkit developed by Environment Australia. Within these domains sites were randomly selected using ARC-INFO, with criteria that sites should be within forest communities at least 2 km apart, and be accessible by roads or tracks. This randomisation process initially produced more than 15,000 sites. This number was reduced to a total of 169 'pre-selected' sites which equates to a sampling intensity of approximately one site per 9,400 ha.

Sites were stratified across three major geographical/catchment divisions of the region (Tambo Catchment, Central South Gippsland, and Central Gippsland), and throughout the altitudinal range within these sub-regions. The area south of the South Gippsland highway which includes Wilsons Promontory National Park and Gippsland Lakes was not surveyed in this study.

### *5.3.3 Ecological Vegetation Classes*

More than 80 EVCs have been identified throughout the Gippsland region. Many of these are represented by isolated or small areas and not all were sampled for fauna during these surveys. Examples of EVCs unsampled for fauna include Wetlands, Granitic Hills / Rainshadow Woodlands, and Plains Woodlands. Thirty-six recognized EVCs were sampled during these fauna surveys, although the majority of these were only assessed by a low number of sites. Floristic information along with structural information and landscape position was used to produce eight EVC groupings: wet forests, damp forests, sub-alpine woodlands, valley riparian forests, montane forests, montane grassy riparian forests, heathy forests, and low foothill forests. The number of sites sampled in each of the eight EVC groupings are shown in Table 5.4. Fauna presence has been tabulated in relation to these eight groups.

**Table 5.4 Ecological Vegetation Classes sampled in the Gippsland region.**

EVC groupings were based on floristic aggregations, structural similarities, and on landscape position.

| EVC groupings | Total |
|---|---|
| Sub-alpine Woodland | 10 |
| Montane Forests | 25 |
| Montane Grassy/Herb-rich Woodlands | 7 |
| Damp Forests | 29 |
| Wet Forests | 24 |
| Lowland-Foothill Forests | 52 |
| Valley- Riparian Forests | 17 |
| Heathy/Herb-rich Forests | 5 |
| Total | 169 |

### *5.3.4 Birds*

Surveys for diurnal birds covered 168 pre-selected fauna sites. In addition, 74 sites were surveyed opportunistically. All sites were surveyed in spring/summer 1997-98 and 123 pre-selected and 6 extra sites were covered in winter. Some nocturnal birds were incidentally recorded during these counts. The main survey technique used was the twenty-minute count where all bird species within a two hectare area were recorded. Species noted 'off-site' (in similar habitat to the survey area) and 'far off-site' were also recorded. Additional species incidentally recorded in these three zones before or after the twenty-minute count were noted as general observations.

One hundred and eleven species were recorded at or in the vicinity of sites while another three species were recorded incidentally. The numbers and diversity of birds were lower than expected, probably due to the effects of drought. Many species which would normally range into drier forest types or aspects appeared to favour damper gully areas. No juvenile individuals were noted and there were fewer territorial or feeding calls heard.

For twenty minute counts, average numbers of birds counted per survey was highest in Montane Grassy/Herb-rich Woodlands and Montane Forests groups (both 20.3 individuals). Most other EVC groups ranged between 18.4 and 15.8 individuals/survey. The lowest average was 11.1 individuals/survey in Heathy/Herb-rich Forests.

Table 5.5 represents a summary of all notable species recorded both on and off-site (ie. in the same vegetation type) for both twenty-minute and general counts in summer and winter. Notable species include those listed as threatened (NRE 1999a), uncommon (fewer than 850 records, *viz.* Emison *et al.* 1987), suspected to be declining or vulnerable (R. Loyn pers. comm.), and noted as being restricted or having a significant part of their range in the Central Gippsland area (Emison *et al.* 1987). Valley-Riparian and Lowland-Foothill Forests had the highest diversity and numbers of notable birds. Wet, Damp and Montane Forests all had a moderate diversity and number of notable birds. All these EVC groups were surveyed with an adequate frequency (36 to 60 sites). The lowest diversity and numbers of notable species were in Heathy/Herb-rich Forests, Montane Grassy/Herb-rich Woodlands and Sub-alpine Woodlands which were surveyed less frequently (7 to 11 sites).

**Table 5.5 Frequency of occurrence of notable bird species within broad EVC groups recorded in summer and winter surveys.**

| | low foothill forests | heathy forests | montane grassy riparian forests | montane forests | sub-alpine woodlands | damp forests | valley riparian forests | wet forests |
|---|---|---|---|---|---|---|---|---|
| **Species** *No. of sites surveyed* | *60* | *8* | *7* | *38* | *11* | *45* | *36* | *37* |
| **Threatened (Vic.)** | | | | | | | | |
| Powerful Owl | 1 | | | | | | 2 | |
| Sooty Owl | | | | | | | 1 | |

| | low foothill forests | heathy forests | montane grassy riparian forests | montane forests | sub-alpine woodlands | damp forests | valley riparian forests | wet forests |
|---|---|---|---|---|---|---|---|---|
| **Species** *No. of sites surveyed* | *60* | *8* | *7* | *38* | *11* | *45* | *36* | *37* |
| **Uncommon (Vic.)** | | | | | | | | |
| Painted Button-quail | 1 | | | | | | | |
| Brush Bronzewing | | | | 1 | | | | 1 |
| Wonga Pigeon | 3 | 1 | | 3 | | 3 | 2 | 1 |
| Collared Sparrowhawk | 1 | | | | | | | |
| Little Lorikeet | 1 | | | | | | 2 | |
| White-throated Nightjar | | | | | | 1 | 3 | |
| Australian Owlet-nightjar | 3 | | | | | | 2 | |
| Pink Robin | 1 | | | 3 | | 1 | | 1 |
| Rose Robin | | | | 2 | | 3 | | 11 |
| Olive Whistler | 1 | | | 14 | 5 | 4 | | 12 |
| Leaden Flycatcher | 4 | | | | | | | |
| Black-faced Monarch | | | | | | | | 5 |
| Brush Cuckoo | | | | 1 | | | | |
| White-bellied Cuckoo-shrike | | | 1 | | | | 5 | |
| Cicadabird | 6 | 2 | | 1 | | 3 | 5 | 4 |
| Pilotbird | | | | 16 | | 14 | | 25 |
| Brown Gerygone | 1 | | | | | 3 | 3 | 1 |
| Large-billed Scrubwren | 2 | | | | | 2 | | 13 |
| Red-browed Treecreeper | 2 | | 5 | 18 | | 11 | 3 | 6 |
| Lewin's Honeyeater | 1 | | | | | 7 | 1 | 14 |
| Satin Bowerbird | 5 | | | | | 8 | 14 | 1 |
| Forest Raven | 3 | | | | | 2 | | 5 |
| **Suspected declining (Vic.)** | | | | | | | | |
| Scarlet Robin | 22 | 2 | | | | 2 | 7 | |
| Buff-rumped Thornbill | 20 | 1 | 3 | | | | 16 | 1 |
| Brown Treecreeper | | | | | | | 1 | |
| **Restricted within RFA region** | | | | | | | | |
| Emu | 3 | | | | | | | |
| Musk Lorikeet | 2 | | | | | | | |
| Bell Miner | 18 | | | | | 15 | 25 | |
| Restless Flycatcher | | | | | | | 2 | |
| Weebill | | | | | | | 6 | |
| Fuscous Honeyeater | | | | | | | 5 | |
| Noisy Friarbird | 1 | 7 | 1 | | | | 8 | |
| **Core range (Vic.)** | | | | | | | | |
| Spotted Quail-thrush | 3 | 1 | 1 | 2 | | 4 | 6 | |
| Yellow-tufted Honeyeater (subsp. *Gippslandicus*) | 8 | | | | | 1 | 73 | |
| **Vulnerable (hollow-nesters)** | | | | | | | | |
| Yellow-tailed Black-Cockatoo | 21 | | | 2 | | 8 | 11 | 18 |
| Gang-gang Cockatoo | 11 | | | 20 | 2 | 7 | 34 | 9 |
| Australian King-Parrot | 6 | 2 | | 1 | | 8 | 11 | 4 |
| Number of notable species | 27 | 7 | 5 | 13 | 2 | 20 | 25 | 18 |
| Number of individuals recorded | 151 | 16 | 11 | 84 | 7 | 107 | 248 | 132 |

### *5.3.5 Reptiles*

Surveys for reptiles were undertaken at all pre-selected survey sites. Three independent survey techniques were used at each site. One technique used a timed 20 minute passive search at the site which was not constrained by area. This procedure was then followed by an active search of the same area, which included when necessary the breaking open of logs and exfoliating rock material to access and identify resident reptiles. The final method was an intensive 20 minute search of a 250m$^2$ sub-plot of the site. Censuses were conducted only between the temperatures of 18$^0$C and 32$^0$C, when animals are mostly likely to be observed basking and could be captured and/or identified.

As expected, low densities of reptiles were recorded from the more elevated and moister forest systems of the region. However, a higher recording rate was anticipated within the heathy forests, and higher encounter rates were expected for White-lipped Snake, Tiger Snake, Black Rock Skink, Metallic Skink, Blue-tongue Lizards, McCoy's Skink, Conventry's Skink, and Spencer's Skink (G. Brown pers. comm.). This may reflect the fact that site selection was not targeted specifically at locations likely to yield high numbers of reptiles.

The results of species abundance across the EVC groupings are shown in Table 5.6. These results show that several species were common and widespread across EVC groupings (e.g. Garden Skink, Southern Water Skink), while others were more restricted in their distribution (e.g. Swamp Skink, Bougainville's Skink, Alpine Water Skink, Tree Dragon (Jacky Lizard), etc.). A large number of unidentified grass skinks and water skinks were recorded as part of these surveys.

Notable records from the surveys include two occurrences of Highland Copperhead Snakes, and records of Tree Goanna, Swamp Skink, Alpine Water Skink, Glossy Grass Skink, and Alpine Bog Skink. Also notable absences were the low recording rates for Brown Snakes and Lowland Copperhead Snakes.

**Table 5.6 Number of reptiles per 100 censuses recorded at pre-selected sites within Ecological Vegetation Class groupings.**

| Species EVC grouping | low foothill forests | heathy forests | Montane grassy riparian forests | Montane forests | sub-alpine woodlands | damp forests | valley riparian forests | wet forests | General Obs. | Totals |
|---|---|---|---|---|---|---|---|---|---|---|
| # of censuses | 135 | 16 | 24 | 65 | 27 | 74 | 48 | 63 | | |
| | | | | | | | | | | |
| Mountain Dragon | 6.7 | | | | | | 8.3 | | | *13* |
| Tree Dragon | | | 8.3 | | | | 16.7 | 1.6 | 2 | *13* |
| Tree Goanna | | | | | | 1.4 | 2.0 | 1.6 | 8 | *11* |
| Copper-tailed Skink | | | 8.3 | | | | | | | *2* |
| Swamp Skink | 0.7 | | | | | | | | | *1* |
| White's Skink | | 18.8 | | | 3.7 | 1.4 | | | | *5* |
| Three-toed Skink | | 18.8 | 12.5 | | | | | | | *6* |
| McCoy's Skink | 8.2 | | | 6.2 | 3.7 | 14.9 | 4.2 | | 2 | *31* |
| Delicate Skink | 8.2 | | | 1.5 | | 1.4 | 2.0 | | 10 | *24* |
| Garden Skink | 56.3 | 150.0 | 120.8 | 15.4 | | 44.6 | 135.4 | 3.2 | 14 | *253* |
| Weasel Skink | 2.2 | | | | | 4.1 | 4.2 | | 7 | *15* |
| Metallic Skink | | | | | | | | | 5 | *5* |
| Coventry's Skink | | 12.5 | 4.2 | | 7.4 | | | 4.8 | | *8* |
| Bougainville's Skink | 0.7 | | | | | | | | | *1* |
| Spencer's Skink | | 18.8 | 8.3 | 21.5 | 11.1 | 2.7 | | 1.6 | | *25* |
| Alpine Water Skink | | | | 4.6 | | | | | | *4* |
| Blotched Blue-tongued Lizard | 0.7 | | | | | | | | 2 | *3* |
| Common Blue-tongued Lizard | 0.7 | | | | | | | | | *1* |
| White-lipped Snake | | | | | | | | | 2 | *2* |
| Eastern Three-lined Skink | | | | | | | | | 2 | *2* |
| Glossy Grass Skink | | | | | | | | | 6 | *6* |
| Red-bellied Black snake | | | | | | | | | 6 | *6* |
| Eastern Brown Snake | | | | | | | | | 1 | *1* |
| Tiger Snake | | | | | | | | 1.6 | 1 | *2* |
| Gippsland Water Dragon | | | | | | | 8.3 | | 35 | *39* |
| Black Rock Skink | 5.9 | | | | | 1.4 | | 1.6 | 1 | *11* |
| Southern Water Skink (CTF) | 8.2 | | 83.3 | 7.7 | 25.9 | 41.9 | | | 2 | *76* |
| Yellow-bellied Water Skink | 0.7 | 18.8 | | 4.6 | | 6.8 | 39.6 | | 11 | *42* |
| Highland Copperhead | | | | 3.1 | 3.7 | | | | 4 | *7* |
| Lowland Copperhead | | | | | | | | | 4 | *4* |
| unidentified Copperhead | | | | | | | | | 1 | *1* |
| unidentified scincid | 73.3 | 93.8 | 37.5 | 58.5 | 107.4 | 67.6 | 41.7 | 4.8 | 3 | *266* |
| unidentified agamid | 1.5 | | | 1.5 | | | | 1.6 | 1 | *5* |
| unidentified snake | 1.5 | | | | | | 2.1 | | 2 | *5* |
| unidentified water skink | 23.7 | | 50.0 | 55.4 | 48.2 | 48.7 | 35.4 | 11.1 | 14 | *167* |
| Alpine Bog Skink | | | | | 7.41 | | | | | *2* |
| Southern Grass Skink | | | | 1.5 | 614.8 | | | | | *167* |
| unidentified grass skink | 4.4 | | 12.5 | 41.5 | 77.8 | 9.5 | 6.3 | | | *67* |
| | | | | | | | | | | |
| Individuals | 250 | 48 | 82 | 119 | 237 | 158 | 134 | 20 | 140 | 1153 |
| Total species | 17 | 7 | 10 | 13 | 11 | 13 | 11 | 10 | | |
| Species/survey | 1 | 1.4 | 1.2 | 1 | 1.7 | 1.1 | 1.1 | 0.3 | | |

Data compiled from all survey methods and from general inspections on site. Observations elsewhere recorded under 'General Observations' category. 'General Observations' and Totals show absolute numbers of reptiles recorded with the RFA study area from other sites, other values are individual animals per 100 censuses.

### *5.3.6 Amphibians*

Frogs were encountered in several ways throughout the Gippsland region. Specific surveys for frog species were undertaken at water bodies after dusk, and records were made of their vocal calls. Similarly searches were made for amphibians during and immediately following warm, wet periods. As both of these types of searches were conducted at localities where EVCs were not defined, results were tabulated by sub-region (Table 5.7). While frogs can be readily identified from their calls, the number of individual frogs is much more difficult to determine. Most species identified are known to be reasonably widespread or common in the region, with the exception of the Giant Burrowing Frog, which is classified as vulnerable (NRE 1999a) and is listed under the *Flora and Fauna Guarantee Act* 1988. This species was detected on the shores of an arm of the Glenmaggie Reservoir.

**Table 5.7 Frog species detected within the Gippsland RFA region.**

| | Central Gippsland | Tambo | Central South Gippsland | Incidental |
|---|---|---|---|---|
| Giant Burrowing Frog | 1 | | | |
| Southern Bullfrog | 1 | 1 | 3 | 1 |
| Striped Marsh Frog | | | 1 | |
| Spotted Marsh Frog | 5 | 2 | 1 | 4 |
| Haswell's Froglet | | 2 | 6 | 1 |
| Common Froglet | 16 | 6 | 7 | 12 |
| Southern Brown Tree Frog | 3 | 1 | 3 | 6 |
| Peron's Tree Frog | 5 | 4 | 3 | 13 |
| Leaf Green Tree Frog | 1 | 1 | | 2 |
| Verreaux's Tree Frog | 9 | 5 | 2 | 2 |
| Blue Mountains Tree Frog | | | | 2 |
| Lesueur's Frog | 9 | 8 | | 53 |
| Victorian Smooth Froglet | | | | 1 |
| Dendy's Toadlet | | | | 1 |

Data represent the number of sites with records of each species. Data includes results from frog survey sites (*Central Gippsland*, *Tambo* and *Central South Gippsland*), and incidental records.

### *5.3.7 Mammals*

Terrestrial mammals were sampled at 150 of the pre-selected sites using hairtubing techniques. Fifteen hair tubes were set at each site for a minimum period of 2 weeks. Ten of the hair tubes were baited with a herbivore bait (rolled oats, peanut butter, pistachio essence), while the remainder used a bait more attractive to carnivores (i.e with sardines also included) attempting to attract rare native species such as quolls. Hairtubes use a sticky surface to retain body hairs from animals as they try to access an enclosed bait. These hairs are species-specific and can be identified by experts using microscopic analysis. Approximately 50% of the tubes returned hairs from the two week sampling period.

A total of 478 identifications were made. Only 'definite' records of species or genera were used in this tabulation, and 'likely' or 'possible' records were omitted. Large numbers of *Antechinus agilis* were recorded, along with fewer records of nine other species (Table 5.8). Less frequently recorded species included Dusky Antechinus, Wombat and Bush Rat. Brushtail possums were recorded frequently across all EVC community groupings, but unfortunately hair analysis could not easily distinguish between Common Brushtail Possums and Mountain Brushtail Possums.

Apart from a single record of an unidentified glider, there were no records of Sugar Gliders which are known to be common in Gippsland (Menkhorst 1997), and were recorded frequently during surveys of owls and arboreal mammals. Similarly, Swamp Rats are known to be common and were not recorded, and Water Rats not detected despite tubes being situated near streams at several sites.

Less common species such as Feathertail Gliders, Brush-tailed Phascogales, Broad-toothed Rats, and rare species such as Smoky Mouse, were not recorded in these surveys. With low returns for most species detected in these surveys, it is difficult to draw conclusions on the frequency of occurrence of species across EVC groupings.

Apart from formal surveys mammals were also recorded throughout the study area in general observations by the field biologists. These records are shown in Table 5.7 with other incidental and opportunistic observations.

**Table 5.8 Number of detections of mammal species from hairtubing surveys.**

| Species | low foothill forests | heathy forests | Montane grassy riparian forests | montane forests | sub-alpine woodlands | damp forests | valley riparian forests | wet forests | Totals |
|---|---|---|---|---|---|---|---|---|---|
| Sites surveyed | *72* | *10* | *14* | *42* | *18* | *44* | *30* | *30* | *260 sites* |
| Agile Antechinus | 96 (3) | | 7 | 25 | 3 | 78 (1) | 14 (1) | 43 (1) | 272 |
| Dusky Antechinus | | | | 2 (1) | | | 1 | 8 (1) | 13 |
| Common Ringtail Possum | | | | (1) | (1) | | | | 2 |
| Common Wombat | (3) | 1 | (2) | 1 (1) | | | 1 | (1) | 10 |
| Black Wallaby | 8 (17) | (2) | 8 (5) | 4 (4) | 1 (1) | 3 (10) | 5 (10) | 2 | 80 |
| Bush Rat | 1 (2) | | | 1 (1) | | | | 2 | 7 |
| Red Fox | 2 (3) | 1 | | (1) | 2 | (1) | 2 (1) | (3) | 16 |
| Cat (feral) | (1) | | | | | (1) | | | 2 |
| unidentified brushtail possum | 10 (14) | (2) | 9 (5) | 1 (5) | 2 (7) | 3 (3) | 2 (2) | (2) | 67 |
| unidentified glider | 1 | | | | | | | | 1 |
| unidentified *Antechinus* sp. | 1 | | | | | | | 3 | 4 |
| unidentified *Rattus* sp. | | | | | | 1 (1) | | | 1 |
| small rodent | (1) | | | | | 1 | | | 2 |
| Individuals | 163 | 6 | 36 | 48 | 17 | 103 | 39 | 66 | 478 |
| Total 'definite' species | 10 | 4 | 4 | 8 | 5 | 7 | 6 | 8 | 8 |
| Species/survey | 2.22 | 0.50 | 2.71 | 1.14 | 1.06 | 2.02 | 1.30 | 2.03 | |

Values in brackets denote records from Scotts and Craig type hairtubes. All other records are from 'Faunatech' type hairtubes.

### *Predator Scats*

A further way that fauna may be detected is by the analysis of hair and other remains from faecal pellets from predators. As the predators may have consumed their prey some distance removed from the collection site, some caution must be used in assigning results to a particular EVC or EVC group. Other problems associated with this method are that some predators, notably cats, tend to bury their scats. Keeping these caveats in mind, the data tabulated (Table 5.9) suggest that Brushtail Possums were widely distributed, and formed a considerable part of the diet of introduced predators, as do Swamp Wallabies, Wombats, Bush Rats, and Common Ringtail Possums. Other common prey items included Greater Glider, Sugar Glider and Dusky Antechinus. Surprisingly the Agile Antechinus was represented with slightly fewer records than the Dusky Antechinus. This may be due to the Agile Antechinus, although generally more common, feeding extensively in trees where they are less accessible to predators. Altogether 19 mammal taxa were identified to species level from remains in predator scats, compared to eight species identified from hair tubes.

**Table 5.9 Number of records of prey items from predator scats.**

| Species | low foothill forests | heathy forests | Montane grassy riparian forests | montane forests | sub-alpine woodlands | damp forests | valley riparian forests | wet forests | incidental | *totals* |
|---|---|---|---|---|---|---|---|---|---|---|
| Platypus | | | | (1) | (1) | | | | (2) | *4* |
| Agile Antechinus | | | | (2) | (2) | (1) | (2) | | (1) | *8* |
| Dusky Antechinus | (3) | | | | (2) | (2) | | 1 (2) | | *10* |
| Long-nosed Bandicoot | | | | | | | | 1 (1) | | *2* |
| Common Ringtail Possum | 3 (3) | | (1) | 1 (3) | (9) | | 1 (3) | 7 | (1) | *31* |
| Greater Glider | 1 (2) | | 1 (1) | 1 | | (1) | 1 (1) | | | *9* |
| Sugar Glider | 1 (2) | | | | | | (2) | (2) | | *7* |
| Koala | | | | | | 1 | | 1 | | *2* |
| Common Wombat | 1 | 1 | 5 | 12 (1) | | | (2) | 5 | | *27* |
| Black Wallaby | 11 (10) | 3 (4) | | 5 (5) | | 2 (2) | 7 (2) | 1 (1) | (2) | *55* |
| Eastern Grey Kangaroo | | | | | | | (1) | | | *1* |
| Bush Rat | (1) | | | (5) | | (2) | (1) | 1 (5) | | *15* |
| European Rabbit | (2) | | (2) | 1 (2) | (2) | | 5 | 1 | | *15* |
| Cattle | | | 1 | 1 | | | | 2 | | *4* |
| Sheep | | | (1) | | | | 2 (2) | | | *5* |
| Sambar | | | | 1 | | | | | | *1* |
| Dingo & Dog (feral) | 4 | 2 | | 2 | | | 2 | 1 | | *11* |
| Red Fox | 2 (1) | | | 2 (4) | (2) | | (1) | | | *12* |
| Cat (feral) | | | | | | | | (1) | | *1* |
| unid. brushtail possum | 11 (10) | 3 | 3 (1) | 15 (13) | (2) | 1 (3) | 5 (10) | 2 (4) | | *83* |
| unidentified *Rattus* sp. | | | | (1) | | | | | | *1* |
| | | | | | | | | | | |
| Surveys | 33 (33) | 6 (6) | 6 (6) | 21 (21) | 7 (7) | 18 (18) | 14 (14) | 16 (16) | | 304 |
| Total 'definite' species | 11 | 4 | 7 | 15 | 7 | 8 | 13 | 14 | | 19 |
| Species/survey | 1.4 | 1.3 | 1.5 | 2.2 | 2 | 0.8 | 2.2 | 2.1 | | |

Bracketed figures indicate record from fox scats, other figures indicate dog or dingo scat.

### *Bats*

The distribution of bats within the study area was assessed by two methods, harp trapping and ultrasonic detection. Results from harp trapping are shown in Table 5.10. Some broad conclusions that can be drawn from these results are that high altitude forests generally have lower diversity than the lower altitude forest communities. Species such as Gould's Wattled Bats and Little Forest Bats are more common in lower altitude and drier forest communities, and Eastern False Pipistrelles and Southern Forest Bats are more common in wet forests, which also occur predominantly in the lower altitudes. Although Lesser Long-eared bats can occur across a wide range of altitudes, captures of bats in these surveys suggests that they are more commonly encountered at lower altitudes. Results from ultrasonic detection are still being formulated, and are consequently not shown here.

Additional harp trapping for bats was also conducted in the study region around the Mt. Useful area during December 1997, to investigate the roosting ecology of selected species. These data are included in Table 5.9 as 'extra information'. The single record of a Eastern Bent-Wing Bat came from this work, and is of note as the species is listed under the *Flora and Fauna Guarantee Act* 1988 because of its restricted colonial maternity sites in caves at a few locations.

**Table 5.10 Numbers of bats recorded from bat trapping within Ecological Vegetation Class groupings**

| **Species** | **low foothill forests** | **heathy forests** | **Montane grassy riparian forests** | **montane forests** | **sub-alpine woodlands** | **damp forests** | **valley riparian forests** | **wet forests** | ***Extra*** | ***Totals*** |
|---|---|---|---|---|---|---|---|---|---|---|
| *Sites surveyed* | *39* | *9* | *2* | *10* | *9* | *19* | *14* | *20* | *50* | |
| | | | | | | | | | | |

| Species | low foothill forests | heathy forests | Montane grassy riparian forests | montane forests | sub-alpine woodlands | damp forests | valley riparian forests | wet forests | *Extra* | *Totals* |
|---|---|---|---|---|---|---|---|---|---|---|
| Gould's Long-eared Bat | 3 | | | | 9 | 5 | | 6 | *21* | *44* |
| Lesser Long-eared Bat | 46 | 1 | 2 | 2 | 3 | 11 | 19 | 8 | *129* | *221* |
| Eastern Bent-wing Bat | | | | | | | | | *1* | *1* |
| Gould's Wattled Bat | 33 | | | | | 4 | 2 | 3 | *5* | *47* |
| Chocolate Wattled Bat | 41 | 5 | 2 | 16 | 51 | 36 | 19 | 38 | *255* | *463* |
| Large-footed Myotis | | | | | | | 1 | | | *1* |
| Eastern False Pipistrelle | 3 | | | | | 2 | 1 | 26 | *7* | *39* |
| Southern Forest Bat | | | 2 | | 10 | 18 | 2 | 58 | *299* | *389* |
| Little Forest Bat | 127 | 2 | | | | 35 | 25 | 1 | *1* | *191* |
| Large Forest Bat | 5 | | | 1 | 3 | 28 | 7 | 38 | *186* | *266* |
| Eastern Broad-nosed Bat | 2 | | | | | | | | | *2* |
| Freetail Bat (eastern form) | 1 | | | | | | | | | *1* |
| | | | | | | | | | | |
| Individuals | 261 | 8 | 6 | 19 | 76 | 139 | 76 | 178 | *904* | *1665* |
| Total species | 9 | 3 | 3 | 3 | 5 | 8 | 8 | 10 | 9 | *12* |
| Species/survey | 1.8 | 0.3 | 2.5 | 0.9 | 1.8 | 2.2 | 2.1 | 2.8 | 3.6 | |

### *5.3.8 Epigeal Invertebrates*

Ground-dwelling invertebrates were sampled as part of the general vertebrate fauna surveys conducted for the RFA process. These were sampled with pitfall traps, which consisted of polyethylene jars dug into the soil with the upper lip continuous with ground level. The traps were set with a 1:1 mixture of ethylene glycol and 70% ethanol. Five traps were set at each pre-selected site and collected 2 weeks later. A total of 850 traps were set during the study accounting for approximately 10,683 trap nights from 135 of the sites. Samples were sealed and sent for analysis by a specialist team at the Museum of Victoria.

Full analysis of these sample for all invertebrate taxa would have been a time consuming and expensive process. Consequently, while all invertebrates were retained for later analysis, only ants were examined to species level. Ants have been identified as a potential 'indicator' taxa with significant responses to environmental conditions and environmental change. As many 'species' still remain unidentified individual 'morpho-species' were used as surrogates in this analysis. Voucher specimens for each 'morpho-species' have been retained at the Museum of Victoria. Findings from this survey will be reported on in Section 5.4

### *5.3.9 General Observations*

In addition to the formal surveys conducted at each site, fauna observed by general observations were recorded for each site. These data include evidence from diggings, scats, scratch marks and other definitive signs. A collation of this data is shown in Table 5.11, and identifies some species which were not readily detected during defined surveys (e.g. Echidna, Broad-Toothed Rat (from scat), Eastern Grey Kangaroo and unidentified Bandicoots).

**Table 5.11 Incidental observations of fauna species with EVC groupings.**

| Species | low foothill forests | heathy forests | montane grassy riparian forests | montane forests | sub-alpine woodlands | damp forests | valley riparian forests | wet forests | incidental | *totals* |
|---|---|---|---|---|---|---|---|---|---|---|
| Superb Lyrebird | 2 | | 2 | 1 | | 3 | | 1 | | *9* |
| Short-beaked Echidna | | | | | | 1 | | 1 | 5 | *7* |
| Brown Antechinus | | | | 1 | | | | | | *1* |
| Unid. *Antechinus* sp. | | | 2 | 1 | 2 | 2 | | | | *7* |
| Common Ringtail Possum | 1 | | | 2 | 3 | 1 | 2 | 4 | 2 | *15* |
| Common Brushtail Possum | | | | | | | | | 5 | *5* |
| Mountain Brushtail Possum | | | | | | | 1 | | 2 | *3* |
| Greater Glider | 1 | 1 | | 2 | | 4 | | | 14 | *22* |
| Yellow-bellied Glider | 1 | | | 3 | | | 4 | | 8 | *16* |
| Sugar Glider | | | | | | | | | 3 | *3* |
| Koala | | | | | | 1 | | 1 | | *2* |
| Common Wombat | 8 | 4 | 4 | 13 | 2 | 14 | 7 | 11 | 7 | *70* |
| Black Wallaby | 7 | 4 | 5 | 5 | | 16 | 5 | 9 | 6 | *57* |
| Red-necked Wallaby | | | | | | | | | 3 | *3* |
| Eastern Grey Kangaroo | 2 | 2 | 3 | | | | 3 | 1 | 5 | *16* |
| Broad-toothed Rat | | | | | | | | | 1 | *1* |
| Bush Rat | | | | 2 | | | | | | *2* |
| unidentified *Rattus* sp. | | | | | 1 | | | | | *1* |
| European Rabbit | 2 | 2 | 1 | 2 | 1 | 2 | 3 | 2 | | *15* |
| Horse (feral) | | 1 | 1 | | 3 | | | | 1 | *6* |
| Cattle (feral) | | | | | | | 1 | | 1 | *2* |
| Sambar | | 1 | | 2 | | | 1 | | 2 | *6* |

| Species | low foothill forests | heathy forests | montane grassy riparian forests | montane forests | sub-alpine woodlands | damp forests | valley riparian forests | wet forests | incidental | *totals* |
|---|---|---|---|---|---|---|---|---|---|---|
| Dingo & Dog (feral) | | | | | 1 | | | | | *1* |
| Red Fox | 1 | | | 3 | | | | 1 | 3 | *8* |
| unidentified bandicoot | | | | 1 | | 1 | | 1 | | *3* |
| unid. brushtail possum | 8 | 3 | 1 | 23 | | 9 | 2 | 9 | 1 | *56* |
| Individuals | 33 | 18 | 19 | 61 | 13 | 54 | 29 | 41 | 69 | *337* |
| Total species | 10 | 8 | 8 | 14 | 7 | 11 | 9 | 11 | 6 | *25* |

## 5.4 Terrestrial Invertebrates

Many of the invertebrate records from forested areas in the south of the region date from early this century and include sites now wholly or largely cleared for agricultural or pastoral purposes. For most groups, there has been no recent census of their status.

### *Land-snails* (Pulmonata)

There are a number of Gippsland snail species associated with wetter forest habitats which are shared with northern Tasmania (e.g. *Prolesophata dyeri* and *Miselaoma and Pernagera* species). Regional endemics include the Punctid *Turbolaoma turbinuloides* (Bairnsdale environs) and the Charopids *Allocharopa tarravillensis* (south Gippsland), *Dentherona illustra, D. jemmysensis, Cralopa colliveri* (Gippsland Lakes area) and *Egilodonta bairnsdalensis.* Most species are highly sensitive to disturbances such as removal or modification of native vegetation and fire. Many are dependent on fallen timber for the maintenance of microhabitat.

### *Earthworms (Oligochaeta)*

The region was well sampled by W. Baldwin Spencer at the turn of the century, though many of his sites are now devoid of native vegetation. Some 8 species were identified in the Warragul district alone. The genera *Diporochaeta* and *Simsia* dominate the fauna. Endemics include species such as *Diporochaeta arnoldi* (Mt Arnold, near Marysville), *D. walhallae* (Walhalla) and *Megascolides australis*. The latter is better known as the Giant Gippsland Earthworm, the only oligochaete listed under the FFG and ESP legislation. It is a deep-burrowing species of heavy clay soils, favouring south-facing aspects. It appears tolerant of some disturbance, provided that it has access to vegetated gullies.

### *Velvet-worms* (*Onycophora)*

The only known regional endemic is *Ooperipatus bulgensis*, which, though recorded only from the Tarra-Bulga National Park (first collected in 1988), is probably of wider distribution in the Strzelecki Ranges. Lack of information on other species is perhaps more symptomatic of low collecting effort than of a paucity of taxa.

### *Millipedes (Diplopoda)*

The Millipede fauna of Victoria was last reviewed by Jeekel (1984), who recognises 15 species of the family Paradoxosomatidae, all but one of which is endemic. Members of other families are also represented, but there have been few studies in recent times. Of the paradoxosomatids, at least 2 are known to be endemic to the Gippsland region, viz *Isocladosoma pallidulum* (Gunyah Gunyah) and *I. guttatum* (Mitchell River National Park). Undescribed species of Millipedes have been located in most new areas surveyed, suggestive of a large and largely unknown fauna. In Gippsland, new taxa are known from near Bruthen, Tarra-Bulga National Park, Mt Taylor and Toongabbie. Millipedes are largely detritus feeders, occurring in leaf litter, debris, fallen logs and the upper soil layers. They are sensitive to disturbance and are unlikely to persist in severely modified environments.

### *Insecta*

There are numerous records of insects in the Australian National Insect Collection records for the Gippsland Region, including endemic species. The survey work for the RFA included collections of ant species (Formicidae). Studies on the full complement of ant fauna on such a large geographic scale are very rare. Results from this study identified 130 different 'morpho-species' from 135 pre-selected sites throughout the study area. In general, between 20 and 25 different 'morpho-species' were detected at most sites, with some sites having a considerable diversity of up to 40 'morpho-species'. The more common taxa include *Rhytidoponera* spp., *Monomorium* spp., *Pheidole* spp., *Melophorus* spp. and *Iridomyrmex* spp. (Appendix G).

## 5.5 Threatened species studies

In addition to the fauna survey reported on in section 5.3, research projects were commissioned to provide information on the distribution and status of threatened species in the Gippsland region. Assessments were produced for the following species:

- Brush-tailed Rock-wallaby *Petrogale penicillata*
- Spot-tailed Quoll *Dasyurus maculatus*
- New Holland Mouse *Pseudomys novaehollandia*

- Smoky Mouse *Pseudomys fumeus*
- Giant Gippsland Earthworm *Megascolides australis*
- Heath Sand Skipper Butterfly *Antipodia chaostola*
- Rare Frogs
- Burrowing Crayfish
- Spiny Crayfish

The aim of the assessments was to provide information that would enhance the understanding of the species' requirements in the context of forest management, and to assist in their management in Gippsland.

### *Brush-tailed Rock-wallaby and Spot-tailed Quoll*

This combined project aimed to clarify the distribution of the Spot-tailed Quoll and Brush-tailed Rock-wallaby in the Gippsland RFA region. Historic records exist for Brush-tailed Rock-wallaby at a number of sites in the region, including Mt Tambo, Snowy Bluff and Mt Kent, which may not have been surveyed for many years. In addition there are many other apparently suitable areas which have never been surveyed for the species. Colonies occupy precipitous habitat where survey is difficult. Occasional records of Spot-tailed Quoll indicate the species is probably present throughout the Eastern Highlands, including the Gippsland RFA region. Spot-tailed Quoll appear to be relatively conspicuous where they occur on rocky habitats and therefore it was considered productive to combine searches for quolls and rock-wallabies.

Aerial photographs were used where possible to pinpoint 'suitable sites' that were then searched thoroughly for signs of the presence of these species, in particular through the identification of scats. Scats of introduced predators (foxes, wild dogs and cats) were collected from the vicinity of rocky outcrops being searched, and analysed to determine prey species. Three days were spent searching rocky outcrops of Mt Seldom Seen. A large shelter in the mid-section of outcrop revealed polished rock, old Brush-tailed Rock-wallaby scat and a Brush-tailed Rock-wallaby skeleton. No evidence of Spot-tailed Quoll were found in the area searched. Two days of searching a section of the Mt Tambo escarpment revealed few shelter/refugia which were to contain no obvious indication of the presence of Brush-tailed Rock-wallaby either at the time of the search or historically. A possible Quoll scat, still to be confirmed by analysis, was found. A 1996 record of Brush-tailed Rock-wallaby on the Atlas of Victorian Wildlife from Garron Creek indicated the possible existence of an extant population in the area. Searches revealed no suitable rock. The report has since been found to be inaccurate and has been corrected.

This project is continuing and other sites, including parts of Ben Craughan, Snowy Bluff, Mt Kent and the Mitchell River System will also be checked for suitable habitat. On completion this project will produce site descriptions, history of the two target species at each site, survey results and other information to assist management decisions during the implementation of the RFA.

### *New Holland Mouse*

This project aims to more accurately determine the distribution of the New Holland Mouse in Gippsland and to gain a better understanding of the impact of fire on populations. Targeted surveys were conducted in areas that have received limited previous survey and in areas of unsurveyed potential habitat. Sand Heathland, Heathy Woodland and Coastal Dune Scrub Mosaic EVCs were delineated and sites selected based on habitat suitability (ie floristics, structure/successional age) and the presence/absence of previous surveys for the species. Trapping has been conducted at sites on the Gippsland plains including private land surrounding Providence Ponds Flora and Fauna Reserve, Crown land in Blond Bay Game Reserve, State forest at Mullungdung, and Snake Island. To date, New Holland Mouse has not been recorded.

Trapping data was collected from a permanent trapping grid established in the Gippsland Lakes Coastal Park to assess and monitor a fire event on a population of the New Holland Mouse. This data was collected and analysed as part of an ongoing study to investigate pre- and post-fire changes in the relative abundance of the species and associated habitat. This study will collect trapping data for the second year post-fire period and will provide information on changes in relative abundance of the New Holland Mouse, and associated habitat, within and between trapping sites over time.

Trapping has been completed at the six sites contained within the area burnt in autumn 1997 and six sites in unburnt adjacent vegetation. Preliminary results indicate an increase in numbers of New Holland Mouse in the burnt area, compared with the 1998 trapping results. Annual vegetation monitoring at each trapping grid is currently being conducted.

### *Smoky Mouse*

This project aimed to determine the presence of the Smoky Mouse at a number of sites within Central Gippsland and describe the micro-habitat of the species at these sites. Information on distribution and habitat preferences will assist the development of management plans relating to park, forest and fire management.

Plant species lists from sites where Smoky Mouse had previously been recorded were used to develop a list of floristic attributes considered to be characteristic of Smoky Mouse habitat. These attributes formed the basis of survey site

selection. Sites that shared a similar complement of flora species and fell within the range of suitable edaphic factors were targeted for survey. Sites were trapped using a combination of 15 Elliot Type A and 10 small wire-mesh cage traps for three consecutive nights. Results of trapping yielded four individuals from three of the 51 survey sites. Targeted areas included Tambo, Pinnibar-Pendergast, Selwyn-Tea Tree State Forests and State forest in the vicinity of Thomson and Macalister as well as parts of the Alpine National Park (Mt Seldom Seen, Buenba Flat, Beloka Range, Wonnangatta River, Howitt).

### *Giant Gippsland Earthworm*

Very little is known about the distribution of the Giant Gippsland Earthworm *Megascolides australis* on public land within the Gippsland RFA area. At present its distribution is mostly known from private land, the only exception being Mt Worth State Park where the species has been recorded from a few sites. The proposed project will survey for the presence of Giant Gippsland Earthworm on public land, including State parks and State forest areas where previous research indicates the presence of potentially suitable habitat. Vegetation types and other relevant habitat factors will be recorded at each location where the earthworm is found. This project is not scheduled to commence until late autumn 1999 when conditions become more suitable for location of the species.

### *Heath Sand Skipper Butterfly*

The Heath Sand Skipper appears to be a habitat specialist, occupying a few rare, scattered and relatively small patches of heathy woodland on northerly slopes of the foothills of the Great Dividing Range. The species is known from a few sedgy (*Gahnia radula*) woodland patches in west Gippsland. The objective of this project was to gain a better understanding of the range and habitat use of the Heath Sand Skipper within the Gippsland RFA Region forests.

Surveys were concentrated on the western edge of the region in forests close to the known occurrence of the Heath Sand Skipper, and targeted areas of heathy woodland, potentially suitable habitat for the species, as well as previously known sites. At sites where the species was found, vegetation types were recorded and a plant species list compiled. Searches were made during summer for both adult butterflies and their larvae, which feed on thatch saw-sedge (*Gahnia radula*) and build a well-concealed shelter near the base of the plant. As the Heath Sand Skipper has a two-year life cycle, relatively large larvae in their second year, should be present during summer.

Specimens were recorded from three separate locations: Tynong North and Moondara State Park and west of Moondara (these sites are located in the Central Highlands RFA region, close to the Gippsland boundary). Although the saw-sedge larval food plant is common and widespread, the butterfly appears to be restricted to areas of heathy woodland, a very uncommon vegetation community occurring on gentle, north facing lower slopes. The dominant eucalypt species included a range of stringybarks and peppermints, which were generally stunted and sparse due to the very infertile yellowish gradational soils. These soils may be seasonally wet, but generally dry out in summer. This heathy woodland habitat straddles the lower foothills to the south of the Great Dividing Range, at altitudes generally below 300 m, from the Cardinia-Gembrook area eastwards to north of Moe. Representative examples are reserved in Bunyip State Park and Moondarra State Park. Fire regimes play an important role in determining the species composition and abundance in this community and maintaining a full range of fire regimes, including unburned areas, would probably assist flora and fauna conservation, both inside and outside conservation reserves.

### *Rare Frogs*

The aim of this study was to conduct targeted surveys for poorly known frog species in the region, to increase knowledge of their distributions, conservation status and habitat associations. The following species were targeted during the survey: Large Brown Tree Frog *Litoria littlejohni*, Warty Bell Frog *L. raniformis*, Giant Burrowing Frog *Helioporous australiacus*, Martin's Toadlet *Uperoleia martini* and Tyler's Toadlet *U. tyleri*.

Surveys in the foothill and montane areas were targeted in the vicinity of historical records of the Large Brown Tree Frog and Giant Burrowing Frog and included the slopes of Mount Elizabeth and Nunniong Plateau, Walhalla, Boola Camp, Colquhoun State Forest and the Strzelecki Ranges. Surveys for the Warty Bell Frog and the two toadlets were directed to lowland areas north east of Stratford, south of Sale and Rosedale, and coastal areas along the Ninety Mile Beach and the Port Arlington area.

Standard timed audio censuses and call playback were conducted at all waterbodies and transects up to 500 m in length along streams or perimeters of large water bodies, were searched by spotlight. Perimeters of small water bodies were searched entirely. Tadpoles were censused by timed dipnet sweeps of waterbodies. Roads were surveyed on wet nights for active frogs. To date, survey results for the target species have yielded few individuals. The Warty Bell Frog was recorded at two locations in the Strzelecki Ranges. Martin's Toadlet was recorded at two localities and Tyler's Toadlet at one locality, north of Yarram. One record of Giant Burrowing Frog was collected during the survey north of Bruthen. Thirteen other species of frog were recorded during the survey.

Further surveys for tadpoles of the Giant Burrowing Frog were conducted in March/April. No tadpoles of this species were recorded.

### *Burrowing Crayfish*

Seven threatened or little known species of crayfish occur within Gippsland forests. Virtually nothing is known about their biology and habitat requirements. This study aimed to investigate the distribution of four species of burrowing crayfish:

- Warragul Burrowing Crayfish *Engaeus sternalis*,
- Narracan Burrowing Crayfish *E. phyllocercus*,
- Strzelecki Burrowing Crayfish *E. rostrogaleatus sp*. nov and
- Lillypilly Burrowing Crayfish *E. australis*,

and to characterise certain habitat parameters which may assist in the conservation of these species. Distributions were surveyed by visiting known sites and by searching likely habitat in surrounding localities. All four species are known to have very limited distributions so it was not expected that the species would occur extensively outside their known range.

Sampling for the Warragul Burrowing Crayfish was concentrated in the Flora and Fauna Reserve along Labertouche Creek where the species was recorded as recently as 1996, as well as surrounding tributaries. A total of 18 sites were examined with 12 sites occurring within Labertouche Flora and Fauna Reserve. Three of these sites were primarily pasture with the remaining sites including native vegetation. No specimens were collected and it appears that this species is extremely rare within its known range and is difficult to collect. The burrow of this species is not obvious from the surface and sampling probably requires destruction of entire creek banks. Given the burrow structure of this species, it most likely has a naturally small distributional range and the most crucial factor in its conservation is to preserve the habitat where it is known to occur. Although pitfall trapping requires long-term monitoring for very little returns, it is less destructive and could be considered in an attempt to extend the known range of this species.

Searching for Narracan Burrowing Crayfish was concentrated in forested areas, in particular Mt Worth State Park and land managed by Hancock Victorian Plantations. This species was located at four of the 34 surveyed sites. One of these sites was a stream bank of Moonlight Creek within Mount Worth State Park, two sites were located in streams just south of Mount Worth and the fourth site was at Elizabeth Creek, approximately 3 kms north of Allambee South. Small pelleted chimneys were located at most of the 14 sites searched in Mount Worth State Park. However, this species cannot be accurately identified from its burrow chimneys. It is not known whether the species is more widely distributed than the location of specimens suggests and it is simply difficult to collect, or whether results reflect the rarity of the species. Previous studies have found the species is very easy to miss on excavation of burrows and it appears likely that it is more widespread within Mount Worth State Park than the results suggest.

All sites where the Narracan Burrowing Crayfish was recorded were surrounded by native vegetation consisting primarily of Mountain Ash, Blackwoods, Silver Wattles, Cassinia, Musk Daisy Bush, Hazel Pomaderris and Blanket Leaf. Several species of tree fern including Rough Tree Fern and Soft Tree Fern, were a predominant feature at all sites. Evidence of disturbance, Blackberry, introduced grasses and other weeds were present at three sites. It appears this species has a relatively low abundance and further searching is unlikely to substantially increase the species range. Clarification of which species was making the small burrows observed at some sites would shed more light on the species' distribution at some of the sites examined.

Surveys are continuing for the Lilly Pilly and Strzelecki Burrowing Crayfish.

### *Spiny Crayfish*

Data collected as part of RFA freshwater surveys of the Gippsland region, as well as other freshwater surveys in the past 5 years, were collated to investigate aspects of the biology of three poorly known species of freshwater crayfish:

- South Gippsland Spiny Cray Euastacus neodiversus,
- Central Highlands Spiny Cray Euastacus woiwuru and
- Southern Spiny Cray Euastacus yarraensis.

Where available, data was collated on the following parameters: distribution, abundance/density (as recorded by electrofishing), sex ratio, size and weight, physico-chemistry of sites (pH, dissolved oxygen, electrical conductivity, water temperature) and instream habitat parameters (substrate composition, organic matter, woody debris, water velocity, per cent of flow, aquatic vegetation). Sampling was conducted primarily using electrofishing during the day. A report will be produced detailing all results and will provide a general assessment of the population structure of each species, and habitat types occupied.

## 5.6 Fauna species reservation analysis

### *5.6.1 Methods*

A reservation analysis has been undertaken to assess the extent to which rare or threatened terrestrial vertebrate species in Gippsland are protected in the Reserve system.

Using data from the Atlas of Victorian Wildlife, both formal survey and incidental records were intersected with existing land tenure to calculate the total proportion of records for each species in each land tenure category (Table 5.11). Categories used were Conservation Reserves, State forest & other public land, and Private Land.

### *5.6.2 Results and discussion*

The results of the assessment are presented in Table 5.12. There are 13 species for which less than 20% of records are in Reserves, however none of these species have their major occurrence in the Gippsland region.

The results should be considered in conjunction with the information on threatening processes in the following chapter. Many threatening processes operate across reserve and off-reserve areas and other measures are in place, in addition to reservation, to provide protection at the species level.

**Table 5.12 Reservation analysis of priority fauna species records in Gippsland**

| Species Name | Total | Conservation reserves | | State forests and Other Public Land | | Private Land including plantation leasehold | | Water bodies | |
|---|---|---|---|---|---|---|---|---|---|
| | | No. | % | No. | % | No. | % | No. | % |
| **Mammals** | | | | | | | | | |
| Spot-tailed Quoll | 3 | | 0 | 3 | 100 | 0 | 0 | | 0 |
| Long-footed Potoroo | 1 | 1 | 100 | 0 | 0 | 0 | 0 | | 0 |
| Broad-toothed Rat | 25 | 21 | 84 | 4 | 16 | 0 | 0 | | 0 |
| Smoky Mouse | 28 | 24 | 86 | 4 | 14 | 0 | 0 | | 0 |
| New Holland Mouse | 171 | 158 | 92 | 2 | 1 | 4 | 2 | 7 | 4 |
| Dingo | 2 | | 0 | 2 | 100 | 0 | 0 | | 0 |
| Southern Horseshoe Bat | 11 | | 0 | 11 | 100 | 0 | 0 | | 0 |
| Eastern Bent-wing Bat | 28 | 5 | 18 | 9 | 32 | 5 | 18 | 9 | 32 |
| **Birds** | | | | | | | | | |
| Swift Parrot | 9 | 3 | 33 | 0 | 0 | 5 | 56 | 1 | 11 |
| Regent Honeyeater | 3 | | 0 | 1 | 33 | 1 | 33 | 1 | 33 |
| Square-tailed Kite | 3 | | 0 | 1 | 33 | 2 | 67 | | 0 |
| Grey Goshawk | 85 | 26 | 31 | 0 | 0 | 34 | 40 | 25 | 29 |
| White-bellied Sea-Eagle | 480 | 191 | 40 | 6 | 1 | 144 | 30 | 139 | 29 |
| Barking Owl | 5 | | 0 | 2 | 40 | 3 | 60 | | 0 |
| Powerful Owl | 182 | 23 | 13 | 124 | 68 | 33 | 18 | 2 | 1 |
| Masked Owl | 20 | | 0 | 9 | 45 | 10 | 50 | 1 | 5 |
| Sooty Owl | 89 | 5 | 6 | 80 | 90 | 4 | 4 | | 0 |
| Chestnut-rumped Heathwren | 10 | 7 | 70 | 1 | 10 | 1 | 10 | 1 | 10 |
| **Reptiles** | | | | | | | | | |
| Glossy Grass Skink | 26 | 9 | 35 | 1 | 4 | 11 | 42 | 5 | 19 |
| Swamp Skink | 20 | 14 | 70 | 1 | 5 | 4 | 20 | 1 | 5 |
| Lace Monitor | 139 | 12 | 9 | 64 | 46 | 63 | 45 | | 0 |
| **Amphibians** | | | | | | | | | |
| Spotted Tree Frog | 24 | 7 | 29 | 17 | 71 | 0 | 0 | | 0 |
| Giant Burrowing Frog | 11 | | 0 | 10 | 91 | 1 | 9 | | 0 |
| Alpine Tree Frog | 211 | 108 | 51 | 53 | 25 | 50 | 24 | | 0 |
| Martin's Toadlet | 4 | 1 | 25 | 1 | 25 | 2 | 50 | | 0 |
| Tyler's Toadlet | 1 | 1 | 100 | 0 | 0 | 0 | 0 | | 0 |
| Large Brown Tree Frog | 1 | | 0 | 1 | 100 | 0 | 0 | | 0 |
| **Invertebrates** | | | | | | | | | |
| Giant Gippsland Earthworm | 117 | 1 | 1 | 3 | 3 | 113 | 97 | 0 | 0 |

Only records post 1970 and with an accuracy of one minute or better were used in this analysis.

# 6 REVIEW OF DISTURBANCES AND THEIR IMPLICATIONS FOR FLORA AND FAUNA

## 6.1 Introduction

The decline of species can be largely attributed to the impacts of disturbances, both direct—on species, and indirect—on essential components of their habitat. In this review, disturbances are defined as activities or events with associated environmental impacts. The environmental impacts may constitute potentially threatening processes (PTPs) for particular taxa. Such potentially threatening processes, as defined under the *Flora and Fauna Guarantee Act* 1988, could pose a significant threat to the survival, abundance and evolutionary development of native species or ecological communities of flora or fauna. There are currently 22 PTPs listed under the *Flora and Fauna Guarantee Act* 1988.

The responses of different plants, animals or communities to disturbances vary according to their ecological and life history characteristics. This review focuses on the relationship between disturbances (ie. activities or events), the environmental impacts of the disturbance and the life history attributes of taxa for which these impacts may constitute a threat (or PTP). For example, a disturbance such as road construction could lead to environmental impacts such as sediment input to streams, direct loss of plants or animals and changes in microclimate. These impacts could constitute PTPs (threats) for taxa or communities with a restricted range, a reproductive strategy sensitive to in-stream turbidity, or which have particular microclimatic requirements for growth or establishment.

Disturbances which have an impact on flora and fauna in the Gippsland Regional Forest Agreement (RFA) region were identified as part of an assessment of vulnerability, population parameters and life history attributes of 301 vascular plant species and 39 terrestrial vertebrates. These species were selected for analysis as they are either classified as rare or threatened in Victoria or considered to be indicators, representative of a suite of species which may be vulnerable to the continued action of threatening processes.

Terrestrial invertebrates are not included in the following discussion, however, a range of disturbances may impact on terrestrial invertebrates. Removal of tree canopy with consequent insolation and the desiccating effects of exposure have a deleterious impact on ground-dwelling invertebrate species reliant on maintenance of microclimate. Litter-dwelling invertebrates and those dependent on fallen timber or debris can be significantly impacted by disturbances. Little is known about the recovery rates of invertebrates from disturbance. Recovery largely depends on the reproductive characteristics and vagility of the taxa and the availability of suitable adjacent recruitment areas. Because of the high levels of endemicity and restricted range in some groups, localised extinctions of some taxa are possible.

The majority of the fauna species considered here are either forest dependent or require a component of their habitat to be within forest or woodland and may be affected by timber harvesting or related activities.

The disturbances reviewed fall into four categories: land management activities directly associated with forestry (such as timber harvesting), more general activities associated with management and use of public and private land (such as clearing native vegetation, grazing or fuel reduction burning), processes resulting from land disturbances such as environmental weed invasion or the impact of introduced fauna, and stochastic events such as wildfire. Each disturbance has been evaluated to determine the extent of its occurrence within the Gippsland study area, the potentially threatening processes which are associated with it, the overall significance of the threat to native flora and fauna in Gippsland, the ecological, life-history and life-form attributes which might predispose a taxon to significant negative impacts, and examples of the plant and animal taxa that might therefore be susceptible to the disturbance. Management systems, including policies and processes, for the amelioration of the adverse impacts of the disturbance are also summarised.

The disturbances reviewed here potentially have negative impacts on individual species of flora and fauna as well as on ecological communities. However, the responses of plants, animals and communities to the same disturbance are often complex and vary depending on the ecology of different taxa. For this reason, the PTPs associated with some disturbances are dealt with separately for flora and fauna. The significance of threats to flora and fauna was assessed through reference to the current literature and consultation with recognised experts in the biology of the species. The assessments were made recognising that practices on public land follow minimum prescriptions required under the Code of Forest Practices for Timber Production (NRE 1996) and various State Acts and Regulations and that practices on private land are in accord with the *Planning and Environment Act* 1987 and the *Catchment and Land Protection Act* 1994. However, the assessments do not take account of additional protection afforded in various Action Statements, Park management plans, nor any additional measures that may be established in the Gippsland Forest Management Plan which is currently in preparation. The following discussion applies only to the Gippsland (RFA) region.

## 6.2 Results and discussion

### *6.2.1 Timber Harvesting*

The Gippsland region is an important source of hardwood sawlogs for Victoria's timber industry. The timber resource is derived from mountain, foothill and low foothill forests (Abbott *et al.* 1993). The predominant commercial species are

Alpine Ash *Eucalyptus delegatensis*, Mountain Ash *E. regnans*, Messmate *E. obliqua* and Mountain Grey Gum *E. cypellocarpa.* Other open forests also provide large quantities of timber for construction activities and the manufacture of paper and paperboard. Species used for these products include Messmate *E. obliqua*, Mountain Grey Gum *E. cypellocarpa*, Silvertop Ash *E. sieberi*, White Stringybark *E. globoidea*, Narrow-leaved Peppermint *E. radiata* and Manna Gum *E. viminalis* (Aldrick *et al.* 1988). Open forests containing species such as Red Stringybark *E. macrorhyncha*, Red Box *E. polyanthemos*, White Stringybark *E. globoidea*, Silvertop Ash *E. sieberi* and White Box *E. albens* provide minor quantities of timber for products such as posts, poles and firewood (Aldrick *et al.* 1988). The extent and accessibility of foothill forests make them an important hardwood resource. However, growth rates are slower than the more productive mountain forests (Abbott *et al.* 1993).

The net productive area of Ash type forest in the region is approximately 59,950 ha (24 per cent of the net productive area in the region), while the net productive area of mixed species forest is 193,900 ha (76 per cent) of the net productive area in Gippsland.

The timber harvesting methods used in Gippsland include seed tree, clearfell and selection systems. The choice of harvesting system is largely determined by the requirements of different eucalypt species for successful regeneration following harvesting.

The harvesting and regeneration of ash forests in Gippsland are predominantly conducted using the clearfelling system which involves the removal of all merchantable, and most non-merchantable, trees from the coupe except for designated habitat trees and seed trees. Most of the understorey is also cleared. The seedbed is then prepared using high-intensity slash-burning or mechanical disturbance, usually in autumn. Collected seed is then sown by hand or aerial means. The system is generally applied in even-aged ash type forests. In practice, many non-eucalypt trees and shrubs in the understorey are also felled to facilitate harvesting and improve safety on site. Once felled, the heads (upper trunk and smaller branches) are removed from the logs and the logs are towed via snig tracks to a landing where they are graded and loaded onto trucks. Following the completion of harvesting, log landings are ripped to reduce soil compaction and the coupe is prepared for a regeneration burn. On sites where a successful regeneration burn cannot be guaranteed, logging debris may be windrowed for burning.

Regeneration is achieved in a number of ways depending on site characteristics**.** These methods include hand or aerial sowing of seed onto a freshly disturbed or burnt seedbed; regeneration from lignotubers or coppice; natural seedfall or slash seed where seedling establishment can occur on disturbed areas and in certain understorey types in the absence of an intense burn; and the use of planted stock. The regrowth is harvested on an average 80 year rotation for Ash and 120 years for Mixed Species (Deane, pers. comm).

Harvesting of mixed forests is mainly carried out using the seedtree system. Mixed species forests include mountain mixed, foothill and box-ironbark forest types. They consist of species that can survive quite severe fires, due to their thick protective bark and ability to produce epicormic shoots. Natural regeneration of these species can occur due to natural seedfall, by coppicing or from lignotubers and thus silvicultural methods can be more flexible, ranging from clearfelling to selection methods (Abbott *et al* 1993).

The seedtree system involves the felling of all except five to nine well-spaced trees per hectare with regeneration achieved through the release of seed from these retained trees onto a prepared seed bed. These seed trees may be removed following the release of seed or retained for habitat purposes. It is generally applied to even-aged and some uneven-aged mixed species stands. This is often favourable for faunal habitat as hollow-bearing over-mature trees are often preferred for retention as they have large crowns and often heavier seed crops.

The selection system involves the harvesting of small patches or single mature trees while retaining habitat trees and minimising damage to the remaining trees. Careful management of retained eucalypt regrowth can negate the need for large scale regeneration treatment.

### *Potentially Threatening Processes Affecting Individual Plant Species*

The potentially threatening processes associated with timber harvesting may be grouped into three general categories:

1. the direct impacts of the harvesting operation, including falling, snigging and loading,
2. the indirect impacts on the site and surrounding vegetation subsequent to harvesting (including the compounding effects of subsequent disturbance such as regeneration burning) and
3. the impacts of a cycle of harvesting (in this case, an average of 80 years) on forest structure, ecology and biodiversity

**Note:** the impacts of regeneration burning, and road construction and maintenance which can be associated with timber harvesting are dealt with in later sections.

A key issue in evaluating the ecological impacts of timber harvesting has been the extent to which harvesting mimics the effects of natural disturbance, of which naturally-occurring wildfire is the principal element. Other natural disturbances include frost, snow, drought and violent windstorms [see Mueck and Ough (1997), Mueck and Peacock (1992) Murphy and Ough (1997)**,** Ough and Murphy (1996), Ough and Ross (1992) and Commonwealth of Australia (1996) for

comparison and identification of similarities and differences between the impacts of clearfelling (including regeneration burning) and wildfire on native forest flora and the recovery response of the vegetation to these disturbances]. Briefly, disturbance that does not mimic a natural event (to which species and ecosystems have become adapted) will disadvantage some species and may advantage others resulting in change in structure and floristic composition of the forest ecosystem/EVC. For example, Silver Wattle *Acacia dealbata* regenerates entirely by soil-stored seed in certain EVCs (Ashton 1981). It requires fire to stimulate germination of this seed. Whereas regeneration burning after clearfell harvesting may mimic the natural system (given appropriate fire characteristics such as temperature), other harvesting methods where seedbed preparation occurs via mechanical disturbance are not successful in encouraging germination of the soil-stored seed of this species.

The potentially threatening processes directly associated with timber harvesting include damage or loss of individuals, particularly as a result of machinery use and falling trees, disturbance to the surface soil structure, disturbance of soil-stored seedbanks, and compaction of the soil surface on snig tracks and log landings. The species at greatest risk are those which rely wholly or partially on vegetative reproduction from organs/structures above, at or immediately below the soil surface (resprouters) after disturbance. See Mueck and Ough (1997) and Mueck and Peacock (1992) for effects in forest ecosystems dominated by Mountain Ash *Eucalyptus regnans*. Tree-ferns (Soft Tree-fern *Dicksonia antarctica* and Rough Tree-fern *Cyathea australis*) are particularly sensitive to mechanical disturbances associated with current clearfelling practices (Mueck and Ough 1997). Also potentially at risk are species which rely totally or partially on soil-stored seed for reproduction.

The potentially threatening processes indirectly associated with harvesting operations include habitat modification, specifically the removal of one or more forest strata and the loss of opportunity to develop habitat elements characteristic of mature and senescent forests (eg tall Tree Fern trunks, decaying logs) on the coupe. This threatening process can have a major impact in certain vegetation types such as those of wetter, protected, riparian or gully environments. The alteration of microclimatic conditions both on the coupe and in adjoining vegetation creates sharp boundaries and results in increased exposure and alteration to the humidity, light and temperature conditions in the adjoining vegetation at least until the regrowth canopy reaches the level of the surrounding vegetation. The distance of penetration of these "edge effects" and their significance in causing floristic changes has yet to be clearly demonstrated, but edge effects are likely to be of greatest threat to EVCs that are linear and small such as those confined to gully or stream habitats and to species which rely on stable, low light, high humidity and moderate temperature regimes. For a review of edge effects and microclimatic changes, see Burgman and Ferguson (1995). On the coupe itself, the microclimatic changes following harvesting are profound. In some cases these changes may mimic the impacts of wildfire. However, the impacts of wildfire may be less extreme than the impacts of clearfelling where some vegetation remains after the fire and species not killed by the fire rapidly resprout and recover (K. Ough, pers. comm.). See Murphy and Ough (1997)**,** Ough and Murphy (1996), Ough and Ross (1992) and Commonwealth of Australia (1996).

Operational trials of "understorey islands", areas within coupes in which machinery is excluded to minimise physical damage to long-lived understorey species, have been undertaken in the Central Highlands (Ough and Murphy 1998).

The additional soil disturbance created by timber harvesting (compared to wildfire or other natural disturbances) has the potential to lead to erosion and sedimentation, both on the coupe and in adjoining vegetation, particularly on steeper sites, on granitic soils and in gullies. Some loss of soil-stored seed may also occur. The severity of this process may vary greatly from site to site. Its overall significance is considered to be low for most plants. Species potentially affected include small forest understorey plants and species of mountain stream margins. The Code of Forest Practices (NRE, 1996) specifies provisions to minimise erosion and sedimentation arising from harvesting operations. Facilitation of the spread of weed species may also occur as a result of soil disturbance (see later section).

The potentially threatening processes associated with the cycle of timber harvesting relate mainly to the frequency and regularity of harvesting (as opposed to that of the natural disturbance regime). A harvesting cycle of an average 80 years applied consistently across the harvested areas of State forest would progressively eliminate mature and old-growth growth stages from these areas, although this effect is mitigated by protection of significant areas in various forest reserve tenures and by the absence of harvesting in some forests of lower productivity. The impact of this on native flora would be greatest in situations where the environmental conditions, structure and floristics of forests continue to change with the age of the stand over hundreds of years. Species dependent on habitat elements or characteristics of mature and old-growth stands are likely to experience a decline concomitant with the decline in the growth stages themselves. Species which require a long period to reach full reproductive maturity may also be at risk.

### *Potentially Threatening Processes Affecting Forest Ecosystems/Ecological Vegetation Classes (EVCs)*

Individual species' response to disturbance will influence the structure and floristics of the vegetation as a whole (including vascular and non-vascular flora) and the inter- and intra-specific dynamics of the whole ecosystem (including vascular flora, non-vascular flora, vertebrate fauna, invertebrate fauna, soil micro-organisms *etc*.).

Different forest ecosystems/EVCs have varying requirements and will respond differently to the various silvicultural systems applied. The frequency and intensity of disturbance (here the silvicultural system being managed for wood production) during a harvesting rotation and the length of rotation appear to strongly influence species composition.

The clearfell system of timber harvesting has greatest impact on the structural and age class attributes at a smaller scale (ie. the coupe level) by creating an essentially even-aged regrowth forest. However, this may vary at a large scale (eg. the forest block level) depending on the amount and type of vegetation retained and the frequency of logging. The result may be a simplification of the age class characteristics of the overstorey trees. On a broad scale the result will be a heterogeneous mosaic of unlogged and logged areas of various ages and utility as habitat for other species (Mueck and Ough 1997). Other harvesting methods impact similarly but to a lesser degree.

Species largely reliant on resprouting as a mode of recovery after disturbance are disadvantaged by mechanical disturbance associated with clearfell harvesting (see previous section). This can induce a significant long-term change in site floristics and may locally eliminate EVCs dominated by these species (Mueck and Ough 1997).

The effects of multiple harvesting cycles are unknown. Silvicultural systems that disturb the same site more than once during a rotation probably have a more significant impact on floristic composition and vegetation structure. In such cases the impacts are compounded and the vegetation has insufficient time between disturbances to recover and become reproductively viable (this includes treatment of a site where regeneration is considered inadequate which may re-disturb the site approximately one to three years after the original disturbance). This may alter the floristic composition by increasing the abundance of pioneer species and opportunistic colonisers or weed species at the expense of more shade tolerant species or species with specific substrate requirements for germination such as Tree Fern trunks and decaying logs (Mueck and Ough 1997, Mueck and Peacock 1992). See also section 6.2.10 below.

Regrowth forests are considered to be more flammable than surrounding mature forest (Jackson 1968). This poses an increased fire risk to adjacent fire-sensitive vegetation (Mueck and Ough 1997).

In all but the rarest cases local provenance is always used in regeneration by seed or seedling methods (Owen Bassett pers. comm.). However, problems arise if the species mix present at the time of harvesting is not represented equally in the seed trees selected, or the species present differ in their ability to re-establish from seed under the prevailing conditions. Consequently there is a possibility for a significant change in the proportion of overstorey species and the overall floristic composition of a coupe following regeneration by seed (Mueck and Ough 1997); the same possibility could apply to regeneration after some natural disturbances. The Code of Forest Practices requires that regeneration techniques aim to approximate the composition and spatial distribution of species present prior to harvesting.

For a list of EVCs potentially threatened by timber harvesting see Table 6.1.

### *Potentially Threatening Processes Affecting Fauna*

Timber harvesting impacts upon a range of fauna species through its immediate and short-term effect of habitat removal and, more importantly, through its medium and longer-term effect of producing even-aged regrowth forests that are less suitable for some species than older forest. Ecologically mature or old-growth forests are generally more structurally and floristically diverse than regrowth forests and provide a greater range of foraging substrates. Mature forests may support higher populations and diversity of bird species (Gilmore 1985, Scotts 1991, Traill 1991). Large old eucalypts provide important resources such as hollows, may have heavier flowering and nectar flows, a more plentiful supply of insects, a higher foliage density and specialised sources of food including peeling bark, mistletoe infestations and rotten wood (Bennett 1993, Traill 1993, Robinson and Traill 1996). Fauna species dependent on these resources are likely to be adversely affected by timber harvesting operations that reduce structural and floristic diversity. Disturbance and loss of litter and ground layers during timber harvesting operations will adversely affect ground foraging species. Soil disturbance has the potential to lead to soil erosion and sedimentation of streams. Subterranean species and those dependent on in-stream habitats are particularly vulnerable to these threatening processes. Timber harvesting operations can also result in some areas of forest becoming sub-optimal through habitat fragmentation. Species may need to expend more energy to forage in fragmented habitat, the ability to reproduce and disperse may be restricted, the likelihood of predation and the probability of mortality resulting from changes in fire regimes and other environmental factors may increase (Norton and Dovers 1994). Species with large home range requirements are particularly vulnerable to habitat fragmentation.

Threatening processes related to timber harvesting include the loss of hollow-bearing trees, the conversion of mature stands to young regrowth stands and fragmentation.

Timber harvesting is considered a major threat to the Spot-tailed Quoll, Sooty Owl, Powerful Owl and Lace Monitor and Long-footed Potoroo (Gippsland record is in a Conservation Reserve). These species generally forage over large areas and most utilise hollow-bearing trees as nest, shelter or foraging sites and a significant proportion of suitable habitat is found in State forest. The Masked Owl and Gang Gang Cockatoo also utilise tree hollows for nesting.

The Regent Honeyeater is known to select larger trees for foraging (Webster and Menkhorst 1992). Large old trees which produce high nectar yields in winter are a significant food resource of the Swift Parrot (Brereton 1996). The Grey Goshawk predominantly utilises older age-classes of forest for nesting and foraging. Conversion of older age-classes of

forest to young regrowth stands as a result of timber harvesting operations can result in the loss of both nesting and foraging habitat for this species (Mooney 1987, Mooney 1988, Mooney & Holdsworth 1988) and a reduction in the quality of foraging habitat for the Regent Honeyeater and Swift Parrot (Traill 1993). The Square-tailed Kite uses traditional nest sites and has a specialised diet consisting mainly of passerine nestlings and eggs taken from nests in the outer foliage of the canopies of eucalypts (Debus and Czechura 1989). Timber harvesting may result in a loss of nest sites and a reduction in prey availability for this species. The Cicadabird is a canopy feeding species which requires continuous forested areas. Canopy loss and habitat fragmentation resulting from timber harvesting are potentially threatening processes for this species (C. Silveira pers. comm.).

For species reliant on in-stream habitat, timber harvesting may potentially cause siltation downstream which can also increase nutrient levels. Areas of regrowth forest which regenerate following timber harvesting operations may potentially alter stream flow and perenniality within catchments. Loss of forest cover may increase light levels reaching streams and thereby stream temperatures (Campbell and Doeg 1989). Populations of the Spotted Tree Frog may be detrimentally affected by altered streambed conditions and changes to water quality and flow such as increased sedimentation via a reduction in the viability of eggs, the survivorship of tadpoles and the availability of egg deposition sites (Gillespie and Hollis 1996, Robertson and Gillespie in prep.). The full range of habitats used by the Spotted Tree Frog during different growth stages and in different seasons has not been fully identified. Other related riverine species are known to use habitats at great distances from streams. Timber harvesting activities also have the potential to reduce local populations of the Spotted Tree Frog, Large Brown Tree Frog and Leaf Green Tree Frog, destroy sheltering sites, affect prey abundance, alter micro-climates, fragment habitat and allow the invasion of exotic weeds and predators (Gillespie and Hollis 1996). The Glossy Grass Skink and Azure Kingfisher feed on aquatic insects and fish; altered stream conditions as a result of timber harvesting operations may indirectly impact on these species by affecting prey (L. Lumsden pers. comm., Shields 1994). For a discussion of the effects of disturbances on freshwater ecosystems and aquatic invertebrates and fish, refer to Chapter 7 on aquatic ecosystems.

Soil disturbance during timber harvesting operations is a potential threat to Blue Mountains Tree Frog and Giant Burrowing Frog that are know to use habitats away from streams. Loss of soil structure, removal of surface sheltering sites and changes to soil microclimate is likely to reduce habitat quality for subterranean species (Saddlier and Pressy 1994, Brown and Bennett 1995). Litter is important foraging habitat of the Pink Robin. Disturbance and loss of litter during timber harvesting operations may adversely affect this species. Ground-dwelling species such as the Broad-toothed Rat, Long-nosed Bandicoot and Red-necked Wallaby may be adversely affected by the reduction of shelter and foraging habitat. White-footed Dunnart populations are unable to persist following timber harvesting due to dense regrowth making the habitat unsuitable. Soil disturbance and a reduction of litter may also affect the availability of hypogeal (underground fruiting) fungi, an important food of the Long-footed Potoroo, Long-nosed Bandicoot and Smoky Mouse. Loss of large trees is a potentially moderate threat for Spencers Skink.

### *Management*

Timber harvesting and associated roading and burning activities are managed under the forest management planning process which includes the Code of Forest Practices for Timber Production (NRE 1996), the Code of Practice for Fire Management on Public Land (CNR 1995), the Gippsland Forest Management Plan (NRE in prep.), regional prescriptions and the annual Wood Utilisation Plans. The Code of Forest Practices for Timber Production and Forest Management Plans are subject to periodic review with formal public consultation, while regional prescriptions and Wood Utilisation Plans are prepared in consultation with regional flora and fauna staff and community input.

The Code of Forest Practices for Timber Production (NRE 1996) sets minimum standards for forest operations. It provides principles and guidelines for regional prescriptions controlling timber production activities in State forest. It aims to ensure that environmental values and water catchments are protected, by careful operation planning, reservation of appropriate areas and vegetation corridors. Such prescriptions particularly benefit certain forest ecosystems (such as riparian EVCs) and the flora and fauna associated with them.

Potentially threatening processes listed under the *Flora and Fauna Guarantee Act* 1988 which may be relevant to timber harvesting are:

- Degradation of native riparian vegetation along Victorian rivers and streams
- Increase in sediment input into Victorian rivers and streams due to human activities
- The invasion of native vegetation by ‘environmental weeds’
- Loss of hollow bearing trees in Victorian native forest

Prescriptions for the protection of flora and fauna habitat are specified in Forest Management Plans. The Gippsland RFA region encompasses the Tambo FMA and parts of the Central Gippsland and Wodonga FMAs. A forest management plan for Gippsland is currently being prepared. Management strategies for species and threatening processes listed under the *Flora and Fauna Guarantee Act* 1988 are detailed in Action Statements and incorporated into forest management plans where relevant. Direct and indirect taking of protected flora associated with timber harvesting requires authorisation under the *Flora and Fauna Guarantee Act* 1988. Priorities and permitted uses in different parts of State

forest are set by forest management zones. In addition to the formal reserve system already in place (National, State, and Wilderness Parks, Conservation Reserves etc.), Special Protection Zones will be defined and managed for conservation (timber harvesting will be excluded). Current prescriptions in the Tambo FMA set a minimum of 5 retained trees per 10 hectares harvested for all forest types for conservation of wildlife habitat within the timber production forest (NRE 1996). Further research on the requirements of hollow-dependent fauna in timber production forests is required. Previous research is reviewed in Gibbons and Lindenmayer (1997).

### *6.2.2 Clearing of native vegetation*

Clearing of native vegetation occurs as part of development for agricultural, industrial, urban, recreational and utility purposes. Clearing of native vegetation associated with road construction and maintenance, mining and quarrying, tourism development, recreation and timber harvesting are threatening processes related directly to these disturbances and are discussed separately.

Historically, the open forests of the lower valleys and river flats and the Gippsland plains of the region were among the most attractive lands for pastoral settlement. The open woodland vegetation that existed over the more fertile flats and valleys was cleared by the first settlers to the region. Since this time large areas of coastal vegetation and non-perennial swamps behind Ninety Mile Beach have been drained and cleared for agricultural development as well as the open red gum woodland of the Gippsland plains. The majority of this vegetation has been converted to pasture and remnant stands are now found mainly along road and railway reserves (LCC 1980, 1982). From the late 1800s, large-scale clearing for settlement took place in the forests of the main Strzelecki range. By 1920 forests remained mainly on land that was considered unsuitable for agriculture. Nearly all farms in the eastern Strzeleckis were abandoned by the early 1930s. Since this time much of the abandoned farmland has been purchased for reforestation (LCC 1972).

In total, approximately one third of the Gippsland region has been cleared, mostly for agriculture (Abbott *et al.* 1993). This widespread loss of habitat has been a significant factor in the decline of many species, causing regional and local population declines, and is largely responsible for the current threatened status of many species.

#### *Potentially Threatening Processes Affecting Fauna*

Clearing of native vegetation associated with agricultural development is a particularly significant threat to species dependent on habitats which were depleted due to past clearing practices and are now found mainly on private land in a largely agricultural landscape. Small animals with low mobility (e.g. small mammals, reptiles and amphibians) are particularly vulnerable to habitat isolation. Isolated populations are vulnerable to extinction from catastrophic events such as wildfire and drought, and are more susceptible to threatening processes including predation and interspecific competition (Bennett 1990, Robinson 1993).

Remnant woodland habitats on fertile soils are important food sources for mobile bird species that move between habitats on a seasonal basis such as the Regent Honeyeater and Swift Parrot. A significant proportion of suitable habitat for these two species within the Gippsland region is on private land. Selective loss of these habitats as a result of further clearing may deplete a food resource at a critical time of year and contribute to local or regional population declines (Bennett 1993). Approximately 40% of the known White-bellied Sea-Eagle nests are located on private land. Breeding pairs are sedentary and loss of habitat on private land is a major threat. Additionally, disturbance generated by clearing within 300 m of nest trees during the breeding season are likely to cause nest abandonment and reduced breeding success (Williams 1997, A. Williams pers. comm.). Species which utilise woodland habitats as well as other forest types (e.g. Square-tailed Kite, Grey Goshawk, Chestnut-rumped Heathwren, Gang-gang Cockatoo, Cicadabird) or species which are able to at least partly utilise cleared habitats, are considered moderately threatened by clearing for agriculture. The Hooded Robin is restricted to woodland habitats. This species is able to forage in largely cleared open paddocks but nesting attempts in the open are generally unsuccessful due to predation (Bell 1984). This species is declining in woodland and agricultural areas (Robinson 1993, Fitri and Ford 1997), and loss of habitat as a result of clearing is considered a moderate threat in Gippsland (R. Loyn pers. comm.).

Species which utilise forest/farmland edge may also be significantly impacted by clearing of native vegetation within Gippsland. The Masked Owl and Barking Owl both utilise forest edge and require open woodland for hunting. The Masked Owl is also known to nest in isolated stands of trees in farmland (Hollands 1991). Loss and fragmentation of habitat as a result of clearing are significant threats to hollow-dependent species that require large areas for foraging, such as the Masked Owl (E. McNabb pers. comm.). Lace Monitors forage over large areas and appear to require connected systems of habitat (Brown and Bennett 1995). Habitat loss and fragmentation as a result of clearing are threats to Spot-tailed Quoll and Yellow-bellied Glider which have large home ranges (C. Belcher, G. Brown and S. Henry pers. comm.). The loss of large trees, both living and dead, which provide foraging and basking substrates and shelter for the Lace Monitor and Spencer's Skink, is likely to adversely impact on populations of these species. Similarly, the destruction of termitaria during clearing operations is likely to negatively impact on the Lace Monitor; these are important oviposition sites (P. Robertson pers. comm.). Loss of habitat associated with the clearing of native vegetation and draining of wetlands was identified as a threatening process for Swamp Skink and Glossy Grass Skink populations in Gippsland. The Blue Mountains Tree Frog is only found in uncleared areas of native vegetation (Macfarlane *et al.* 1987), and the Leaf Green Tree Frog is known to have been displaced in areas cleared for agriculture (Gillespie and Hines in review). Habitat

loss and a reduction in litter and ground debris layers, which harbour invertebrate prey, as a result of clearing of native vegetation may be deleterious to these species, as well as to the Large Brown Tree Frog.

### *Potentially Threatening Processes Affecting Flora*

Potentially threatening processes directly associated with clearing of native vegetation include damage or loss of individual plants, disturbance to soil-stored seedbanks (dependent on the method of clearing), changes to structure and composition and loss or modification of habitat. This is particularly threatening to taxa that are rare, have specialised habitat requirements, low fecundity, and small or isolated populations where there is reduced opportunity for recolonisation.

Within Gippsland, clearing of native vegetation (as defined above) is a particularly significant threat to EVCs and species dependent on plains, woodland, coastal and sub-alpine habitats. Few if any detailed studies of the impact of clearing on native flora have been undertaken. The greatest need for research is in the area of the impact of vegetation fragmentation on the reproductive biology of key taxa, and on the long-term management of remnants. Few if any native plants can survive broadscale clearance of vegetation where the result is conversion of the land to intensive human use for urban, industrial, tourism, agricultural or other purposes. However, clearing for agriculture does not always eliminate all native species. While the conversion of native vegetation to unimproved pasture usually involves the removal of trees and shrubs, many native herbs survive and in some cases prosper. However, as only vigorous reproducers (eg. many weed species) can tolerate such disturbance, its impacts are likely to be greatest on species with relatively low reproductive output. Once pastures are improved with the addition of exotic pasture species and fertiliser almost all native species are eliminated.

Many of the threatening processes indirectly associated with this disturbance result from fragmentation and isolation of habitat. Suitable habitat for species dependent on depleted vegetation exists only in small, isolated remnants. Populations of these species such as Purple Diuris *Diuris punctata*, Leafy Greenhood *Pterostylis cucullata*, Metallic Sun-orchid *Thelymitra epipactoides*, Dwarf Kerrawang *Rulingia prostrata* and Bushy Hedgehog-grass *Echinopogon caespitosus* are generally small and are particularly vulnerable to further loss of habitat as a result of clearing. Many local populations now consist of isolated groups persisting in habitat islands within the broader landscape. For flora this presents barriers to the spread of propagules to and from remnants leading to a reduction in the gene pool resulting in inbreeding and reduced fitness for reproductivity and recruitment. Another effect is an increase in vulnerability to extinction as vegetation is less able to recover or regenerate from catastrophic events or threatening processes which cause gradual depletion (eg. road maintenance works, weed invasion, fertiliser drift). Isolated patches of vegetation may also be more susceptible to decline in response to insect predators and the spread of pathogens or disease.

Other indirect effects of the clearing of native vegetation include the facilitation of the spread of introduced species (which quickly colonise after disturbance and often out-compete indigenous species), increased susceptibility to grazing pressure, erosion and soil compaction. In addition, small, isolated populations may not be sufficient to attract and sustain insect pollinators and the cessation of natural processes (eg. fire) which previously maintained diversity and vigour. In addition, the widespread clearing of deep-rooted native vegetation and its replacement with shallow-rooted pastures and crops has resulted in rising water-tables and salinity which is a factor contributing to tree dieback in rural areas (Clunie in prep.).

The depletion level of particular EVCs is influenced by many factors including arability, access and topography. EVCs most threatened by this process are those of the low foothills or plains.

For a list of EVCs potentially threatened by clearing of native vegetation see Table 6.1.

### *Management*

Further clearing of native vegetation is significantly mitigated by the implementation of native vegetation retention controls under the *Planning and Environment Act* 1987. Under the Act, land holders and public authorities must apply for a permit to clear native vegetation from any parcel of land greater than 0.4 ha. For areas less than 10 ha, applications are assessed by Shire Councils and for areas greater than 10 ha, NRE is a referral authority**.** Minor clearing associated with normal farm and domestic activities are not subject to these controls. Areas of significant vegetation and/or fauna habitat are protected by this process. Fragmentation of native vegetation is also minimised. Permits to clear native vegetation are generally only granted for small areas with little significance or slightly larger areas of degraded native vegetation.

The rate of clearing of private land is monitored by NRE through a database of clearing applications and satellite imagery which allows detailed comparison between current and past extent of tree clearance. Since the introduction of planning restrictions on the clearing of native vegetation on private land in 1989, the rate of vegetation loss has decreased tenfold in Victoria.

The clearing of native vegetation on public land requires Departmental approval. Planning permission may also be required in some cases. Major developments, including many mining and extractive industry developments, are the subject of Environment Effects Statements, in which the impacts on native flora and fauna are usually considered. The taking of protected flora associated with clearing requires authorisation under the *Flora and Fauna Guarantee Act* 1988.

### *6.2.3 Fuel Reduction Burning*

Fire is a fundamental element of the Australian environment. The effects of fire on flora and fauna vary depending on the scale, frequency, intensity and season of burns (Wilson 1996). Many native terrestrial plants have evolved reproductive mechanisms in response to fire. Fauna also respond to fire and factors such as shelter and food requirements and behavioural patterns will affect these responses (Wilson 1996).

Fuel reduction burning is carried out in a wide range of forest types in Gippsland. Fuel reduction burns are usually of low intensity that aim to reduce the ground, understory and bark fuel loadings, and are conducted in spring or autumn when conditions are optimal for maximum effectiveness with low risk of escape or excessive damage to living trees. It generally occurs at a frequency of 4-6 years for areas that require asset protection, and less frequently for other areas. (NRE 1999b). Other fire prevention activities carried out on public land include fuel reduction on roadsides and other remnants which may include ploughing and slashing. As a potentially threatening process, regeneration burning following timber harvesting is discussed below in section 6.2.4.

#### *Potentially Threatening Processes Affecting Flora*

The impacts of fuel reduction burning include the direct impact of the fire itself and the indirect impacts of an imposed fire regime which may differ from the "natural" (pre-European) regime (eg. fire interval, intensity and season of burn) that can result in changes to vegetation floristics and structure. Fuel reduction burning may affect heathy EVCs and EVCs of drier environments relatively more than other vegetation types because these EVCs burn more readily than other types. Less flammable vegetation and EVCs of wetter environments are rarely subject to fuel reduction burning.

The direct impact of a fuel reduction burning event is the damage or loss of fire sensitive species as a result of the fire itself. This impact is of low significance in naturally frequently burnt vegetation types (eg. grassy woodlands) comprised of fire resistant or fire tolerant species which are adapted to regenerate following fire, but of high significance in fire-sensitive vegetation and can result in total loss. Such vegetation is often associated with gullies which provide enhanced protection from fire for fire-sensitive vegetation and are rarely burnt.

Another potentially threatening process associated with fuel reduction burning is inappropriate fire conditions. That is, many species (and EVCs) require, or are adapted to, a natural burning regime where the frequency, season and intensity of burning fall within certain ranges. When burning frequency is too high species may fail to reproduce adequately before the next burn so that there are no propagules available for regeneration after subsequent burning events. This is a problem to obligate seed reproducers such as members of the Proteaceae, Fabaceae and Epacridaceae families which frequently occur in heathy EVCs. In addition, fires must be in the appropriate season and at a suitable intensity in order to stimulate germination and to provide suitable conditions for establishment and to avoid competition from native or introduced species better suited to the fire regime.

For a list of EVCs potentially threatened by fuel reduction burning see Table 6.1.

#### *Potentially Threatening Processes Affecting Fauna*

Fuel reduction burning in Gippsland is regarded as a major threat to the Long-footed Potoroo, Smoky Mouse, New Holland Mouse and Masked Owl. This process is considered a moderate threat to 15 species, a minor threat to 7 species and an unknown threat to 12 species.

The effects of fire on fauna varies depending on the fire regime. These regime variables include the scale, frequency, intensity and season of burns (Wilson 1996). The immediate and short-term impacts of fire on fauna populations are related to mortality during the fire, loss of shelter and nesting habitat, increased predation and decreased prey availability. Longer-term effects involve changes to vegetation characteristics. Inappropriate burning regimes, such as too frequent or too infrequent burning, can alter vegetation floristics and structure, and may affect habitat suitability for some fauna. Recolonisation of burnt areas by fauna is influenced by the presence of adequate foraging, shelter and breeding sites (Humphries and Tolhurst 1992).

Some fauna may be specially adapted to certain successional stages of vegetation. The Smoky Mouse and New Holland Mouse appear reliant on understorey vegetation components strongly influenced by the frequency and intensity of fires (Menkhorst 1995c), and inappropriate fire regimes represent an important threatening process for these species (P. Menkhorst pers. comm.). However, there is a lack of information on the ecological requirements of these species, especially in relation to fire (Lee 1995, Menkhorst 1995c). In addition, the Smoky Mouse and New Holland Mouse exist in small isolated populations, and have been recorded in commonly burnt EVCs, and inappropriate fire regimes have the potential to cause local population extinctions. The Swamp Skink is believed to be reliant on late successional stages of riparian scrub and coastal heathland, and inappropriate fire regimes may be a threat to this lizard (Gillespie *et al.* 1992).

Frequent low-intensity burns can simplify, and eventually eliminate, dense understorey (Catling 1991). This can reduce shelter and foraging sites for a range of species such as the Spot-tailed Quoll, Long-footed Potoroo, Long-nosed Bandicoot, Chestnut-rumped Heathwren, Hooded Robin, Glossy Grass Skink and Lace Monitors. The death of young trees and shrubs as a result of frequent burns can result in the loss of roosting habitat and may negatively affect the abundance of suitable prey for the Masked Owl (E. McNabb pers. comm.). Dense shrubs around nesting trees of the

Powerful Owl offer protection against predators such as foxes for pre-fledged owlets who climb into the shrubs after falling to the ground (Hollands 1991, McNabb 1996). Fuel reduction burning that reduces this protection may result in an increase in predation of the owlets. Loss of litter and ground layer cover threatens species that are dependent upon these habitats for shelter and prey, such as Martin's Toadlet, Tyler's Toadlet and Lace Monitors (Kemp *et al.* 1994, Alexander 1997).

Fuel reduction burns are generally concentrated along the State forest/private land boundary. Species which utilise this edge habitat may be negatively impacted by this disturbance. Ecotones are important foraging habitat for the Square-tailed Kite whose specialised diet consists mainly of passerine nestlings and eggs (Debus and Czechura 1989, Marchant and Higgins 1993). Annual fuel reduction burns may have an adverse effect on forest and woodland bird communities and cause prey shortages for the Square-tailed Kite (Debus and Czechura 1992).

The effect of fire on hypogeal (underground fruiting) fungi, an important food resource for the Long-footed Potoroo and Long-nosed Bandicoot, is unclear; research results are contradictory. However, if the effects on fungi availability are detrimental as recent research suggests (Thomas *et al.* 1994), the impact on these marsupials is potentially severe, especially for the Long-footed Potoroo which appears to rely heavily on fungi (Scotts and Seebeck 1989). In addition, the Long-footed Potoroo has a very restricted distribution in the Gippsland region; any degradation of habitat due to fuel reduction burning could have a large impact on populations.

#### *Management*

Fire management in Gippsland is guided by the Code of Practice for Fire Management on Public Land (CNR 1995a,b), which outlines general principles and guidelines for fuel reduction burning, and Regional Fire Protection Plans. Each Fire Protection Plan includes a fuel management strategy based on five zones. To maintain fuel at defined levels, fuel-reduction burns are undertaken in three of the strategically located zones. Areas containing significant biological, cultural or economic values which can be damaged by fire are located in Zone 5, in which prescribed burning is excluded, or Zone 4, where the ecological requirements of an area are given priority. Before fuel reduction burning is undertaken on Public land, each burn must be the subject of an approved burn plan in accordance with the Code of Practice for Fire Management on Public Land and regional fire protection plans. These plans detail ecological issues, including the known or likely presence of rare or threatened fauna in, or near, the area to be burned, and particular habitats needing protection. Such plans must take into account prescriptions developed for the protection of threatened species (CNR 1995a,b).

Flora and Fauna Guarantee Action Statements include fire management prescriptions for listed species that are threatened by this process. However, for the majority of species, the effects of fuel reduction burning are unknown, particularly the effect of burning frequencies. Monitoring of fauna populations is required to determine the effectiveness of prescriptions, which are often developed with a limited knowledge of a species' ecology, the effects of the process on a species' habitat, and the impact on populations. Records for fuel reduction burns generally include the boundaries of the burnt area but not the patchiness of the burn. It is therefore difficult to interpret the impact of fuel reduction burning retrospectively. NRE is undertaking long-term research on fuel reduction burns in the Wombat State Forest, which includes vegetation types found in Gippsland.

### *6.2.4 Regeneration burning*

Regeneration burning is a standard component of forest management in most harvesting operations in Gippsland. It involves the burning of the windrowed or heaped debris from harvesting (including heads, butts, and other material such as unusable logs and non-commercial species). The primary purpose of regeneration burning is to create optimal conditions for the natural germination of eucalypt seed shed from retained seed trees, or for sown seed where this is required. Regeneration burns must be of high intensity to be effective. They usually take place in late summer or early autumn. Unsuitable weather conditions and/or late season harvesting sometimes result in harvested coupes not being burnt until the following season. Regeneration burns occur in areas where clearfell harvesting systems are employed. The impacts of regeneration burning are discussed here with reference to flora. For a discussion of the impacts of planned fire on fauna see section 6.2.3 above.

#### *Potentially Threatening Processes Affecting Flora*

The direct impact of regeneration burning is the damage or loss of fire sensitive species as a result of the fire itself. This impact is strongly associated with regeneration burning, particularly where it may reinforce direct damage or loss as a result of timber harvesting. At greatest risk are fire sensitive species on the coupe and in the surrounding vegetation. Species also at threat are obligate root resprouters which may be stimulated to resprout by mechanical disturbance of the harvesting operation or by the regeneration burn but unable to withstand these disturbances in combination. Where the coupe is bounded by gullies regeneration burns can impact upon the gully vegetation which tends to comprise a greater proportion of fire sensitive species than other vegetation types unless measures are implemented to prevent spread of fire into these EVCs (eg. Montane Riparian Thicket, Cool Temperate Rainforest). Given also the typically linear configuration of these sensitive EVCs any intrusion of fire has the potential to modify microclimatic conditions (reinforcing changes associated with timber harvesting) to allow the establishment of weeds or species from the adjacent EVCs.

The longer-term, indirect impacts of a regime of regeneration burning include failure to reproduce adequately (where the intensity or season are unsuitable), absence of suitable conditions for establishment as a result of fire and competition from native or introduced species better suited to the fire regime. Assuming a harvesting cycle of 80 years, these impacts are likely to affect only those species which are adapted to fire frequencies greater than 80 years. However, it is important to assess these longer-term impacts of regeneration burning within the broader context of disturbance, which includes harvesting, roading, wildfire and disease in some cases.

#### *Management*

The Code of Forest Practices contains specific guidelines to prevent damage to surrounding vegetation from regeneration burns, particularly in relation to riparian EVCs which are fire-sensitive. The Code specifies that where fire is needed to produce a seedbed, measures must be taken to protect, as far as practicable, retained vegetation including streamside buffers, habitat trees, and areas of existing regrowth that could be damaged by fire.

### *6.2.5 Planned Absence of Fire*

The deliberate exclusion of fire is a result of successful fire prevention and fire suppression activities directed towards the protection of life, property and other assets. It also may reflect management decisions, to exclude fire as much as possible (eg. in fire-sensitive vegetation such as rainforests and sub-alpine communities). The deliberate exclusion of fire is particularly associated with remnant vegetation in areas where fuel reduction burning may not be regularly undertaken, and where wildfires have been successfully prevented or suppressed.

#### *Potentially Threatening Processes Affecting Flora*

The threatening processes associated with the long-term absence of fire are similar to those indirect impacts of the types of planned fire discussed above. For example, the frequency, intensity or season of fire may increase competition from other native or introduced species better suited to the fire regime. When burning frequency is too high, species may fail to reproduce adequately before the next burn so that there are no propagules available for regeneration after subsequent burning event. This is a problem for obligate seed reproducers such as members of the Proteaceae, Fabaceae and Epacridaceae families.

The EVCs most prone to structural and floristic changes in the absence of fire include EVCs that carry a high proportion of species that are dependent on fire for reproduction via resprouting and/or seedling establishment such as members of the Proteaceae, Fabaceae and Epacridaceae families (eg. Heathy EVCs) and those such as grasslands and grassy woodlands that require fire to reduce biomass of dominant ground species so as to allow establishment of other species and thereby increase biodiversity.

For a list of EVCs potentially threatened by planned absence of fire see Table 6.1.

#### *Management*

Ecological burns are undertaken in accordance with management plans or Action Statements for specific species, communities or sites.

### *6.2.6 Unplanned Fire (Wildfire)*

Fire is a fundamental element of the Australian environment and most native terrestrial plants have evolved reproductive mechanisms in response to fire. See Gill *et al*. 1981 for a general introduction.

Fire is the major natural disturbance maintaining the mosaic of floristic and structural diversity within native vegetation (others include flood, high winds etc). This mosaic is important in maintaining a natural system which provides floristic and habitat diversity, a propagule source and results in vigorous individuals able to withstand pests and disease. For example, native grasslands dominated by Kangaroo Grass *Themeda triandra* require periodic burning. Without regular fires this species increases and dominates to the exclusion of other species, resulting in a net loss in diversity and abundance. Periodic burning reduces the biomass of the Kangaroo Grass without killing it and opens up inter-tussock spaces allowing other species to flourish.

Similarly, fire can be a positive disturbance for fauna populations. Even intense wildfires can be patchy, resulting in a mosaic of structure and floristics within an area. Consequently, a natural fire regime may result in a range of habitats providing for a range of fauna with different requirements.

Wildfire may have both positive and negative outcomes for flora and fauna populations. Negative impacts of wildfire are generally associated with other human-induced disturbances and it is in this context that wildfire will be discussed here.

The intensity, frequency and season of occurrence of fires strongly influences the overall impact of the fire, and the subsequent response of both plants and animals. Fire can cause direct mortalities of animals and may eliminate critical habitat components. Species occurring in small disjunct populations, or species with narrow habitat requirements, are particularly vulnerable to wildfire. The effect of wildfire on populations of most species covered by this review is largely speculative.

### *Potentially Threatening Processes Affecting Flora and Fauna*

Wildfire may result in loss of fire sensitive species, encouragement of weed invasion or loss of or decrease in reproductive capacity. Effects of fire on vegetation are dependent on the fire frequency, fire intensity and season of burn. These effects include changes in species composition and abundance, and physical and age structure. All species respond uniquely to the combination of fire regime, other disturbances and potentially threatening processes (eg. weed invasion) that may be operating locally or regionally.

The intensity of a fire may determine the degree to which the vegetation is altered initially. High intensities can initially damage all strata while low intensity fires may only damage the lower layers (Meredith 1988). Low intensity fires generally leave more areas of un-burned vegetation but high intensity fires can also be restricted or patchy in extent. Low intensity fires leave more areas of unburnt vegetation, and allow animals to shelter in burrows, under rocks or in hollows during fires.

Following a fire a range of environmental factors will interact to determine the characteristics of the vegetation and its suitability for particular fauna species. Vegetation often recovers in a series of stages or successions. Recolonisation of fauna can be related to these stages, with species returning once particular habitat components are again present (Friend 1993). A burnt area of forest may not return to its original form but may provide habitat and resources for a different suite of fauna. Because the system is dynamic, further disturbance such as another fire may result in further changes in structure and floristics depending on the interval between fires, fire intensity, climatic and other factors.

The season of burn may determine how an area and associated fauna respond to fire. For example breeding seasons may be interrupted. Autumn fires are generally hotter than spring burns (Wilson 1996) and the response of vegetation (and associated fauna) may differ depending on the heat and intensity of the burn. The frequency of wildfire can influence the regeneration of vegetation and therefore the recolonisation of animal species. The recolonisation of a species into a particular area is influenced by the dispersal abilities of the species, the existence of any metapopulations within reach of the burnt area and the sizes of those populations (Bennett 1990). Wildfire in fragmented, restricted and fire-sensitive habitats may eliminate important habitat, contracting the distribution of already restricted flora and fauna even further or resulting in loss of local populations with little chance of recolonisation.

Within Gippsland wildfire is regarded as a major threat to the Long-footed Potoroo and a moderate threat to 21 species. There are 11 species for which the effects of this potentially threatening process are unknown, including the two bat species reviewed.

Adverse effects of wildfire on animal species are related to mortality during the fire, subsequent loss of shelter and nest sites, reduction in prey availability and foraging substrate, and increased risk of predation by introduced species (Catling 1991, Wilson 1996). Species with low mobility, such as small ground mammals and skinks, may not be able to escape during a fire, and perish. Behavioural patterns and shelter and food requirements of species will affect their responses to a fire (Friend 1993, Wilson 1996).

A reduction in numbers of arboreal and ground dwelling species as a result of wildfire can impact on predators such as the Powerful Owl and Sooty Owl (E. McNabb pers. comm.). A loss in tree hollows reduces nesting and shelter sites for a number of species, including Owl species, the Gang-gang Cockatoo, Spot-tailed Quoll, Yellow-bellied Glider and Lace Monitor.

Fires can destroy understorey vegetation, which may be an important foraging resource for Yellow-bellied Gliders, or habitat for species that nest on or near the ground, such as Broad-toothed Rat and Long-nosed Bandicoot. Damage to the outer canopy of eucalypts may impact on the Square-tailed Kite which feeds on passerine nestlings and eggs taken from nests situated within this section of the tree (Debus and Czechura 1989). Disturbance of the litter and ground debris by wildfire eliminates important foraging and shelter habitat for many species such as the Long-nosed Bandicoot, Martin's Toadlet, Tyler's Toadlet, Lace Monitor, Glossy Grass Skink and Spencer's Skink (Bramwell *et al.* 1992, Ehmann 1992, Alexander 1997, Hutchinson and Donnellan 1988, Clemann 1997). The effect of fire on hypogeal (underground-fruiting) fungi, an important food resource for the Long-footed Potoroo and Long-nosed Bandicoot, is not clear, although recent research suggests a detrimental effect (Thomas *et al.* 1994). The habitat of the Smoky Mouse appears to be fire generated, although the exact relationship between such habitat and fire is not fully understood (Lee 1995). In addition, the Long-footed Potoroo, Broad-toothed Rat and Smoky Mouse exist in small isolated populations which could decline if a wildfire destroyed all the suitable habitat in an area. The Swamp Skink may also be dependent on certain successional stages of vegetation (Gillespie *et al.* 1992), and wildfire may destroy or alter the habitat of this lizard. The Giant Burrowing Frog may be vulnerable to unplanned fire because of the isolated nature of populations (Gillespie 1990).

Vegetation in sub-alpine areas is especially sensitive to damage caused by wildfire because of a very limited growing season and slow growth rate (McDougall 1982). The risk of wildfires occurring in these areas is heightened by recreation-related human presence (Mansergh *et al.* 1991). Many Broad-toothed Rat records are from sub-alpine areas (Atlas of Victorian Wildlife); their habitat is potentially under threat of damage from unplanned fire. In addition, populations of this species are often small and isolated making them particularly vulnerable to stochastic events such as wildfire (Bennett 1990).

For a list of EVCs potentially threatened by wildfire see Table 6.1.

### *Management*

The Department of Natural Resources & Environment has the responsibility for prevention and suppression of fire in State forest, National Parks and reserves and all protected public land. The Code of Practice for Fire Management on Public Land (CNR 1995a) and regional fire protection plans include strategies for fire prevention, preparedness, fire suppression and recovery after wildfire. Significant and sensitive natural values are taken into account by these plans which can be revised regularly to take account of new information.

Regional fire protection plans include a fuel management strategy incorporating a zoning system for fuel management. The fuel management strategy aims to reduce the rate of wildfire spread and improve the prospects for controlling wildfire close to assets and in strategically located regional corridors. The fuel management strategy zoning gives consideration to the natural values (including fauna values) and principles of environmental care. Similarly, fire suppression follows consideration of factors including values at risk from the wildfire or suppression activities.

There has been much research on the effects of fire on mammals and birds in general. However, there is a lack of knowledge for some groups such as arboreal marsupials and bats. Some habitat types have been covered by research more than others. Information on the responses to fire of reptiles and amphibians is extremely limited (Wilson 1996). The effect of fire frequency on populations also requires more research. The large number of species for which the effects of this disturbance are unknown highlights a need for fire-related research.

## *6.2.7 Grazing*

Grazing of cattle and sheep is the most widespread form of agriculture in Gippsland (Aldrick *et al.* 1988). These animals, as well as feral and naturalised exotic animals including rabbits, hares, deer, goats and brumbies, are the main agents of grazing or browsing and trampling of native vegetation within Gippsland. Rabbits are widespread within the study area, though they are generally absent or only present in small numbers in the high country. Populations of hares occurring at higher elevations are generally small and scattered, although in the Wonnangatta-Moroka Unit of the Alpine National Park hares are common, particularly on sub-alpine plains. Goats are generally uncommon in the study area, occurring mainly as small, scattered flocks. Brumbies are mainly recorded from the high country, where herds are generally small and widely scattered. The biggest populations of brumbies occur in the Cobberas-Tingaringy Unit of the Alpine National Park. Deer are found in a variety of forest environments where populations are generally small, although these populations appear to be increasing in size (DCE 1992b,c). Browsing by native herbivores is only considered as a disturbance in this review where it is significantly beyond the natural range of impact (over-browsing). This is usually restricted to cases where populations of native browsers become concentrated beyond carrying capacity in confined or isolated areas of native vegetation. Over-browsing by native herbivores is virtually unknown in the major blocks of public land, but may be a significant problem in some public land blocks and on private land.

On public land, licensed grazing of domestic stock, particularly cattle, is practised throughout Gippsland and includes areas within State forest, the Alpine National Park, roadside reserves and water frontages. Forest grazing is often a significant part of the enterprise of individual licensees. In the Alpine National Park, the majority of cattle are grazed on sub-alpine blocks above 1220 m elevation. A smaller number of cattle also occupy forest areas below 1200 m. Cattle are generally grazed on alpine leases between December and May (DCE 1992b,c).

### *Potentially Threatening Processes Affecting Flora*

The impact of grazing will depend on the grazing species, intensity, timing, duration, stocking rate, EVC, local environmental conditions (eg. steepness, erodability, soil type) and climatic conditions (Clunie in prep). Grazing, browsing or trampling can result in direct damage to or loss of plants and the potential for reduced reproductive output, especially where reproductive structures are significantly affected.

Less direct potentially threatening processes associated with grazing are habitat modification (structurally and floristically), reduction in the litter layer, soil disturbance, and compaction or erosion, particularly where grazing or trampling is intense. Site conditions can exacerbate the impact, for example, on steep sites, in drainage lines or on particular soil types (heavy clays - pugging; sands, silts and gravels - erosion; peats - physical fragmentation). Another less direct potentially threatening process associated with grazing is environmental weed invasion (see below), where soil disturbance is combined with animals acting as seed dispersal vectors, via seed in manure or adhering to hooves, feet or coats. These processes can lead to the simplification of the vegetation overall and reduced structural and floristic heterogeneity (Lunt 1991, Brown and Bennett 1995, Robinson and Traill 1996). Grazing may also affect the health and longevity of existing vegetation including the overstorey due to increased nutrient levels, root damage and soil compaction which may lead to dieback (Landsberg *et al.* 1990).

The ecological attributes which predispose plants to threat from grazing include palatability (mainly herbaceous species, but may include woody species when young, such as some *Eucalyptus* spp, *Acacia* spp and *Coprosma* spp) and occurrence in habitats which tend to be grazed more frequently or heavily, such as grassy habitats. Habitats affected by grazing are principally the grassy and forb-rich EVCs. The historical combination of alienation, grazing and clearing has resulted in most grazed EVCs being scarce on public land and are often present as degraded remnants on private land.

For a list of EVCs potentially threatened by grazing see Table 6.1.

### *Potentially Threatening Processes Affecting Fauna*

Species particularly vulnerable to threatening processes associated with grazing include those whose habitat is largely restricted to remnant patches of habitat within an agricultural landscape, species which live underground or forage in the sub-soil or litter layers, species which require structural complexity near ground-level, and species restricted to sensitive vegetation types.

Lack of regeneration as a result of grazing of remnant patches of native vegetation is a significant threat to the long-term persistence of species such as the Regent Honeyeater, Swift Parrot, and Hooded Robin. A significant proportion of the preferred habitat of these species is found in remnant patches of woodland habitat on private land, roadside reserves and water frontages. Trees in paddocks are particularly vulnerable to dieback processes associated with grazing, including soil compaction, increased nutrients causing changes to soil chemistry, and girding of trees (Heatwole and Lowman 1986). Lack of regeneration resulting in long-term loss of habitat may also have a significant impact on species which utilise forest farmland edges, such as the Masked Owl and Barking Owl. A significant proportion of active White-bellied Sea-Eagle nests known from the region are on private land. Loss of potential nest sites as a result of tree dieback and lack of regeneration of future habitat due to grazing are potentially significant issues for the species on private land (Williams 1998).

Elimination and simplification of understorey vegetation, and trampling of litter as a result of grazing, are threatening processes for a range of reptile species, particularly skinks, and other ground-foraging animals such as the Broad-toothed Rat, White-footed Dunnart, Smoky Mouse and Long-nosed Bandicoot. The Swamp Skink and the Glossy Grass Skink are reliant on tussock life-form vegetation for basking, shelter and foraging sites (Clemann 1997), and this vegetation is very sensitive to trampling by domestic stock (P. Robertson pers. comm.). Grazing may result in the degradation of foraging habitat for ground dwelling mammals such as the White-footed Dunnart, Smoky Mouse and Long-nosed Bandicoot. The Long-footed Potoroo and Red-necked Wallaby rely on dense understorey vegetation for shelter, particularly from introduced predators and may be impacted by simplification of this habitat component as a result of grazing. Litter is an important habitat component of the Chestnut-rumped Heathwren and Hooded Robin. Understorey shrubs provide foraging substrates for species such as Pink Robin and Chestnut-rumped Heathwren; Chestnut-rumped Heathwren also utilises low shrubs and grass tussocks as nest sites (Blakers *et al.* 1984, Emison *et al.* 1987) which are vulnerable to loss of eggs and young resulting from trampling by cattle. The Azure Kingfisher nests in tunnels excavated in stream banks near the water. Erosion and collapse of river banks as a result of grazing of streamside frontages may result in lost nesting habitat for this species (Shields 1994).

Sub-alpine vegetation is generally slow growing, and seedling establishment is rare (McDougall 1982). Therefore, it is particularly sensitive to physical disturbance and modification arising from grazing and trampling. In the harsh sub-alpine environment the light, friable soils are particularly prone to erosion if exposed (LCC 1982). The Broad-toothed Rat has mainly been recorded from sub-alpine areas within Gippsland and may suffer loss of food and cover as a result of disturbances associated with grazing (Menkhorst 1995a). Restricted to sub-alpine environments, the Alpine Tree Frog has specialised habitat requirements, and populations of this species are potentially threatened by habitat loss and degradation as a result of grazing and trampling. Populations of this frog are disjunct, and the species is declining (Hunter *et al.* 1997). It breeds in streamside pools, bogs and fens, and on the margins of artificial lakes on plains or in open valleys. Trampling of breeding sites by cattle has the potential to cause declines of the Alpine Tree Frog (Gillespie *et al.* 1995). Stream-side vegetation is used by Spotted Tree Frogs, and Large Brown Tree Frogs as sheltering and basking sites. Habitat modification as a result of grazing may adversely affect these species (Hero *et al.* 1991, Watson *et al.* 1991, Tyler 1997).

### *Management*

Grazing on public land including State forest is permitted under licence. In State forest grazing licences are issued annually for periods up to twelve months and are subject to regulations under relevant legislation (eg. *Forests Act* 1958). Licences are issued for seven years for parts of the Alpine National Park and specify the maximum number of stock that may be grazed on the licensed areas. Licences include conditions, which can include the exclusion of cattle from areas of special conservation significance or from areas requiring rehabilitation. Seven year licences are being introduced for the seasonal, alpine and bush grazing licences in State forest from 1998.

Each Region has a Land Protection Regional Advisory Committee which advises the regional manager on matters related to grazing, such as stock entry and exit dates, stock numbers and other seasonal management issues.

It is intended that populations of introduced grazers/browsers (rabbits, hare, deer, brumbies, goats) with the potential to cause environmental damage be monitored in the Alpine National Park and control measures instigated on an as needs basis (DCE 1992a,b,c).

On other public land including State forest, deer, brumbies and hares are not actively controlled. Goats are heavy browsers and have the potential to significantly alter vegetation communities. Populations are generally small and transient within Gippsland and control programs are initiated as required. Rabbits are the most widespread pest species in

the study area and have a significant impact on vegetation communities leading to altered structure, floristics and soil erosion. Coordinated public and private land control programs are ongoing (M. Chapman pers. comm.). The release of the Rabbit Calicivirus Disease is a major initiative in rabbit control. Its effectiveness will come to light once the results of monitoring programs are published. Over-browsing by native browsers is generally dealt with by issuing permits to reduce the relevant populations.

Management of grazing by domestic stock of stream frontages and roadsides (including unused road reserves) is an important issue for flora and fauna conservation within Gippsland. Licensed grazing of native vegetation on public land is subject to periodic review, with the option of specifying licence conditions. On public roadsides managed by local government, development of roadside management plans which address issues such as grazing are critical to ensure habitat conservation for many species. Grazing on stream frontages and other vegetation remnants on public land which are important for understorey species or fauna needs to be compatible with the maintenance of identified values.

If adequate regeneration of trees and shrubs is maintained, roadside grazing may be compatible with habitat management for species such as Regent Honeyeater and Swift Parrot. Research is required to investigate the role of grazing in controlling the growth of introduced pasture species.

Two of the major impacts of grazing are listed as Potentially Threatening Processes under the *Flora and Fauna Guarantee Act* 1988. These are: *The degradation of native riparian vegetation along Victorian rivers and streams* and *Soil erosion and vegetation damage and disturbance in the sub-alpine regions of Victoria caused by cattle grazing.*

Few studies exist which examine the effects of different grazing regimes on many terrestrial species. There is a critical need for research to clearly define these impacts, and for active management to prevent further degradation, especially on public land (Bennett 1993).

### *6.2.8 Road construction and maintenance*

Road construction and maintenance may involve the clearing of vegetation, major earthworks to form the road pavement and batters, road-widening and upgrading, works to construct bridges, culverts and drains and installation of utilities. A variety of classes of roads and tracks are constructed on public land, both in conservation reserves and State forest to provide access for commercial timber harvesting, fire management, catchment management and recreation. Construction activities can directly destroy habitat, create barriers to movement, increase the potential of erosion and weed invasion, alter hydrological regimes and increase water turbidity and siltation when associated with creek crossings (Lumsden *et al*. 1991).

In timber harvesting areas throughout Gippsland there is a requirement for a well constructed and maintained network of roads capable of carrying heavy vehicles. Road construction and maintenance activity is extensive. However, in terms of overall length, narrow tracks constitute the majority of the road and track network in State forests in Gippsland.

In the agricultural areas of Gippsland region, road reserves make up a significant proportion of the remnant native vegetation and provide important links between remnant patches. Roadworks such as road-widening and upgrading and installation of utilities, have the potential to degrade native vegetation (particularly the ground layer), reduce habitat and contribute to weed invasion.

#### *Potentially Threatening Processes Affecting Flora*

The potentially threatening processes associated with this disturbance include direct damage or loss of plants by machinery, habitat loss and/or fragmentation, altered micro-climatic and light conditions, erosion, sedimentation, introduction of soil or gravel contaminated with weed seed or fungal spores and the facilitation of weed spread due to continual disturbance of road margins. The impact of road construction and maintenance is greatest in the construction phase, especially where the road is major and the terrain is steep, requiring large batters. Stream crossings sometimes present major engineering challenges, and have been shown to be the main sources of sediment input to streams. The erosion hazard will also be greatest in steep terrain, particularly in high rainfall areas. Gully vegetation is therefore most at risk from the major impacts of road construction and maintenance.

*Degradation of native riparian vegetation along Victorian rivers and streams, Increase in sediment input into Victorian rivers and streams due to human activities*, and *The invasion of native vegetation by environmental weeds* are listed as Potentially Threatening Processes under the *Flora and Fauna Guarantee Act* 1988.

Indirect impacts of road construction and maintenance include potentially threatening processes that lead to habitat modification (soil erosion, sedimentation, microclimatic changes, increase of water turbidity and alteration of hydrological regimes). These processes are most significant in the vicinity of gullies in the steeper, higher-rainfall, mountainous parts of Gippsland. In addition, gullies and streams act as conduits for the spread of weed propagules downstream. Consequently species and EVCs associated with gully and riparian environments are most likely to be affected.

For a list of EVCs potentially threatened by road construction and maintenance see Table 6.1.

### *Potentially Threatening Processes Affecting Fauna*

Species particularly vulnerable to threatening processes associated with road construction and maintenance include those dependent upon roadside vegetation as habitat, species associated with riparian environments or species dependent on sensitive habitat types.

Roadworks such as road-widening, upgrading and installation of utilities degrade and can reduce habitat by removing and damaging mature trees, saplings and shrubs, and may also result in weed invasion causing a deterioration of ground-layer habitat. Roadworks may also contribute to eucalypt dieback as a result of altered drainage patterns, nutrient run-off or introduced plant pathogens (Heatwole and Lowman 1986, Landsberg *et al.* 1990, Robinson *et al.* in prep). Loss and degradation of remnant roadside vegetation is considered a minor threat to many species. In addition to loss of habitat, upgraded sealed roads carry faster traffic and may result in more road-kills of some species (Robinson *et al.* in prep.). Lace Monitors are known to use roadside vegetation, and roadkills of this species are not uncommon (Atlas of Victorian Wildlife, P. Robertson pers. comm.).

Roads can fragment habitat and create barriers to movement. Species with limited mobility, such as small mammals and reptiles, are particularly vulnerable. White-bellied Sea-eagles are particularly vulnerable to disturbance while nesting. Road construction and maintenance activities in the vicinity of nest sites may cause breeding pairs to abandon nests, leading to reduced breeding success (Williams 1997). Roads may also create corridors that facilitate the invasion of weeds and exotic predators such as foxes and cats into various frog habitats (May and Norton 1996). These activities may also threaten Lace Monitors by removing and fragmenting habitat (P. Robertson pers. comm.).

Construction of roads and tracks can result in the exposure of soil which is then vulnerable to erosion and weed invasion, and can result in increased sedimentation of streams and alteration of riparian habitats. The major source of unacceptable increases in stream sedimentation is likely to be roads and tracks, including fire trails and accessible roads used for timber harvesting, recreation and management access (O'Shaughnessy and Associates 1997). Increases in sediment loads can be detrimental to the Spotted Tree Frog and Giant Burrowing Frog by affecting the growth and survival of eggs and tadpoles, or by changes to the general characteristics of the riparian habitat which may affect adult recruitment, breeding or survival (Gillespie 1990, Watson *et al.* 1991, Mazzer 1994). Roads may also create corridors that facilitate the invasion of weeds and exotic predators such as foxes and cats into various frog habitats (May and Norton 1996). Alterations to hydrological regimes and increased siltation as a result of roading activities may negatively impact on Leaf Green Tree Frog, Large Brown Tree Frog, Alpine Tree Frog, Martin's Toadlet, Tyler's Toadlet, Swamp Skink and Glossy Grass Skink populations. The Large-footed Myotis and Azure Kingfisher are largely dependent on aquatic prey. Increased sedimentation and turbidity of streams may indirectly affect these species through reduced prey availability (L. Lumsden pers. comm.).

### *Management*

In State forest, all new roads and tracks must be built to comply with the Code of Forest Practices for Timber Production (NRE 1996). The Code includes goals and guidelines covering the planning, location, design, construction, maintenance and use of timber extraction roads and stream crossings. In all cases, efforts are made to reduce the environmental impacts consistent with safety considerations, traffic levels and engineering requirements. Such factors will affect the extent to which desired environmental outcomes can be accommodated.

A report prepared by O'Shaughnessy and Associates (1997) was commissioned to provide expert advice on means to protect water quality in catchments supporting Spotted Tree Frog populations. Recommendations were made concerning road management including monitoring during periods of heavy rain, application of road standards across complete catchments and standards for stream crossings and culverts. The allocation of resources to the repair of existing road networks was also recommended (O'Shaughnessy and Associates 1997).

In State forest attention is paid to planning the road and track network to avoid threatened species habitat, minimise environmental damage and provide high standard stream crossings. All new roads and tracks must be built to standards outlined in the Code of Forest Practices (NRE 1996). However, many roads and tracks were built prior to introduction of the Code and do not meet these standards. The likelihood of new road construction in Gippsland, in particular within sub-alpine environments, is low. However, there are a range of processes (eg. Code of Forest Practices) in which flora and fauna values are addressed prior to the approval of the construction of new roads on public land. Management aims include the progressive improvement of the design and drainage of the road network to minimise sedimentation run-off and meet appropriate road standards.

VicRoads (a Victorian Government agency) is responsible for main roads and highways throughout Victoria. VicRoads has published an environmental strategy (VicRoads 1995) which includes objectives and commitments relating to the conservation of native flora and fauna. Local municipalities are responsible for all other public roads (and roadsides) excluding those managed by NRE. Local Government Roadside Management Plans which incorporate guidelines for habitat management should assist in achieving conservation objectives for species dependent upon roadside vegetation in the agricultural landscape. Development of Roadside Management Plans requires liaison with major land managers who have impact on roadside vegetation including local government authorities, Country Fire Authorities and local land holders (Davidson and Robinson 1992).

### *6.2.9 Recreation*

A range of recreational activities taking place in Gippsland can disturb flora and fauna, and damage or destroy habitat. These activities include skiing (cross country and downhill), four-wheel driving, hiking, camping, caving, fishing, canoeing, boating, trail bike riding, car rallies and horse riding. Such activities can directly remove or trample vegetation, compact soil, cause pollution and sedimentation of streams, contribute to erosion and facilitate the spread of weeds. Within Gippsland, species most vulnerable to threatening processes associated with recreational activities are those particularly sensitive to disturbance, those dependent on sensitive habitat types, and those whose distributions are restricted to areas where recreational activities are concentrated.

Vehicle-based activities can result in disturbance of habitats in the vicinity of focal points such as camping areas and natural features. At stream crossing points high levels of vehicle traffic can result in localised bank erosion and sedimentation. Vehicle use can also result in the erosion and transport of soil, potentially carrying plant diseases and weed propagules.

Snow sport and associated development of facilities is a significant, albeit highly localised, form of recreation in Gippsland. Its impacts can include clearing, habitat fragmentation and habitat disturbance during the construction and maintenance of facilities (runs, trails, lifts, buildings, utilities infrastructure), pollution and associated indirect impacts such as the spread of environmental weeds.

#### *Potentially Threatening Processes Affecting Flora*

The potentially threatening processes associated with recreation activities that directly impact on native vegetation are the direct damage or loss of individuals and habitat loss or modification via weed invasion, soil disturbance etc.

For flora restricted to sub-alpine habitats, clearing of native vegetation is potentially a major threat. Species confined to these areas have limited distributions and population size, specialised habitat requirements and are recorded from habitats (EVCs) that are highly sensitive to disturbance. In addition sub-alpine vegetation is characterised by slow establishment and growing rates and is slow to recover from damage (McDougall 1982). Any further loss or degradation of habitat as a result of clearing for resort development or other recreational activities is a significant threat to these sub-alpine species and is likely to cause population decline and have a significant impact on their survival in the region.

Indirect impacts on vegetation result in overall habitat degradation which may involve disturbance to soil structure by compaction and erosion, the facilitation of spread of disease, pathogens or environmental weeds, altered soil or surface hydrology, the increase in sediment input into streams and pollution/eutrophication of wetlands and streams, including those in sub-alpine regions.

The EVCs likely to be at greatest risk from recreational activities are those associated with coastal, sub-alpine or riparian environments where recreation activities are concentrated. Species at risk from recreational activities include those sensitive to trampling, erosion, altered hydrology, sedimentation, weed invasion and plant pathogens. For EVCs and species of restricted environments (eg. coastal and sub-alpine habitats) and those that have become restricted due to their historic favourability for human use (usually fertile environments), clearing of native vegetation for recreational use is potentially a major threat.

For a list of EVCs potentially threatened by recreation see Table 6.1.

#### *Potentially Threatening Processes Affecting Fauna*

Within Gippsland, species most vulnerable to threatening processes associated with recreational activities are those dependent on sensitive habitat types and whose distributions are restricted to areas where recreational activities are concentrated. Recreational activities can damage habitat and can directly affect the animals themselves.

Being restricted to sub-alpine areas, the Alpine Tree Frog has a limited distribution in Victoria. Most of the Broad-toothed Rat records within Gippsland are from sub-alpine areas. Habitat of these species includes sub-alpine grassland and heathland, and sphagnum bog communities. These communities contain vegetation characterised by slow establishment and growing rates, and are therefore sensitive to disturbances and take a long time to recover from damage (McDougall 1982). In conjunction with habitat damage, recreational activities can directly affect the animals. Populations of sensitive sub-alpine fauna are often small and restricted to areas of suitable habitat. Loss and degradation of habitat as a result of recreational activities is likely to cause population declines for these species, and significantly affect their ability to survive in the region.

The Spotted Tree Frog has a limited and disjunct distribution in Gippsland, rendering this species particularly vulnerable to disturbances. Recreational activities including camping, fishing, horse riding and vehicle use occur at many of the sites from which the Spotted Tree Frog has disappeared (Gillespie and Hollis 1996). Recreational fishing and bait collection, including the use of frogs as bait and the disturbance of stream habitat while in search of other live bait, may be a significant cause of Spotted Tree Frog population declines (Watson *et al.* 1991). The White-bellied Sea-Eagle is sensitive to disturbance, particularly during the breeding season when disturbance at the nest site can lead to nest abandonment, resulting in reduced breeding success (Dennis and Lashmar 1996, Williams 1997). The Gippsland coast is a stronghold of the White-bellied Sea-Eagle and recreational activities near nest sites are likely to cause population declines and is

considered a major threat to the species (A. Williams pers. comm.). Protection of White-bellied Sea-Eagle nest sites from disturbance is recognised as a significant factor in the conservation of this species (Clunie 1994). Camping and associated activities may disturb Lace Monitors (P. Robertson pers. comm.).

### *Management*

Vehicle-based activities on public land are managed through the relevant management planning process (Forest Management Area Plan or Park Management Plan). Effort is generally made to encourage activities in appropriate zones where these activities are compatible with overall management objectives, or where impacts can be minimised.

Snow sport and associated resort development and management is required to take into account a range of legislation including provisions of the *Flora and Fauna Guarantee Act* 1988 and local planning requirements.

The sub-alpine area, most of which is included in the Alpine National Park, is used year round for a range of recreational activities. These activities are allowed throughout much of the National Park, although certain restrictions apply, for example, horse riding is allowed only during set periods of the year and is excluded from certain areas (DCE 1992a). The Park is divided into a number of zones, including areas set aside as Special Protection Zones, where stricter controls on recreation apply. Recreation activities are not permitted in Reference Areas. Wilderness Zones cater only for non-mechanised recreation. Within the Bogong Unit of the Alpine National Park there are Special Protection Zones for the Broad-toothed Rat, Smoky Mouse, Alpine Water Skink and Spotted Tree Frog. These are areas of suitable habitat that are managed "primarily to maintain, protect or enhance the special features they encompass" (DCE 1992a,b). Within these zones new recreation-related construction is not to be carried out pending assessment of possible impacts and will only proceed if it can be clearly demonstrated that special features can be adequately protected.

## *6.2.10Environmental weed invasion*

Environmental weeds are widespread throughout Gippsland, occurring in all habitats and areas. Invasion of environmental weeds involves the naturalisation and spread of exotic taxa and the extension beyond "normal" range or habitat of native species.

The impact of environmental weeds varies. Some are relatively benign, occurring at low cover/abundance levels and/or spreading slowly. Others spread rapidly due to high reproductive output, large dispersal ranges and/or broad habitat tolerances. The most destructive environmental weeds are those which out-compete native species to the extent that their habitat can become grossly modified, with particular niches being lost altogether.

Important pest species in Gippsland include Ragwort *Senecio jacobea,* Blackberry *Rubus* spp., St Johns Wort *Hypericum perforatum*, Tutsan *H. androsaemum*, Sweet Briar *Rosa rubiginosa*, Ox-eye Daisy *Leucanthemum vulgare*, Boxthorn *Lycium ferocissimum*, English Ivy *Hedera helix*, Furze *Ulex europeus* and various thistles. One native species of concern is Sweet Pittosporum *Pittosporum undulatum.*

### *Potentially Threatening Processes Affecting Flora*

Environmental weed invasion is a potentially threatening process leading to competition and habitat modification. Environmental weed invasion can occur in any EVC but those EVCs and species growing in environments with adequate moisture and soil fertility are more susceptible. These include riparian zones, relatively fertile soil types and fragmented habitats in close proximity to weed sources, such as waste disposal areas and agricultural lands. Various suites of weeds are often found in particular environments where disturbance regimes and environmental characteristics are suitable. For example, Blackberry *Rubus fruticosus* spp. agg. in riparian and gully environments.

For a list of EVCs potentially threatened by environmental weed invasion see Table 6.1.

### *Potentially Threatening Processes Affecting Fauna*

Weeds are a considerable problem in parts of Gippsland. On public land, Blackberries are a problematic weed, particularly in riparian habitat, while St John's Wort is a serious environmental weed in forested areas (N. Penrose pers. comm.). Weed invasion causes loss and deterioration of ground-layer habitat and reduces access to litter and is a potentially threatening process for ground-foraging birds such as Chestnut-rumped Heathwren and Hooded Robin. The Pink Robin may lose breeding habitat in stream-side gullies if these sites are invaded by Blackberries, although the extent of this threat is unknown (R. Loyn pers. comm.). Similarly, the invasion of stream-side habitat by weeds such as Blackberries may result in the loss and degradation of habitat for the Spotted Tree Frog (Tyler 1997, Robertson and Gillespie in prep.).

### *Management*

*The invasion of native vegetation by environmental weeds, and the spread of Sweet Pittosporum outside its natural range*, are listed as Potentially Threatening Processes under Schedule 3 of the *Flora and Fauna Guarantee Act* 1988. The management of environmental weed invasions is the responsibility of the land manager. On public land, environmental weeds are considered along with agricultural weeds under the Victorian *Catchment and Land Protection Act* 1992. Under this Act, weed species may be listed as State Prohibited, Regionally Prohibited or Regionally Controlled

weeds. Within this framework, regional environmental weed management priorities are established through the relevant management plans and will be addressed in the proposed Gippsland Forest Management Plan (in prep.).

The Victorian Parliament, through the Environment and Natural Resources Committee, has investigated the significance of the weed problem in general, including specific reference to environmental weeds (Parliament of Victoria 1998). The Commonwealth, in consultation with State and Territory agencies, has recently completed the National Weeds Strategy (ARMCANZ & ANZECC 1997) which outlines strategies to address major issues. Limited resources and a general lack of strategic planning, tactical planning, follow-up, monitoring and experimental management are the major issues identified in the National Weeds Strategy. A Victorian Weeds Strategy has been developed within the context of the National Weeds Strategy to reduce the impact of weeds (NRE 1998 draft report.). Also, the Department of Natural Resources and Environment has produced a draft *West Gippsland Weed Action Plan* (NRE 1999a), one of ten regional Weed Action Plans being prepared within the State with community input arranged by the regional Catchment Management Authorities (CMAs). The draft plan provides a framework for the assessment and management of all types of weed problems in West Gippsland (NRE 1999b unpub.).

The distribution of environmental weeds is generally well understood as a result of knowledge gained from floristic surveys conducted in Gippsland. A considerable amount of research on the ecology and management of particular environmental weeds, especially those that impact on agriculture, has been undertaken. The most significant gaps in knowledge are the ecology of a suite of environmental weeds that do not impact significantly on agriculture, the long-term management of multi-species invasions and the relationship between weed invasion and other disturbances.

### *6.2.11Introduced Fauna Species*

This category covers predation by introduced species (e.g. cat, fox, trout), as well as competition by introduced species for resources such as food or shelter. It does not include predation or competition by native species. Introduced animals can also act as vectors for weed propogules (Mansergh and Marks 1993). The impact of introduced fauna on vegetation is discussed in the section on grazing.

Populations particularly at risk from predation by introduced animals are those that have a very localised and/or fragmented distribution, or occur in specific habitats which have been largely destroyed or modified by humans (Seebeck and Clunie 1997). Introduced carnivores are likely to have their greatest impact on ground-dwelling or ground-nesting animals (Bennett 1993).

#### *Potentially Threatening Processes Affecting Fauna*

Wild dogs are considered a problem in the Gippsland region, both for their impact on livestock and the damage caused by predation on native fauna (N. Penrose pers. comm.). Foxes and cats are widespread throughout Victoria, occurring in most habitat types. Predation by foxes and cats is listed as a potentially threatening process under the *Flora and Fauna Guarantee Act* 1988, with published action statements for both species (Mansergh and Marks 1993, Seebeck and Clunie 1997). Predation by cats is also listed as a threatening process under the *Endangered Species Protection Act* 1992, and a threat abatement plan has been prepared (Dickman 1996). The extent of cat and fox predation on native animals is largely determined by prey availability (May and Norton 1996). Rabbits are a major prey item for both species, with alternative prey sought (including native fauna) when rabbit numbers decline (Catling 1988). However, cats tend to prey on native fauna even when rabbits are readily available (May and Norton 1996). In areas where rabbits are scarce (such as sub-alpine areas and dense forest), native fauna, including mammals, birds, reptiles, invertebrates and amphibians, are more heavily relied upon by predators (May and Norton 1996, Seebeck and Clunie 1997). With the introduction of the Rabbit Calicivirus Disease, predation upon native animals may increase as rabbit numbers decline (Seebeck and Clunie 1997).

Predator control in the Gippsland region involves snaring and baiting for foxes and dogs, mainly along the private land/state forest interface. In the Alpine National Park methods used to control wild dogs include the utilisation of buried poison baits, electric fencing, snaring and shooting. Cats in the Park are controlled using treadle snares, baiting and, occasionally, wire possum cages and shooting. Foxes are controlled in the Park using 1080 baits, buried baits, treadle snares, fumigation, shooting and harbour destruction (DCE 1992a,b,c), while wild dogs are usually controlled using baits, snares and electric fences to exclude the dogs from areas containing livestock (N. Penrose pers. comm.).

Both cats and foxes may prey selectively upon certain species (Mansergh and Marks 1993). The Fox was found to prey heavily on the Broad-toothed Rat in Kosciuszko National Park, and is likely to do so elsewhere (Green and Osborne 1981). Foxes are considered a threat to this species in the Alpine National Park (DCE 1992a,b,c). Juveniles of the Red-necked Wallaby are also sometimes heavily preyed upon (Johnson 1987, Menkhorst 1995d). Bird species that forage and nest on or near the ground (e.g. Hooded Robin), are vulnerable to predation by foxes, cats and dogs, with both individuals and eggs being taken. Species such as the Long-footed Potoroo and Smoky Mouse have a limited distribution in the Gippsland region, and predation has the potential to have a significant impact on populations, particularly at the local level. Cats prey on the Eastern Bent-wing Bat and Southern Horseshoe Bat as they leave their cave/mineshaft roosts; this predation is regarded as a moderate threat to these bat species (Menkhorst and Lumsden 1995, L. Lumsden pers. comm.).

Predation of the eggs and tadpoles of the Spotted Tree Frog by trout represents a major threat to this species in Gippsland (Watson *et al.* 1991, G. Gillespie pers. comm.). It is unknown whether Giant Burrowing Frog tadpoles are palatable to exotic fish species such as trout and adults of this species may be at risk from foxes and cats (Gillespie 1997). Tadpoles of the Leaf Green Tree Frog are known to be palatable to trout, and this may be a major factor in the low occurrence of this frog in upland streams (Gillespie and Hines in review, G. Gillespie pers. comm.). Although Blue Mountain Tree Frog tadpoles are known to be palatable to introduced trout, this species is mostly found in lowland streams where trout are absent (G. Gillespie pers. comm.). Juvenile Lace Monitors, Swamp Skink and Glossy Grass Skink may be at risk from predation by foxes and cats. This threat may be exacerbated by predation by domestic pets on populations that occur close to towns.

Competition with introduced species for food and nest hollows is recognised as a moderate threat to the Dingo and Spot-tailed Quoll, and a minor threat to the Masked Owl, Regent Honeyeater and Swift Parrot. Some dietary overlap between cats and foxes and the Spot-tailed Quoll is evident, and competition for prey items may potentially threaten the viability of the Quoll in Gippsland (Mansergh 1984, Mansergh and Belcher 1992). Foxes also compete for prey with the Dingo (Brown and Triggs 1990) and Masked Owl (R. Loyn pers. comm.). Introduced prey such as rabbits may be important dietary components for such species, particularly in agricultural areas. However, the effect of competition between these species and foxes is unknown. Lace Monitors also exhibit dietary overlap with foxes and cats, and may thus compete for food with these exotic predators. Feral European Honeybees are known to occupy hollow trees, and may compete for this resource with several native species that use hollows. Preferred sites for Honeybees are generally within drier mixed-species eucalypt forests. Eucalypt nectar is an important dietary item of the Regent Honeyeater and Swift Parrot; both species exploit sites with high nectar yield and Honey Bees may compete for nectar with these species (Menkhorst 1997).

European Carp stir up water debris increasing turbidity to such an extent that the Azure Kingfisher, which requires clear water to locate prey, has trouble feeding. This potentially threatening process may significantly impact on Azure Kingfisher populations, which have difficulty detecting prey in murky water (R. Loyn pers. comm.).

The significance of predation on individuals by introduced species, competition for resources such as tree hollows and food items, and invasion of habitat by weeds for many species is largely unknown. Research is needed to identify the extent of these potential threats. Control programs for introduced species need to be closely monitored to assess their effectiveness at protecting populations of native fauna.

#### *Management*

Pest animal control measures in Gippsland include programs coordinated with adjacent landowners (Good Neighbour Program) and, where feasible, targeted programs throughout the region. Management plans include strategies relating to pest animal control. For example, the Alpine National Park Bogong Unit Management Plan (DCE 1992a) includes strategies specific to wild dogs, brumbies, cats, foxes, hares and other introduced animals. In addition, for threatened species including Broad-toothed Rat strategies are provided aimed at reducing the threat from predation by introduced animals.

### *6.2.12 Pest Control*

This category includes mortality of native species as a result of consuming poison baits (non-target poisoning), and secondary poisoning as a result of ingestion of poisoned prey. The loss of major food sources following control programs for introduced species such as rabbits is a potentially threatening process associated with this disturbance. Spraying of herbicides and pesticides for weed and insect control, and food chain contamination by heavy metals are also included in this category.

Foxes and wild dogs are controlled in Gippsland by snaring and baiting, mainly along the private land/State forest interface (Abbott *et al.* 1993), which may impact on native species. The Spot-tailed Quoll is at risk from non-target poisoning by ingesting 1080-poisoned baits intended for foxes and dogs (Mansergh and Belcher 1992, Belcher 1995c, Murray 1998). Although baits are buried to minimise the risk of non-target poisoning, Spot-tailed Quolls are known to dig up and ingest buried baits (Belcher 1995c, Belcher 1998, Murray 1998). It has been recommended that baits be buried to a depth of at least 10 cm as quolls are then less likely to unearth them (Murray 1998). The Dingo is a declared pest species under the *Catchment and Lands Protection Act* 1994, and is therefore also a target for these methods of pest control. The Dingo is afforded some protection within the Alpine National Park where it is considered an indigenous species, although control methods for wild dogs and foxes are carried out in certain areas of the park (DCE 1992a,b,c). Pest control is considered a major threat to the survival of the Spot-tailed Quoll, Masked Owl and Dingo (C. Belcher, R. Loyn pers. comm. and P. Menkhorst pers. comm.).

Rabbits are a major prey item for the Masked Owl and Lace Monitor, and a reduction in rabbit numbers due to control programs, such as poisoned-baiting and Calicivirus, is considered a potential threat to these species. There is also a risk of secondary poisoning from consuming poisoned rabbits or rats (Peake *et al.* 1993, R. Loyn and P. Robertson pers. comm.). Secondary poisoning via the ingestion of poisoned prey is also a threat to the Spot-tailed Quoll (Mansergh and Belcher 1992, Belcher 1995c), White-bellied Sea-Eagle (Clunie 1994) and Grey Goshawk (Mooney 1988). Rabbit control can also involve the destruction of burrows and piles of logs and debris that might harbour these animals. These control activities are a potential threat for species that use these sites for shelter and foraging, including the Lace Monitor

(P. Robertson pers. comm.). This species is also at risk from consuming baits laid for other carnivores (G. Brown pers. comm.).

Insectivorous bats, such as the Eastern Bent-wing Bat and Southern Horseshoe Bat, may be susceptible to poisoning through the bio-accumulation of pesticides ingested via prey (Dunsmore *et al.* 1994), although the full extent of this is unknown. Top order predators such as the Grey Goshawk and White-bellied Sea Eagle may also be susceptible to food chain contamination by pesticides (Bilney and Emison 1983, Clunie 1994, Mooney and Holdsworth 1988). The Spotted Tree Frog and Alpine Tree Frog may also be affected by such chemicals, either by direct poisoning or loss of prey (G. Gillespie pers. comm.). The use of herbicides for the control of weeds may be detrimental to the Giant Burrowing Frog, and the larvae of Martin's Toadlet and Tyler's Toadlet (Mazzer 1994, Gillespie 1997).

The effect of pest control methods on most species is not well documented. It is important that pest control programmes are closely monitored for adverse impacts on native fauna, and their effectiveness in controlling target species. Often, the ecological implications for native fauna of pesticide use is unknown, but potentially significant given the importance of insects and other invertebrates as prey for many species. This issue requires further investigation.

### *6.2.13Firewood Collection*

In addition to sawlog production, forests are managed for a variety of other timber products including firewood, hardwood fencing materials, hewn timbers, bush sawn or split timbers, stakes and props, piles and bridge timber.

In Victoria, firewood represents one of the highest volume forest products, with a total annual consumption in the range of 1.2 - 2.5 million cubic metres (RAC 1992, Read Sturgess and Associates 1995). Within the Gippsland region, the majority of firewood collected from public land, including State forest and the sides of public roads, is by private or domestic collectors for their own use. Harvesting of firewood by commercial collectors who collect firewood for sale, either to merchants or directly to consumers, is mainly concentrated on private land. Within State forest, firewood is collected from slash and thinnings following timber harvesting operations, as well as from fallen timber and debris on the forest floor in unharvested areas. Collection of firewood by private collectors is often permitted following thinning and stand improvement operations (G. Jephcott pers. comm.). Most firewood collection occurs near major population centres, such as the forests around Heyfield and Yarram. Tree species most commonly collected for firewood include Red Box *Eucalyptus polyanthemos*, Ironbark *Eucalyptus sideroxylon*, various Stringybark species and, less commonly, some gum species (G. Jephcott pers. comm.).

#### *Potentially threatening processes affecting Flora*

The direct impacts of firewood collection and minor forest produce are similar to those for timber harvesting. These include damage or loss of individuals as a result of accessing the site and the removal of timber, alteration of microclimatic conditions and the loss or modification of habitat. Logs, litter and debris provide important microhabitats and substrates for smaller plants and fungi. Removal and disturbance of these elements may result in loss of symbiotic fungi and changes in nutrient and moisture levels.

Indirect impacts include the facilitation of weed invasion, the spread of pathogens, fragmentation and isolation of habitat, soil compaction, increased erosion and sedimentation and disturbance to the understorey by vehicles. EVCs directly affected by firewood collection are principally those on more gentle terrain, near private land or that are easily accessible by road in the foothills, to the Gippsland plains.

For a list of EVCs potentially threatened by firewood collection and other minor forest produce see Table 6.1.

#### *Potentially threatening processes affecting Fauna*

Fallen logs, branches and timber debris and, on private land, standing live and dead trees, are removed and the litter layer is disturbed during firewood collection. Fallen timber provides shelter, refuge, foraging and breeding sites for many fauna (Brown and Bennett 1995, Silveira *et al.* 1997). Firewood collection is likely to be a significant threat to species that utilise fallen branches and logs, or hollows in dead standing trees (Robinson 1994) such as the Spot-tailed Quoll (Belcher 1997). Logs, litter and debris are important microhabitats for many species of reptile, providing foraging areas for invertebrate prey, breeding and basking sites, and shelter from predators (Webb 1985, Greer 1989). Fallen logs provide shelter for Swamp Skinks and juvenile Lace Monitors, and foraging and basking sites for Swamp Skinks and Spencer's Skinks (Smales 1981, Ehmann 1992, Brown and Bennett 1995, Cogger 1996, Alexander 1997).

Accumulations of woody debris are important microhabitats for ground foraging birds. The disturbance and loss of litter, invertebrates and shelter as a result of firewood collection are threatening processes for species such as the Chestnut-rumped Heathwren (Robinson 1994).

The loss of old trees from woodland remnants on private land is a particularly significant threat to species that utilise these habitats. Wooded farmland provides foraging habitat for the Barking Owl (Emison *et al.* 1987) and foraging and nesting habitat for the Masked Owl (Hollands 1991). Standing dead trees provide habitat for the arboreal Spencer's Skink, and foraging, basking and shelter sites for the Lace Monitor (Brown 1986, Ehmann 1992, Green and King 1993, Brown and Bennett 1995). Loss of this habitat component as a result of firewood collection is likely to contribute to population declines of both species. Within Gippsland, the Regent Honeyeater and Swift Parrot are at least partially

dependent on remnant woodland habitats on either private land, streamside reserves or roadside reserves. Firewood collection contributes to overall loss and degradation of their woodland habitats, and maybe a significant threat to these species.

### *Management*

Harvesting of standing trees for firewood is not permitted on public land within Gippsland. However, in some areas, standing dead trees are felled and removed for firewood by illegal cutters. On private land harvesting of firewood for domestic use and the cutting of standing dead trees is exempt from the Native Vegetation Retention Controls . One of the major impacts of firewood collection, *The loss of hollow-bearing trees* is listed as a Potentially Threatening Process under the *Flora and Fauna Guarantee Act* 1988.

The *Flora and Fauna Guarantee Act* 1988, *Conservation, Forests and Lands Act* 1987 and the *Planning and Environment Act* 1987 provide some controls for firewood collection on private land. Commercial harvesting of firewood on private land requires a permit issued by NRE. Domestic collection on private land is exempt under the Native Vegetation Retention Controls.

Firewood collection for domestic use on public land is controlled by the issue of licences that stipulate the amount of timber permitted to be collected and the duration of the licence. Licences are usually for the collection of fallen or felled timber only. Green firewood harvesting may be allowed as part of silvicultural thinning programs. Maps of collection areas are included with licences.. Local government permission and a licence is required for firewood collection along roadsides. Some Shires have roadside management plans which ban firewood collection from certain sites. The number of licences issued for commercial firewood operations on public land depends on an assessment of the amount of wood available in accordance with the Wood Utilisation Plan in each FMA. Commercial cutters must also hold a forest operators licence and operate in accordance with the Code of Forest Practices for Timber Production (NRE 1996), and local NRE prescriptions.

The Regent Honeyeater Action Statement recognises firewood collection as an issue, particularly for woodland remnants on private land. Firewood collection may be compatible with Regent Honeyeater conservation, provided mature trees are retained and sufficient areas allowed to regenerate (Menkhorst 1993). However, for the majority of listed species covered by this review, Action Statements are yet to be published, and for these and other species threatening processes associated with firewood collection is recognised and documented. Research is required to address the long-term ecological effects of firewood harvesting on vertebrate fauna, which to date are largely unknown (Robinson 1994).

## *6.2.14Illegal collecting/harvesting*

This disturbance includes direct interference to plants and animals by humans in the form of collection or deliberate hunting, poisoning, or trapping.

### *Potentially Threatening Processes Affecting Flora*

Deliberate collection is a significant disturbance or threat to native orchids, particularly terrestrial orchids including *Caladenia* spp., *Diuris* spp., *Calochilus* spp. and *Prasophyllum* spp. Illegal collecting of Tree Ferns, especially Soft Tree-fern *Dicksonia antarctica* has occurred in Gippsland in the past and probably still does occur today but not in large quantities (J. Morey pers. comm.).

For a list of EVCs potentially threatened by illegal collecting/harvesting see Table 6.1.

### *Potentially Threatening Processes Affecting Fauna*

The Square-tailed Kite is under threat from egg collectors (Garnett 1992a, Marchant and Higgens 1993), and although the extent of this activity within Gippsland is unknown, it is potentially significant given the small population size of this species in the region. Cockatoos and parrots are prized for the live pet trade, although the extent of illegal collection within Gippsland is uncertain. The impact of this disturbance on the Swift Parrot and Gang-gang Cockatoo is unknown. Lace Monitors have been the target of illegal collection in the past, but this is believed to be only a minor threat to this species at present (P. Robertson pers. comm.). Illegal collection of the Spot-tailed Quoll is also a possibility although this is regarded as being a minor threat to the species (C. Belcher pers. comm.).

### *Management*

*Collection of native orchids* is listed as a Potentially Threatening Process under the *Flora and Fauna Guarantee Act* 1988. Removal of wildlife from the wild is prohibited under the *Wildlife Act* 1975, and the FFG Act requires a permit to take from the wild all listed species. Tree Fern collection is only permitted with a permit under the FFG Act.

## *6.2.15Dieback*

Tree dieback is a process involving the protracted decline of health and vigour of trees. It is characterised by progressive general deterioration, beginning with a decline and thinning of the crown, and often ending in the death of the tree (Heatwole and Lowman 1986). Isolated trees or whole forests may be affected, although dieback is generally more severe for isolated trees or small remnants amongst pasture than for larger protected blocks (Bennett 1993). Causes of tree dieback are not fully understood, although it is likely many factors interact to contribute to tree stress which may lead

to dieback (Landsberg and Wylie 1983). Possible contributing factors include: insect defoliation, fungal diseases, drought, fire, altered water tables, increased salinity, nutrient imbalances as a result of applications of fertilisers, soil erosion and reduced soil aeration, land clearing, lack of regeneration and overgrazing (Heatwole and Lowman 1986). Nutrient redistribution and enrichment by livestock may be a key factor contributing to the abundance of defoliating insects and, hence, dieback in woodland remnants used by grazing stock (Landsberg *et al.* 1990). Grazing can also contribute to dieback through soil compaction, root damage, tree girding and prevention of regeneration.

### *Potentially Threatening Processes Affecting Flora*

The direct impact of dieback and related processes involves the damage or loss of plants. This can lead to changes in vegetation structure, composition and diversity, the alteration of microclimatic conditions and the loss or modification of habitat.

In forest blocks, dieback is generally associated with fungal pathogens such as *Phytophthora cinnamomi* (Cinnamon Fungus) or defoliation by phasmatid insects. Some plant communities may be altered following outbreaks of Cinnamon Fungus. Plants susceptible to the fungus may be replaced by resistant species, changing the species composition of the community (Kennedy and Weste 1986, Weste 1986).

The spread of Cinnamon Fungus is facilitated by the use of infected gravel during road construction, and through the run-off of drainage water from infected sites. Infected soil may be introduced to uninfected areas of forest by vehicles and machinery.). Stringybarks and peppermints are more susceptible to fungi-induced dieback than gums, boxes and ironbarks (Neumann *et al.* 1981, Weste 1993). Understorey species in these forests may also be affected (Weste 1993), and plants on dry steep slopes that succumb to Cinnamon Fungus are often not replaced, leading to increased erosion of the soil surface (Kennedy and Weste 1986). Within Gippsland, dieback, attributable to a range of causes such as Cinnamon Fungus, is problematic in scattered parts of the region. Dieback of Forest Red Gum *E. tereticornis*, a rare community occurring primarily on private land and roadsides on the Gippsland Plains, is considered a major problem (B. Ward pers. comm.).

For a list of EVCs potentially threatened by dieback see Table 6.1.

### *Potentially Threatening Processes Affecting Fauna*

Dieback is not a significant threat to fauna species that are mainly recorded from large blocks of forest. However, for the fauna of remnant vegetation in agricultural land eucalypt dieback is a significant threat.

Remnants of habitat amongst farmland provide important foraging resources and shelter sites for a number of species. They often contain large old trees on fertile soils that provide copious and relatively predictable sources of nectar, which is critical for the survival of species such as the Regent Honeyeater (Menkhorst 1997), and Swift Parrot (Tzaros and Davidson 1996, Tzaros 1997). Trees suffering from dieback may produce fewer flowers and lower quantities of nectar. Loss of foliage also results in a reduction of foraging substrate for insectivores such as the Cicadabird (C. Silveira pers. comm.). Loss of canopy cover reduces protection from predators and environmental effects, such as strong wind and extreme heat and cold, which may lead to a decrease in sub-canopy bird species (Er 1997). This can lead to a reduction of prey for species such as the Square-tailed Kite which feeds mainly on passerine nestlings and eggs taken from nests in the outer foliage (Debus and Czechura 1989). Loss of nest sites is a threatening processes associated with eucalypt dieback for species such as the Masked Owl and White-bellied Sea-Eagle, particularly as these species are known to utilise remnant trees in paddocks as nest sites (Debus and Rose 1994, Williams 1998). Tree dieback may degrade Lace Monitor and Spencer's Skink habitat. Dieback associated with Myrtle Wilt is a potential threat to the Pink Robin which breeds exclusively in mountain forest gullies, particularly those containing cool temperate rainforest of Myrtle Beech (Blakers *et al.* 1984, Loyn 1985).

### *Management*

The implications of dieback for a number of the fauna and flora species covered by this review are unknown. Development of appropriate long-term management strategies are essential and requires a major research effort (RAC 1992).

*The use of Phytophthora cinnamomi-infected gravel in construction of roads, bridges and reservoirs* is listed as a potentially threatening process under Schedule 3 of the *Flora and Fauna Guarantee Act* 1988.

The National Parks Service Guidelines and Procedures Manual (CNR 1995) addresses *Phytophthora cinnamomi* control in parks. Management plans for Parks in the region include strategies addressing pathogens in Parks. Environmental care principles relating to minimising spread of weeds/pathogens are also included in exploration and mining licences in Victoria. The Code of Forest Practices identifies gravel pits and soil stockpiles must not be located at sites where soil-borne plant pathogens are prevalent unless approved sanitation measures are observed.

## *6.2.16Mining/Quarrying*

The main deposits for extractive industries in Gippsland are brown coal, sand, gravel and limestone (Aldrick *et al.* 1988, Abbott *et al.* 1993). The Gippsland Sedimentary Basin contains approximately 95% of Victoria's deposits of brown coal, which is used mostly for electricity generation (Aldrick *et al.* 1988, Abbott *et al.* 1993). Large quantities of high-grade

building and road-making materials are available in Cainozoic sand and gravel deposits, and the region contains many quarry sites and sand/gravel pits. Clay and soil are also extracted from a number of quarries within the region. To minimise haulage costs, sources of crushed rock and gravel are often sought close to where they will be used (DCE 1992b Abbott *et al.* 1993). Mineral deposits occurring in the region include gold, copper-platinum, copper-uranium, bauxite, tin and nickel-platinum (Abbott *et al.* 1993). Issues associated with mining/quarrying include tailings disposal and treatment, disposal of effluent or treatment wastes, and new surface works or developments.

### *Potentially Threatening Processes Affecting Flora and Fauna*

Issues associated with mining/quarrying include tailings disposal and treatment, disposal of effluent or treatment and disposal of other wastes and surface disturbance which may result in loss of habitat elements that are not easily replaced during rehabilitation (DCE 1992a, Silveira *et al.* 1997). Poorly planned and located quarries and borrow pits can have an adverse effect on water quality which may have deleterious effects on the vegetation downstream and on the in-stream fauna. These effects may also impact upon species dependent on aquatic prey, such as the Large-footed Myotis (L. Lumsden pers. comm).

Although mining is considered a threatening process, past mining activities would have had greater impact on species than modern mining activities which are regulated through a range of mechanisms. Effects include direct loss of species and habitat both as a result of digging and associated activities. Mining/quarrying has the potential to impact on a large number of species, but due to the small scale and number of operations in Gippsland, this disturbance is currently considered as a minor threat or not a threat to the majority of species covered by this review. Species and EVCs directly affected by mining and quarrying include those associated with riparian habitats. Surrounding EVCs may be indirectly affected by weed invasion. Quarrying can particularly impact on vegetation of sub-alpine areas such as sphagnum mossbed and bog communities which are slow growing and therefore sensitive to damage. Fauna likely to be threatened by mining activities include Spotted Tree Frog, Giant Burrowing Frog, White-bellied Sea-eagle, and bats which utilise old mines (Eastern Bent-wing Bat, Southern Horseshoe Bat).

Mining and eductor dredging in and around upland streams can cause deterioration of upland riparian habitats. Eductor dredging is illegal in Victoria as it is believed to alter the natural ecology of streams (Watson *et al.* 1991). Effects can include an increase in turbidity of water downstream of an operation, mobilisation of chemicals such as mercury, local bank erosion and increased bed erosion (Parliament of Victoria Environment and Natural Resources Committee 1994). Disappearances and declines of Spotted Tree Frog populations appear to be linked to eductor dredging activities, which can have deleterious effects on frog embryos, larvae and adults (Watson *et al.* 1991). Impacts on populations may not be restricted to the area dredged, but also to habitats downstream of these activities (Gillespie and Hollis 1996). Although eductor dredging is currently illegal in Victoria, the Snowy Creek, which contains populations of the Spotted Tree Frog, is still subjected to this activity (G. Gillespie pers. comm.). Mining activities may impact on Giant Burrowing Frog populations through increased sedimentation and possible chemical pollution of streams upstream of breeding locations (Mazzer 1994).

Disused mine shafts are important roosting sites for the Eastern Bent-wing Bat and the Southern Horseshoe Bat. The reworking of old mines can cause bats to abandon their roosts and is considered a moderate threat to both these species (L. Lumsden pers. comm.). The disturbance caused by mining and quarrying activities in the vicinities of White-bellied Sea-Eagle nests during the breeding season, are highly likely to cause nest abandonment and is potentially a moderate threat to the species in the region (A. Williams pers. comm.).

For a list of EVCs potentially threatened by mining/quarrying see Table 6.1.

### *Management*

Mineral exploration, mining and extractive industries are not permitted in Reference Areas, nor in national, state and wilderness parks, except where a tenement or application pre-dates the park and the Minister responsible for national parks consents to these activities. For restricted Crown land, including most conservation reserves, the consent of the responsible Minister is required, which may be conditional, but not unreasonably witheld. Mining and exploration operations require a licence and work plan approved by Minerals and Petroleum Victoria (a division of NRE) before exploration or mining works can be undertaken. For mining and exploration on unrestricted Crown land, relevant land management divisions of NRE can comment on licence applications, conditions and work plans, which can address environmental considerations such as biodiversity conservation. Similarly, extractive industries require a work plan and the consent of the relevant Minister for extractive operations.

## *6.2.17Other Disturbances*

### *Dams/Impoundments*

Within Gippsland, major dams/impoundments include Lake Glenmaggie, Yallourn Storage, Hazelwood Pondage, Cowwarr Weir, Agnes River storage and Lake Narracan.

**Potentially Threatening Processes Affecting Flora and Fauna**

Potentially threatening processes associated with dam/impoundment construction and subsequent operation include direct damage and loss of vegetation, increases in sediment input to rivers and streams, modifications to natural temperature fluctuations and flow rates (Koehn *et al.* 1996) and degradation of adjacent native riparian vegetation. These processes are listed under the *Flora and Fauna Guarantee Act* 1988. Loss and fragmentation of habitat is also a potentially threatening process associated with dams and impoundments. Species particularly sensitive to this disturbance are those dependent upon riparian habitats, species or EVCs with restricted distributions and specialised habitat requirements which occur in the vicinity of dams, and those EVCs which occupy the site of the dam itself. The pre-1750 mapping exercise highlights these EVCs. This vegetation is adapted to, and has a requirement for, a natural flooding regime which has been altered with the increased requirement of water for agricultural and other purposes via controlled release from water impoundments. Salinity is an associated threatening process resulting from large-scale irrigation together with extensive clearing of native vegetation. Salinity occurs in isolated patches throughout the region, but is of particular concern within the Macalister irrigation district and the area around Lake Wellington (N. Penrose pers. comm.). This threatening process, its effect on flora and fauna and recommendations for amelioration are outlined in Clunie (in prep).

The Azure Kingfisher is sensitive to disturbances that result in the fouling of streams and alterations to stream flow, as well as the removal of adjacent riparian vegetation. This species nests in tunnels that it excavates in stream banks, which are liable to flood as a result of water releases from impoundments (Shields 1994). Cold water releases from impoundments can change the water temperature in rivers downstream, which is known to have a significant effect on the species composition and abundance of fish and macroinvertebrate fauna (Koehn *et al.* 1996). This may result in reductions in food availability for the Azure Kingfisher and this disturbance is considered a major threat to the species in Gippsland (R. Loyn pers. comm.). Dams and aqueducts upstream from Spotted Tree Frog sites can result in alteration of stream flow regimes. A reduction of water in streams, or an excess of water from releases, may result in reduced breeding opportunities or reduced survival of eggs and tadpoles (Watson *et al.* 1991, Gillespie *et al.* 1995). Water storage activities, including de-silting, may result in changes to the water quality of streams, and adversely affect populations of this frog (Robertson and Gillespie in prep.). Disturbances to wetland habitat may threaten Swamp Skink and Glossy Grass Skink populations through the disturbance or loss of habitat.

For a list of EVCs potentially threatened by dams/impoundments see Table 6.1.

**Management**

The environmental impacts of dams/impoundments have been the subject of numerous studies and it is recognised that construction and operation of these structures have many adverse effects on downstream fauna. There are processes to minimise these impacts such as environmental flow allocations, construction of fish ladders and regulating the temperature of water flowing out of storages. For major developments Environment Effect Statement processes would apply and these must take account of the full range of impacts.

### *Interspecific Competition*

This category refers to competition for resources such as food and shelter between native fauna species. Although this occurs to some extent for most native species, this category has been included for species that are particularly impacted by this process. Competition from introduced species is discussed in section 6.2.11 above.

Interspecific competition has been identified as a minor threat in Gippsland to the Regent Honeyeater (P. Menkhorst pers. comm.). Loss of high quality sites and fragmentation can lead to increased competition for limited resources between Regent Honeyeaters and other nectivores. The expenditure of energy in aggressive encounters could potentially reduce the available time and energy for feeding (Franklin and Robinson 1989, Ford *et al.* 1993, Menkhorst 1993). The effect of interspecific aggression on accessibility of nectar, breeding success, use of optimum habitat and the survival of the Regent Honeyeater requires monitoring and research (Menkhorst 1993, Menkhorst 1997). Interspecific competition from aggressive nectivores is also a potential threat to the Swift Parrot, however, the significance of this disturbance in the Gippsland region is unknown. Competition between White-bellied Sea-Eagles and Wedge-tailed Eagles for nest sites and food has been recorded, although its significance is not known (Clunie 1994, Wiersma 1996).

### *Mineshaft Collapse*

Mineshaft collapse and mineshaft entrances becoming overgrown are recognised as major threats to the Southern Horseshoe Bat and Eastern Bent-wing Bat. These species are dependent on caves and mineshafts for roosting and breeding. Restricted access to roost sites, and loss of breeding habitat due to these processes, is likely to lead to a decline of population numbers in Gippsland (L. Lumsden pers. comm.).

### *Vandalism*

This category covers the deliberate interference to animals by humans through activities such as shooting and disturbance at nest and roost sites. This category does not include interference for animal collection. Vandalism is a major threat to the Eastern Bent-wing Bat and Southern Horseshoe Bat, a moderate threat to the Square-tailed Kite, Grey Goshawk and White-bellied Sea-Eagle, and a minor threat to the Lace Monitor.

Human disturbance of roost sites of the Eastern Bent-wing Bat and the Southern Horseshoe Bat may cause the bats to abandon the site. Disturbance of bats in torpor causes them to use valuable energy reserves to raise body temperatures in order to become active. During winter when food supplies are low, energy supplies may not be replenished and mortalities may occur (Lumsden *et al.* 1991). The White-bellied Sea-Eagle is also vulnerable to human disturbance, particularly at the nest. Birds may desert nests if disturbed by humans (Hunt and Mooney 1983). The action statement for this species emphasises that visitors to nest sites will be discouraged, and the sites kept confidential (Clunie 1994).

The Square-tailed Kite is known to have been the target of illegal shooting (Jolly 1989). Similarly, shooting of the Grey Goshawk and White-bellied Sea-Eagle is known to have occurred in Tasmania (Mooney 1986, Brereton and Mooney 1994). There are no known incidences of illegal shooting of Grey Goshawks in Gippsland however, small populations could be significantly impacted by the loss of individuals. Lace Monitors may also be the target of random acts of vandalism (P. Robertson pers. comm.).

### *Climate Change*

The Enhanced Greenhouse Effect is the increase of greenhouse gases caused by human activities, and the resultant warming of the atmosphere (Bennett *et al.* 1991). Potential effects of this process include changes in the distribution of natural ecosystems and, consequently, flora and fauna. Species identified as especially at risk from this phenomenon include those with small, disjunct populations, species with narrow habitat requirements and restricted habitats, and those that are poor dispersers. Species with these characteristics will be less capable of adapting to resultant environmental changes, such as alterations in climate patterns. A further problem is the depletion of the ozone layer, resulting in increased amounts of ultraviolet radiation reaching the earth (Bennett *et al.* 1991). This process has been identified as a particular threat to the Alpine Tree Frog, Spotted Tree Frog, Broad-toothed Rat, Pink Robin and Sooty Owl.

Both flora and fauna living in sub-alpine and high montane environments typically exist in small isolated populations which are particularly vulnerable to environmental change. These species may have few response options as their habitat contracts uphill as a result of climatic warming (Bennett *et al.* 1991). Sub-alpine fauna under threat due to their limited habitat requirements include the Broad-toothed Rat and Spotted Tree Frog (Bennett *et al.* 1991, SAC (1991), SAC (1996), G. Gillespie pers. comm.). The Alpine Tree Frog is likely to be affected by alterations to breeding conditions as a result of climate changes associated with the Greenhouse Effect. Increases in ultraviolet radiation is known to cause death of eggs and larvae, and it is thought that this has contributed to population declines (Broomhall 1997, Hunter *et al.* 1997, Tyler 1997, G. Gillespie pers. comm.).

The Pink Robin breeds in wet gullies. The preferred habitat of this species contains Cool Temperate Rainforest of Myrtle Beech *Nothofagus cunninghamii* (Blakers *et al.* 1984, Loyn 1985). Under climate warming scenarios its breeding range is predicted to contract substantially (Bennett *et al.* 1991). Habitat alteration as a consequence of climate change associated with the Enhanced Greenhouse Effect is considered a moderate threat to Sooty Owl populations (Bennett *et al.* 1991, R. Loyn pers. comm.).

Greenhouse-related climate change may be a long-term issue for many threatened species. An examination of potential effects of this process on a number of representative fauna using BIOCLIM (Bennett *et al.* 1991, Brereton *et al.* 1995) indicated that most would undergo reductions in bioclimate range following climate change. Human development has created a large number of barriers which will prevent less mobile species from shifting their ranges in response to climate change. In order to accommodate changes in the distribution of fauna, Brereton *et al.* (1995) proposes the need for long-term biotic conservation strategies.

### *Loss of Genetic Diversity*

Loss of genetic diversity is a threat to small, fragmented or isolated populations or less mobile species. Genetic dilution has been identified as a potential threat to the Dingo (Corbett 1995). Dingoes and Dogs have a history of interbreeding; producing hybrids and reducing the proportion of pure bred Dingoes. The exact extent of this hybridisation is not clear, partly due to the difficulty in distinguishing pure Dingoes from Dingo/Dog hybrids. However, it is believed that this process represents a significant threat to the pure Dingo in Gippsland (Corbett 1995).

Genetic pollution of natural populations of native flora is most likely to occur from garden escapes or as a result of the establishment of plantations of silvicultural or horticultural species closely related to native species within reproductive range. The advent of genetically-modified types may increase the impact. The other major source of genetic pollution is as a result of the use of non-local provenance seed or seedlings in re-afforestation or forest regeneration following harvesting. This is not currently practised, although it tended to occur more frequently in the past. Although potentially significant, major impacts have not been revealed by research to date.

**Table 6.1 Potentially Threatening Processes affecting EVCs in the Gippsland RFA**

| EVC No. | EVC Name | Potential Threatening Processes |
|---|---|---|
| 1 | Coastal Dune Scrub Mosaic | clearing, inappropriate fire regimes, recreation, car park and road construction and maintenance, residential development |
| 2 | Coast Banksia Woodland | recreation, clearing, inappropriate fire regimes, residential and commercial development, |

| EVC No. | EVC Name | Potential Threatening Processes |
|---|---|---|
| 3 | Damp Sands Herb-rich Woodland | grazing, weed invasion, inappropriate fire regimes, clearing, agriculture, plantation development |
| 5 | Coastal Sand Heathland | recreation |
| 6 | Sand Heathland | recreation, inappropriate fire regimes |
| 7 | Clay Heathland | |
| 8 | Wet Heathland | clearing, weed invasion, alteration of drainage patterns and flooding regimes |
| 9 | Coastal Saltmarsh | alteration of drainage patterns and flooding regimes, recreation, clearing, residential and commercial development |
| 10 | Estuarine Wetland | residential and commercial development, alteration of drainage patterns and flooding regimes, recreation |
| 11 | Coastal Lagoon Wetland | alteration of drainage patterns and flooding regimes |
| 12 | Wet Swale Herbland | grazing, trampling, weed invasion, alteration of drainage patterns and flooding regimes |
| 15 | Limestone Box Forest | grazing, clearing, minor forest produce, weed invasion, habitat loss, timber harvesting, fragmentation, inappropriate fire regimes, fire, recreation |
| 16 | Lowland Forest | timber harvesting, clearing, weed invasion, inappropriate fire regimes, fire, minor forest produce, recreation, dieback |
| 17 | Riparian Scrub Complex | alteration of drainage patterns and flooding regimes, indirect impacts of road construction and maintenance, weed invasion |
| 18 | Riparian Forest | weed invasion, grazing, recreation, mining, clearing, fire, indirect impacts of road construction and maintenance and timber harvesting, alteration of drainage patterns and flooding regimes |
| 19 | Riparian Shrubland | weed invasion, mining |
| 20 | Heathy Dry Forest | timber harvesting, fire, inappropriate fire regimes, mining/quarrying, minor forest produce, recreation |
| 21 | Shrubby Dry Forest | inappropriate fire regimes, fire, timber harvesting, recreation, minor forest produce |
| 22 | Grassy Dry Forest | clearing, weed invasion, grazing, fire, timber harvesting, minor forest produce, recreation |
| 23 | Herb-rich Foothill Forest | timber harvesting, clearing, grazing, weed invasion, minor forest produce |
| 28 | Rocky Outcrop Shrubland | weed invasion, inappropriate fire regimes |
| 29 | Damp Forest | timber harvesting, inappropriate fire regimes, fire, indirect impacts of road construction and maintenance, weed invasion |
| 30 | Wet Forest | timber harvesting, inappropriate fire regimes, indirect impacts of road construction and maintenance, weed invasion, illegal collecting/harvesting |
| 31 | Cool Temperate Rainforest | fire, clearing, indirect effects of timber harvesting and of road construction and maintenance, illegal collecting/harvesting, dieback |
| 32 | Warm Temperate Rainforest | fire, clearing, indirect effects of timber harvesting and of road construction and maintenance |
| 34 | Dry Rainforest | fire |
| 35 | Tableland Damp Forest | timber harvesting, inappropriate fire regimes, fire, weed invasion |
| 36 | Montane Dry Woodland | grazing, inappropriate fire regimes, recreation, weed invasion |
| 37 | Montane Grassy Woodland | clearing, grazing, weed invasion, recreation |
| 38 | Montane Damp Forest | timber harvesting, inappropriate fire regimes, fire, weed invasion |
| 39 | Montane Wet Forest | timber harvesting, indirect impacts of road construction and maintenance, weed invasion |
| 40 | Montane Riparian Woodland | weed invasion, grazing, indirect impacts of road construction and maintenance, inappropriate fire regimes, alteration of drainge patterns and flooding regimes |
| 41 | Montane Riparian Thicket | indirect impacts of road construction and maintenance, indirect impacts of timber harvesting |
| 42 | Sub-alpine Shrubland | recreation, fire |
| 43 | Sub-alpine Woodland | grazing, recreation, weed invasion, fire |
| 44 | Treeless Sub-alpine Mosaic | grazing, recreation, weed invasion |
| 45 | Shrubby Foothill Forest | minor forest produce, timber harvesting, inappropriate fire regimes |
| 47 | Valley Grassy Forest | weed invasion, grazing, clearing, agriculture, minor forest produce |
| 48 | Heathy Woodland | inappropriate fire regimes, recreation |
| 53 | Swamp Scrub | grazing, weed invasion, fragmentation |
| 55 | Plains Grassy Woodland | habitat loss, clearing, agriculture, fragmentation, grazing, weed invasion, road construction and maintenance, minor forest produce, timber harvesting, inappropriate fire regimes, dieback |
| 56 | Floodplain Riparian Woodland | habitat loss, clearing, agriculture, fragmentation, timber harvesting, minor forest produce, alteration of drainage patterns and flooding regimes, grazing, weed invasion, indirect impacts of road construction and maintenance |
| 61 | Box Ironbark Forest | timber harvesting, firewood and post and pole production, mining, habitat loss, fragmentation, weed invasion, clearing, inappropriate fire regimes, recreation |
| 72 | Granitic Hills Woodland | recreation |
| 73 | Rocky Outcrop Shrubland/Herbland Mosaic | weed invasion |
| 74 | Wetland Formation | alteration of drainage patterns and flooding regimes, salinity, grazing, weed invasion, habitat loss, clearing, agriculture, indirect impacts of road construction and maintenance |
| *82 | Riverine Escarpment Scrub | weed invasion |
| 83 | Swampy Riparian Woodland | clearing for agriculture, grazing, weed invasion, alteration of drainage patterns and flooding regimes, indirect impacts of road construction and maintenance |
| 107 | Lake Bed Herbland | grazing, alteration of drainage patterns and flooding regimes, weed invasion |
| 126 | Swampy Riparian Complex | clearing for agriculture, grazing, weed invasion, alteration of drainage patterns and flooding regimes, indirect impacts of road construction and maintenance |
| 127 | Valley Heathy Forest | clearing, agriculture, habitat loss, weed invasion, inappropriate fire regimes, minor forest produce |
| 132 | Plains Grassland | inappropriate grazing regime, clearing, agriculture, habitat loss, fragmentation, weed invasion, road construction and maintenance, inappropriate fire regimes |
| 133 | Limestone Pomaderris Shrubland | grazing, weed invasion, mining |

| EVC No. | EVC Name | Potential Threatening Processes |
|---|---|---|
| 135 | Gallery Rainforest | fire, clearing, indirect effects of timber harvesting and of road construction and maintenance |
| 136 | Sedge Wetland | grazing, alteration of drainage patterns and flooding regimes, weed invasion |
| 140 | Mangrove Shrubland | alteration of drainage patterns and flooding regimes, recreation, earthworks and construction associated with development |
| 141 | Sandy Flood Scrub | inappropriate fire regimes |
| 143 | Estuarine Wetland/Coastal Saltmarsh Mosaic | alteration of drainage patterns and flooding regimes, recreation |
| 151 | Plains Grassy Forest | grazing, minor forest produce, agriculture, clearing, weed invasion, timber harvesting, recreation, dieback |
| 160 | Coastal Dune Scrub | clearing, inappropriate fire regimes, recreation, car park and road construction and maintenance, residential development |
| 161 | Coastal Headland Scrub | recreation, soil erosion, weed invasion, residential development, clearing |
| 163 | Coastal Tussock Grassland | soil erosion, clearing |
| 169 | Dry Valley Forest | clearing, grazing, weed invasion, recreation, inappropriate fire regimes |
| 175 | Grassy Woodland | grazing, weed invasion, habitat loss, fragmentation, clearing, agriculture, timber harvesting, minor forest produce, mining |
| 177 | Valley Slopes Dry Forest | soil erosion, weed invasion |
| 192 | Montane Rocky Shrubland | inappropriate fire regimes, weed invasion |
| 201 | Shrubby Wet Forest | timber harvesting, indirect impacts of road construction and maintenance |
| 206 | Sub-alpine Grassland | grazing, weed invasion, recreation |
| 207 | Montane Grassy Shrubland | grazing, weed invasion |
| 210 | Sub-alpine Wet Heathland | grazing, fire, recreation |
| 309 | Calcareous Swale Grassland | grazing, weed invasion |
| 310 | Wet Rocky Outcrop Scrub | fire |
| 316 | Shrubby Damp Forest | timber harvesting, fire, inappropriate fire regimes, recreation, weed invasion |
| 318 | Montane Swamp | grazing, alteration of drainage patterns and flooding regimes, weed invasion, indirect impacts of road construction and maintenance |
| 319 | Montane Herb-rich Woodland | timber harvesting, grazing, weed invasion, |
| 702 | Montane Grassland | clearing, grazing, weed invasion, mining |
| 863 | Floodplain Reedbed | altered drainage patterns and flooding regimes, weed invasion |
| 877 | Lowland Herb-rich Forest | timber harvesting, inappropriate fire regimes, fire, clearing, grazing, weed invasion, recreation, minor forest produce |
| 879 | Coastal Dune Grassland | recreation, soil erosion |

# 7 AQUATIC SPECIES ASSESSMENT

## 7.1 Introduction

This aquatic species assessment for the Gippsland RFA Region provides an overview of information on fish and aquatic macroinvertebrates, to assist in the development of management arrangements which address the issue of viability of populations of aquatic native species throughout their natural ranges.

To meet this objective, the following assessments have been conducted:

- identification of the distribution, habitat and life history attributes of aquatic biota (primarily fish and aquatic macroinvertebrate species);
- identification of factors affecting the conservation status (risk of extinction) of aquatic species;
- identification of the threatening processes (disturbances) affecting aquatic species and their habitat;
- a description of the current management prescriptions for aquatic species and their habitat, with priority given to those species which are rare or threatened; and
- identification of the gaps in survey and research on aquatic species, habitats and threatening processes.

### *Characteristics of Aquatic Systems*

The quality of aquatic habitats and the diversity of the associated fauna are influenced by activities that occur in the catchment beyond the rivers, streams or wetlands themselves. The impacts of activities such as water regulation, timber harvesting, roading, grazing, recreation and mining are expressed indirectly in the aquatic habitat through environmental changes such as degraded water quantity and quality (e.g. increased sedimentation, nutrients, toxic chemicals). Hence, off-site management is essential to ensure the viability of aquatic biodiversity.

Because rivers and streams are linear ecosystems, all points in the system are connected. Water and energy (food) flow downstream, and so can the influences of disturbance. A significant disturbance at a single site (a source of sediment for example) can have impacts many kilometres downstream, even in areas which may have adequate local protection in place.

Additionally, some species may use different parts of the river system at some stage in their life cycle. Migratory fish species in particular can move through an entire river system from the headwaters to the sea, hence, appropriate environmental conditions are required in the entire river system. A small section of a stream that is significantly degraded may block fish passage and exclude species from key habitats, which may in turn affect breeding success.

A good example of this is found in the Yarra River, where a relatively small barrier at Dight's Falls in the lower reaches has effectively prevented a number of migratory fish species from utilising the upper Yarra River, even though suitable habitat exists in many parts of the system. A fish ladder constructed in 1996/7 has been successful in reintroducing many species of migratory fish into the Yarra catchment. Similar examples in the Gippsland region are found at Cowarr Weir, which excludes migrating fish from habitat in the Aberfeldy River, and Lake Narracan, which excludes fish from the upper Latrobe River.

Many threatening processes operate across reserve and off-reserve areas and other measures are in place, in addition to reservation, to provide protection at the species level. The strategy for conserving biodiversity relies not just on a CAR reserve system, but also on the application of ecologically sustainable forest management practices in off-reserve areas.

Protection of the stream length is recognised in the Victorian Biodiversity Strategy, where a key vision is to restore native vegetation along almost 90% of the rivers and streams by the year 2020 (State of Victoria 1997: *Victoria's Biodiversity: Directions in Management*, p. i)

## 7.2 Aquatic Fauna of the Gippsland RFA Region

### *7.2.1 Fish*

The Gippsland RFA Region is bordered on its northern edge by the ridge of the Great Dividing Range (with the exceptions of the upper Mitta Mitta River included in the region and the upper Wongungarra River included in the North East Victoria RFA Region). Except for the upper Mitta Mitta River, all rivers in the region flow south into Bass Strait, many via the Gippsland Lakes system.

Twenty-one native freshwater fish have been recorded from the Gippsland RFA Region to date (Victorian Fish Database). Of these, six are listed as threatened fauna in Victoria (NRE 1999) and five of these are also listed under the *Flora and Fauna Guarantee Act* 1988 (Table 7.1). None of the 21 native fish species that have been recorded in the region are endemic to the region.

Two species (Macquarie Perch and Two-spined Blackfish) are restricted to the segment of the Mitta Mitta River flowing into Dartmouth Dam, and one (Mountain Galaxias) has been found in the RFA region on both sides of the Great Dividing Range. The remaining species only occur in the region south of the Great Dividing Range.

Of the southern species, Australian Mudfish is restricted to Wilsons Promontory and Pouched Lamprey occurs across South Gippsland to the Snowy System. Three further species (Australian Bass, Cox's Gudgeon and Striped Gudgeon) reach the western limit of their range in the Gippsland RFA Region, while the Dwarf Galaxias reaches its eastern extent in the Region. The Striped Gudgeon and Spotted Galaxias have not been recorded from the forested areas of Gippsland, but has been found at lower altitudes in these systems previously, and may potentially range further upstream. The remaining 11 species are wide-ranging and occur throughout the southern flowing streams in the region.

Fifteen of the native species (76% of the native fish species) are known or suspected to migrate as part of their life cycle (Table 7.1). Macquarie Perch north of the divide undertake an upstream spawning migration, with larvae subsequently drifting downstream. All of the other migratory species occur south of the divide. Of these, five species spawn either at sea or in estuaries (the two eel species, Australian Bass, Common Galaxias and Tupong) with a subsequent upstream migration of juveniles. Eight species spawn in freshwater lowland or upstream reaches (Spotted Galaxias, Australian Mudfish, Australian Grayling, Pouched Lamprey, Short-headed Lamprey, Broad-finned Galaxias, Striped Gudgeon, and Cox's Gudgeon, with larvae or young adults usually washed downstream during high flows in winter/spring, to re-migrate upstream at a later life stage. Migration is suspected for Australian Smelt, but this has not been confirmed.

Table 7.1. **Scientific and common names, conservation status (NRE 1999), FFG and/or ESP listing, and presence of migration of the native freshwater fish species found in the Gippsland RFA Region.**

| Scientific name | Common Name | Conservation Status | FFG/ESP Act status | Migratory |
|---|---|---|---|---|
| *Anguilla australis* | Short finned Eel | | | + |
| *Anguilla reinhardtii* | Long finned Eel | | | + |
| *Gadopsis bispinosus* | Two-spined Blackfish | | | |
| *Gadopsis marmoratus* | River Blackfish | | | |
| *Galaxias brevipinnis* | Broad-finned Galaxias | | | + |
| *Galaxias maculatus* | Common Galaxias | | | + |
| *Galaxias olidus* | Mountain Galaxias | | | |
| *Galaxias truttaceus* | Spotted Galaxias | | | + |
| *Galaxiella pusilla* | Dwarf Galaxias | Lower Risk | FFG | |
| *Geotria australis* | Pouched Lamprey | | | + |
| *Gobiomorphus australis* | Striped Gudgeon | Vulnerable | | + |
| *Gobiomorphus coxii* | Cox's Gudgeon | Endangered | FFG | + |
| *Macquaria australasica* | Macquarie Perch | Endangered | FFG | + |
| *Macquaria novemaculeata* | Australian Bass | | | + |
| *Mordacia mordax* | Short-headed Lamprey | | | + |
| *Nannoperca australis* | Southern Pigmy Perch | | | |
| *Neochanna cleaveri* | Australian Mudfish | Endangered | FFG | + |
| *Philypnodon grandiceps* | Flat-headed gudgeon | | | |
| *Prototroctes maraena* | Australian Grayling | Vulnerable | FFG/ESP | + |
| *Pseudaphritis urvillii* | Tupong | | | + |
| *Retropinna semoni* | Australian Smelt | | | +**?** |

Note: **FFG** - *Flora and Fauna Guarantee Act* 1988 ; **ESP** - *Endangered Species Protection Act* 1992.

No Action Statements for any of these FFG Act listed species have been completed. A Recovery Plan for the ESP Act listed species has not been completed. (**?** - migratory status suspected)

### *7.2.2 Aquatic Macroinvertebrates*

There is insufficient data to estimate the total number of aquatic macroinvertebrate species in the Gippsland region. The three known non-decapod macroinvertebrate taxa in the region are listed as threatened fauna in Victoria (CNR 1995), and one is listed under the *Flora and Fauna Guarantee Act* 1988. Two of the taxa, the damselfly *Hemiphlebia mirabilis* and the caddisfly *Plectrotarsus gravenhorsti* are known from Wilsons Promontory (but occur elsewhere in the state), while the stonefly, *Thaumatoperla timmsi* is known only from around Lake Tarli Karng (Table 7.2).

The decapod crustacea (freshwater crays, prawns, shrimp and crabs) fauna of the area are better known (Table 7.3), having been the target of taxonomic and distributional studies (e.g. Morgan 1986; Horwitz 1990) and have been included as part of fish surveys conducted since 1990 (see below). Numerous incidental records also exist.

**Table 7.2. Aquatic macroinvertebrates known from the Gippsland RFA Region listed (or nominated) under the *Flora and Fauna Guarantee Act* 1988 or included in the CNR list of threatened Victorian fauna**

| Scientific Name | Class, Order | Conservation Status | FFG/ESP Act Status |
|---|---|---|---|
| *Hemiphlebia mirabilis* | Insecta, Odonata | Vulnerable | FFG** |
| *Plectrotarsus gravenhorstii* | Insecta, Trichoptera | Insufficiently known | |
| *Thaumatoperla timmsi* | Insecta, Plecoptera | Rare | |

Note: **FFG** - *Flora and Fauna Guarantee Act* 1988 ; **ESP** - *Endangered Species Protection Act* 1992.

** - Action Statement completed.

Table 7.3. **Scientific and common names, conservation status (CNR 1995) and FFG listing of the native freshwater decapod crustacea found in the Gippsland RFA Region.**

| Scientific name | Common name | Conservation Status | FFG/ESP Act status |
|---|---|---|---|
| **Parastacidae** | | | |
| *Cherax destructor* | Common Yabby | | |
| *Engaeus affiniss* | Central Highlands Burrowing Cray | | |
| *Engaeus australis* | Lilly Pilly Burrowing Cray | Rare | |
| *Engaeus cunicularis* | Granular Burrowing Cray | | |
| *Engaeus cymus* | North Eastern Burrowing Cray | | |
| *Engaeus hemicirratulas* | Gippsland Burrowing Cray | | |
| *Engaeus karnanga* | South Gippsland Burrowing Cray | | |
| *Engaeus laevis* | Richards Burrowing Cray | | |
| *Engaeus phyllocerus* | Narracan Burrowing Cray | Rare | FFG |
| *Engaeus quadrimanus* | Lowland Burrowing Cray | | |
| *Engaeus rostrogaleatus* | Strzelecki Burrowing Cray | Rare | |
| *Engaeus tuberculatus* | Tubercle Burrowing Cray | | |
| *Euastacus crassus* | Alpine Spiny Cray | Rare | |
| *Euastacus kershawi* | Gippsland Spiny Cray | | |
| *Euastacus neodiversus* | South Gippsland Spiny Cray | Rare | |
| *Euastacus woiwuru* | Central Highlands Spiny Cray | | |
| **Atyidae** | **Shrimps** | | |
| *Paratya australiensis* | Freshwater Shrimp | | |
| **Hymenosomatidae** | | | |
| *Amarinus lacustris* | Freshwater Crab | | |

Note: **FFG** - *Flora and Fauna Guarantee Act* 1988 ; **ESP** - *Endangered Species Protection Act* 1992.

An Action Statement has not been prepared for the Narracan Burrowing Crayfish.

Sixteen species of cray are known from the Gippsland RFA Region, along with a single species of shrimp and one species of freshwater crab. All decapod crustacea species are native. Of the crays, there is one species of common yabby (*Cherax*), four species of spiny cray (*Euastacus*), and 11 species of burrowing crays (*Engaeus*). The known range of the Alpine Spiny Cray (*Euastacus crassus*) has recently been extended to coastal Victorian catchments south of the Great Dividing Range (T. Raadik, NRE, pers. comm.), and is likely to be present in the Gippsland RFA Region.

Of the species, one spiny cray (*Euastacus neodiversus*) and 5 burrowing crays (*Engaeus rostrogaleatus, E. karnanga, E. phyllocerus, E. australis, E. curvisuturus*) are restricted to the Gippsland RFA Region.

While only five of the taxa have been accorded conservation status (CNR 1995) and only one is listed under the *Flora and Fauna Guarantee Act* 1988, the diverse nature of the freshwater cray fauna and the presence of a number of endemic species makes the "crayfish fauna" in the Gippsland RFA Region particularly significant. This is particularly the case in sites where a high diversity of crayfish are sympatric (e.g. 5 species of burrowing crayfish have been recorded together in Lillypilly Gully on Wilsons Promontory).

## 7.3 Review of Existing Site-Based Data

The data review process involved systematically working through the Victorian Freshwater Database to determine the adequacy of existing site-based biological data. The outputs of the review were used to identify priority areas and data gaps that could be filled through additional survey work. As there are no fixed standards on the density of survey effort to adequately construct an inventory of species present, the data review relied on expert knowledge and professional judgment.

The distribution of survey sites where adequate data on fish and aquatic macroinvertebrates is shown in Map 14.

### *7.3.1 Fish*

Intensive inventory surveys of fish assemblages in the Gippsland RFA Region have primarily been conducted by the Department of Natural Resources and Environment (NRE). Some investigations which incidentally recorded fish species, were conducted by other government agencies, universities or private individuals.

#### *Pre - 1990 fish surveys*

Very few historical records (before 1970) of fish distribution and composition exist for the Gippsland RFA Region. The only records that do exist are spasmodic, consisting of observations of individual species from only a few locations. The only survey conducted before 1970 was at three sites on Wilsons Promontory in 1964 (Frankenberg 1969). The first comprehensive survey of fish assemblages was conducted at 11 sites on the Mitchell River in 1972 (Tunbridge, unpublished data). Between 1972 and 1990, 17 major surveys, and a number of minor surveys, were conducted in the area. A total of 259 sites (Table 7.4), exclusive of resampled sites, were sampled during this period**.**

Seven of the major surveys were fisheries oriented, only targeting larger, recreational species, using techniques not designed to capture all fish species (eg. netting with large mesh sizes). These types of surveys are referred to in this report as "partial surveys" as the smaller fish species would not be adequately sampled during these surveys. Other surveys regarded as "partial surveys" included those targeting a certain species of fish (eg. setting glass eel net for Australian Grayling).

**Table 7.4. Major Surveys conducted for freshwater fish in the Gippsland RFA Region prior to 1990.**

| Date | Area surveyed | Sites surveyed | Source |
|---|---|---|---|
| 1964 | Wilsons Promontory | 3 | Frankenberg 1969 |
| 1972 | Mitchell catchment | 11 | Tunbridge (unpub. data)* |
| 1973-1976 | Mitta Mitta | 12 | Tunbridge 1977 |
| 1974 | Mitchell catchment | 4 | Dixon 1976 |
| 1974 | Wilsons Promontory catchment | 6 | Jackson and Williams 1980 |
| 1977-1978 | Mitchell and Thomson catchments | 21 | Tunbridge (unpub. data)* |
| 1978-1985 | Mitchell, Thomson, LaTrobe and South Gippsland Catchments | 39 | Baxter 1985* |
| 1979 | South Gippsland | 6 | Jackson 1980 |
| 1980 | Wilsons Promontory catchment | 26 | Jackson and Davies 1983a |
| 1980-1983 | Mitchell catchment | 5 | Jackson and Koehn 1988 |
| 1982-1983 | Mitchell and Thomson catchments | 48 | Harrington (unpub. data) |
| 1983 | Tambo catchment | 11 | McKenzie (unpub. data) |
| 1983 | South Gippsland | 8 | ARI (unpub. data) |
| 1983-1987 | Thomson catchment | 6 | Tunbridge (unpub. data)* |
| 1986-1987 | South Gippsland | 4 | Baxter 1987* |
| 1987 | Tambo and South Gippsland catchments | 23 | Baxter *et al* 1988* |
| 1988 | South Gippsland | 7 | Baxter *et al* 1989* |
| 1988-1989 | Tambo catchment | 6 | Hortle (unpub. Data) |

* indicates fisheries surveys.

#### *Post - 1990 fish surveys*

Since 1990, survey coordination in the region has improved, mainly due to intensive sampling of specific areas, with 69 new sites (exclusive of resampled sites) being assessed in major surveys. Further, the majority of these surveys used techniques that potentially sampled the entire community rather than just selected species (e.g. electrofishing - termed "full" surveys). Many of these sites were in smaller streams.

Several areas within the region have been intensively surveyed since 1990 (Table 7.5). As part of the RFA research program to sample data gap areas, O'Connor (unpublished data) surveyed 34 sites in the Tambo and South Gippsland Basins. Raadik (unpublished data) surveyed 12 sites in the Tambo and Mitchell catchments as part of a survey for Australian Bass (*Macquaria novemaculeata*). Hortle (unpublished data) also sampled nine new sites in the upper Tambo catchment as part of an ongoing program to monitor the impact of a copper mine. A number of new sites have also been sampled in fisheries assessments (targeting recreational species) and other miscellaneous surveys.

There is generally wide spatial coverage of sampling records across the region, though many survey sites fall into fairly restricted areas where survey intensity has been very high due to specific projects. Consequently there is extensive knowledge of fish from only a few areas within the region. As part of the RFA project, streams and tributaries within known data-gap areas are being targeted. At the time of writing, this survey is still underway and additional sites will be sampled.

The number of freshwater survey sites in the Gippsland RFA Region appears to be reasonable at 340 (Table 7.6). Of these 171 sites (50% of the total sites) are considered to be full surveys (full coverage of species diversity) which provide adequate data quality.

By comparison, Jackson and Davies (1983b) surveyed 115 sites in the Grampians region, in an area approximately 40% the size of the Gippsland RFA Region, and Cadwallader (1979) surveyed 60 sites in one river system (Seven Creeks). It is considered that these scales of intensity are required to give excellent survey coverage. If the Gippsland RFA Region were to be surveyed at the same intensity as the Grampians, approximately another 150 sites would be required.

Because of the nature of individual survey objectives, 82 sites (24%) have been located in areas set aside for conservation purposes, with almost half of these (40 sites) located in the Wilsons Promontory National Park. One hundred and thirty-five sites (40%) were located in private land and other areas of public land (eg. stream frontages), and 121 sites (36%) have been located in State forest with many surveyed since 1990, or within the last 15-20 years.

Table 7.5. **Major surveys conducted for freshwater fish in the Gippsland RFA Region since 1990.**

| Date | Area surveyed | Sites surveyed | Source |
|---|---|---|---|
| 1990 | Mitchell catchment | 5 | Museum of Victoria |
| 1990-1995 | Tambo catchment | 9 | Hortle (unpub. data) |
| 1991 | Thomson catchment | 3 | Baxter *et al* 1992* |
| 1991 | South Gippsland catchment | 3 | Shirley (unpub. data) |
| 1992-1993 | Mitta Mitta | 6 | Koehn *et al*. 1995 |
| 1993 | South Gippsland catchment | 3 | Raadik (unpub. data) |
| 1993/1995 | Tambo and Mitchell catchments | 12 | Raadik (unpub. data) |
| 1996 | Thomson catchment | 4 | Raadik 1996 |
| 1997 | Tambo and South Gippsland catchments | 34 | O'Connor (unpub. data) |

indicates fisheries assessment surveys.

**Table 7.6. Summary of information on fish survey sites in the Gippsland RFA Region to 1997.**

| Land tenure | State forest | | Private land and other Public land | | Conservation reserves | | |
|---|---|---|---|---|---|---|---|
| Survey Type / River Basin | Full | Partial | Full | Partial | Full | Partial | Total |
| Mitta Mitta | | | 13 | | 1 | | **14** |
| Tambo | 32 | 15 | 10 | 10 | - | - | **67** |
| Mitchell | 12 | 15 | 15 | 13 | 6 | 11 | **72** |
| Thomson | 7 | 19 | 8 | 9 | 3 | 16 | **62** |
| LaTrobe | 3 | 2 | 3 | 3 | - | - | **11** |
| South Gippsland | 10 | 6 | 29 | 23 | 19 | 27 | **114** |
| **Sub total** | 64 | 57 | 78 | 58 | 29 | 54 | |
| **Total sites** | **121** | | **136** | | **83** | | **340** |
| **% of total** | 35.6% | | 40.0% | | 24.4% | | |

Full - all fish species recorded; Partial - only larger, recreational species collected.

## *7.3.2 Aquatic macroinvertebrate fauna*

### *Pre-1990 macroinvertebrate surveys*

The Department of Water Resources (DWR 1989) recorded 67 sites where aquatic macroinvertebrate surveys have been conducted in the Gippsland RFA Region prior to 1990 (Table 7.7). There is considerable overlap in these studies with sites sampled in the Central Highlands RFA Region and some overlap in the North-East RFA Region. The studies were conducted primarily to investigate the impact of human disturbance on stream systems. Studies of the construction of the Thomson Dam (Malipatil and Blyth 1982; Doeg *et al.* 1987; Marchant 1987) and the release of SEC cooling waters into the Latrobe River (Metzeling *et al.* 1984; Marchant *et al.* 1984) were all conducted by the Museum of Victoria. A few sites were sampled in the Tambo River as part of environmental effects statements and surveys of the impact of gold mine wastes. Sites in the upper Mitta Mitta River were sampled as part of a major study of Dartmouth Dam (St. Clair and Blyth 1981) and for an environmental assessment of the Dinner Plain development (Latrobe Valley Water and Sewerage Board 1984).

These studies used a variety of different survey techniques, different identification schemes and levels of taxonomic resolution. Data comparisons between these surveys need to be treated with caution.

Table 7.7. **Major surveys conducted for aquatic macroinvertebrates in the Gippsland RFA Region prior to 1990.**

| Date | Catchment | Sites surveyed | Institutions responsible |
|---|---|---|---|
| 1981-1984 | Mitta Mitta | 8 | Latrobe Valley Water and Sewerage Board, Museum of Victoria |
| 1985-1987 | Tambo | 17 | Latrobe Valley Water and Sewerage Board, Kinhill Pty Ltd |
| 1979 | Mitchell | 4 | Museum of Victoria |
| 1982-1984 | Thomson | 14 | Museum of Victoria |
| 1982-1987 | LaTrobe | 24 | Museum of Victoria, Environment Protection Authority, APM Pty Ltd |

### *Post-1990 macroinvertebrate surveys*

Since 1990, no new large-scale macroinvertebrate surveys investigating specific sources of disturbance have been conducted in the Gippsland RFA Region.

However, as part of the Monitoring River Health Initiative (MRHI), a program of sampling is being conducted to enable the prediction of aquatic macroinvertebrate community composition in streams throughout Australia. Although not intended as a biodiversity measurement (it is designed as a monitoring tool) this program produces good quality data on the distribution of many species and communities. Fifty-two sites have been monitored by the Victorian EPA in the Gippsland RFA Region (Table 7.8, Map X). Additional sampling at 72 sites using the same methodology as the MRHI, has been conducted over 1997/1998 by NRE as part of the RFA research program (P. Papas, NRE, unpublished data, Table 7.8, Map X).

The sites surveyed under the MRHI and RFA research program will provide valuable baseline data for the region, particularly for some of the more common taxa. However, more significantly, the data from these 124 sites can be used to construct a regional predictive model, allowing the invertebrate fauna at an unknown site to be predicted on the basis of the river characteristics (e.g. water quality, altitude, bed structure). This would be important to apply in the design of a monitoring program for aquatic species.

Table 7.8. **Number of sites sampled as part of the MRHI and RFA in each catchment in the Gippsland RFA Region.**

| Catchment | **Number of sites - MRHI** | **Number of sites - RFA** |
|---|---|---|
| Mitta Mitta | 5 | 6 |
| Tambo | 10 | 18 |
| Mitchell | 7 | 18 |
| LaTrobe | 8 | 8 |
| Thomson | 15 | 20 |
| South Gippsland | 7 | 2 |

## 7.4 Life History and Population Parameters for Aquatic Fauna

A priority list of 19 aquatic species (Table 7.9) was compiled for inclusion in the more detailed assessment of species' response to disturbance and life history dynamics. The list consists of species in the Gippsland RFA Region which are listed under the *Flora and Fauna Guarantee Act* 1988, the Commonwealth *Endangered Species Protection Act* 1992 (ESP Act) and the Threatened Fauna of Victoria list (CNR 1995).

Table 7.9. **Priority aquatic species included in the disturbance and life history assessment.**

| Species Name | Common Name |
|---|---|
| **Fish** | |
| *Gadopsis marmoratus* | River Blackfish |
| *Galaxias olidus* | Mountain Galaxias |
| *Galaxias truttaceus* | Spotted Galaxias |
| *Galaxiella pusilla* | Dwarf Galaxias |
| *Geotria australis* | Pouched Lamprey |
| *Gobiomorphus australis* | Striped Gudgeon |
| *Gobiomorphus coxii* | Cox's Gudgeon |
| *Macquaria australasica* | Macquarie Perch |
| *Macquaria novemaculeata* | Australian Bass |
| *Neochanna cleaveri* | Australian mudfish |
| *Prototroctes maraena* | Australian Grayling |
| **Decapod Crustacea** | |
| *Engaeus australis* | Lillypilly Burrowing Cray |
| *Engaeus phyllocerus* | Narracan Burrowing Cray |
| *Engaeus rostrogaleatus* | Strzelecki Burrowing Cray |
| *Euastacus crassus* | Alpine Spiny Crayfish |
| *Euastacus neodiversus* | South Gippsland Spiny Cray |
| **Non-decapod invertebrates** | |
| *Hemiphlebia mirabilis* | Dragonfly |
| *Plectrotarsus gravenhorsti* | Caddisfly |
| *Thaumatoperla timmsi* | Stonefly |

### *7.4.1 Fish*

Basic life history and population characteristics for fish species was obtained primarily from Cadwallader and Backhouse (1983) and Koehn and O'Connor (1990).

***Gadopsis marmoratus* (River Blackfish)**

A moderate sized (adults to 60 cm) non-migratory species, located both sides of the divide. Adults live in relatively quiet upland and lowland streams. Spawning occurs in freshwater during spring/summer, triggered by rising water temperatures. Adult females (maturity occurs at 3-4 years old) lay few (<500) eggs attached to the substrate in hollow logs. The parental male guards the eggs. Eggs hatch after about 2 weeks. Larvae are believed to live among leaf litter for at least 12 months.

***Galaxias olidus* (Mountain Galaxias)**

A small (adults to 15 cm) non-migratory species, located both sides of the divide. Adults live in stony fast-flowing streams. Spawning occurs in freshwater during winter/spring. Spawning trigger is unknown. Adult females (maturity occurs at 2 years old) lay few (<500) eggs onto the substrate. Incubation time is unknown.

***Galaxias truttaceus* (Spotted Galaxias)**

A small (adults to 20cm) highly salt tolerant species. Spawning occurs in autumn/early winter with 5,000-6,000 adhesive eggs which take 4-6 weeks to hatch. Spotted Galaxias have an unusual spawning strategy where eggs are laid amongst riparian substrate and vegetation. Eggs are out of water for days or weeks and must be shaded by riparian vegetation to avoid desiccation. (Note that *Galaxias brevipinnis* also uses this spawning strategy). Larvae are washed to sea and adults have an upstream migration in September-December. Preferences for slack waters adjacent to current under logs, behind boulders etc.

***Galaxias pusilla* (Dwarf Galaxias)**

A very small (adults to 4cm) aestivating species. Adults prefer slow flowing waters. Usually found in swamps, or around margins of pools or lakes, often overgrown with aquatic vegetation. Thought to only survive where *Geocherax* sp. is common. Spawning occurs in late winter/early spring, with 100-200 eggs laid onto stones and vegetation. Is thought not to migrate, and has an annual life cycle.

***Geotria australis* (Pouched Lamprey)**

An anadromous species to 67cm. Spawning occurs in late spring/early summer in a nest of stones. Pouched Lampreys contain a large number of eggs (58,000). Ammocoetes burrow into mud/soft sediment during the day. At 90-115mm ammocoetes migrate to the sea usually in July/August. Adults mature at sea, then migrate upstream from July-December and can climb wet vertical surfaces.

***Gobiomorphus australis* (Striped Gudgeon)**

A small (adults to 23cm) migratory species. Spawning occurs in late summer/early April. Eggs are laid in uniform, compact single layers on solid surfaces such as rocks and logs. Males guard eggs during incubation which lasts for about four days. Juveniles migrate upstream after winter floodwaters subside. They have a preference for muddy waterholes and sluggish creeks, and can negotiate wet rock surfaces around rapids and waterfalls.

***Gobiomorphus coxii* (Cox's Gudgeon)**

A small (adults to 19cm) species found in rapidly flowing waters. It has been known to climb vertical wet walls. Spawning occurs in March/April, with eggs laid on rocks. The male guards and fans the nest. Eggs hatch in 3 to 5 days. It is thought that the young are washed downstream and later migrate up the river.

***Macquaria australasica* (Macquarie Perch)**

A moderate sized (adults to 46 cm) migratory species, located north of the divide (although a population was translocated to the Yarra River). Adults live in deep holes in slow flowing waters. Spawning occurs in freshwater during late spring after an adult upstream migration, triggered by rising water temperatures. Adult females (maturity occurs at 2-4 years old) lay up to 100,000 eggs into the water column which settle. Eggs hatch after 1-3 weeks (depending on temperature). Larvae are washed downstream and adults migrate downstream after spawning.

***Macquaria novemaculeata* (Australian Bass)**

A moderate sized (adults to 58cm) species. Adults have a downstream spawning migration from April-June. Spawning occurs in winter/spring in estuaries. Final oocyte maturation and onset of spawning is dependent on floods. Produce about 100,000 non-adhesive demersal eggs which incubate in 3-4 days. Adults then migrate upstream in August-October. Larvae start schooling at about 45mm and migrate upstream from October to April. Juveniles are commonly associated with macrophyte beds.

***Neochanna cleaveri* (Australian mudfish)**

A small (adults to 14cm) aestivating species. It inhabits swamps at low altitudes (<40m asl) which usually only contain water for parts of the year. Spawning occurs in winter/spring. Juveniles migrate upstream from the sea in September-November. It has been found in waters with no dissolved oxygen.

***Prototroctes maraena* (Australian Grayling)**

A moderate sized (adults to 33cm) anadromous species usually found in clear, fast-flowing water alternating between pools and riffles. Schooling occurs over summer. Spawning occurs in autumn, probably dependent on an increase in stream flow. About 50,000 eggs released which need freshwater for eggs to hatch and develop normally and take 2-3 weeks to hatch. Larvae are swept downstream to brackish water or estuary.

### *7.4.2 Aquatic macroinvertebrates*

Little is known about the life history of most of the aquatic macroinvertebrate species listed in Table 7.9. Some specific information is known for some of the crustacea (Horwitz 1990), and only one of the insects (*Hemiphlebia mirabilis* - Trueman *et al*. 1992).

***Engaeus australis* (Lillypilly Burrowing Cray)**

Restricted to Wilsons Promontory (Lillypilly Gully, Mt. Ramsay, Scales Cove). It is found on the hillslopes adjacent to the flood-plain where the burrows receive no water from the floodplain. In Lillypilly gully this species is one of five burrowing cray species. Gravid females have been found in October. Individuals exhibit hues of red and orange dorsally fading to white ventrally.

***Engaeus phyllocerus* (Narracan Burrowing Cray)**

This species is restricted to locations above 120 m above sea level in the hills to the north and west of East Strzelecki in South Gippsland. It is typically found in the flood-bed regions of fern tree gullies in wet sclerophyll forests, and the burrows characteristically have more than two openings. Individuals typically exhibit orange and blue hues and are found in broad sympatry with *Engaeus hemicirratulus* (Gippsland Burrowing Cray). Berried females have been found in late September.

***Engaeus rostrogaleatus* (Strzelecki Burrowing Cray)**

The Strzelecki Burrowing Cray is restricted to high altitude regions (> 400 m above sea level) of Eastern Strzelecki ranges. This area is generally wet Sclerophyll forest dominated by mountain ash. It was frequently found in sympatry with *Engaeus hemicirratulus* (Gippsland Burrowing Cray).

***Euastacus crassus* (Alpine Spiny Crayfish)**

*Euastacus crassus* is a relatively small (maximum: 58 mm) freshwater spiny crayfish found on both sides of the Great Dividing Range in semi-alpine regions in Victoria. This species is found as far west as the Mount Beauty-Mt Hotham region at altitudes above 1000 m. Little is known about the life history or biology of the species.

***Euastacus neodiversus* (South Gippsland Spiny Cray)**

*Euastacus neodiversus* is a relatively small (maximum: 45 mm) freshwater spiny crayfish found in Wilsons Promontory and the Strezelecki ranges at elevations from 50-600m above sea level. It displays little geographic variation over its range, which is divided in two by the lowland of Yanakie isthmus. Is often sympatric with other *Engaeus* species.

**Hemiphlebia mirabilis (Damselfly)**

*Hemiphlebia mirabilis* is a small damselfly living in the edge vegetation of riverine billabongs and swamps. Adults emerge in summer. Water may dry at some times of the year and the species may have resistent eggs or larvae (Trueman *et al*. 1992).

***Plectrotarsus gravenhorsti* (Caddisfly)**

*Plectrotarsus gravenhorsti* is a caddisfly found mainly in the Yarra and Goulburn River catchments, but is also noted from Wilsons Promontory (Wildlife Atlas). Nothing is known specifically of its life history or habitat requirements.

***Thaumatoperla timmsi* (Stonefly)**

*Thaumatoperla timmsi* is a large stonefly from a single site near Lake Tarli Karng. Nothing is known specifically of its life history or habitat requirements. However, if it is similar to other *Thaumatoperla* species (e.g. the Stirling Stonefly *Thaumatoperla flaveola*), it probably spends a number of years as a nymph under rocks in flowing streams before emerging. Adults would have poor powers of dispersion and hence, a low ability to recolonise if disturbed.

## 7.5 Review of Disturbances and their Implications for Aquatic Fauna in the Gippsland Region

A review of the current state of knowledge of the impact of threatening processes on aquatic species was conducted to provide information to assist in setting priorities for management and research during the development of the Gippsland RFA. The review covered priority aquatic species (Table 7.9) in the Gippsland RFA Region, and was based on existing scientific literature and expert opinion.

A number of activities occurring within catchments have either been shown to, or have the potential to have serious impacts on aquatic ecosystems, and therefore on aquatic species. However, a distinction must be made between the

activities, and the environmental changes that arise as a result of the activity (Table 7.10). It is the environmental change that has a direct bearing on aquatic species. It should be noted that it is mostly of little relevance which disturbance activity creates the disturbance impact (e.g. sedimentation from timber harvesting and roads would produce the same impact on aquatic fauna as sedimentation from recreation or other sources). However, the intensity of the effect may differ between the sources, with, for example, weir cleaning producing very high levels of turbidity and deposited sediment for a short time, while roads may produce lower levels but extended over time.

The most common environmental change caused by land use activities in the catchments is an increase in sediment accession to rivers and streams (resulting from 8 of the 12 activities in Table 7.10). Increased sedimentation of rivers is a listed Potentially Threatening Process under the *Flora and Fauna Guarantee Act* 1988.

Increased levels of sediment can adversely affect all aspects of freshwater ecosystems by reducing water quality and degrading or destroying habitat. Increased turbidity or suspended sediment can lead to a reduction in plant and algae growth, reducing the amount of available food or shelter for aquatic biota, reduce visibility in the water column, affecting feeding rates for fish that feed by visually locating prey, and coat or abrade the gills of fish and aquatic macroinvertebrates, leading to a decrease in oxygen transfer across the gills and either asphyxiation or reduced fitness.

Elevated levels of deposited sediment on the stream bed can fill in deep pools, destroying habitat for some fish species, smother crevices in the substrate between rocks or bits of wood, reducing substrate variation and available habitat, smother eggs deposited on the stream bed, and smother sites used as rearing areas for juveniles.

Table 7.10. **Broad disturbance categories (Activity) with associated Environmental Change that have potentially significant impacts on aquatic ecosystems**

| Activity | Major environmental change |
|---|---|
| Timber harvesting | • Increased sedimentation and turbidity<br>• Increased nutrient concentrations in water |
| Roading | • Increased stream bed and bank degradation<br>• Increased sedimentation and turbidity |
| Clearing of vegetation | • Increased stream bed and bank degradation<br>• Increased sedimentation and turbidity<br>• Increased nutrient concentrations in water<br>• Increased pesticide concentrations in water |
| Grazing of stock | • Increased stream bed and bank degradation<br>• Increased sedimentation and turbidity<br>• Increased nutrient concentrations in water<br>• Reduced availability of swamp/headwater habitat |
| Mining/Quarrying | • Increased sedimentation and turbidity<br>• Increased toxic chemical concentrations in water |
| Waste disposal | • Increased nutrient concentrations in water<br>• Increased toxic chemical concentrations in water |
| Fire | • Increased sedimentation and turbidity<br>• Increased nutrient concentrations in water |
| Fire control | • Increased sedimentation and turbidity<br>• Increased toxic chemical concentrations in water |
| Pest control | • Increased pesticide concentrations |
| Introduced species | • Increased competition with native species<br>• Increased predation on native species |
| Harvesting/Collecting | • Reduced population numbers |
| Recreation | • Increased stream bed and bank degradation<br>• Increased sedimentation and turbidity |
| Dams | • Alteration to flow regimes<br>• Increased sedimentation and turbidity<br>• Decreased water temperature<br>• Barriers to fish passage |

Other significant activities potentially alter the natural stream chemistry by increasing levels of nutrients (fire, logging, grazing, waste disposal) or toxic chemicals (pest control, mining, waste disposal, fire control through use of retardants). Introduction of toxic material into rivers is a Potentially Threatening Process listed under the *Flora and Fauna Guarantee Act* 1988.

The construction and operation of dams and weirs represent a major disturbance to aquatic systems. Where low level offtakes are used (many older dams) water temperature can be lowered substantially. Storage and release of water at different times also changes the natural flow regimes. Dams can also present a barrier to migratory fish species. Altered temperature regimes, altered flow regimes of rivers, and barriers to fish passage are all listed Potentially Threatening Process under the *Flora and Fauna Guarantee Act* 1988. Increased sedimentation can occur either during construction or cleaning.

Introduced species can have serious impacts on stream fauna through increased competition for space and food, or through direct predation on native species.

While the potential impacts of these activities and associated environmental changes are well established, few scientifically derived data (i.e. valid field studies) are available that directly relate the impact of most activities to any of the priority aquatic species.

Therefore, in most cases, the impact on priority species in Gippsland needs to be predicted from the results of studies conducted elsewhere. For example, a significant reduction in the population of River Blackfish *Gadopsis marmoratus* in Armstrong Creek (the upper Yarra River catchment) was attributed to increased sedimentation due to weir cleaning (Doeg and Koehn 1994). It is therefore likely that a similar increase in sedimentation in the Gippsland RFA Region would have the same impact on local blackfish populations.

No data are available on the impact of timber harvesting on the two priority Galaxias species (*G. olidus* and *G.truttaceus*) although disturbance to the riparian zone would affect spawning success of the latter, due to its unusual spawning strategy of laying eggs amongst riparian vegetation. Graynoth (1979) showed that increased sedimentation from clearfelling without buffers in New Zealand severely reduced numbers of the local species *G. divergens* in streams. It could be assumed that a similar increase in sedimentation in Gippsland, through any of the disturbance categories in Table 7.10, would produce a similar reduction in density of forest dependant galaxiids in Gippsland streams. The Code of Forest Practices for Timber Production requires that all streams be buffered from timber harvesting to minimise the risk of increased sedimentation.

Numerous other studies exist where good data are available on the broad impacts of various activities or environmental change, but not necessarily involving the priority species in the Gippsland RFA Region. Changed sediment regimes were implicated in the decline of many invertebrate species in the Thomson River below the Thomson Dam (Doeg *et al.* 1987), and changed flow and temperature regimes were likely to be responsible for the decline in native fish in the Mitta Mitta River below Dartmouth Dam (Koehn *et al.* 1995). Laboratory studies have shown that light coatings of silt can significantly increase the mortality of eggs of the Common Galaxias (J. Koehn, NRE, unpublished data).

Hence, while specific data relating activities or disturbances and the impacts on priority species may not exist, sufficient information is available to adequately predict the likely impacts on priority species in the Gippsland RFA Region. With these considerations in mind, priority species affected by each of the eleven environmental changes listed in Table 7.10 are presented in Table 7.11.

Table 7.11. **Priority species affected by each of the environmental changes listed in Table 7.10.**

| Disturbance impact | Species Affected | Comments |
|---|---|---|
| Increased sedimentation and turbidity | *Gadopsis marmoratus, Galaxias olidus*, *Galaxias truttaceus, Galaxiella pusilla, Geotria australis, Macquaria australasica, Macquaria novemaculeata, Prototroctes maraena*<br><br>*Euastacus crassus, Euastacus neodiversus*<br><br>*Plectrotarsus gravenhorsti, Thaumatoperla timmsi* | Fish which lay demersal eggs in streams<br><br>Decapod crustacea which live in-stream<br>Stream dwelling non-decapod invertebrates |
| Increased nutrient concentrations | No data | |
| Increased pesticide concentrations | No specific data. Unlikely that species would be affected by herbicides, but likely that most species would be affected by other biocides | |
| Increased stream bed and bank degradation | All species except *Hemiphlebia mirabilis* affected. Two *Engaeus* species and *Galaxias truttaceus* particularly affected. | *Hemiphlebia* not found in streams<br>*Engaeus* species burrow in stream banks<br>*Galaxias* spawn in riparian zone |
| Increased competition and predation on native species by introduced species | *Galaxias olidus*, *Galaxias truttaceus*, *Galaxiella pusilla, Prototroctes maraena, Neochanna cleaveri*<br><br>*Euastacus neodiversus, Euastacus crassus* | Predation on juveniles and adults, competition with adults<br><br>Predation on stream dwelling decapods |
| Increased toxic chemical concentrations | No specific data, but likely that all species affected, depending on nature of toxin | |
| Alteration to flow regimes | *Gobiomorphus australis, Gobiomorphus coxii, Macquaria novemaculeata, Galaxias truttaceus, Prototroctes maraena,* | Species known to require floods, other fish species also likely to be affected |
| Decreased water temperatures | *Gadopsis marmoratus, Galaxias truttaceus, Galaxiella pusilla, Macquaria australasica, Macquaria novemaculeata, Prototroctes maraena,* | Breeding temperature dependant |
| Barriers to fish passage | *Galaxias truttaceus, Geotria australis, Gobiomorphus australis, Macquaria australasica, Macquaria novemaculeata, Neochanna cleaveri, Prototroctes maraena* | Migratory species |
| Reduction of swamp/headwater habitat | *Galaxias olidus, Galaxiella pusilla, Geotria australis, Neochanna cleaveri*<br><br>*Hemiphlebia mirabilis* | *Neochanna and Galaxiella* in Swamps, *Geotria, Mordacia* and *Galaxias* spawn in headwaters, *Hemiphlebia* in wetlands |
| Reduced population numbers through harvesting | No specific data, but unlikely to be a significant impact | |

Information is lacking regarding the degree of environmental change required before there are significant impacts on aquatic species. For example, pest control may introduce pesticides into the water, but the actual amount of pesticide will vary between individual operations, depending on a number of factors such as operator skill or even the weather on the particular day of operation. While it is clear that large volumes of pesticides will have serious implications for aquatic biota, it is not clear whether there is an "acceptable" level, below which no significant impact will occur.

Similarly, all activities that increase sedimentation in streams will do so at different levels. Weir cleaning and dam construction results in significant increases, with demonstrated impacts. Less well established is the impact of lower levels, or indeed, the level of increase which causes no long-term impact.

## 7.6 Conservation Measures for Aquatic Fauna

A range of conservation measures are currently in place or proposed for the protection of streams and catchments in the Gippsland RFA Region.

Following the Land Conservation Council's (LCC) Rivers and Streams Special Investigation (LCC 1991) the Government declared the corridors of the Mitta Mitta (above Lake Dartmouth), the Mitchell and Wonnangatta Rivers and the Thomson River (below the dam and above Cowarr weir to be Heritage River Areas because of their significant natural, scenic, cultural heritage and recreational values. Draft management plans for these heritage rivers have been produced and include strategies to protect significant environmental values in each river (Table 7.12, NRE 1997a).

Table 7.12. **Environmental values to be protected in Heritage River corridors in the Gippsland RFA Region (from LCC 1991)**

| Heritage River | Environmental values to be protected |
|---|---|
| Mitta Mitta River | • Macquarie Perch spawning habitat |
| Mitchell and Wonnangatta Rivers | • Native fish diversity<br>• Habitat and passage for Australian Grayling<br>• Fishing opportunities for native species in the lower Mitchell River |
| Thomson River | • Fishing opportunities for Freshwater Blackfish<br>• Habitat and passage for Australian Grayling |

Timber harvesting is excluded from the seven Essentially Natural Catchments in the Gippsland RFA Region (LCC 1991). These are in the Tambo River catchment (Stony Creek), in the Mitchell River catchment (Punchen Creek and Pinnacle Creek East Branch), a large area in the upper Avon River catchment (including the Avon, Turton and Dolodrook Rivers and Ben Crauchan Creek), two areas in the upper Wongungarra River (the headwaters and Blue Rag Creek), and Mount Vereker Creek.

General conservation measures are in place for the protection of streams and catchments. These include the Code of Forest Practices for Timber Production and Roading Prescriptions (e.g. NRE 1996). The Code of Forest Practices contains a number of measures to protect water quality, including:

- the retention of a buffer strip at least 20m wide around permanent streams, permanent springs, swampy ground and bodies of standing water. Increased minimum buffer widths apply for low permeability soils on low slopes (30m) and low permeability soils on higher slopes (40m).
- the retention of a filter strip at least 10m wide around temporary streams and drainage lines (15m minimum on low permeability soils on higher slopes);
- the application of slope limits;
- standards for the design, construction, maintenance and rehabilitation of roads, tracks, bridges, log landings and log dumps; and
- the suspension of activities during wet weather.

Specific Conservation guidelines have been produced for some of the priority aquatic species (Table 7.13). These are generally *Flora and Fauna Guarantee Act* 1988 restrictions of collection, and fishing regulations, mainly bag and size limits, and closed seasons during breeding (NRE 1997b). Fishing regulations also exist for *Euastacus* species in Victoria.

Table 7.13. **Specific Conservation guidelines and activities (apart from standard Timber harvesting prescriptions - see above) for priority aquatic species.**

| Species Name | Conservation guidelines or activity |
|---|---|
| **Fish** | |
| *Gadopsis marmoratus* | Fishing Regulations: Size limit of 22cm, closed season 1 September-31 December. |
| *Galaxias truttaceus* | |
| *Galaxias olidus* | |
| *Galaxiella pusilla* | FFG collecting restrictions. |
| *Geotria australis* | |
| *Gobiomorphus australis* | |
| *Gobiomorphus coxii* | FFG collecting restrictions. |
| *Macquaria australasica* | FFG collecting restrictions;<br>Fishing regulations: 10 per day bag limit, 25 cm size limit, no netting allowed |
| *Macquaria novemaculeata* | Fishing regulations: Size limit of 25cm. |
| *Neochanna cleaveri* | FFG collecting restrictions. |
| *Prototroctes maraena* | FFG collecting restrictions;<br>Fishing regulations: no netting allowed |
| **Decapod Crustacea** | |
| *Engaeus australis* | |
| *Engaeus phyllocerus* | FFG collecting restrictions. |
| *Engaeus rostrogaleatus* | |
| *Euastacus crassus* | Fishing regulations: Bag limit 10, size limit of 9cm[1], no taking of females with eggs or young attached, no taking of soft-shelled individuals, restrictions on equipment used |
| *Euastacus neodiversus* | Fishing regulations: Bag limit 10, size limit of 9cm[1], no taking of females with eggs or young attached, no taking of soft-shelled individuals, restrictions on equipment used |
| **Other macroinvertebrates** | |
| *Hemiphlebia mirabilis* | FFG collecting restrictions. |
| *Plectrotarsus gravenhorsti* | |
| *Thaumatoperla timmsi* | |

1. The 9cm size limit effectively means that these smaller spiny crayfish cannot be taken in Victoria

Fishing regulations from NRE (1997b).

## 7.7 Data Gaps

### *7.7.1 Fish*

There are no significant data gaps in fish distributional data from the Gippsland region following the sampling of additional sites under the RFA research and survey program. However, many rivers and streams have still only been sampled at a single site, and many historical survey sites fall into 'hot spot' areas where survey intensity has been very high due to specific projects. Consequently there is extensive knowledge of fish from only a few areas within the RFA Region.

Significant data gaps exist on life history and population characteristics for all priority fish species. Much of the current information is derived from casual observations during other research, rather than well-conducted scientific surveys and research. In particular, the most significant gaps relate to spawning behaviour, including induction cues and location of egg laying sites, both within the catchment and within the stream (Table 7.14). Cues for migration are generally poorly known, particularly for small upland species (Table 7.15), as are preferred larval habitats, and tolerances to turbidity and temperature.

Few data are available relating priority fish species to particular disturbances. The most serious gap is the lack of data on reactions to increased sedimentation and turbidity from a number of disturbances (Table 7.10). Tolerances to increased turbidity are generally unknown (Table 7.15). For species where egg laying sites are unclear (Table 7.14), the impact of deposited sediment cannot be determined.

Table 7.14. **Summary of missing or inadequate spawning data for fish species.**

| Species Name | Age at spawning | Breeding cues | Egg laying site | Location in catchment | Number of eggs laid | Incubation time of eggs |
|---|---|---|---|---|---|---|
| *Gadopsis marmoratus* | | | | | | |
| *Galaxias olidus* | | | | | | |
| *Galaxias truttaceus* | | | | | | |
| *Galaxiella pusilla* | | | | | | |
| *Geotria australis* | | | | | | |
| *Gobiomorphus australis* | | | | | | |
| *Gobiomorphus coxii* | | | | | | |
| *Macquaria novemaculeata* | | | | | | |
| *Neochanna cleaveri* | | | | | | |
| *Prototroctes maraena* | | | | | | |

Shaded - no data; horizontal - conflicting or incomplete data (e.g. based on only a single observation). Based on Koehn and O'Connor (1990).

**Table 7.15 Summary of adequacy of movement, habitat preference and tolerance (turbidity and temperature) data for fish species.**

| Species Name | Migratory | Movement trigger | Larvae habitat | Adult habitat | Turbidity tolerance | Temperature tolerance |
|---|---|---|---|---|---|---|
| *Gadopsis marmoratus* | | | | | | |
| *Galaxias olidus* | | | | | | |
| *Galaxias truttaceus* | + | | | | | |
| *Galaxiella pusilla* | | | | | | |
| *Geotria australis* | + | | | | | |
| *Gobiomorphus australis* | + | | | | | |
| *Gobiomorphus coxii* | + | | | | | |
| *Macquaria novemaculeata* | + | | | | | |
| *Neochanna cleaveri* | + | | | | | |
| *Prototroctes maraena* | + | | | | | |

Shaded - no data; horizontal - incomplete data (e.g. based on only a single observation). Based on Koehn and O'Connor (1990).

### *7.7.2 Aquatic Macroinvertebrates*

There are still considerable gaps in the knowledge of aquatic macroinvertebrates in the Gippsland RFA Region. As with the entire Victorian aquatic macroinvertebrate fauna, there has been no effort to produce comprehensive species lists or distributions for the region.

While only three non-decapod aquatic macroinvertebrate taxa are included in the priority list (Table 7.9), there are likely to be many more taxa in the region that are rare, restricted in their distribution, or have undergone serious declines that would make them suitable for inclusion in a priority list. The lack of adequate distributional and historical data makes the identification of these species impossible.

Even where a conservation status has been determined, the distribution of the majority of the priority aquatic macroinvertebrates (Table 7.9) is known only in relatively general terms. There has been no effort to accurately define the limits of their distribution with specific surveys (similar to that done for the Stirling Stonefly for example).

Taxonomically, the aquatic macroinvertebrate fauna of the Gippsland RFA Region is poorly studied. A few groups (decapod crustacea in particular) are well known, but common groups (eg. most of the aquatic diptera) are only known to the generic level. In other groups, aerial adults are well described, but there has been limited work done on the more often collected aquatic larval phases of the life cycle. This is improving for a number of groups (e.g. mayflies, stoneflies) as a result of taxonomic work conducted through Monash University and the Victorian EPA. However, the general lack of taxonomic work severely hampers any attempt to identify any other priority species with restricted or rare distributions.

Almost no comprehensive data are available for life histories of priority aquatic macroinvertebrate taxa (and most other macroinvertebrate taxa as well). Information has only been gained through casual observations, rather than specific scientific surveys and research.

In addition, the impacts of disturbance and different levels of environmental change are not well known and, in most cases, has been inferred from related research. Possibly more important, while data on broad tolerances or preferred habitat are available for some species (see above), for almost all of the impacts associated with activities in the Gippsland RFA Region, adequate data to determine “no effect” levels do not exist. While criteria or suggested maximum levels of environmental change are quoted for numerous chemical or physical parameters (e.g. ANZECC 1992), these are by necessity broadly based, and designed for general ecosystem protection. The level of impact on priority species will depend on the sensitivity of each of those species to the actual degree of environmental change caused by the activity, and this aspect is not well known for aquatic systems.

In light of the above assessment, further survey and research is required in order to fill data gaps and there is a need to establish monitoring programs relevant to aquatic species. As new information on the distribution of threatened species, important components of life cycles, or the impact of disturbance becomes available, management prescriptions will need to be reviewed.

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Scarlett, N. H. (1984) *Wahlenbergia densifolia*

Scarlett, N. H. (1985) *Carex paupera*

Scarlett, N. H. (1985) *Euphrasia scabra*

Scarlett, N. H. (1986) *Euphrasia collina* ssp. *muelleri*

Scarlett, N. H. & Tonkinson, D. (1980-87) *Diuris punctata var punctata*

Atlas of Victorian Wildlife. Database maintained by the Flora and Fauna Branch, Department of Natural Resources and Environment: Melbourne

Cheal, RFA database

Flora Information System. Database maintained by the Flora and Fauna Branch, Department of Natural Resources and Environment: Melbourne

VROTPOP. Database maintained by the Flora and Fauna Branch, Department of Natural Resources and Environment: Melbourne

Scientific Advisory Committee Nominations, Recommendations and Final Recommendations:

SAC (1989*) Nomination for a taxon (Adiantum diaphanum) for listing under the Flora and Fauna Guarantee Act, 1998*. Scientific Advisory Committee, Department of Natural Resources and Environment: Victoria.

SAC (1989*) Nomination for a taxon (Cyathea leichhardtiana) for listing under the Flora and Fauna Guarantee Act, 1998*. Scientific Advisory Committee, Department of Natural Resources and Environment: Victoria.

SAC (1989*) Nomination for a taxon (Discaria nitida) for listing under the Flora and Fauna Guarantee Act, 1998*. Scientific Advisory Committee, Department of Natural Resources and Environment: Victoria.

SAC (1989*) Nomination for a taxon (Discaria pubescens) for listing under the Flora and Fauna Guarantee Act, 1998*. Scientific Advisory Committee, Department of Natural Resources and Environment: Victoria.

SAC (1989*) Nomination for a taxon (Olearia astroloba) for listing under the Flora and Fauna Guarantee Act, 1998*. Scientific Advisory Committee, Department of Natural Resources and Environment: Victoria.

SAC (1989*) Nomination for a taxon (Pterostylis cucculata) for listing under the Flora and Fauna Guarantee Act, 1998*. Scientific Advisory Committee, Department of Natural Resources and Environment: Victoria.

SAC (1989*) Nomination for a taxon (Thelymitra epipactoides) for listing under the Flora and Fauna Guarantee Act, 1998*. Scientific Advisory Committee, Department of Natural Resources and Environment: Victoria.

SAC (1990*) Nomination for a taxon (Dillwynia capitata) for listing under the Flora and Fauna Guarantee Act, 1998*. Scientific Advisory Committee, Department of Natural Resources and Environment: Victoria.

SAC (1990*) Nomination for a taxon (Diuris punctata) for listing under the Flora and Fauna Guarantee Act, 1998*. Scientific Advisory Committee, Department of Natural Resources and Environment: Victoria.

SAC (1990*) Nomination for a taxon (Euphrasia scabra) for listing under the Flora and Fauna Guarantee Act, 1998*. Scientific Advisory Committee, Department of Natural Resources and Environment: Victoria.

SAC (1991*) Nomination for a taxon (Brachyscome tenuiscapa) for listing under the Flora and Fauna Guarantee Act, 1998*. Scientific Advisory Committee, Department of Natural Resources and Environment: Victoria.

SAC (1991) *Nomination for a taxon (Carex paupera) for listing under the Flora and Fauna Guarantee Act, 1998.* Scientific Advisory Committee, Department of Natural Resources and Environment: Victoria.

SAC (1991) *Nomination for a taxon (Cyathea cunninghamii) for listing under the Flora and Fauna Guarantee Act, 1998.* Scientific Advisory Committee, Department of Natural Resources and Environment: Victoria.

SAC (1991) *Nomination for a taxon (Drabastrum alpestre) for listing under the Flora and Fauna Guarantee Act, 1998.* Scientific Advisory Committee, Department of Natural Resources and Environment: Victoria.

SAC (1991) *Nomination for a taxon (Epilobium willisii) for listing under the Flora and Fauna Guarantee Act, 1998.* Scientific Advisory Committee, Department of Natural Resources and Environment: Victoria.

SAC (1991) *Nomination for a taxon (Poa saxicola) for listing under the Flora and Fauna Guarantee Act, 1998.* Scientific Advisory Committee, Department of Natural Resources and Environment: Victoria.

SAC (1991) *Nomination for a taxon (Prasophyllum chasmogamum) for listing under the Flora and Fauna Guarantee Act, 1998.* Scientific Advisory Committee, Department of Natural Resources and Environment: Victoria.

SAC (1991) *Nomination for a taxon (Wahlenbergia densifolia) for listing under the Flora and Fauna Guarantee Act, 1998.* Scientific Advisory Committee, Department of Natural Resources and Environment: Victoria.

SAC (1991) *Final recommendation on a nomination for listing (Adiantum diaphanum) under the Flora and Fauna Guarantee Act, 1998.* Scientific Advisory Committee, Department of Natural Resources and Environment: Victoria.

SAC (1991) *Final recommendation on a nomination for listing (Almaleea capitata) under the Flora and Fauna Guarantee Act, 1998.* Scientific Advisory Committee, Department of Natural Resources and Environment: Victoria.

SAC (1991) *Final recommendation on a nomination for listing (Brachyscome tenuiscapa) under the Flora and Fauna Guarantee Act, 1998.* Scientific Advisory Committee, Department of Natural Resources and Environment: Victoria.

SAC (1991) *Final recommendation on a nomination for listing (Carex paupera) under the Flora and Fauna Guarantee Act, 1998.* Scientific Advisory Committee, Department of Natural Resources and Environment: Victoria.

SAC (1991) *Final recommendation on a nomination for listing (Cyathea leichhardtiana) under the Flora and Fauna Guarantee Act, 1998.* Scientific Advisory Committee, Department of Natural Resources and Environment: Victoria.

SAC (1991) *Final recommendation on a nomination for listing (Discaria nitida) under the Flora and Fauna Guarantee Act, 1998.* Scientific Advisory Committee, Department of Natural Resources and Environment: Victoria.

SAC (1991) *Final recommendation on a nomination for listing (Discaria pubescens) under the Flora and Fauna Guarantee Act, 1998.* Scientific Advisory Committee, Department of Natural Resources and Environment: Victoria.

SAC (1991) *Final recommendation on a nomination for listing (Diuris punctata) under the Flora and Fauna Guarantee Act, 1998.* Scientific Advisory Committee, Department of Natural Resources and Environment: Victoria.

SAC (1991) *Final recommendation on a nomination for listing (Drabastrum alpestre) under the Flora and Fauna Guarantee Act, 1998.* Scientific Advisory Committee, Department of Natural Resources and Environment: Victoria.

SAC (1991) *Final recommendation on a nomination for listing (Epilobium willisii) under the Flora and Fauna Guarantee Act, 1998.* Scientific Advisory Committee, Department of Natural Resources and Environment: Victoria.

SAC (1991) *Final recommendation on a nomination for listing (Euphrasia scabra) under the Flora and Fauna Guarantee Act, 1998.* Scientific Advisory Committee, Department of Natural Resources and Environment: Victoria.

SAC (1991) *Final recommendation on a nomination for listing (Olearia astroloba) under the Flora and Fauna Guarantee Act, 1998.* Scientific Advisory Committee, Department of Natural Resources and Environment: Victoria.

SAC (1991) *Final recommendation on a nomination for listing (Poa saxicola) under the Flora and Fauna Guarantee Act, 1998.* Scientific Advisory Committee, Department of Natural Resources and Environment: Victoria.

SAC (1991) *Final recommendation on a nomination for listing (Pterostylis cucculata) under the Flora and Fauna Guarantee Act, 1998.* Scientific Advisory Committee, Department of Natural Resources and Environment: Victoria.

SAC (1991) *Final recommendation on a nomination for listing (Thelymitra epipactoides) under the Flora and Fauna Guarantee Act, 1998.* Scientific Advisory Committee, Department of Natural Resources and Environment: Victoria.

SAC (1991) *Final recommendation on a nomination for listing (Wahlenbergia densifolia) under the Flora and Fauna Guarantee Act, 1998.* Scientific Advisory Committee, Department of Natural Resources and Environment: Victoria.

SAC (1991) *Final recommendation on a nomination for listing: Alpine Bog Community Nomination No. 159.* Department of Conservation and Environment, East Melbourne.

SAC (1991) *Final recommendation on a nomination for listing: Increase in sediment imput to rivers and streams due to human activities.* Department of Conservation and Environment, East Melbourne.

SAC (1991) *Final recommendation on a nomination for listing:* Lathamus discolor *(White 1970) Swift Parrot Nomination No. 173.* Department of Conservation and Environment, East Melbourne.

SAC (1992) *Nomination for a taxon (Lepidium aschersonii) for listing under the Flora and Fauna Guarantee Act, 1998.* Scientific Advisory Committee, Department of Natural Resources and Environment: Victoria.

SAC (1992) *Nomination for a taxon (Rulingia prostrata) for listing under the Flora and Fauna Guarantee Act, 1998.* Scientific Advisory Committee, Department of Natural Resources and Environment: Victoria.

SAC (1992) *Final recommendation on a nomination for listing (Cyathea cunninghamii) under the Flora and Fauna Guarantee Act, 1998.* Scientific Advisory Committee, Department of Natural Resources and Environment: Victoria.

SAC (1992) *Final recommendation on a nomination for listing (Lepidium aschersonii) under the Flora and Fauna Guarantee Act, 1998.* Scientific Advisory Committee, Department of Natural Resources and Environment: Victoria.

SAC (1992*) Final recommendation on a nomination for listing (Prasophyllum chasmogamum) under the Flora and Fauna Guarantee Act, 1998*. Scientific Advisory Committee, Department of Natural Resources and Environment: Victoria.

SAC (1992*) Final recommendation on a nomination for listing (Rulingia prostrata) under the Flora and Fauna Guarantee Act, 1998*. Scientific Advisory Committee, Department of Natural Resources and Environment: Victoria.

SAC (1992) *Final recommendation on a nomination for listing: Alteration to the natural flow regimes of rivers and streams.* Department of Natural Resources and Environment, East Melbourne.

SAC (1992) *Preliminary recommendation on a nomination for listing: Alteration to the natural temperature regimes of rivers and streams.* Department of Natural Resources and Environment, East Melbourne.

SAC (1992) *Final recommendation on a nomination for listing*: Sphenomorphus kosciuskoi *(Kinghorn, 1932) - Alpine Water Skink Nomination No. 222*. Department of Conservation and Environment, Victoria.

SAC (1993*) Nomination for a taxon* (*Glycine latrobeana*) *for listing under the Flora and Fauna Guarantee Act, 1998*. Scientific Advisory Committee, Department of Natural Resources and Environment: Victoria.

SAC (1993*) Nomination for a taxon (Thelymitra matthewsii) for listing under the Flora and Fauna Guarantee Act, 1998*. Scientific Advisory Committee, Department of Natural Resources and Environment: Victoria.

SAC (1993*) Final recommendation on a nomination for listing (Thelymitra matthewsii) under the Flora and Fauna Guarantee Act, 1998*. Scientific Advisory Committee, Department of Natural Resources and Environment: Victoria.

SAC (1994*) Nomination for a taxon (Boronia galbraithiae) for listing under the Flora and Fauna Guarantee Act, 1998*. Scientific Advisory Committee, Department of Natural Resources and Environment: Victoria.

SAC (1994*) Nomination for a taxon* (*Isopogon prostratus*) *for listing under the Flora and Fauna Guarantee Act, 1998*. Scientific Advisory Committee, Department of Natural Resources and Environment: Victoria.

SAC (1994*) Final recommendation on a nomination for listing (Boronia galbraithiae) under the Flora and Fauna Guarantee Act, 1998*. Scientific Advisory Committee, Department of Natural Resources and Environment: Victoria.

SAC (1994*) Final recommendation on a nomination for listing* (*Glycine latrobeana*) *under the Flora and Fauna Guarantee Act, 1998*. Scientific Advisory Committee, Department of Natural Resources and Environment: Victoria.

SAC (1994*) Final recommendation on a nomination for listing* (*Isopogon prostratus*) *under the Flora and Fauna Guarantee Act, 1998*. Scientific Advisory Committee, Department of Natural Resources and Environment: Victoria.

SAC (1995*) Nomination for a taxon (Agrostis billardierei var filifolia) for listing under the Flora and Fauna Guarantee Act, 1998*. Scientific Advisory Committee, Department of Natural Resources and Environment: Victoria.

SAC (1995*) Nomination for a taxon (Bracteantha sp. aff. subundulata) for listing under the Flora and Fauna Guarantee Act, 1998*. Scientific Advisory Committee, Department of Natural Resources and Environment: Victoria.

SAC (1996*) Nomination for a taxon (Asplenium hookerianum) for listing under the Flora and Fauna Guarantee Act, 1998*. Scientific Advisory Committee, Department of Natural Resources and Environment: Victoria.

SAC (1996*) Nomination for a taxon (Euphrasia collina ssp. muelleri) for listing under the Flora and Fauna Guarantee Act, 1998*. Scientific Advisory Committee, Department of Natural Resources and Environment: Victoria.

SAC (1996*) Nomination for a taxon (Prasophyllum frenchii) for listing under the Flora and Fauna Guarantee Act, 1998*. Scientific Advisory Committee, Department of Natural Resources and Environment: Victoria.

SAC (1996*) Nomination for a taxon (Pseudoraphis paradoxa) for listing under the Flora and Fauna Guarantee Act, 1998*. Scientific Advisory Committee, Department of Natural Resources and Environment: Victoria.

SAC (1996*) Final recommendation on a nomination for listing (Agrostis billardierei var filifolia) under the Flora and Fauna Guarantee Act, 1998*. Scientific Advisory Committee, Department of Natural Resources and Environment: Victoria.

SAC (1996*) Final recommendation on a nomination for listing (Bracteantha sp. aff. subundulata) under the Flora and Fauna Guarantee Act, 1998*. Scientific Advisory Committee, Department of Natural Resources and Environment: Victoria.

SAC (1996) *Final recommendation on a nomination for listing: Degradation of native riparian vegetation along Victorian rivers and streams.* Department of Natural Resources and Environment, East Melbourne.

SAC (1996) *Preliminary recommendation on a nomination for listing:* Pseudomys fumeus *Brazenor 1934 - Smoky Mouse Nomination No. 421*. Scientific Advisory Committee, Flora and Fauna Guarantee. Department of Natural Resources and Environment, East Melbourne.

SAC (1997*) Final recommendation on a nomination for listing (Asplenium hookerianum) under the Flora and Fauna Guarantee Act, 1998*. Scientific Advisory Committee, Department of Natural Resources and Environment: Victoria.

SAC (1997*) Final recommendation on a nomination for listing (Euphrasia collina ssp. muelleri) under the Flora and Fauna Guarantee Act, 1998*. Scientific Advisory Committee, Department of Natural Resources and Environment: Victoria.

SAC (1997*) Final recommendation on a nomination for listing (Prasophyllum frenchii) under the Flora and Fauna Guarantee Act, 1998*. Scientific Advisory Committee, Department of Natural Resources and Environment: Victoria.

SAC (1997*) Final recommendation on a nomination for listing (Pseudoraphis paradoxa) under the Flora and Fauna Guarantee Act, 1998*. Scientific Advisory Committee, Department of Natural Resources and Environment: Victoria.