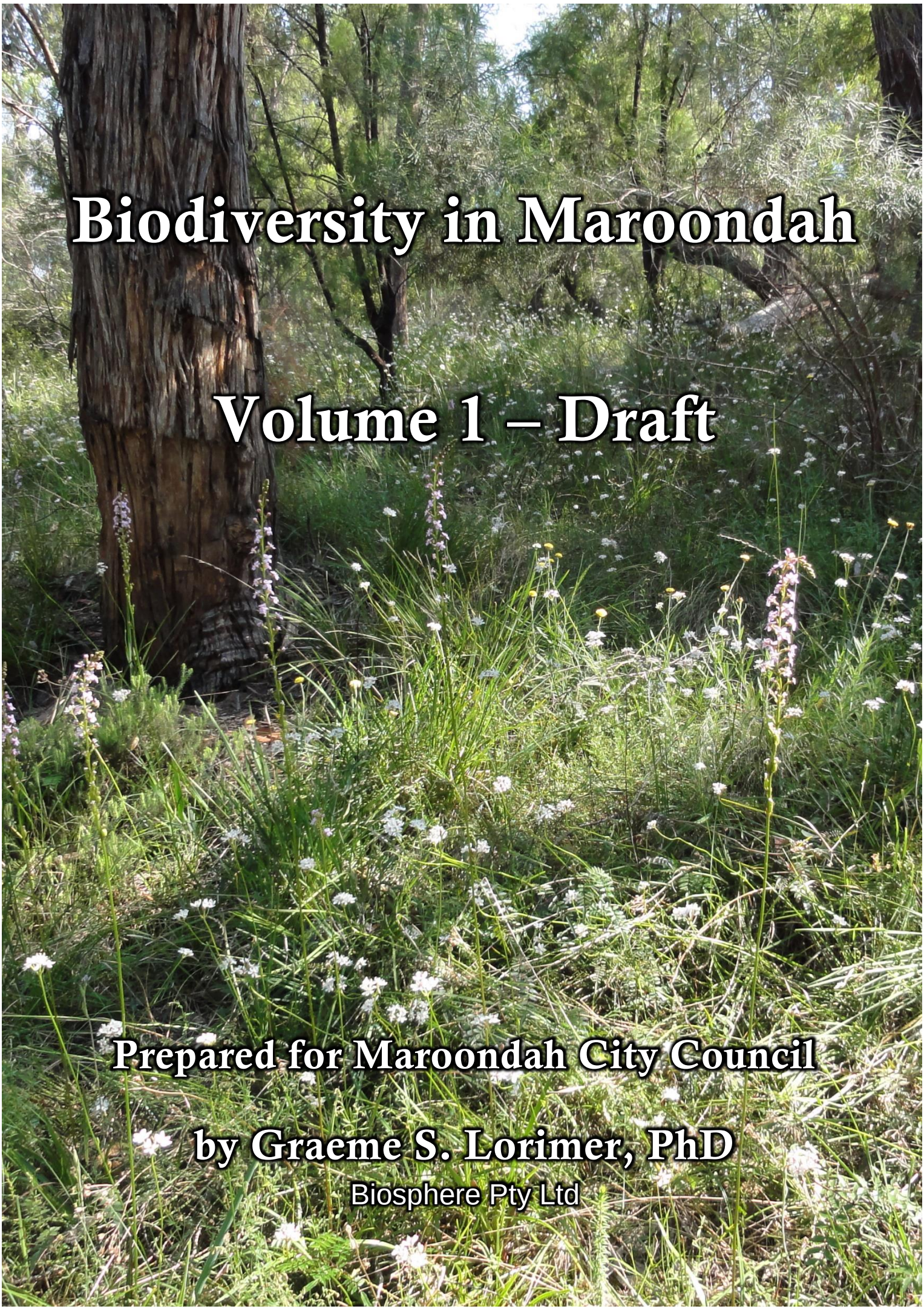

Biodiversity in Maroondah

Volume 1 – Draft

Prepared for Maroondah City Council

by Graeme S. Lorimer, PhD

Biosphere Pty Ltd

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Volume 1

Version 0.8 – DRAFT, 18 February 2019

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Preface

This version of Volume 1 is a complete draft apart from the omission of the Executive Summary that will appear in the final version. Volume 2 is not yet complete.

The work reported here forms part of a larger investigation by Maroondah City Council called the 'Municipal Wide Vegetation Review'. This report provides information about flora and fauna with a focus on indigenous (locally native) species, communities and habitats. Another consultant's report titled *'Maroondah Canopy & Landscape Analysis 2011 to 2016'* by Kaspar (2018) deals with changes over that period in the municipality's cover of trees, whether indigenous or otherwise. At the time of writing, a team from the University of Melbourne is investigating whether soil-borne *Phytophthora* disease is a cause of a concerningly high rate of eucalypt deaths. There is also a *'Maroondah City Council Vegetation Policy Review'* document by Scott (2018).

Maroondah City Council is combining the information from these sources with an internal review of its vegetation-related policies, priorities, practices and planning measures to determine what changes may be desirable.

I would like to thank the following people for assisting the investigation reported here:

- Council officers Peter Newbigin, Dale Bristow and Luci Johnston, as project managers for Maroondah City Council;
- The following property owners and occupiers for permitting me to inspect their flora and fauna: Margaret and Adrian Baber, Ashley Ross, Croydon Primary School, Melba College and Yarra Valley Grammar School;
- The following council staff who provided useful information about the presence of flora or fauna at particular locations: Craig Mauger, Laura Metcalfe, Sarah Scott-Cochrane, Karin Smith, Manu Thomas;
- The following additional people who provided useful information about the presence of flora or fauna at particular locations: Carol Clarke, Stephanie Dean, Ruth Jackson, Sharon Mason, Annette O'Sullivan and Tarmo Raadik; and
- Dr Matt Dell for checking my uncertain identifications of mosses and liverworts.

– GSL

Glossary

biodiversity. The diversity of all forms of life, including species, the genetic diversity within each species and the diversity of communities that species form. Biodiversity spans organisms from the smallest virus to the largest trees. Biodiversity cannot be measured simply by the number of distinct species, communities and genetic variants; it takes into account how diverse these things are in size, ecological function, evolutionary origins and other respects.

ecosystem. The combination of a community of living things and the physical features that support it, such as climate, soil and water.

ecosystem services. Practical benefits that flora and fauna provide to humans, such as the shade, wind protection and air purification provided by trees or the pollination of garden plants by insects.

ESO. Environmental Significance Overlay, a mechanism under planning schemes to require a planning permit for specified activities that may have adverse environmental impacts. Unlike a VPO, the ESO can regulate subdivision and works even if vegetation is not involved and even if the impacts are off-site.

herbarium (plural *herbaria*). A collection of plant specimens or a museum where such a collection is housed. Each Australian state and territory has a herbarium and they represent a critical resource for botanical research and studies of the kind reported here.

indigenous. A species of flora or fauna is 'indigenous' to an area if it occurred there prior to European colonisation. A species may be indigenous to one part of Maroondah and not to another.

invertebrate. An animal without a backbone, e.g. an insect, spider, worm or mollusc.

Millennium Drought. The period of record drought in Victoria from c. 2001 to 2010.

SLO. Significant Landscape Overlay, a mechanism under planning schemes to require a planning permit to conduct certain activities such as tree removal that may adversely affect landscape features. An SLO can sometimes provide incidental protection for biodiversity.

taxon (plural *taxa*). Any grouping of organisms in the classification system of living things, particularly a species, subspecies, variety or form. Hybrids can be regarded as taxa even though they combine genes of multiple species.

vertebrate. An animal with a backbone. The vertebrates indigenous to Maroondah include mammals, birds, reptiles, frogs and fish.

VPO. Vegetation Protection Overlay, a mechanism under planning schemes to require a planning permit to remove, lop or destroy specified types of vegetation. It cannot regulate subdivision, land use or works unless vegetation is involved.

wild. A plant or animal is described in this report as 'wild' if it has not been planted or released into the area where it is found. 'Wild' includes descendants of planted plants and descendants of released animals, as long as they are not under direct human control. The species may be indigenous or not.

Executive Summary

[to be written once Volume 2 is complete]

1 Introduction

1.1 Context

In 2014, Maroondah City Council adopted the *'Maroondah 2040 Community Vision'* policy document, which expressed the local community's consensus about its preferred future. It includes the following vision: 'A green and leafy community that protects and enhances our natural environment will continue to be highly valued, with the built environment respecting the natural landscape'. The associated 'key directions' include:

'4.6 Protect and restore biodiversity and native habitat for local plants and animals on public and private land;

'4.7 Preserve and enhance Maroondah's canopy vegetation;

'4.8 Create and foster a culture within our community that is committed to protecting the unique features of Maroondah's landscape, including our ridgelines, waterways, canopy vegetation, green open space and bushland reserves; …

'4.10 Encourage increased green spaces within activity centres that link the built environment to the natural landscape.'

These objectives are affirmed in the Council's *'Maroondah Sustainability Strategy 2016–2020'* of 2016, along with an additional 'key direction' to 'Establish improved monitoring and evaluation of biodiversity in the municipality'.

The report you are now reading responds to these objectives. It aims to provide a clear, contemporary understanding of Maroondah's biodiversity: what species and ecosystems it comprises; where it is concentrated; what threatens and sustains it; and what Council and the community can do to protect, restore and improve it.

1.2 What Does Maroondah's Biodiversity Encompass?

The term 'biodiversity' is normally taken to mean the diversity of all forms of life, including the diversity of species, the genetic diversity within each species and the diversity of communities that species form. Importantly, 'biodiversity' is not just a word for 'living things'; it refers to how much diversity there is among living things and their communities, e.g. diversity in their evolutionary origins and ecological roles.

Communities may be tiny to extensive, and a large community may have smaller communities within it. An 'ecosystem' is a community of living things together with the associated physical environment, such as the climate, soil and water.

Maroondah's biodiversity includes life forms from viruses and mites to very large trees. For practical reasons, little information is available about the microbes, invertebrates and fungi in Maroondah (or other municipalities, for that matter). Therefore, this report contains limited information about these 'lower' organisms, but we should still recognise that they are critically important to higher organisms, including humans. The fieldwork for this study did include mosses, liverworts and complex algae, laying the groundwork for future investigations of these organisms.

This study has a primary focus on wild flora and fauna rather than domesticated animals and cultivated plants. That is partly because wild flora, fauna and communities contribute much more to biodiversity, and partly because the issues surrounding domesticated animals and cultivated plants are quite different from wild animals and plants. Nevertheless, domesticated animals and

cultivated plants are addressed in this report where they affect wild indigenous species, as in the cases of garden plants that provide habitat for wildlife or go wild and displace indigenous species.

Among Maroondah's wild flora and fauna, this report focuses on indigenous species and natural communities. (A species is here taken to be indigenous to Maroondah if it was present prior to European colonisation.) The focus on indigenous species and natural communities is because they represent the essence of nature and carry the greatest values of biodiversity, as discussed below. Nevertheless, wild non-indigenous species are discussed where they are supporting or threatening indigenous flora or fauna, or where they are expanding their ranges into Maroondah due to climate change or other factors.

1.3 The Importance of Maintaining Biodiversity

Biodiversity and nature more generally are critically important to humanity and the other 8.7 million species on Earth. An understanding of that importance has been an important guide to how the present study has been conducted.

Table 1 provides a classification of the important attributes of nature in Maroondah.

Table 1. Categories of nature's importance.

Category of Nature's Importance	Examples
1. Practical 'ecosystem services'	The role of trees in purifying air and providing shade and wind protection; Stormwater purification by organisms in wetlands.
2. Financial and economic benefits	The premium on home values that a neighbourhood gains from the presence of trees and bushland; The costs that would be incurred to replace the functions of ecosystem services if nature wasn't doing them; The many businesses and employees involved in management of natural assets such as trees, parks and streams.
3. Human attachment to nature: (a) Fulfilment of humanity's innate desire to engage with nature and feel its inspiration, comfort and restorative powers ('biophilia'); and (b) Consequent benefits to human health, wellbeing, childhood health and quality of life	Our attraction to flowers and waterfalls; The popularity of gardens, zoos and 'green & leafy' neighbourhoods; Natural retreats for restoring soul & energy; Greater productivity and faster recovery from illness when people have contact with plants and animals (e.g. Franklin 2012); Benefits to childhood development (concentration, emotional regulation, motor skills, less sickness, …) (e.g. Chawla 2015); The use of natural themes and inspiration in the arts and architecture.

Category of Nature's Importance	Examples
4. Natural heritage: Nature's contribution to sense of place and our concepts of who we are, how we fit into history and nature's grand design, and what we should pass on to future generations	Ancient trees that are conserved to provide a connection with the past; Aboriginal reverence for nature and the associated concept of 'caring for country'.
5. Caring for species other than our own: Altruistic recognition that humanity should respect the existence of the other 8.7 million species on Earth and the ecosystems they form, independently of any practical benefit that humanity may derive from them	Success of the current, local 'Save Our Skinks' crowd-funding project; Campaigns to stop whaling; Governmental measures to save threatened species; The commitment 'To ensure that all species of indigenous flora and fauna remain present in Maroondah' in the Maroondah Planning Scheme.

In Maroondah, the practical ecosystem services of item 1 above fall into the following categories:

Microclimate moderation: Trees provide shade and protection from wind. Their shade and transpiration, along with transpiration by other plants, reduce temperatures on hot days, reducing human's reliance on artificial cooling. Cold, still nights are moderated by the turbulence and radiative effects of tree canopies, reducing frost damage and humans' reliance on heating. Reductions in heating and cooling also reduce energy costs and pollution from power stations. Shade also prevents ultraviolet damage to materials and the skin and eyes of humans and other animals. All these benefits are becoming more important as extremes of weather increase in frequency. See Akbari (2002) and Heisler & Grant (2000) for more details.

Air purification: Leaves are known to absorb gaseous pollutants and trap health-affecting airborne particles (Omasa *et al*. 2002). The turbulence created by vegetation can increase the rate of dilution of air pollution but the associated reduction in windspeed can reduce the dilution of pollution discharged beneath a tree canopy. Green walls and roofs on building envelopes can also be used as effective air pollution abatement measures (Abhijith *et al.* 2017).

Noise reduction: As examples: (a) traffic noise experienced at 1.5 m above ground (ear level) can be halved (3 dB) by a 5 m-wide band of moderately dense vegetation beside a road, compared with no vegetation (Ow and Ghosh 2017); and (b) a 7.5 dB reduction can be achieved by a 50 m-wide wheat crop. The appearance of vegetation can also make noise less annoying.

Stormwater runoff regulation: Rapid runoff from impervious surfaces is recognised in Maroondah City Council's 'Water Sensitive City Strategy' as a problem for flooding and pollution. It is also very ecologically damaging and causes costly erosion. These problems are worsening due to increased impervious surfaces and the trend toward more extreme weather events. Vegetation and the associated soil organisms improve soil porosity and reduce runoff (Bot and Benites 2005). All vegetated ground can contribute to reducing floods and water erosion.

Water purification: Vegetation can trap larger contaminants in water runoff (e.g. dog faeces) and take up nutrient pollution. Silt and other fine particles in runoff become deposited on foliage rather than reaching aquatic environments. Wetland plants and aquatic invertebrates are so effective at removing water pollution that wetlands are now commonly constructed for that

purpose. However, in much of Maroondah, the capacity of vegetated ground to purify water is negated by application of fertiliser and toxic chemicals to promote or inhibit plant growth.

These ecosystem services can be provided by plant species inside or outside their natural ranges, i.e. the species do not have to be locally indigenous. The same is true of some of the financial and economic benefits in item 2 of Table 1.

By contrast, items 3, 4 and 5 are about nature, so the benefits are largely associated with species in their natural domain. That is one reason why this report has an emphasis on locally indigenous species. The other reason is that so much of Maroondah's natural environment has been lost irreplaceably that the remainder has become precious. The complex web of life that makes up a natural environment cannot be replaced in the way one might replace plants in a garden.

Item 3 in Table 1 – the importance of people having regular contact with nature – has been gaining increasing recognition over recent years. The underlying concept known as 'biophilia' was introduced by Fromm (1964, 1973), then further developed and popularised by Wilson (1984). In essence, biophilia is the innate attraction that humanity feels toward nature, and the dependence we have on connecting with nature for our health, wellbeing, childhood development and quality of life. Recognition of the importance of connecting people with nature has reached such a level that it occupies a substantial part of the Victorian Government strategy on biodiversity, *'Protecting Victoria's Environment – Biodiversity 2037'*. An outcome of the recognition of biophilia is the 2017 *'Victorian Memorandum for Health and Nature'* created by the Victorian ministers for health and environment. It includes the following commitment:

> *'The Victorian Government is committed to encouraging communities to interact more with nature, both in Victoria's parks and other open spaces, because being in nature is good for our health and is a highly cost effective health improvement strategy. The benefits of being active in nature are recognised in the Government's key health and environment policy platforms: the Victorian Public Health and Wellbeing Plan 2015–19 and in Protecting Victoria's Environment: Biodiversity 2037.'*

Leaving aside direct benefits to humans, the diversity of flora and fauna is ecologically important because it underpins the resilience of ecosystems as conditions change. For example, the more diverse the species present in an ecosystem, the greater the likelihood that as conditions vary (e.g. from drought to wet years), plants of one kind or another will always be able to grow and provide food for herbivores, and so on up the food chain.

By definition, declines in biodiversity occur through the disappearance of species, communities or genetic variants. Loss of species has been happening at varying rates in Maroondah ever since European settlers began clearing the land and introducing foreign plants and animals. It has also been happening on a more localised scale in each of Maroondah's patches of natural and semi-natural habitat. As indigenous species are lost, their communities become less resilient and there can be a vicious cycle of loss of dependent species.

Therefore, loss of species is an ecological problem at all scales from a small patch of habitat right up to the global scale. That is the ecological reason why biodiversity investigations and strategies typically have a strong focus on species or communities that have been assessed as being at high risk of becoming extinct globally, regionally or (less commonly) locally. Another reason for a focus on threatened species and communities is that humans tend to value things more highly – as being more precious – as they become rarer. Section 5.1 and Chapter 7 deal with species that have died out in Maroondah or are at risk of becoming extinct at any scale from local to global.

A simplistic response to loss of biodiversity might be to simply plant more plant species and release more fauna species. That does not work. Reintroducing the species that have been lost is not viable in the medium or long term unless the original causes of those losses are corrected,

which is often not practicable even when the causes are known. Ideally, introducing new species to a community might replace some of the ecological roles of the lost species without competing too much with indigenous species. However, it is difficult to predict what the ecological consequences of introducing a species to an ecosystem will be and there can be significant ecological risks. The risks associated with planting of non-indigenous trees to replace declining wild eucalypts are discussed in Section 5.1.5 on p. 37. Australia's history is littered with ecological problems resulting from planting or releasing organisms outside their natural ranges; e.g. rabbits, blackberries and Sweet Pittosporum.

1.4 How is Biodiversity Distributed Across Maroondah?

Because of the focus on wild, and particularly indigenous, species, most of the fieldwork for this report was done in areas where those species were known or suspected to be concentrated. Most of those sites were identified in the 1995–1997 report, *'Sites of Biological Significance in Maroondah'* (Lorimer *et al*. 1997) and some others have been discovered since. The known 'sites of biological significance' are individually described in Volume 2, along with observed changes. Chapter 8 summarises this study's findings about the sites' importance, observed changes and threats, as well as opportunities for Council and the community to maintain and improve their natural values.

However, there is no clear threshold between the biodiversity of 'sites of biological significance' and areas that have not been so labelled. Most indigenous species of tree, mammal, bird, frog and flying invertebrate occur both inside and outside the sites. Some indigenous species of groundcover and bird occur mainly outside the sites of biological significance. Even animals that occur mainly within the sites often venture out for purposes such as finding mates or foraging for food in lean times. Importantly, indigenous flora and fauna in suburban gardens, nature strips and small parks greatly increase the contact that people have with nature in their daily lives – e.g. through the presence of birds and birdsong. In addition, the ecosystem services of vegetation are beneficial to more people if the vegetation is located where people are concentrated, rather than in more pristine areas. For these reasons, a distinctive feature of this report is that Chapter 9 considers the role of land outside the 'sites of biological significance' for conserving biodiversity and providing opportunities for people to enjoy nature.

2 The Knowledge Base for this Study

This study has gathered new data and drawn upon pre-existing information from literature, databases, museum specimens and the author's extensive previous fieldwork. (The term, 'museum', is taken to include the herbaria, or plant museums, of the Australian states and territories.)

2.1 Previous Literature and Studies

To determine Maroondah's natural, pre-settlement biodiversity and how it compares with the present condition, it is important to investigate the earliest possible records of vegetation and fauna.

The oldest documentation of Maroondah's vegetation inspected during this study are maps of the Crown Lands Office from as early as 1848. These historical maps are available online: some from the Public Records Office of Victoria and others from the State Library of Victoria. As discussed in more detail in Chapter 3, areas of the maps are labelled with broad vegetation characteristics such as 'Steep Stringybark Ranges', 'Well grassed forest' and 'Scrubby Flat'.

These maps were evidently not consulted for the Department of Environment, Land, Water and Planning's mapping of pre-settlement vegetation communities (Oates and Taranto 2001), which sometimes conflict with the historical maps (Chapter 4.4).

The oldest textual records of the flora and fauna of Maroondah found during this study are in reports of excursions by the Field Naturalists Club of Victoria from 1890 to 1936. The reports are published in their journal, 'The Victorian Naturalist' and have recently been made available online as scanned images (www.biodiversitylibrary.org/bibliography/43746#). These reports provide useful and interesting information about how many more plant species there were in Maroondah over a century ago, as discussed in Chapter 3.

Excursions of the Field Naturalists Club of Victoria to Maroondah reduced in frequency through the early decades of the twentieth century as reports of clearing and blackberries increased and reports of interesting flora and fauna reduced. The last excursion reported in *The Victorian Naturalist* appears to have been in 1936, but there have been infrequent, unreported excursions in recent decades.

This study found no documents with useful descriptions of Maroondah's flora and fauna between 1936 and 1987, when a period of intense study of the local flora began. In 1987, Andrew Paget prepared a vegetation management plan for Birts Hill Reserve on behalf of the Croydon Conservation Society. The society then produced the booklet, 'Trees and Wildflowers of Croydon 1988', with the assistance of botanist, David Cameron. The booklet lists the indigenous flora of ten reserves and gives a very brief summary of each reserve's history and ecological condition. Around the same time, local naturalist and (then) Council officer, Helen Moss, began compiling descriptions and lists of indigenous plants for various pieces of land belonging to the Croydon City Council, then for Maroondah City Council when councils amalgamated in 1994. Ms Moss produced a series of booklets about local flora and fauna for the council and was a contributor (along with the present author) to the Croydon Conservation Society's updated and expanded booklet, 'Trees and Wildflowers of Croydon 1995'.

The present author's previous report, *'Sites of Biological Significance in Maroondah'* (Lorimer *et al*. 1997) and the associated flora and fauna data provides an unusually extensive basis for deter–mining ecological changes since that time. That study produced copious observational data about flora and fauna at 132 'sites of biological significance', including (in part) species lists, timed bird

censuses, mapping of ecological communities and site-by-site estimates of how much of each vegetation community was in each of four categories of ecological condition. Each plant species' level of risk of becoming locally extinct was assessed using objective criteria, but that method has since been made obsolete by the international standard 'Red List' categories, criteria and guidelines of the International Union for the Conservation of Nature (see www.iucnredlist.org/about/publication/assessment-process). Similarly, the method used in 1997 to assess each site's level of biological significance was made obsolete in 2005 when the Victorian Government published *Standard Criteria for Sites of Biological Significance in Victoria*' (Amos 2004).

Many of Maroondah City Council's bushland reserves have been the subject of bushland management plans prepared since 1997, mostly by the present author – see the Bibliography (p. 136). These have mostly included more detailed information than the 1997 'Sites of Biological Significance' report, such as the population sizes and exact locations of plant species that are scarce in each reserve or more widely. These management plans and the associated observational data have provided useful opportunities for detecting ecological change through comparison against observations taken in the present study.

Planning permit applications involving removal of vegetation are sometimes accompanied by information about flora or fauna that is not otherwise available, particularly on private land. That information can be quite useful for detecting removal (and potentially local extinction) of plant species and fauna habitat, which is important for assessing changes in biodiversity. The present author has assisted Council to assess a few of these planning permit applications in the past two decades but information from other permit applications could not be accessed due to privacy constraints.

The *'Maroondah Habitat Corridors Study'* (Context 2005) was consulted for this study but its usefulness was limited. The corridors mapped in that study were surmised on the basis of factors such as linear continuity of tree canopy with little evidence about the importance of those factors for wildlife movement. No evidence was presented that wildlife actually moves preferentially along the presumed corridors. The present study therefore investigated habitat corridor research beyond Maroondah, such as that of Beier and Noss (1998), Braaker *et al*. (2014) and Lorimer *et al*. (2009).

Other documents that were used in this report appear in the Bibliography (p. 136).

2.2 Past Observational Records

An important input to any analysis of an area's biodiversity is prior observational data about the presence and abundance of as many species as possible. In the present study, the main source of prior records was the author's own observational records from Maroondah: 465 plant specimens, over 18,500 other plant records and 5,500 fauna records. (For these purposes, a 'record' indicates the presence of a particular taxon (i.e. species, subspecies etc.) at a particular location at a particular time or period, with or without additional information such as numbers of individuals, life stages or reproductive success.) These records are stored in the author's field notes and databases along with 11 plant specimens, 3,853 other plant records and 718 fauna records by the author's co-workers, plus 117 plant records and 129 fauna records provided by others. Among the author's own records are monthly lists of mammals, birds, reptiles, frogs and butterflies during his residency in Bayswater North for fourteen years and Ringwood North for 2½ years.

Another important source of prior data for this study comes from the collections of plant specimens at the herbaria, or plant museums, of the Australian states and territories. Details of most specimens are now available online via the 'Australasia's Virtual Herbarium' website (avh.ala.org.au), and all 1,844 records of wild plants with mapped locations in Maroondah were

downloaded for this study on 25th July 2018. They date back as far as 1885. Due to mapping inaccuracy, some of the downloaded records were actually from outside Maroondah. Equally, some records mapped outside Maroondah may actually belong inside, so a wider search was made for rare plant species. A small number of specimens were examined at the National Herbarium of Victoria.

'Australasia's Virtual Herbarium' is part of the 'Atlas of Living Australia', which is Australia's central repository of observational data about flora and fauna. Records of fauna specimens were obtained from that source, similarly to the plant specimen data.

In principle, specimens provide quite reliable records of what species occurred at specific locations at the times they were collected. They are identified by experts in the relevant group of plants or animals, unlike most records without specimens. Whenever doubt is raised about the identification of a specimen, the accuracy can be tested by an expert inspecting the specimen and making any necessary corrections. Whenever new species are described to split up what had previously been regarded as a single, variable species, experts inspect the affected specimens to determine which new species is represented by each specimen. Updated identifications of specimens find their way into the Atlas of Living Australia.

These are substantial advantages of specimen records over other types of records. The most significant botanical discoveries that I have made in Maroondah are backed up by specimens that have been, or will soon be, lodged at the National Herbarium of Victoria.

However, even experts sometimes misidentify specimens, particularly if the specimens are poor (e.g. missing important parts). Also, specimen collectors sometimes mix up which specimen came from where. These problems can occur whether or not a record is backed up by a specimen.

Modern technology is providing substitutes for specimens of plants and animals, although the substitutes are still somewhat inferior. A recording of a frog call can be extremely diagnostic, and Melbourne Water's 'Frog Census' mobile phone app allows people to record calls and automatically send them and the phone's location to a frog call expert for identification and storage. The resulting records up to 2018 were analysed in the present study.

The Atlas of Living Australia contains records of flora and fauna with and without specimens to back them up, as does the state government's Victorian Biodiversity Atlas (VBA), the 'eBird' database (www.ebird.org) and BirdLife Australia's database. The vast majority of these records simply support the direct observations made during this study. The author sought to authenticate most of the remaining records by consulting the observer and/or seeking to observe the same species. Clearly unreliable records were discounted.

In and adjacent to Maroondah, the VBA currently contains 6,902 fauna records and 7,424 flora records that are not duplicates of the author's records or the herbarium specimens mentioned above. The oldest of the flora records are from 1978 but 99% are dated 1986–2015. The fauna data go back as far as 1883 museum specimens. Most VBA records are duplicated in the Atlas of Living Australia.

Most of the VBA flora records from Maroondah other than the present author's have an identifier code beginning with a 'T', indicating a list of species thought to occur within an area. The VBA only records the location of each area as the coordinates of a point within the area, without any indication of the area's extent or boundaries. Some lists with coordinates in Maroondah may well be for large areas extending beyond Maroondah. The lists often include (in part) third-party recollections of species. Therefore, despite the date on a list, some of the records may be much older. Recollections are sometimes inaccurate in species or location and they may have been based on (or confused by) obsolete taxonomy.

A common error in the VBA's records of flora and fauna is that their locations have been wrongly mapped – most of them on the wrong properties where the habitat is quite different from the correct location. The most extreme case in Maroondah is a list of plants headed '180 Morrison Rd-Longwarry North' that is mapped to be in Heathmont, over 50 km away – far more than the claimed accuracy of 5 m.

While it is easy to tell in this case that the mapped location does not match the location in the heading, most plant lists in the VBA are headed only with code numbers rather than addresses. Often, the only way one can recognise a mapping error is that a list contains species that could not have occurred at the mapped location. An example is list E13503, which is mapped in Bayswater North with a claimed accuracy of 15 m but it contains *Banksia spinulosa* and *Melaleuca squarrosa*, whose natural ranges extend no closer than Montrose. By chance, I happened to have a 20-year-old paper copy of the original field data sheet with the code number on it, which revealed that the list was actually for Eastfield Park, Croydon. My fieldwork there revealed that *Banksia spinulosa* and *Melaleuca squarrosa* were planted, not wild. On its own, the list in the VBA would have been quite misleading.

Unfortunately, the VBA provides its contributors no way to indicate whether a recorded plant or animal is wild. For example, a list in the VBA headed 'Ringwood Aquatic Centre' (but mapped at Maroondah Federation Estate) provides no warning that most of the species on the list are garden plants, including the listed 'rare or threatened' species, Southern Blue-gum and Spotted Gum. A false impression is thereby created that Aquanation provides habitat for rare species. A good botanist will realise that these species do not occur naturally anywhere near Ringwood, but only someone with a good knowledge of the local flora and the particular site would realise that some other species on the list, such as Red Box, do not occur naturally in the area but were planted.

One also needs to be wary of the substantial number of misidentifications that appear in the VBA. The VBA has no capacity for a contributor to indicate their confidence in their identifications, so 'best guesses' are indistinguishable from expert, confident identifications. Most unusual plant records from the VBA were discounted in this study after visiting the mapped locations and finding that a similar but different species occurs there.

Because of all the problems just discussed, readers are advised to be very discriminating about records of flora and fauna.

However, special mention should be made about eBird, which is a wonderful resource for up-to-date, frequent lists of birds from large numbers of locations. Although it is not immune from the problems just described for other online resources, there is so much data that unreliable records tend to stand out compared with numerous other records from the same vicinity around the same time. Unusual records are often corroborated by multiple observers, and it is often possible to contact the observers to check reliability.

'Fungimap' is another 'citizen science' project that plays an important role in providing biodiversity information. Naturalists led by fungus experts have gathered extensive data about the distribution of fungi, including in Maroondah. Their data are lodged with the Atlas of Living Australia, from where they were accessed for the present study.

Outside the realm of reports and databases, a number of important observations of flora and fauna were provided to this study verbally or in correspondence by members of the Maroondah community. Contributions were sought through Council publications and by direct approaches to local naturalists and organisations such as Maroondah Bushlinks. The most prolific contributors were Council staff who manage reserves, followed by local naturalists. The major contributors are listed in the Preface. In nearly all cases, the author was able to visit the sites of the contributed observations to ensure accuracy in identification and gain further details such as current population sizes.

2.3 Fieldwork

To update, augment and verify the pre-existing biodiversity information discussed above, this study conducted hundreds of hours of fieldwork between June 2017 and December 2018. Some of the fieldwork was in recognised sites of biological significance and some was to investigate biodiversity across the remainder of Maroondah, such as nature strips, gardens and wasteland.

With a finite budget and time, one has a choice between inspecting fewer sites in fine detail or more sites in less detail. It was decided to intensively survey the biodiversity of a representative selection of the recognised sites of biological significance and to survey the remaining sites in less detail. The intensive surveys provide data that can be compared with that of the 1997 'Sites of Biological Significance' study and subsequent management plans. The comparisons allow the determination of changes in the presence and abundance of plant species and in some cases, fauna. Although the budget did not allow intensive survey of all recognised sites of biological significance (as in 1997), it was thought important to inspect every site to at least determine any readily discernible changes and to update site boundaries for the Maroondah Planning Scheme.

The intensively surveyed sites were chosen to be representative of all sites, covering combinations of:

- The largest, most natural and highly significant sites through to a stand of less than two dozen remnant eucalypts with no native understorey;
- Nature reserves, amenity reserves, stream reserves, road reserves, schoolgrounds, a church's grounds, private residential properties and vacant industrial land;
- All major types of indigenous vegetation ('Ecological Vegetation Classes');
- Lakes, streams, floodplains, lower to upper slopes, ridges and hilltops; and
- Sites scattered around the whole municipality, including sites in areas experiencing rapid urban development (e.g. Ringwood Lake Park) through to some outside the Urban Growth Boundary.

The following tasks were conducted at the most intensively surveyed sites:

- Mapping and describing the types of vegetation or habitat present;
- For each type of habitat, compiling a full list of indigenous and non-indigenous plant species, whether wild or planted, as well as categorising the abundance of each species;
- Recording population sizes and precise locations of plant species that are in precariously small numbers either in the site or more widely;
- Recording indigenous and introduced vertebrates, butterflies and wildlife habitat whenever observed during the fieldwork;
- Noting matters that are threatening or supporting the site's biodiversity, or opportunities for restoration or enhancement, with particular emphasis on the rarer species; and
- Considering the appropriateness of the site's current planning controls, from the perspective of biodiversity.

This study's inclusion of mosses, liverworts and complex algae (charophytes) in the fieldwork is a very uncommon feature for a municipal-wide biodiversity study.

Some of the most biodiverse sites were each surveyed during multiple seasons, particularly late autumn (for rare orchids), spring and early summer (particularly for grasses and wetland plants).

At some sites, not all of the tasks listed above were undertaken; e.g. introduced plant species were not surveyed at all sites with extensive gardens and lawns. Spotlighting and owl-call playback

surveys were conducted at very few sites. In Volume 2, the detailed information about each site includes a description of the data gathered.

Some indigenous species of flora and fauna that are rare in Maroondah could not be found in any of the intensively surveyed sites, so searches were conducted in other locations that displayed appropriate habitat or where the species had been recorded in the past.

The detection rate for reptiles and bats was inevitably poor due to the lack of a targeted survey. In addition, because animals were not caught, some skinks and bats that were observed could not be identified. More generally, there has been little effort to determine the diversity of Maroondah's reptiles and bats throughout history. Therefore, Section 12.4.1 (p. 103) includes a recommendation that the Department of Environment, Land, Water and Planning conduct a survey of reptiles and bats.

Altogether, the fieldwork in this study produced over 9,000 plant records and over 1,500 fauna records. Specimens were collected from approximately sixty of the more unusual or scientifically interesting plants to validate their existence and/or facilitate future research.

3 Maroondah's Original Vegetation

Land uses since colonisation have not only destroyed most of Maroondah's natural habitat but they have substantially altered the ecological composition, structure and functioning of the remaining habitat.

Aboriginal burning practices prior to colonisation had major effects on Australia's landscape, flora and fauna (Bowman 2008), Maroondah being no exception. Aborigines also harvested many plants for food, fibre, tools and other uses (Gott 2008), which must have significantly favoured some of Maroondah's plant species over others. That, along with Aboriginal egg harvesting and the killing of animals for meat, fur, sinews etc., would have affected Maroondah's pre-colonisation fauna.

Importantly, Aborigines did not historically cut down whole, mature trees. Consequently, Maroondah's pre-colonisation forests were dominated by very large eucalypts well over a century old. Those trees' dominance in capturing sunlight, soil moisture and nutrients would have restricted the resources available to other plants beneath their crowns, including young eucalypts. Competing understorey plants would have been thinned out during droughts until the remaining plants were left with enough resources to survive.

Since colonisation, few eucalypts have been allowed to reach even one century old, as evidenced by their trunk diameters. The forests of Maroondah today are regrowth from repeated tree removal for timber, firewood and land clearing. Young eucalypts need less space to obtain their required resources, so they have grown up closer together than was possible prior to colonisation.

For these reasons (and others too complicated to cover here), we can conclude that Maroondah's forests prior to colonisation would have been dominated by larger, less dense eucalypts than today.

The early settlers would have had different standards about forest density than today. Maps of the area by the government offices in the mid-nineteenth century label most of Maroondah with annotations such as 'thickly wooded' and 'steep scrubby stringybark ranges', interrupted by 'scrubby flats' and swamps on floodplains. District Surveyor, Mr C. Hodgkinson, remarked on an 1855 map of the area from Ringwood to Mitcham and Wantirna, 'The land comprised in this survey is of inferior quality, moderately undulating and thickly wooded'. By contrast, the part of Croydon that lies eastwards from Dorset Rd and north of Hull Rd is marked on an 1858 map as 'well grassed forest', consistent with the Yellow Box and Candlebark forest that can still be seen along Lincoln Rd today.

Preserved plant specimens and reports of excursions by the Field Naturalists Club of Victoria provide useful historical information about Maroondah's biodiversity. They show that there were once many more orchid species and probably many more other plant species than remain today. For example, a report of an excursion between Ringwood and Dandenong Ck in 1890[*] states, 'The orchid *Caladenia deformis, with its pretty blue flowers, was very conspicuous in many places'*, whereas there have been no records of that species from anywhere in Maroondah since 1926 (a specimen of Elizabeth Coleman at the NSW Herbarium). The historical record is quite skewed toward orchids, which have always gained the greatest attention from plant enthusiasts. Section 5.1 provides evidence of which species are known to have occurred in Maroondah historically and which ones remain today.

[*] *The Victorian Naturalist*, Volume VII (1890), p. 85.

3.1 Questionably Indigenous Species

There are also a few plant species that occur in Maroondah today and are commonly regarded as indigenous but were probably not present at the time of colonisation. The clearest example is the Drooping Cassinia or Sifton Bush. In his paper segregating the species from *Cassinia arcuata* and giving it the new name *Cassinia sifton*, Orchard (2017) notes the lack of early records of the species from Victoria and he documents its rapid expansion from New South Wales in the wake of early mining and land clearing. However, the same traits that allowed the species to expand so effectively from New South Wales following European settlement may have also allowed the species to periodically colonise Maroondah between ice ages or in the wake of major bushfires. Orchard also acknowledges that the species may have originally reached New South Wales from Victoria prior to it dying out in Victoria before European settlement.

There are also several cases of plant and animal species expanding their ranges into Maroondah from natural populations that lived nearby prior to colonisation. Two vine species – the Wonga Vine (*Pandorea pandorana*) and Twining Silkpod (*Parsonsia brownii*) – are extreme examples, having expanded out of their previous habitat of rainforests and wet forests in the Dandenong Ranges and elsewhere, now acting as serious environmental weeds in Maroondah.

Of course, such examples are few compared with the number of plant species from further afield (particularly overseas, e.g. ivy, blackberry and pines) that have become established in Maroondah's native vegetation. These are discussed in Section 5.3 (p. 41).

4 Ecological Communities

4.1 'Bioregions' and the EVC System

The Department of Environment, Land, Water and Planning's standard, state-wide classification scheme for vegetation types in Victoria is called 'Ecological Vegetation Classes', or EVCs. An EVC consists of vegetation with a fairly consistent set of principal factors that drive the ecological processes that govern the types of plants present. Typical examples of those factors include climate, soil, topography and fire frequency. In practice, identification of a site's EVCs normally relies substantially on visible features of the vegetation itself, such as the height and density of different vegetation strata and the presence of 'indicator species' of plants.

Two stands of vegetation may be classified as the same EVC even if many of the plant species are different, as long as the different species reflect similar ecological adaptations – e.g. adaptation to frequent, fast floodwaters on the banks of major streams. Conversely, vegetation with similar mixtures of species may be classified into different EVCs if there are signs of different ecological processes at work; e.g. different canopy heights and densities of shrubs and ground flora.

In 2001, a predecessor of the Department of Environment, Land, Water and Planning produced two maps of EVCs in the Port Phillip and Western Port region: one for the EVCs of current-day native vegetation and the other of EVCs that were inferred to have been present in 1750. These maps and the characteristics of the EVCs are described by Oates & Taranto (2001), who described them as 'first drafts'. They also contain substantial errors in some places. However, there has been negligible subsequent revision affecting Maroondah. The polygons that represent the EVCs on the maps are available for download from the Victorian Government's 'Data.Vic' website.

The present author's rendering of the polygons for the year 1750 appears in Figure 1. Despite inaccuracies (particularly in Croydon North, Heathmont and Kilsyth South), the map broadly accords with nineteenth century maps (Chapter 3) and a substantial fraction of Maroondah's remaining native vegetation.

Much of Figure 1 is occupied by an expanse of yellow (Valley Heathy Forest) interrupted mainly by bands of blue along creeks and their floodplains. North of the Valley Heathy Forest, the colours (EVCs) are different and they form a more complex pattern. The area dominated by Valley Heathy Forest and its enclosed creeks and floodplains is part of the 'Gippsland Plain' biogeographic subregion, or 'bioregion'. The area to the north and a small part of the Dandenong Ranges in the southeastern corner are parts of the 'Highlands – Southern Fall' bioregion. Topography is the main factor determining the difference between bioregions in Maroondah: the Gippsland Plain area has gently undulating topography and broad, well-spaced floodplains, whereas the Highlands – Southern Fall has generally steeper, less weathered terrain with gullies close together.

The Department of Environment, Land, Water and Planning's delineation of the boundary between the two bioregions is shown as a red line on Figure 1. It is obviously a rather rough approximation but the EVC mapping is an approximation, anyway.

Figure 1 does not show Maroondah's original wetlands. Nor does it distinguish the vegetation of stream channels, because no EVC has even been described by the Department for these habitats with their unique vegetation, fauna and hydrology. The present report does recognise these communities.

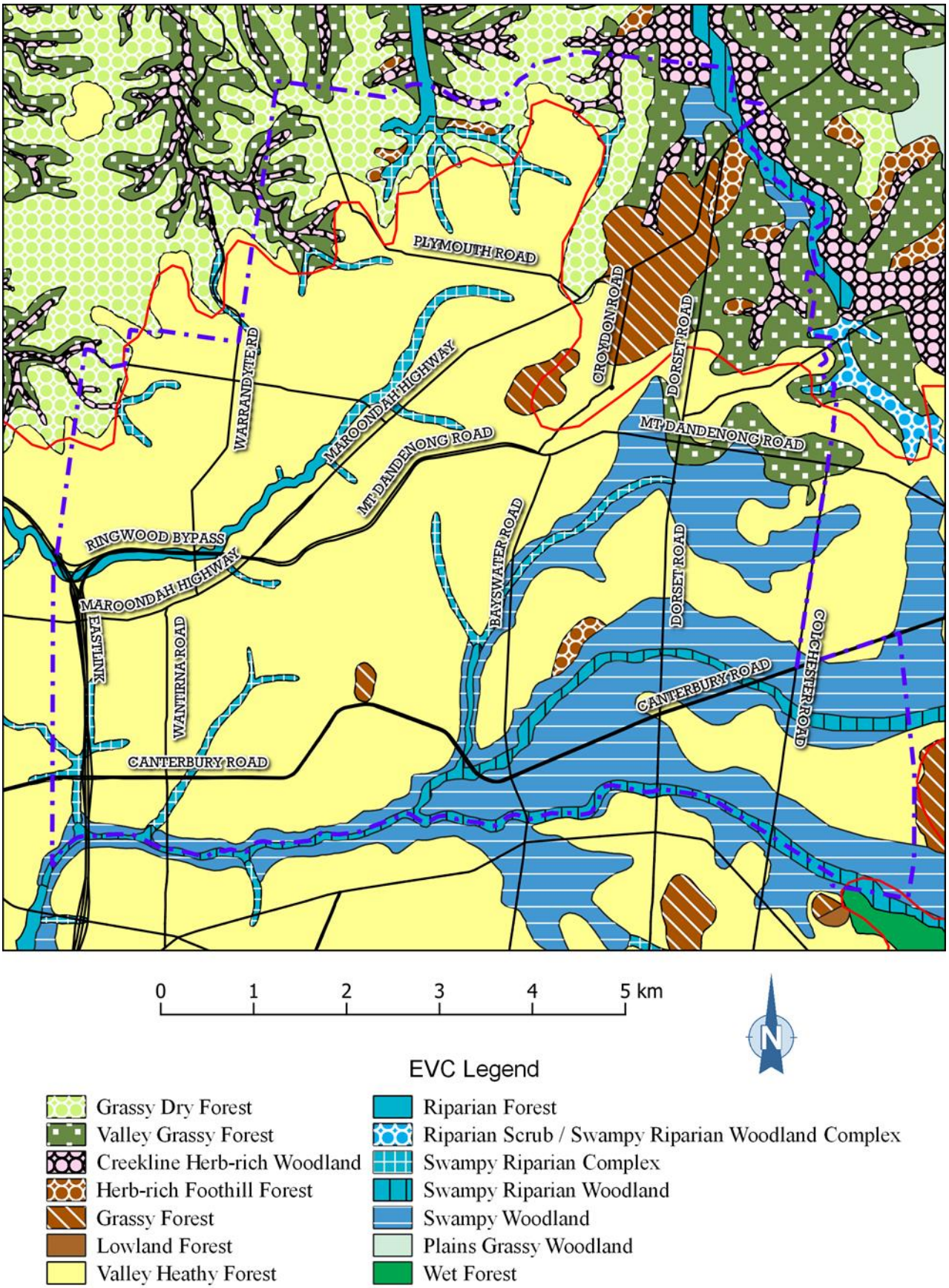

Figure 1. Map of Ecological Vegetation Classes (EVCs) in 1750.
Maroondah's boundary is the purple dash-dot line. The red line is the approximate boundary between two biogeographic regions. The polygons representing the EVCs are copyright © The State of Victoria, Department of Environment, Land, Water & Planning 2018.

4.2 Relationship of EVCs to Lorimer's (1997) Communities

Table 2 is provided to allow translation between the habitat types described in *'Sites of Biological Significance in Maroondah'* (Lorimer *et al.* 1997) and the EVC system.

Table 2. Relationship between the habitat types of Lorimer *et al*. (1997) and EVCs, with their associated code numbers.

Habitat type of Lorimer et al. 1997	Ecological Vegetation Class (EVC)
1 Wetlands – still water	74 Wetland Formation
1 Stream channels	none – see Section 4.3
2 Herb-rich Plains Grassy Wetland	653 Aquatic Herbland, which falls within EVC 74 – Wetland Formation.
3 Swamp Scrub	53 Swamp Scrub
4 Manna Gum Riparian Forest	18 Riparian Forest
5a Swamp Gum Forest of hilly country	164 Creekline Herb-rich Woodland
5b Swamp Gum Forest of broad valleys	On stream banks: 83 Swampy Riparian Woodland; Elsewhere: part of 937 Swampy Woodland
6 Silver-leafed Stringybark forest of poorly drained alluvium	part of 937 Swampy Woodland
7 Messmate Subriparian Forest	a variant of 18 Riparian Forest
8 Mixed eucalypt forest with Silver-leafed Stringybarks	16 Lowland Forest and most forms of 127 Valley Heathy Forest
9 Mixed eucalypt forest without Silver-leafed Stringybarks	In Highlands Southern Fall: 47 Valley Grassy Forest; In Gippsland Plain: 128 Grassy Forest and occasional forms of 127 Valley Heathy Forest
10 Messmate and Peppermint Forest	23 Herb-rich Foothill Forest
11 Yellow Box – Candlebark Forest	part of 47 Valley Grassy Forest
12 Peppermint and Bundy Woodland	part of 47 Valley Grassy Forest
13 Box-Stringybark Woodland	22 Grassy Dry Forest

4.3 Identification and Distribution of EVCs Today

The following sections describe the EVCs of current-day native vegetation in Maroondah, including some EVCs that have been overlooked in the Department of Environment, Land, Water and Planning's vegetation maps. Subheadings include the code numbers given to the EVCs by the Department of Environment, Land, Water and Planning except that no EVC has been described for stream channels. Additional details about EVCs are provided by Oates and Taranto (2001).

4.3.1 Stream Channels

Stream channels are subject to frequent floodwater at high speed, which removes almost all tree seedlings that germinate except the introduced Desert Ash (*Fraxinus angustifolia*) and willows (*Salix* species). The vegetation is quite distinctive. The brow and slopes of a channel are dominated by creeping and scrambling species, most of which are now introduced (e.g. Kikuyu

Cenchrus clandestinus, Creeping Buttercup *Ranunculus repens* and the hybrid bindweed, *Calystegia sepium* × *silvatica*). The introduced Seaside Daisy (*Erigeron karvinskianus*) and Angled Onion (*Allium triquetrum*) are very common. The ferns, Tender Brake (*Pteris tremula*) and Bracken (*Pteridium esculentum*), are commonly present at intervals along the stream – the former species being questionably indigenous. Indigenous rushes, sedges and grasses are concentrated close to low water level, particularly Clustered Rush (*Juncus gregiflorus*), Loose-flower Rush (*Juncus pauciflorus*), Swamp Club-rush (*Isolepis inundatus*), Nodding Club-rush (*Isolepis cernua*), Australian Sweet-grass (*Glyceria australis*) and Clustered Wallaby-grass (*Rytidosperma racemosum*). Angled Lobelia (*Lobelia anceps*), Slender Knotweed (*Persicaria decipiens*), Water Plantain (*Alisma plantago-aquatica*), the moss *Rhynchostegium tenuifolium* and the liverwort *Lunularia cruciata* are also usually present near low water level. Common Pondweed (*Potamogeton ochreatus*) is usually present in the water, increasingly accompanied in recent years by Dense Waterweed (*Egeria densa*), which has been released from aquariums.

Stream channels also support a distinctive collection of fauna, including Platypus, Rakali (or Australian Water Rat), yabbies, fish, freshwater mussels and many other invertebrate species totally dependent on streams.

The characteristics of stream channels just described seem to vary very little within Maroondah, regardless of the EVC of the adjacent vegetation outside the channels. The main variation is that the most natural channels within Creekline Herb-rich Woodland have more fern species, particularly Soft Water-fern (*Blechnum minus*) and Mother Shield-fern (*Polystichum proliferum*). However, that distinction is being lost, as those fern species have declined badly over the past two decades due to the Millennium Drought and hydrological changes from urban development.

4.3.2 EVC 74 – Wetland Formation

Wetlands were abundant on Maroondah's floodplains prior to colonisation, as evidenced by nineteenth century maps, but drainage work seems to have destroyed all of them. There are, however, artificial wetlands: (a) lakes and ponds; (b) wet depressions created incidentally by excavations; and (c) two wetlands beside Dandenong Creek formed by meanders of the original creek channel that were cut off when the creek was straightened and piped.

'EVC 74 – Wetland Formation' represents an aggregate of various kinds of wetlands. Maroondah's current-day wetlands vary greatly in character between drought and wet years, making the selection of a single EVC difficult or arbitrary. In this report, wetlands are not classified more finely than 'Wetland Formation'.

4.3.3 EVCs 18 & 83 – Riparian Forest and Swampy Riparian Woodland

The banks of Maroondah's larger, perennial streams support either Swampy Riparian Woodland or Riparian Forest, depending on whether the valleys have broad or narrow floodplains, respectively. Swamp Gum (*Eucalyptus ovata*) is overwhelmingly the dominant eucalypt species in natural Swampy Riparian Woodland, whereas Manna Gum (*Eucalyptus viminalis* subspecies *viminalis*) dominates natural Riparian Forest, sometimes with other species of tall eucalypts. In natural stands, Swampy Riparian Forest differs from Riparian Forest in having fewer broad-leafed species such as Hazel Pomaderris (*Pomaderris aspera*), Victorian Christmas Bush (*Prostanthera lasianthos*) and Hemp Bush (*Gynatrix pulchella*); However, these can rarely be used as indicators in Maroondah today because so many have been planted without regard to their natural habitats.

Swampy Riparian Woodland is confined to a rather narrow band (~ 10–30 m) each side of a stream, flanked by Swampy Woodland. Riparian Forest usually extends the full width of the alluvium that defines a floodplain. It is not uncommon for it to extend beyond the floodplain on

the sheltered side, where it manifests as the 'Messmate Subriparian Forest' of Lorimer *et al*. (1997).

Both Mullum Mullum Creek and Dandenong Creek have segments of Riparian Forest alternating with segments of Swampy Riparian Woodland, contrary to the much simpler pattern depicted on Figure 1.

The 'Swampy Riparian Complex' (EVC 126) that once occurred in Maroondah along minor tributaries and the upper reaches of the major streams has effectively vanished, having been reduced to occasional Swamp Gums or Swamp Paperbarks (*Melaleuca ericifolia*), e.g. at Ringwood Lake Park.

4.3.4 EVCs 937 & 53 – Swampy Woodland and Swamp Scrub

Swampy Woodland occurs in the Gippsland Plain bioregion on poorly drained soil that is sodden in winter and dry in summer, not exposed to fast-moving floodwater. It once covered most of the floodplains of the Gippsland Plain in Maroondah, as depicted on Figure 1. However, only a small fraction of it remains and many of its distinctive plant species died out (or almost so) during the Millennium Drought and most of those species have not recovered. Swampy Woodland has deteriorated worse than any other EVC in Maroondah over the past two decades, followed by the related Creekline Herb-rich Woodland (Section 4.3.5).

Most surviving examples of Swampy Woodland are now identifiable only by the presence of Swamp Gums (*Eucalyptus ovata*) and/or Swamp Paperbark (*Melaleuca ericifolia*) on poorly drained ground (but not stream banks) accompanied by a few hardy species of winter-sodden soils, e.g. Centella (*Centella cordifolia*), Common Bog-rush (*Schoenus apogon*), Common Love-grass (*Eragrostis brownii*), Mat Grass (*Hemarthria uncinata*) and club-rushes (*Isolepis* species). Among the many species that were fairly common up to the 1990s but are now very rare or locally extinct in Maroondah are Woolly Tea-tree (*Leptospermum lanigerum*), Rosemary Everlasting (*Ozothamnus ferrugineus*), Glandular Daisy-bush (*Olearia glandulosa*), Red-fruit Saw-sedge (*Gahnia sieberiana*), water-ferns (*Blechnum* species), Spreading Rope-rush (*Empodisma minus*), Square-stem Twig-rush (*Baumea tetragona*), Long Purple-flag (*Patersonia occidentalis*), Short Purple-flag (*Patersonia fragilis*), Tufted Blue-lily (*Thelionema caespitosum*), Swamp Daisy (*Allittia cardiocarpa*), Running Marsh-flower (*Ornduffia reniformis*), Swamp Goodenia (*Goodenia humilis*), Common Rapier-sedge (*Lepidosperma filiforme*), Hooker's Fescue (*Hookerochloa hookeriana*), Swamp Wallaby-grasses (*Amphibromus* species), Glandular Brooklime (*Gratiola pubescens*), *Centrolepis* species and Pygmy Sundew (*Drosera pygmaea*). The only examples of Swampy Woodland that retain any of the species just mentioned are Dexter's Bush in Heathmont, Dorset Recreation Reserve in Croydon, the Healesville Freeway Reservation in Bayswater North, Bungalook Conservation Reserves in Kilsyth South and Appletree Hill Reserve in Kilsyth South.

In Maroondah and surrounding areas, Swamp Scrub can be regarded as the swampiest part of Swampy Woodland where Swamp Gums are sparse and Swamp Paperbark forms a dense thicket over ferns and sedges. The paperbark thickets at Eastfield Park in Croydon and Appletree Hill Reserve in Kilsyth South have a structure that matches Swamp Scrub and also the expected abundance of sedges. Perhaps they also once had the expected ferns. It is also possible that these areas have come to look like modified Swamp Scrub as a result of historical clearing of more typical Swampy Woodland. This is a quite likely explanation of the paperbark thickets at the Healesville Freeway Reservation in Bayswater North.

4.3.5 EVC 164 – Creekline Herb-rich Woodland

The dissected terrain of the Highlands – Southern Fall bioregion in Maroondah's north means that gullies and small creeks have narrower floodplains than the Gippsland Plain and they experience less seepage and runoff from the adjacent slopes. The native vegetation of those valleys comprises Creekline Herb-rich Woodland on the alluvium of the narrow valley floors and Valley Grassy Forest on the slopes, or occasionally Herb-rich Foothill Forest on the most sheltered slopes.

The eucalypts of Creekline Herb-rich Woodland are Swamp Gums (*Eucalyptus ovata*) and occasional outliers from the flanking EVCs, particularly Candlebark (*Eucalyptus rubida*). Up to the 1990s, most stands were distinguishable from Swampy Riparian Woodland by a substantial density of ferns, particularly Rough Tree-fern (*Cyathea australis*), Mother Shield-fern (*Polystichum proliferum*), Soft Water-fern (*Blechnum minus*) and Common Maidenhair (*Adiantum aethiopicum*), but these have since become extremely scarce. The same is true of Shining Buttercup (*Ranunculus glabrifolius*). Hooker's Fescue (*Hookerochloa hookeriana*) was once quite common but appears to have completely died out from Maroondah's Creekline Herb-rich Woodland since 2000.

The combined effects of the Millennium Drought and gully erosion from urban development can explain why so many plant species declined or died out in Creekline Herb-rich Woodland since the 1990s.

Now that so many distinguishing species of Creekline Herb-rich Woodland are so scarce, the most reliable way of identifying what is left of the EVC today is often by the presence of alluvium on a gully floor or beside a minor creek, with signs of Valley Grassy Forest or Grassy Dry Forest on the slopes, ridges or hills that drain into the valley.

4.3.6 EVC 22 – Grassy Dry Forest

Grassy Dry Forest occurs in Maroondah's north and northwest, on the tops of ridges and hills with shallow, stony soil. It extends for typically 10–30 m from crests down slopes with northerly or westerly aspects but scarcely at all in opposite directions. In Croydon North, Figure 1 shows Grassy Dry Forest extending too far south to the intersection of Yarra Rd and Maroondah Hwy, where Valley Heathy Forest actually occurs.

Apart from the topographic position and the character of the soil, the easiest way of recognising most stands of Grassy Dry Forest is by noting the combination of wild eucalypts. Red Stringybark (*Eucalyptus macrorhyncha*) and Bundy (*Eucalyptus goniocalyx*) are always present and Red Box (*Eucalyptus polyanthemos*) is the only other wild eucalypt that may be present (other than rare outliers). If the understorey is not too modified from a natural state, the ground flora is sparser than other EVCs in Maroondah, with plenty of exposed leaf litter. Grey Tussock-grass (*Poa sieberiana* variety *sieberiana*) and Red-anther Wallaby-grass (*Rytidosperma pallidum*) are the dominant grasses and the first of these is uncommon in Maroondah's other EVCs.

4.3.7 EVC 47 – Valley Grassy Forest

Valley Grassy Forest can occur from near the crests of ridges and hills right down slopes to the edge of the floors of gullies and creek valleys, where Creekline Herb-rich Woodland is the naturally-occurring EVC. Patches of it can still be found scattered across all of its natural distribution in Maroondah, which includes the northeast, Warranwood and northwest of Kubis Dr, Ringwood North. On Figure 1, the Ringwood North area is wrongly mapped as Grassy Dry Forest and the areas mapped as Valley Grassy Forest along Mt Dandenong Rd should be Valley Heathy Forest.

Valley Grassy Forest often includes the eucalypt species of Grassy Dry Forest (i.e. Red Stringybark, Bundy and sometimes Red Box) but additional species are present, particularly Yellow Box (*Eucalyptus melliodora*), Candlebark (*Eucalyptus rubida*) and Narrow-leafed Peppermint (*Eucalyptus radiata*). Candlebark is extremely uncommon in other EVCs in Maroondah but it has been particularly subject to clearing and it does not regenerate well from seed. Valley Grassy Forest never contains Silver-leafed Stringybark (*Eucalyptus cephalocarpa*), which would suggest Valley Heathy Forest. Also, it rarely contains Messmate Stringybark (*Eucalyptus obliqua*), which would suggest Valley Heathy Forest, Grassy Forest or Herb-rich Foothill Forest. Those last two EVCs very rarely contain Yellow Box in Maroondah.

The eucalypts of Valley Grassy Forest largely overlap with other EVCs so it is often important to consider the understorey, if there are enough wild indigenous plants to be diagnostic. Valley Grassy Forest's ground flora are mostly dominated by grass species but Spiny-headed Mat-rush (*Lomandra longifolia* subspecies *longifolia*) is often very dense on lower slopes due to seepage from uphill. By comparison, Valley Heathy Forest has a higher density of small shrubs (e.g. the Common Flat-pea, *Platylobium obtusangulum*) and the Small Grass-tree (*Xanthorrhoea minor*).

Grey Tussock-grass (*Poa sieberiana*) and the Beaked Fireweed (*Senecio prenanthoides*) are common in Valley Grassy Forest (as in Grassy Dry Forest) whereas those species tend to be replaced by Soft Tussock-grass (*Poa morrisii*) and Rough Fireweed (*Senecio hispidulus*) in similar EVCs. Small-leafed Bramble (*Rubus parvifolius*) is more abundant in Valley Grassy Forest than similar EVCs whereas Bracken (*Pteridium esculentum*) and Thatch Saw-sedge (*Gahnia radula*) tend to be less abundant.

In the somewhat modified state of Maroondah's surviving native vegetation, it is often very difficult or impossible to find plant species to identify Valley Grassy Forest as distinct from Grassy Forest, Herb-rich Foothill Forest or Valley Heathy Forest, particularly near the interface between two EVCs. Valley Grassy Forest is the most common EVC downslope of Grassy Dry Forest but Grassy Forest occupies that position on the west-facing slope of Hochkins Ridge Nature Conservation Reserve and beside Glenvale Rd north of Barnsdale Way, Ringwood North (contrary to Figure 1).

4.3.8 EVC 23 – Herb-rich Foothill Forest

In Maroondah, Herb-rich Foothill Forest is confined to lower slopes with southerly to easterly aspect, in Warranwood Reserve and arguably next to the retarding basin at Barnsdale Way, Ringwood North; however, the latter stand is not very natural and could be regarded as just an interfacial zone between Grassy Forest uphill and Creekline Herb-rich Foothill Woodland to the south. Herb-rich Foothill Forest does not occur at or near Woodland Park in Croydon South, contrary to Figure 1.

Herb-rich Foothill Forest is dominated by Messmate Stringybark (*Eucalyptus obliqua*) and (to a lesser degree) Narrow-leafed Peppermint (*Eucalyptus radiata*), sometimes with smaller numbers of other eucalypt species but not Silver-leafed Stringybark (*Eucalyptus cephalocarpa*). Yellow Box (*Eucalyptus melliodora*) and Candlebark (*Eucalyptus rubida*) are normally absent but might occur as rare outliers from an adjacent stand of Valley Grassy Forest. Lowland Forest has a similar overstorey but can be distinguished in more natural stands by its more dissected, undulating terrain with wiry grasses (particularly Forest Wire-grass, *Tetrarrhena juncea*) and species reflecting lower fertility, e.g. Red-fruit Saw-sedge (*Gahnia sieberiana*), Screw fern (*Lindsaea linearis*), Cut-leaf Xanthosia (*Xanthosia dissecta*) and members of the Protea family (Proteaceae).

4.3.9 EVC 128 – Grassy Forest

Grassy Forest in and near Maroondah has a canopy of Red Stringybark (*Eucalyptus macrorhyncha*), Messmate Stringybark (*Eucalyptus obliqua*), Narrow-leafed Peppermint (*Eucalyptus radiata*) and Bundy (*Eucalyptus goniocalyx*). White Stringybark (*Eucalyptus globoidea*) is also present at Grandfill Reserve, Croydon. A useful distinction from similar EVCs that contain these eucalypts is that Grassy Forest hardly ever contains any of the box eucalypts or Silver-leafed Stringybark (*Eucalyptus cephalocarpa*) or Candlebark (*Eucalyptus rubida*). The ground flora is quite dense with grasses and often Thatch Saw-sedge (*Gahnia radula*). Bracken (*Pteridium esculentum*) forms dense patches.

Figure 1 depicts a patch of Grassy Forest to the west and southwest of Croydon Rd, Croydon. That corresponds to Wicklow Hill, which is higher and stonier than the surrounding terrain. Grassy Forest remains there at Grandfill Reserve. The larger patch of Grassy Forest mapped just to the northeast (e.g. along Croydon Rd) is wrongly mapped as that area contains an abundance of Silver-leafed Stringybark (*Eucalyptus cephalocarpa*), which indicates Valley Heathy Forest rather than Grassy Forest. As a result, the bioregional boundary on Figure 1 is also wrongly mapped by about 1 km. However, there is Grassy Forest 700 m further north at Hochkins Ridge Nature Conservation Reserve, where the Department of Environment, Land, Water and Planning's map shows Grassy Dry Forest. The small hill mapped on Figure 1 just north of Canterbury Rd in Ringwood East has too little native vegetation left to validate the mapping.

In many parts of Victoria, Grassy Forest has not been distinguished from Herb-rich Foothill Forest. Oates and Taranto (2001) state that 'Further sampling and analysis are required to clarify the relationship s of drier forest types', including Grassy Forest.

4.3.10 EVC 127 – Valley Heathy Forest

Valley Heathy Forest is the dominant EVC of native vegetation on the gently undulating terrain that occupies most of the Gippsland Plain in Maroondah. It occurs from hilltops to the edges of floodplains, despite the term 'Valley' in its name. Today, it is represented by small, widely-scattered patches and vestiges along roads and railway lines.

Valley Heathy Forest is quite variable, reflecting the diversity of soil moisture and aspect across the undulating topography where it occurs. Silver-leafed Stringybark (*Eucalyptus cephalocarpa*) is usually present and it distinguishes Valley Heathy Forest from Maroondah's other EVCs except for those of floodplains and stream banks. Bundy (*Eucalyptus goniocalyx*), Messmate Stringybark (*Eucalyptus obliqua*), Red Stringybark (*Eucalyptus macrorhyncha*) and/or Narrow-leafed Peppermint (*Eucalyptus radiata*) are also usually present. Yellow Box (*Eucalyptus melliodora*) occurs in some stands, particularly on Loughnan Hill, Ringwood.

The ground flora of the more natural stands is rich in small shrubs and wildflowers, particularly orchids and lilies. Like Lowland Forest, it often combines species of poorly drained ground (e.g. Common Bog-rush (*Schoenus apogon*) and Cut-leaf Xanthosia (*Xanthosia dissecta*) with Red-anther Wallaby-grass (*Rytidosperma pallidum*), which typically occurs in soils that become very dry in summer. Some other diagnostic species that tend to be more abundant than similar EVCs other than Lowland Forest include Honeypots (*Acrotriche serrulata*), Common Flat-pea (*Platylobium obtusangulum*), Small Grass-tree (*Xanthorrhoea minor*), Slender Sword-sedge (*Lepidosperma gunnii*), Nodding Greenhood (*Pterostylis nutans*) and Milkmaids (*Burchardia umbellata*). Compared with Lowland Forest, Valley Heathy Forest has more herbaceous plants and species that retreat to underground organs each summer ('geophytes'), e.g. Chocolate Lily (*Arthropodium strictum*) is often one of the dominant ground flora species in spring. Lowland Forest is further distinguished by its taller trees, the common presence of Red-fruit Saw-sedge (*Gahnia sieberiana*) and greater abundance of Forest Wire-grass (*Tetrarrhena juncea*) and plants

in the Protea family (Proteaceae) such as *Hakea* species, Silver Banksia (*Banksia marginata*) and Prickly Geebung (*Persoonia juniperina*).

4.3.11 EVC 16 – Lowland Forest

Lowland Forest is most similar to Valley Heathy Forest, from which it can be distinguished by the features described in the previous paragraph. Messmate Stringybark (*Eucalyptus obliqua*) is the dominant species, followed by Narrow-leafed Peppermint (*Eucalyptus radiata*). Smaller numbers of other eucalypts may be present but not Candlebark (*Eucalyptus rubida*) or species in the box group. The ground flora is often so dense, deep and tangled as to impede walking.

Lowland Forest is not shown in Maroondah on Figure 1 but it occurs in Kilsyth South at Eastwood Golf Course and Bungalook Conservation Reserves, and as a remarkable western outlier in Heathmont from Uambi (on Allens Rd) to H.E. Parker Reserve.

4.4 Conservation Status of the EVCs

The conservation status of a species or community states its likelihood of becoming extinct or whether it is already extinct. The Department of Environment, Land, Water and Planning has expanded the usual use of that term so that an EVC can be classified as 'Endangered' or 'Vulnerable' in a bioregion solely on the basis of its current extent relative to its presumed pre-colonisation extent, regardless of any known threats. The criteria used by the Department were published in *'Native Vegetation – A Framework for Action'* (NRE 2002), adopting the following categories (in order): Presumed extinct; Endangered; Vulnerable; Depleted; Rare; and Least Concern.

The Department's assessment of the bioregional conservation status of EVCs in Maroondah appears in Table 3.

Table 3. Bioregional conservation status of EVCs in Maroondah.

EVC No.	EVC Name	Bioregional Conservation Status	
		Gippsland Plain	Highlands – Southern Fall
16	Lowland Forest	Vulnerable	–
18	Riparian Forest	Vulnerable	Least Concern
22	Grassy Dry Forest	–	Least Concern
23	Herb-rich Foothill Forest	–	Least Concern
47	Valley Grassy Forest	–	Vulnerable
53	Swamp Scrub	Endangered	–
74	Wetland Formation	Endangered	Endangered
83	Swampy Riparian Woodland	Endangered	Vulnerable
126	Swampy Riparian Complex	Endangered	Endangered
127	Valley Heathy Forest	Endangered	Vulnerable
128	Grassy Forest	Endangered	Vulnerable
164	Creekline Herb-rich Woodland	–	Vulnerable
937	Swampy Woodland	Endangered	Endangered

The greater prevalence of 'Endangered' EVCs in the Gippsland Plain bioregion compared with the Highlands – Southern Fall is due to the greater retention of forests in hillier parts of Victoria. The Highland – Southern Fall bioregion extends to Wallan, Morwell North, north of Buchan and near Mt Hotham.

The conservation status of EVCs was a major determinant of the level of planning protection given to vegetation under the state-wide 'Native Vegetation Framework' between 2003 and 2013. The 'Framework' was then replaced. Now, conservation status plays no role in most cases of vegetation clearing. To be precise, it appears only in the 'decision guidelines' and then only in cases involving clearing of 'endangered' EVCs under the 'Intermediate' or 'Detailed' Assessment Pathways.

While the conservation statuses above have been determined separately within each bioregion, it would be possible to apply the same assessment procedure on the basis of current and past vegetation within Maroondah. That has not been done but it seems clear that if it was, all EVCs would fit the 'endangered' category on the local scale.

5 Wild Plant Species

5.1 Indigenous Plants

Appendix A (p. 104) provides an inventory of Maroondah's wild, indigenous plant species for which valid records were found in this study. ('Wild' means excluding planted plants.) The inventory includes:

- 482 flowering species, or 492 if named hybrids and multiple subspecies are included;
- 21 fern species;
- 41 species of moss;
- 8 species of liverwort;

This makes a total of 552 species, or 562 if named hybrids and multiple subspecies are included.

As described in Chapter 10 (p. 69), one cannot be sure whether some species are indigenous to Maroondah. Appendix A includes such species, with a comment.

Algae are not included in Appendix A because there is too little data to provide a meaningful representation of Maroondah's algal diversity. Most alga species are aquatic and microscopic or filamentous, requiring specialised surveying and microscopic analysis by an expert. The only species large enough to be detected in the present study was the stonewort, *Chara corallina*, of which a single plant was found at Hochkins Ridge Drainage Reserve in Croydon North. *Chara* species are of considerable scientific interest because they represent the ancestors of vascular plants such as flowering plants. *Chara corallina* must be quite rare in Maroondah or else it would have been detected more often during this study or in a previous botanical survey. The solitary plant that was found is at high risk from gully erosion, which is occurring due to urbanisation of the catchment and lack of effective stream stabilisation.

5.1.1 Mosses and Liverworts

Mosses and liverworts (bryophytes) are not often included in botanical surveys or studies of biodiversity. This is probably due to a combination of scarcity of expertise, the high investment in time and effort required to find and identify these tiny plants, and the self-perpetuating problem of limited prior data with which to compare newly acquired data. The present study is the first to aim to provide a baseline inventory of mosses and liverworts in Maroondah. It relies mostly on the fieldwork of this study, augmented mainly by herbarium specimens.

Most mosses and liverworts produce spores that can be carried high into the atmosphere, regularly travelling very large distances. The minute fraction of spores that land in a suitable place for the species is all it takes to perpetuate the species. Consequently, many species are naturally widespread around much of the world and others are likely to have established in Victoria so soon after European settlement that no-one can tell whether they are indigenous in Maroondah or not. These factors are unlike flowering plants and (to a lesser degree) ferns.

Another feature that distinguishes mosses and liverworts from flowering plants and ferns is their adaptability to the built environment, due to their habitat requirements and tolerances. Different species have different requirements for climate, shade, lack of competition and various characteristics of the surface on which they grow (the substrate), e.g. pH, moisture retention, nutrient availability, roughness and inclination to vertical. A few square centimetres are all it takes for spores of a suitable moss or liverwort to establish. A typical house and garden provide a wider range of habitat characteristics than in local forests; e.g. alkaline and acid surfaces, dry and damp

spots, fertile and infertile areas, and surfaces with various frequencies of cultivation or cleaning. Some species are adapted well to lawns, others to potting mix, others to roof tiles. Consequently, the author found more species of moss and liverwort around home than in even the largest and most natural of Maroondah's conservation reserves. While the spores of many of the urban species may have been continually landing in Maroondah long before European settlement, many would not have previously been able to reach maturity due to the lack of suitable habitat and substrates.

This study did not search much for mosses and liverworts in the built environment, so that part of Maroondah's biodiversity remains incompletely understood, as it is in urban Australia generally.

5.1.2 Plant Species that have Died Out

Appendix A indicates with red text the species that can be presumed to have died out in Maroondah. The criteria used are that these species have not been recorded for over thirty years despite surveys, or not for at least ten years despite targeted searching at the previously known sites under good conditions for detection. Mosses and liverworts that have not been recorded for many years are not deemed here to have died out because the absence of recent records could be simply due to the scarcity of searches for them.

Eighty indigenous species of ferns and flowering plants in Appendix A can be presumed to have died out in Maroondah, plus one named hybrid. (In the rest of this section of the report, statistics about 'species' include named hybrids and multiple subspecies within a species.) That represents a 16% rate of local extinction since European settlement. It is inevitable that some additional plant species died out before anyone noticed them or left a record of their former existence. It is also likely that some species of ferns or flowering plants are yet to be detected, and that is almost certainly the case for the 'lower' (or non-vascular) flora. New discoveries are made at least every few years, and particularly when a study like the present one is conducted.

The orchid family (Orchidaceae) is the largest family of plants in the world by numbers of species. Analysis of the information in Appendix A indicates that the orchid family was, and still is, the largest family of indigenous plants in Maroondah. There are 92 indigenous orchid species and named hybrids in Appendix A, of which 52 cannot be presumed to have died out. Today, we can be confident that at least 40 out of Maroondah's 92 orchid species and hybrids (i.e. 43%) have died out in Maroondah and are unlikely to reappear. Many of them have not been recorded for more than eighty years; others much more recently.

The orchid family is the family that has suffered the highest percentage loss of species in Maroondah, by far. Table 4 provides statistics for flowering plants more generally, for ferns and for the fifteen families with the largest numbers of species. (The last column is discussed in Section 5.1.3.)

The variability among families in the local extinction rate is remarkable. Whereas 43% of orchid species can be presumed to have died out in Maroondah, no wattles, eucalypts or Apiaceae species appear to have died out, and only one out of 50 grass species. Lilies in Asparagaceae and Asphodelaceae have also proved themselves to be good survivors.

The high rate of loss of orchid species is similar to the rest of Victoria, Australia and the world. It can be partially explained by the strong dependence of most orchids on highly specific conditions being met for their survival and reproduction, particularly the presence of specific fungi and insect pollinator species. However, this study found no explanation why some groups of orchids, such as the leek-orchids of genus *Prasophyllum*, have suffered many sudden extinctions or population collapses over the past two decades, even in areas where there has been no evident change in their habitats.

Table 4. Statistics about survival of species in Maroondah.
'Critically endangered' in the last column refers to the risk of dying out in Maroondah.

Plant group	Number of species		Local extinction rate	Number of critically endangered
	Historically	Presumed still present		
Flowering plants	492	415	16%	161
Ferns and fern allies	21	17	19%	10
By family:				
Orchidaceae – orchids	92	52	43%	32
Poaceae – grasses	49	48	2%	14
Asteraceae – daisies	48	42	13%	16
Cyperaceae – sedges	29	28	3%	11
Fabaceae (excl. *Acacia*) – peas	23	20	13%	9
Fabaceae – *Acacia*	16	16	0%	3
Myrtaceae	18	18	0%	5
Juncaceae – rushes	17	15	12%	3
Asparagaceae	10	9	10%	0
Apiaceae	9	9	0%	3
Asphodelaceae	9	9	0%	2
Campanulaceae	9	8	11%	5
Plantaginaceae	8	7	13%	4
Proteaceae	7	6	14%	6
Haloragaceae	6	5	17%	4
Polygonaceae	6	6	0%	3

For example, countless thousands of *Prasophyllum brevilabre* and *P. odoratum* flowered on the west face of Mt Dandenong after any fire in the 1980s and early 1990s but the author has been unable to find any in the past decade or more. Loss or displacement of the underground fungus on which the orchids depend is one plausible explanation why the collapse of these species occurs without visible signs of habitat change. The only one of the seven species of *Prasophyllum* historically recorded in Maroondah that may not have died out is *Prasophyllum brevilabre*, but it has not been recorded since 1999.

Given that so many plant species have died out in Maroondah, it is important to investigate the potential for more species to do so.

5.1.3 Species Facing Local Extinction

The most rigorous way of assessing the risk of each remaining plant species dying out of an area such as Maroondah is to apply the international standard 'Red List' categories, criteria and guidelines of the International Union for the Conservation of Nature (see Lorimer (2011) and www.iucnredlist.org/about/publication/assessment-process). The present study's budget did not extend to a full analysis of all Maroondah's surviving plant species but some species can be confidently placed in the category of 'critically endangered' for their likelihood of dying out in Maroondah. That category is the most serious one, notionally equivalent to at least a 50% chance of dying out within ten years or three generations of the species, whichever is longer. The criteria

and guidelines involve consideration of subpopulation sizes, population declines and rate of natural immigration from outside the area under consideration (e.g. seeds blowing into Maroondah). The criteria based on geographic range do not apply to an area as small as Maroondah.

The fieldwork for this study paid particular attention to searching for species believed to be candidates for the 'critically endangered' category. Population details were taken whenever such species were found. In many cases, information was also sought from local naturalists and ecologists. While a full, formal assessment under the Red List criteria and guidelines could not be undertaken, many candidate species were assessed to the level where one can be confident that they are in the 'critically endangered' category. For example, quite a few species easily meet the criteria because they are only known to be represented by substantially less than fifty mature, wild individuals despite searching in all the previously known locations. Note that planted individuals do not count toward population sizes.

It is important to note that there are quite a few species that may well meet the criteria for 'critically endangered' but that have not been categorised as such here because further investigation is needed.

Despite the resultant bias toward under-reporting, it is remarkable that 39% of the extant flowering plant species in Appendix A, and 53% of the extant fern species, are clearly or very probably in the 'critically endangered' category of risk of dying out in Maroondah. A dissection of the number of species in this category within each of the largest families of plants appears in the last column of Table 4.

In nearly all groups of plants, Table 4 suggests that more species may die out in Maroondah within a decade than have died out since European settlement.

There is only a weak correlation between the percentage loss of species up to today and the percentage loss predicted by the 'critically endangered' ratings in Table 4.

It may ultimately be found that the IUCN Red List criteria and guidelines overestimate the risk of a species dying out in an area like Maroondah. For example, the criteria do not take into account the measures taken by Maroondah City Council and its citizens to prevent species becoming extinct. (Some species have already been saved from dying out, e.g. the Kilsyth South Spider-orchid.) Conversely, there are numerous species that are only known to have less than five mature individuals in the whole municipality, making them undoubtedly deserve the tag of 'critically endangered'. It should also be understood that major droughts will probably finish off many species facing local extinction. Therefore, there may be fewer local extinctions among the 'critically endangered' species over the coming decade if no major drought occurs, or more if one does occur.

It should be expected that a more extensive analysis would find substantial numbers of additional plant species falling into the lower IUCN Red List categories, 'endangered' and 'vulnerable'. Conducting such an analysis is beyond the scope of the present study.

While orchids are by far the family of plants with the worst prospects of dying out in Maroondah, there is another category of plants that is similarly at risk. Table 5 lists all Maroondah's plant species that are confined (or almost so) to floodplain soil that is hard and dry in summer and is kept sodden (but not inundated) throughout the wetter months of the year by seepage.

Table 5. Species specially adapted to winter-sodden / summer-dry floodplains.
For species unable to be found in the present study, the 'Missing since' column shows the year of the most recent record. Population estimates in the last column are based on this study's fieldwork.

Scientific name	Common name	Missing since	Pop'n. estimate
Presumed to have died out in Maroondah			
Burnettia cuneata	Lizard Orchid	1921	–
Centrolepis fascicularis	Tufted Centrolepis	2001	–
Chorizandra cymbaria	Heron Bristle-rush	c. 1998	–
Cycnogeton alcockiae	Water-ribbons	1996	–
Drosera binata	Forked Sundew	1945	–
Mazus pumilio	Swamp Mazus	2000	–
Microtis atrata	Yellow Onion-orchid	1926	–
Pultenaea sericea	Heathland Bush-pea	1902	–
Ranunculus inundatus	River Buttercup	1992	–
Utricularia tenella	Pink Bladderwort	1897	–
Xerochrysum palustre	Swamp Everlasting	1996	–
Critically endangered with dying out in Maroondah			
Allittia cardiocarpa	Swamp Daisy	2016	0–10
Almaleea subumbellata	Wiry Bush-pea		20–40
Amphibromus archeri	Pointed Swamp Wallaby-grass		2–5
Aphelia gracilis	Slender Aphelia		~1,000
Baumea rubiginosa	Soft Twig-rush	2012	0–2
Baumea tetragona	Square Twig-rush		1–2
Centrolepis aristata	Pointed Centrolepis		~100
Centrolepis strigosa	Hairy Centrolepis		~100
Drosera pygmaea	Tiny Sundew	2005	0–10
Epacris gunnii	Ace of Spades	1995	–
Eryngium vesiculosum	Prickfoot		10–50
Gonocarpus micranthus	Creeping Raspwort	2012	0–20
Goodenia elongata	Lanky Goodenia		0–10
Goodenia humilis	Swamp Goodenia		~100
Gratiola pubescens	Glandular Brooklime		~500
Hookerochloa hookeriana	Hooker Fescue		~50
Isolepis fluitans	Floating Club-rush		10–50
Juncus filicaulis	Thread Rush		1
Lepidosperma filiforme	Common Rapier-sedge		20–50
Lepidosperma longitudinale	Pithy Sword-sedge		1
Leptospermum lanigerum	Woolly Tea-tree		1–5
Olearia glandulosa	Swamp Daisy-bush		1
Ozothamnus rosmarinifolius	Rosemary Everlasting		1
Patersonia fragilis	Short Purple-flag		30–50
Ranunculus glabrifolius	Shining Buttercup		20–50
Rytidosperma aff. *caespitosum* (South-west Swamps)	Porphyry Wallaby-grass		20–50
Schoenus lepidosperma	Slender Bog-rush		5–10
Schoenus maschalinus	Leafy Bog-rush	2000	0–5
Schoenus tesquorum	Soft Bog-rush		10–100
Selaginella uliginosa	Swamp Selaginella	2012	0–5
Stylidium despectum	Hundreds and Thousands		1–20
Thelionema caespitosum	Tufted Blue-lily		50–100
Utricularia dichotoma	Purple Bladderwort	2001	0–10
Viminaria juncea	Golden Spray	2012	–

Of the 45 species in Table 5, eleven can be confidently presumed to have died out in Maroondah and seventeen others either could not be found in this study or had fewer than five individuals. Every surviving species in Table 5 is classified as critically endangered. The species in Table 5

come from a wide range of plant families, habits and life histories, indicating that the problem is associated with the habitat, unlike the situation with the orchid family.

Until c. 2000, most of the species listed in Table 5 were fairly common or abundant, contributing a great deal of distinctiveness to the Swampy Woodland where they occurred. The loss or imminent loss of so many species from a vegetation community is a significant problem for biodiversity not only at the level of species but also at the level of a community. In addition, the loss is not only important within Maroondah but also more widely, because Swampy Woodland is a regionally endangered EVC. The author has observed the same phenomenon in Knox and it seems inevitable that it is more widespread, as the factors that appear to be responsible are also widespread.

For these reasons, the loss of plant species specially adapted to winter-sodden floodplains represents the single greatest contribution to species dying out in Maroondah for the foreseeable future.

The cause of this collapse of species can be inferred from the trajectory during and since the Millennium Drought. The species all require soil that is sodden in winter, so it is perhaps not surprising that so many suffered during the drought. However, only *Aphelia gracilis* recovered when the drought broke. By contrast, nearly all wetland plant species recovered remarkably quickly and fully.

The species in Table 5 demonstrably survived the countless droughts that must have occurred through pre-history. One likely reason why recovery was so poor following the Millennium Drought is the unnaturally long duration of the drought, exhausting nature's capacity to recover. Until this millennium, the habitat occupied by the species in Table 5 has been reliably sodden during the crucial winter establishment phase of their seedlings, so those species have not needed to be adapted to winter dryness, as those of drier places must. Seeds were able to germinate during less dry parts of the Millennium Drought, only for most of the germinants to die from subsequent dryness before they produced seeds for the next generation. For that reason as well as natural attrition, the soil-stored seeds of most plants must have dwindled in numbers over the decade of drought. The observed lack of regeneration following the drought suggests that the soil-borne seed bank became exhausted.

The severity and long duration of the Millennium Drought have been attributed to human-induced climate change.

Another apparent cause for the loss or decline of species in Table 5 was urban development and drainage works causing permanent lowering of water tables and reduction of the seepage on which the community relies.

A related but less direct cause can be seen on the floodplain in the southwest of Hochkins Ridge Nature Conservation Reserve (Site 51 in Volume 2). The catchment of the creek there has become so covered with impervious surfaces that the creek is now dry most of the time and experiences highly erosive, gushing flows during rainfall events. The resulting gully erosion has gouged a trench up to about 2 m deep in places, thereby draining the water table to a similar depth. In 2000, there were approximately one dozen of the locally rare Hooker's Fescue (*Hookerochloa hookeriana*) among other plants of swampy ground. Today, those plants have been replaced by introduced pasture species adapted to drier conditions.

It is appropriate to introduce at this stage the concept of 'extinction debt', which refers to future loss of species resulting from the delayed impacts of past actions. A good example is provided by the Heron Bristle-rush, *Chorizandra cymbaria*, at Bungalook Conservation Reserves in Kilsyth South. The species is regionally rare and has never been recorded any closer than Macclesfield, on the other side of the Dandenong Ranges. It was found in 1988 in regrowth where a creek had

recently been filled in to facilitate residential development along Tereddan Drive. Despite concerted efforts to save the species, it died out 10–15 years later. In retrospect, the reason was that the species requires swampy conditions and the creek destruction was part of efforts to drain the land. There are other examples in Maroondah where species have become locally extinct decades after the events that precipitated the extinctions.

'Extinction debt' is sometimes used as an excuse for doing nothing to prevent local extinctions, on the presumption that extinction is inevitable. Instead, the concept can prompt us to consider what threatening processes have been set in train by past events and what action can be taken to reverse those processes. To take the example of the Heron Bristle-rush, if the drying of the land by the drainage works had been identified as the threatening process, it may have been possible to rehydrate the land by bringing water from stormwater pipes to the surface.

5.1.4 Legally Protected Species

There are three main legal instruments that confer a level of protection to certain rare or threatened plant species in Victoria:

- The federal *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act);
- The Victorian *Flora and Fauna Guarantee Act 1988* (FFG Act); and
- The *'Advisory List of Rare or Threatened Plants in Victoria – 2014'*, which has a role through the Victoria Planning Provisions in all planning schemes in Victoria.

Appendix A (p. 104) identifies all rare or threatened species affected by any of these documents. A more detailed assessment of Maroondah's surviving populations of those species follows. Note first that some of the species are locally common and fairly secure.

Acacia stictophylla – Dandenong Range Cinnamon Wattle

> 'Rare' (but not threatened) in the 'Advisory List', because despite the species' large population size and apparent security, its geographic range is relatively small – from Warrandyte to Wantirna South and the Dandenong Ranges. This species appears to be secure in Maroondah.

Austrostipa rudis subsp. *australis* – a subspecies of the Veined Spear-grass

> 'Rare' (but not threatened) in the 'Advisory List', because despite substantial populations, it has a relatively small known geographic distribution in Victoria. Maroondah and Knox appear to be the species' heartland in Victoria, each with at least hundreds of plants, including conservation reserves.

Caladenia sp. aff. *venusta* (Kilsyth South) – Kilsyth South Spider-orchid

> 'Critically Endangered' under the EPBC Act; 'Threatened' under the FFG Act; 'Endangered' in the 'Advisory List'; critically endangered in Maroondah.
>
> This is one of the most threatened species in the world, with a global population of two wild plants (one of which appears unable to flower) and three potted plants raised from seed of one of the wild plants. Both wild plants are in Kilsyth South. A management plan is in place to bring the species back from the brink of extinction. The main short-term threat to the species is from orchid enthusiasts trampling seedlings or removing the wild plants. Inbreeding is a longer-term threat. There are very high penalties under the EPBC Act for any action that may threaten the orchids.

Dianella amoena – Matted Flax-lily

‘Endangered’ under the EPBC Act; ‘Threatened’ under the FFG Act; ‘Endangered’ in the ‘Advisory List’; critically endangered in Maroondah.

This species has turned out to be more common and widespread than when it was given legal protection, which was soon after it was first described as a species. However, most plants are found as one or two isolated individuals, raising serious concerns about inbreeding. A patch that grew at the Croydon District Golf Club was dug up and put into cultivation by Candlebark Indigenous Nursery when the course was sold for residential development. The only known wild plants in Maroondah now were discovered during the present study: one plant at Croydon Primary School and 1 patch beside the Lilydale Railway Line in Croydon, east of Dorset Rd. The principal and management staff now of Croydon Primary School know about the school’s plant and its rarity and have expressed keenness to look after it. The Biodiversity Manager of Metro Trains is aware of the patch on the rail reservation and is taking steps to protect it. It would be desirable to exchange pollen between the wild plants and a cultivated plant from the former golf course.

Diuris behrii – Golden Cowslips

‘Vulnerable’ in the ‘Advisory List’; critically endangered in Maroondah. (The Department of Environment, Land, Water and Planning use only two categories of extinct risk: ‘Endangered’ and ‘Vulnerable’. The latter is the lower of the two.)

Dozens of this species were discovered on the Healesville Freeway Reservation in 1996, along with many other regionally rare species. VicRoads and Department of Environment, Land, Water and Planning fenced the area and stopped it being slashed. As a result, the area has mostly become a dense thicket of paperbark and tea-tree. Like the other rare species, Golden Cowslips cannot survive in a thicket and it has not been seen since c. 2000 despite the author searching in several subsequent years during flowering time. It may reappear if the vegetation is returned to its previous state, with summer slashing.

Eucalyptus × *brevirostris* – a hybrid eucalypt

‘Rare’ (but not threatened) in the ‘Advisory List’. Under the international Red List criteria, hybrids are excluded from all threat categories on the basis that as a general rule, even if all individuals die out, more can be created by artificial hybridisation and others may occur spontaneously in the wild as long as both parent species occur in proximity to each other. In this case, the parent species are Red Stringybark (*Eucalyptus macrorhyncha*) and Messmate Stringybark (*Eucalyptus obliqua*), which commonly grow together in Maroondah. The hybrids are moderately common but generally overlooked. This particular hybrid is of no greater importance than the many other eucalypt hybrids in Maroondah, but it differs in that it is the only one that has been scientifically named.

Eucalyptus yarraensis – Yarra Gum

‘Rare’ (but not threatened) in the ‘Advisory List’; ‘critically endangered’ in Maroondah. Three trees of this species occur at H.E. Parker Reserve in Heathmont (where threatened by current engineering work along Dandenong Creek); another few a few hundred metres further east, and a few at Ringwood Golf Course. No young plants could be located in this study and some of the mature trees are in poor condition.

Kunzea leptospermoides – Yarra Burgan

‘Poorly known’ (but suspected to be rare or threatened), in the ‘Advisory List’. The ‘poorly known’ designation results from lack of clarity about how this species differs from ‘*Kunzea* sp. (Upright form)’. The Royal Botanic Gardens’ provisional guidelines for distinguishing the two species often fail in Maroondah, as the leaf width is generally consistent with *K. leptospermoides* but the leaf shape and/or pedicel length often point to ‘*K.* sp. (Upright form)’. Regardless of how the taxonomy is ultimately resolved, the local plants proliferate greatly following land clearing and they are under no threat in Maroondah or more widely; in fact, they can become so dense as to threaten other indigenous species of flora and fauna.

Platylobium infecundum – a flat-pea

‘Endangered’ in the ‘Advisory List’. This species was only recognised as such in 2011, having formerly been regarded as part of *Platylobium formosum*. Its type locality (i.e. the location from which a specimen was taken to define the species) is H.E. Parker Reserve in Heathmont. This species is not uncommon from central and southern Maroondah to Wantirna South and Ferntree Gully, and abundant in the Dandenong Ranges. It does not occur far beyond that area. The ‘infecund’ in the name reflects the absence of any records of seeds being produced by the species; i.e. when plants die, they are unlikely to be replaced.

Pterostylis clivosa – Red-tip Greenhood (formerly *Pterostylis* sp. aff. *parviflora*)

‘Rare’ (but not threatened) in the ‘Advisory List’; ‘critically endangered’ in Maroondah. As at autumn 2018, nine individuals were found at FJC Rogers Reserve and a few dozen at Bungalook Conservation Reserves. These numbers have not changed significantly over the past twenty years or more.

Pterostylis × *ingens* – Sharp Greenhood (a hybrid)

‘Rare’ (but not threatened) in the ‘Advisory List’. As explained above, the international Red List criteria exclude hybrids from all threat categories. However, in this case, the hybrid is unlikely to occur spontaneously or with human assistance because the two parent species (*Pterostylis falcata* and *Pterostylis nutans*) hardly ever flower at the same time. In addition, *Pterostylis falcata* has died out from Maroondah and for many kilometres beyond. There is a single, thriving colony of *Pterostylis* × *ingens* at Bungalook Conservation Reserves, showing no decline since its discovery in c. 1990.

Rytidosperma aff. *caespitosum* (South-West Swamps) – Porphyry Wallaby-grass

‘Poorly known’ (but suspected to be rare or threatened), in the ‘Advisory List’; ‘critically endangered’ in Maroondah.

The present author is researching the plants that currently go under this name, and has discovered that they belong to three distinct species. One of those species appears to occur only at one place on Earth: Bungalook Conservation Reserves in Kilsyth South. (There is also a 19th Century specimen of Baron Sir Ferdinand von Mueller’s at the National Herbarium of Victoria with the locality recorded as ‘Dandenong Range’, which would have been taken to include Kilsyth South at that time.) The species at Bungalook Conservation Reserves is at extreme risk of global extinction. Melbourne Water destroyed over half the population during 2017–2018 by herbicide, badly timed mowing and installation of a drain to dry out the swampy habitat on which the species depends. At the time of writing, steps have been proposed to avoid repetition of herbicide spraying and harmful mowing but not the drying out of the species’ habitat.

Senecio campylocarpus – Floodplain Groundsel

> 'Rare' (but not threatened) in the 'Advisory List'. This is another species that was declared 'Rare' soon after it was described (in 2004) and then discovered to be more common than initially thought. Its copious windblown seeds can travel large distances and germinate in large numbers on bare mud where water levels recede around wetlands. It probably dies out in Maroondah during droughts and recolonises when conditions improve. This has probably occurred for millennia. During this study, it was found at Bungalook Conservation Reserves and beside Ringwood Lake. It is likely to occur sometimes at other waterbodies.

The *Flora and Fauna Guarantee Act 1988* provides a level of protection not only for threatened species but also for certain, more common classes of wild plants that are popular as cut flowers or garden specimens. Examples include all ferns except Bracken, all grass-trees and all members of the orchid and daisy families. The Act also protects all plants living in listed threatened ecological communities, none of which occurs in Maroondah.

It is quite likely that no more rare or threatened plant species with current legal protection remain to be discovered in Maroondah. One may gain a different impression from the regular reports of additional species (e.g. Green Scentbark, *Eucalyptus fulgens*) but my checks of such reports over the past two decades have always resulted in their dismissal as misidentifications.

At the time of writing, the Department of Environment, Land, Water and Planning advises that it has a new, substantially changed edition of the *'Advisory List or Rare or Threatened Plants in Victoria'* ready for publication. When that happens, more of Maroondah's plant species are likely to be listed and many currently listed species are likely to be placed in higher threat categories.

5.1.5 Eucalypt Deaths

Certain species of eucalypt have suffered extensive population reduction and ill-health in peri-urban Melbourne during and since the Millennium Drought (i.e. since the turn of the millennium). The most seriously affected species observed in this study were Red Stringybarks and White Stringybarks (*Eucalyptus macrorhyncha* and *Eucalyptus globoidea*), followed by Messmate Stringybark (*Eucalyptus obliqua*). The prevalence of dead and dying trees is quite patchy. Even within a small area that has been affected, there can be quite healthy trees among badly affected trees of the same species.

Figure 2 depicts a moderately severe example of affected eucalypt crowns, at Birts Hill Reserve in Croydon North.

One factor that seems to be an inevitable contributor to the death or decline of some trees is excessive tree density. The eucalypt species in Maroondah are 'crown shy', i.e. they do not tolerate overlapping crowns. Consequently, their trunks must be spaced apart at distances similar to their crown diameters. A typical crown diameter of a mature eucalypt in Maroondah is 12 m but most local forests have trunks less than 5 m apart as a result of regeneration following past clearing. At these densities, trees (and understorey) suffer from over-competition and the weaker trees die – mostly during times of stress such as midsummer during drought. It may seem that the stress factors such as drought are the causes of the tree deaths or decline but they are just the *coup de grâce* for trees that cannot survive to maturity, anyway. The surviving trees benefit from the reduced competition.

However, excessive tree density cannot be the cause of eucalypt decline and deaths at some sites where trees are not unnaturally dense, e.g. at Birts Hill Reserve (Site 45).

Figure 2. The crowns of dying eucalypts in Birts Hill Reserve, Croydon North.

Therefore, when areas of seriously defoliated eucalypts were encountered during the fieldwork for the present study, an effort was made to check for visible signs of causes. Leaves were inspected from ground level, often with binoculars, to check for yellowing, insect attack or possum damage. Attention was paid to whether the worst-affected leaves were toward the tips of the branches or further back. The density of possum faeces was checked beneath dying trees to gauge the amount of possum browsing. Trunks were checked for exudate from borer holes ('kino'). The health of any neighbouring grass-trees or heath plants was checked because those species act as bellwethers for harmful Cinnamon Fungus. No attempt was made to analyse the content of soil or leaves to check for fungal disease or nutrient problems.

The yellowing of leaves that accompanies some causes of eucalypt decline was not observed. Insect damage did not seem abnormal.

Many eucalypts showed the following signs consistent with excessive possum damage:

- Bite-marked or torn leaves, which are principally toward the tips of the branches in the case of Common Ringtail Possum damage or further back in the case of Common Brushtail Possums;
- A high density of possum faeces beneath affected trees that still have a reasonable amount of foliage;
- Tree decline is greatest in the species most palatable to possums, e.g. stringybarks and Swamp Gums (*Eucalyptus ovata*) rather than Red Box (*Eucalyptus polyanthemos*); and
- The least damage is found in trees that cannot be accessed by possums without going to the ground, which possums avoid doing because of the risk of being eaten by a fox.

In addition, in the few cases where crown health was recorded in winter and checked again in summer, there was a marked improvement. That would be consistent with possum damage (among other things) because eucalypt leaf growth may exceed consumption by possums during the active growth season in late spring and summer but the possums may gradually deplete the foliage during the low growth phase leading into winter. One year's observations at a small

number of sites is inconclusive. However, the observed seasonality does not seem consistent with some potential causes such as certain fungal diseases.

Recent studies in Manningham (abutting Maroondah) and the Mornington Peninsula (Yugovic 2015) have shown that possum browsing is a major cause of eucalypt deaths in those areas. A simple test was found to be ringing trunks with plastic bands that possums cannot climb (Yugovic 2015). This was done to five trees in 2016 at the 100 Acres Reserve in Park Orchards, 1½ km outside Maroondah, as reported by Luke Dragonetti of Manningham City Council. The trees had no leaves at the time of banding but showed new growth within a few weeks, clearly indicating an excessive possum population in the reserve. Of course, banding only works if possums cannot access the trees from adjacent trees or shrubs, above the plastic bands. Even if only one tree in a reserve is banded and seen to recover, that would indicate an excessive possum population which could explain foliage loss throughout the area. Corrective measures could then be considered, such as reducing connectivity between trees.

Banding of eucalypt trunks would be an easy, quick way to determine the severity of possum browsing in Maroondah.

A study by the University of Melbourne, funded by Maroondah City Council, is investigating whether Cinnamon Fungus (*Phytophthora cinnamomi*) or a related organism is killing trees by rotting their roots. The outward signs of Cinnamon Fungus disease are that:

- Trees show greatest symptoms (and often sudden death) during times of water stress, when Cinnamon Fungus is most active and the affected root system is unable to supply the tree's peak water needs (Jones *et al.* 2015); and
- Adjacent sensitive species die or become very sickly, particularly grass-trees and the Common Heath *Epacris impressa* (Cahill *et al.* 2008).

The fieldwork of the present study observed that debilitated eucalypts were often surrounded by healthy grass-trees and heaths, indicating against Cinnamon Fungus as a problem. No signs of affected grass-trees or Common Heath were found anywhere. In sites visited in both summer and winter of 2017, the symptoms of eucalypt decline were markedly worse in winter, contrary to the expectations of Cinnamon Fungus.

Whatever may be found to be the direct cause(s) of eucalypt decline in a particular area, it should be kept in mind that excessive tree density may be an underlying cause if trunks are much closer than 10 m apart.

In nature, whenever one type of organism declines or disappears, others take its place. That can be desirable or undesirable. At Birts Hill Reserve (Site 45) in 2017, the area beneath the dead and dying eucalypt crowns in Figure 2 put on a better wildflower display than perhaps anywhere else in Maroondah that year – see Figure 3. The reduced competition from trees for sunlight, soil moisture and nutrients appears to have favoured the wildflowers, as one might expect. Shrubs and trees can be expected to increase in coming years as part of ecological succession. Eucalypts may re-establish, depending on the cause of the recent decline and whether it abates.

This example is not to diminish the importance of eucalypt decline but to demonstrate that natural processes are responding and they offer hope in cases like Birts Hill Reserve. In vegetation that is less natural, reduced competition from dying eucalypts allows introduced species such as Sweet Pittosporums to thrive and displace indigenous flora and fauna, including any regenerating eucalypts.

Figure 3. Wildflowers thriving beneath the dying eucalypt crowns of Figure 2 at Birts Hill Reserve.

It is tempting to think that where indigenous eucalypts are dying out, perhaps we should plant different species that might be more robust and replace some of the dwindling ecological functions of the dying trees. The planted trees might be from other parts of Maroondah or further afield. This idea is being called 'support planting' within Maroondah City Council.

In cases like Birts Hill where natural processes are favouring indigenous plants, 'support planting' runs the risk of disrupting the natural regeneration. It may also upset complex, unknown ecological interactions. These risks would only be worth taking if the cause of eucalypt decline at a particular site has been well investigated and it is clear that the cause cannot be corrected and will not abate naturally.

There are far less ecological risks from 'support planting' in areas with little if any natural understorey. The risks may be less than those of doing nothing and completely losing a eucalypt canopy. However, it would still be sensible to first investigate the cause of the eucalypt decline at each site and see if it is a temporary phase or can be corrected.

If 'support planting' is undertaken in response to eucalypt deaths, it may be best to do it in conjunction with planting the species that have died. Once the planted trees are large enough to start competing with each other, an assessment could be made about whether the original species are healthy, in which case the 'support planting' can be thinned out.

It may be salutary to consider the history of past episodes of eucalypt decline in the local district and southeastern Australia more generally. Jurskis and Turner (2002) recounted episodes in Victoria between the 1940s and 2002 that had been variously attributed to salt, thirteen types of insects, five types of fungi, five kinds of vertebrate animals, four climatic perturbations and a parasitic plant. Many of these factors may have played a role in past episodes in Maroondah. One such factor involved Bell Miners. Loyn *et al*. (1983) demonstrated that abundant Bell Miners were indirectly causing eucalypt decline in Olinda. The same phenomenon was readily seen in

Maroondah in the 1970s to the 1990s (Lorimer *et al.* 1997). Like most other factors that might have caused past episodes of eucalypt decline in Maroondah, Bell Miners are no longer active; The present study could find no Bell Miners in Maroondah despite searching for them.

The history of past episodes of eucalypt decline suggest that we may find the current decline to be a temporary (albeit possibly serious) episode. Nature may heal itself. We may also be able to facilitate healing with a little more investigation.

5.1.6 Hybridisation of Common Correa

The Common Correa (*Correa reflexa* variety *reflexa*) is indigenous to Maroondah and this study found it in at least sixteen sites. However, in most sites, the offspring of wild plants are predominantly hybrids, crossed with garden plants in the same genus. Figure 4 shows a dense patch of the hybrids and a comparative view of the natural vegetation 25 m away to show the natural state of the vegetation.

Hybridisation appears to have arisen from pollen carried from ornamental Correas in neighbouring gardens, including *Correa alba*, *Correa baeuerlenii*, *Correa glabra*, *Correa reflexa* variety *speciosa* and probably cultivars such as *Correa* 'dusky bells'. Hybridisation is so prevalent that it appears likely that the indigenous form of Common Correa may die out in Maroondah within a decade or two.

Some of the hybrids exhibit the phenomenon of 'hybrid vigour', giving rise to dense patches that currently reach many tens of square metres like the one in Figure 4. The dense wildflowers that once occupied such areas have been killed or heavily suppressed by the Correas.

We therefore have the unusual situation in which the conservation of a species and its habitat requires the destruction of some of its own offspring (i.e. the hybrids). Knox City Council has been doing so in its jurisdiction since May 2012. There is an urgent need to do the same in Maroondah.

Selective removal of hybrids is confounded by the similarity of some of them to the natural Correas. The following features of the natural Correas help to distinguish them from the hybrids:

- The upper surfaces of the leaves are dull, fairly light green and at least slightly rough or mealy;
- Two leaves clasp the base of each flower. ('Base' means the end closest to the stalk);
- Flowers are probably never red or reddish; and
- The calyx (the cup surrounding the flower where it attaches to the stalk) is usually quite mealy, never smooth.

Indigenous nurseries in the region generally sell a mixture of the natural Common Correa and hybrids. Some of those nurseries particularly promote red-flowered hybrids because of the attractiveness of the flowers, thereby potentially worsening the spread of hybrids. Notably, the author found no hybrids in the stock at CRISP nursery in Ringwood.

Unfortunately, non-indigenous Correas are so common in gardens near nature reserves that hybridisation is probably impossible to stop. Nevertheless, it would be prudent for Maroondah City Council to not exacerbate the problem by planting Correas within (say) 200 m of nature reserves where wild Correas grow.

Figure 4. Top: A dense thicket of hybrid Correas in Birts Hill Reserve; Bottom: A representative view of other vegetation in the reserve.

5.2 Range Expansions into Maroondah

The past twenty-five years have seen some remarkable cases of species that previously occurred in forests of the nearby hills and have extended their range into Maroondah.

The first species observed to expand its range into Maroondah was the Wonga Vine, *Pandorea pandorana*. It occurred naturally in wet forests of the Dandenong Ranges, a few kilometres east of Maroondah, at the time of colonisation. The earliest record of it in Maroondah appears to be in 1990, on the western edge of Hochkins Ridge Nature Conservation Reserve. It presumably arrived via its windborne seeds. Since then, Wonga Vine has spread through Maroondah and beyond, often smothering large numbers of plants in native vegetation and substantially transforming habitat for flora and fauna. Figure 5 depicts an example in Ringwood North, where the vegetation was grassy and open when I surveyed it in 1997.

The aggressive spread of Wonga Vine represents a significant threat of local extinction of other species of flora and fauna.

Interestingly, the most rapid phase of spread of this species occurred during the Millennium Drought – the driest period in the history of the region – even though the species' previous range was in wet forests and rainforests.

Figure 5. Wonga Vine smothering all indigenous understorey in Ringwood North.

Twining Silkpod (*Parsonsia brownii*) is taking a very similar trajectory to Wonga Vine. The first record in Maroondah appears to have been in 2001 at 'Uambi', where it was absent in thorough surveys in 1997 and 1998. It appeared in Appletree Hill Reserve, Kilsyth South (Site 70 of Volume 2) in the past few years and is behaving similarly to the Wonga Vine in Figure 5.

The matted form of Nodding Saltbush (*Einadia nutans*) was common in drier parts of Victoria but has been spreading towards Maroondah. It has become common in Manningham municipality, immediately north of Maroondah, and it was first found in Maroondah during this study. In Manningham, it often smothers ground flora and is now the target of control efforts.

River Club-rush (*Schoenoplectus tabernaemontani*) occurs naturally in the Melbourne region, on the edge of the water of major streams (principally, the Yarra River). Before it began being used in planting about fifteen years ago, it was not recorded any closer to Maroondah than the Yarra River, and not in any wetland within at least 20 km of Maroondah. However, since it has been

planted in artificial wetlands, it has spread (presumably by waterbirds) into at least four natural wetlands in Maroondah, and many others in the region. In some cases, such as wetlands near the corner of Canterbury and Dorset Roads (Site 72 of Volume 2), it is aggressively displacing the natural plant and animal species. It is significantly reducing biodiversity in the affected wetlands.

It is therefore recommended that River Club-rush should not be planted in Maroondah.

Not all plant species that behave like Wonga Vine, Twining Silkpod, Nodding Saltbush and River Club-rush come from outside Maroondah. In this study, Small-leafed Clematis (*Clematis decipiens*) was found in many locations where it was absent during the surveys of the 1997 *'Sites of Biological Significance in Maroondah'* study. The new environments appear to have become drier in the interim, perhaps due to a combination of climate change, drainage works and increased impervious surfaces in the landscape. In some of the new locations, the clematis is smothering and displacing shrubs and ground flora, and perhaps displacing fauna.

Shiny Cassinia (*Cassinia longifolia*) is another plant species spreading within Maroondah but it has not shown a tendency to aggressively displace other plant species.

5.3 Naturalised Plants

Hundreds of non-indigenous plant species have become naturalised in Maroondah, from overseas or from other parts of Australia. ('Naturalised' means they persist and reproduce without deliberate assistance.) Many of the naturalised species are confined to gardens and wasteland where they have negligible, or no, impact on indigenous flora or fauna. This study did not attempt to document such plants.

Appendix B lists plant species that are naturalised in Maroondah's natural and semi-natural habitats.

It is common for people to regard any non-indigenous plant species within native vegetation as 'environmental weeds'. However, it is more helpful to reserve that term for species that are causing the loss of indigenous plants or preventing them from establishing, sometimes called 'drivers' of environmental change. Some other naturalised plants are better regarded as symptoms or 'passengers' of environmental change, not drivers (MacDougall and Turkington 2005). Removing 'passengers' from a site usually results in rapid recolonisation by the same, or similar, species unless one changes the underlying unnatural conditions that led to their presence.

Species that the present author regards as being major 'drivers' are highlighted with underlining in Appendix B.

Interestingly, Sweet Pittosporum is arguably the most serious environmental weed in Maroondah despite occurring naturally in warm temperate rainforest in Gippsland. It was evidently a popular garden plant in decades past, often under the name 'Mock Orange'.

5.4 Climate Change

Maroondah's climate is changing. The state government's booklet, *'Climate-ready Victoria: Greater Melbourne'* (dated November 2015) outlines the expected consequences for flora, fauna and humans. For flora and fauna, the consequences are listed as:

- 'Amplification of existing threats to flora and fauna;
- 'Changes to habitat;
- 'Altered disturbance regimes; and

- ‘Changing dynamics of invasive species’.

Section 5.1.3 (p. 28) indicates that the most severe threats to Maroondah’s flora involve species adapted to floodplain soils that are sodden in winter and dry in summer, the cause being drier winter conditions. Climate change is predicted to be a substantial and increasing contributor to those drying conditions.

Conversely, plants of ridges and hilltops survived the Millennium Drought much better and appear to be more tolerant of our drying climate.

These observations suggest that in general, vegetation of drier soils will be less affected by climate change than vegetation of damper soils. Wetland plants have shown themselves to be very adaptable to drying conditions, being able to regenerate when water returns following drought.

Mistletoes are a special case worthy of note. I estimate that approximately 95% of mistletoes on Maroondah’s eucalypts died during the Millennium Drought and none of them has been replaced. Those mistletoe species were common across most of Maroondah prior to the drought but are now scarce and highly localised. Mistletoes have very rarely been propagated in Australia. The seeds are dispersed solely by Mistletoebirds, which rarely venture into areas that have lost their mistletoes because the birds’ diet requires mistletoe fruits. We have lost both a beautiful, fascinating bird and an ecologically important group of plants from most of Maroondah for the long term; perhaps forever. Maroondah may also have already lost the Imperial Jezebel butterfly, whose larvae only eat mistletoes.

Climate change is predicted to cause worse droughts than the Millennium Drought in future.

The only place in Maroondah where mistletoes are surviving well is Bungalook Conservation Reserves in Kilsyth South. That site has many mistletoes of a species – Grey Mistletoe – that grows only on wattles and survived the Millennium Drought well. The Grey Mistletoes are supporting a population of Mistletoebirds, which may disperse seeds from the few remaining eucalypt mistletoes in the vicinity. However, Melbourne Water has proposed to remove the mistletoe-bearing wattles, which are regarded as a threat to the stability of the levee on which they grow. This highlights how the threats of climate change are often compounded by other stresses.

As some plant species die out from climate change and other causes, the vacated ecological niches in native vegetation will be taken by other species. Some of those species will be indigenous to Maroondah; some may grow naturally nearby and expand into Maroondah; some will come from gardens; and some will arrive from far away. The new arrivals will compete with some of the surviving indigenous species, thereby raising the likelihood of further local extinctions.

On the other hand, some introduced plants that already occur in Maroondah’s native vegetation will suffer from climate change. For example, blackberries and Sweet Vernal-grass diminished greatly during the Millennium Drought (as demonstrated in nearby Knox by Lorimer 2007), to the benefit of some indigenous species.

Some of Maroondah’s indigenous plant species are likely to benefit from climate change. Shiny Cassinia (*Cassinia longifolia*) may be an example, as it has expanded into historically moister habitats during and since the Millennium Drought.

6 Fungi and Lichens

Appendix C (p. 126) contains an inventory of 119 species of fungi and lichens that have been reported in Maroondah. Almost all the records were downloaded from the Atlas of Living Australia. Many species have not been recorded for over a century, probably due to the greater interest in fungi long ago. Fortunately, the Field Naturalists Club of Victoria and the National Herbarium of Victoria have created the FungiMap project in recent years and are starting to fill a large gap in our understanding of Victoria's fungi. That is important because fungi play vital roles in the environment. Some of them can be harmful to humans or other organisms. They are vital for nutrient cycling and the food chain. Most plants rely to a substantial degree on soil fungi to make nutrients available to their roots. Changes in fungi may be the cause of the collapse of some populations of orchids, which are vitally dependent on particular species of fungi.

Unfortunately, due to the shortage of information about local fungi and the limited scope of this study, no further analysis can be provided here. It is important to recognise this gap when considering this report's assessment of Maroondah's biodiversity.

7 Fauna and Wildlife Habitat

7.1 Habitat Features

This study found the following types of habitat being used to significant degrees by Maroondah's native fauna:

1. Expanses of natural and semi-natural forest and woodland, which provide habitat for the broadest range of fauna, from microorganisms and tiny invertebrates to Powerful Owls and Kangaroos;
2. Bushland residential areas with natural and semi-natural forest interspersed with homes and associated constructions. These areas support a subset of the fauna found in larger, less interrupted patches of forest;
3. Fragmented strips and small patches of semi-natural forest and revegetation beside roads and railway lines, supporting a subset of the fauna found in bushland residential areas (principally birds, insects and possums, and probably bats);
4. Fragmented strips and small patches of semi-natural forest and revegetation beside streams, supporting similar fauna to the last category as well as birds that move regularly along stream corridors, such as ibis and the White-faced Heron;
5. Streams, which provide habitat for microorganisms, worms, molluscs, yabbies, many insect larvae, fish, waterbirds, Buff-banded Rail, Rakali (or Australian Water Rat) and Platypus;
6. Wetlands, which provide habitat for microorganisms, aquatic invertebrates, birds, Shortfin Eel, Flathead Gudgeon, frogs and lizards;
7. Nature strips with mature street trees of species that are locally indigenous or Australian native. The trees provide food, nest sites, protective cover and movement corridors for birds and insects;
8. Open expanses such as ovals and wasteland, which provide habitat for a small number of bird species such as swallows, Black-shouldered Kites and Masked Lapwings;
9. The municipality's three golf courses, which combine artificial wetlands like item 6 (albeit polluted), strips of trees like item 7 and open expanses like item 8;
10. Public parks and residential gardens not falling into the previous categories, where one finds predominantly introduced fauna but also common urban wildlife such as possums, Rainbow Lorikeets, Magpies and Marbled Geckoes.

The first six categories above account for most of Maroondah's native wildlife (as well as indigenous flora) and they form the 'sites of biological significance' in Volume 2.

The following sections provide more details about the habitat in wetlands and non-aquatic habitats.

7.1.1 Wetlands

Wetlands are taken here to encompass all still bodies of water, even if they dry out regularly. As mentioned in Section 4.3.2 (p. 18), historical maps show extensive wetlands prior to colonisation but drainage work seems to have destroyed all of them. There are, however, artificial wetlands: (a) lakes and ponds; (b) wet depressions created incidentally by excavations; and (c) two wetlands beside Dandenong Creek formed by meanders of the original creek channel that were cut off when the creek was straightened and piped.

The fauna and flora of wetlands depend substantially on depth, frequency of dry periods and the slope of the ground around the wetland edges.

The presence of fringing rushes or sedges at most of the waterbodies provides cover and a food source for a range of wetland fauna such as tadpoles and Australian Reed Warblers. Shallow water supports a wide range of birds such as dabbling ducks, coots, moorhens, swamphens, herons, egrets and spoonbills. Deeper water with underwater plants supports diving waterbirds such as grebes, cormorants and Blue-billed Ducks.

Steep banks of wetlands minimise the area available for shallow water with rushes or sedges. That is very counterproductive for wetland fauna (not to mention flora). Most of Ringwood Lake and most waterbodies in golf courses suffer from this problem. By contrast, the lake at Bungalook Conservation Reserves in Kilsyth South has become so full of sediment that it is now all shallow and dense with wetland plants. The ducks and cormorants that once abounded there are now scarce. A combination of open water and vegetated shallow water is ideal.

Trees adjacent to wetlands are important for some waterbirds. The near-threatened Nankeen Night Heron relies on dense tree cover next to water for roosting. Australian Wood Ducks nest in tree hollows near water.

Many of Maroondah's wetlands are in poor ecological condition and contain excessive nutrients but they still provide important waterbird habitat. For example, Ringwood Lake is rather polluted but it still supports a range of wildlife including the Nankeen Night Heron, which is listed as 'near threatened' in Victoria. All lakes in Maroondah with permanent water are likely to provide refuges for waterbirds when rural wetlands dry up during droughts. For example, the pond outside the Croydon Library is small and has nutrient pollution but threatened waterbird species such as Blue-billed Duck and Great Egret took up residence there during the Millennium Drought.

The main cause of nutrient pollution at Ringwood Lake and the Croydon Library pond appears to be feeding of ducks.

7.1.2 Non-aquatic Habitat

With the exception of aquatic environments, the most important determinants of habitat value for Maroondah's wildlife are the naturalness, density, type and structural complexity of vegetation.

For birds, the most relevant evidence comes from research in Maroondah and nearby municipalities by White *et al*. (2005). They collected data about birds and vegetation in nature reserves and the following three types of residential streetscapes: (a) areas with predominantly indigenous or Australian native trees; (b) areas with predominantly mature, introduced trees; and (c) recently developed areas.

White *et al*. found that nature reserves had the largest number of species of native birds and the largest number of 'foraging guilds' of native birds. There were almost as many native bird species and slightly fewer foraging guilds in streetscapes dominated by indigenous or Australian native plants. Streetscapes of mature, introduced trees had markedly fewer native birds and higher incidence of a few introduced species, particularly Common Myna, Common Blackbird and Spotted Dove. The only significant difference in recently developed streetscapes was that the abundant introduced species were Common Myna, Common Starling and House Sparrow.

The number of native bird species was also found to be correlated with the number of indigenous or Australian native shrubs and the presence of leaf litter. The presence of more insect-eating bird species in the nature reserves and indigenous / Australian native streetscapes was inferred to reflect a greater abundance and diversity of insects in those environments.

The authors concluded:

> *'Remnants of native vegetation act as vital refugia of indigenous fauna in the urban landscape. …the retention and establishment of* [Australian] *native vegetation within streetscapes can complement existing remnant vegetation and the bird communities contained therein. Native streetscapes can potentially benefit native birds by:*
>
> - *'Facilitating the movement of species throughout the urban landscape;*
> - *'Providing habitat that is advantageous to native birds over introduced species; and*
> - *'Enhancing remnant vegetation in parks by diffusing abrupt edges between remnants and the built environment and reducing levels of isolation between parks (e.g. Catterall et al. 1991).*
>
> *'Many of the benefits of native streetscapes for native birds, as outlined above, are not realised in exotic streetscapes, as evidenced by the findings of this study. Considering the benefits of native streetscapes for bird communities, the implementation of effective strategies and incentives that encourage the planting of native vegetation in streetscapes and gardens should be paramount. This should include the full complement of vegetation life-forms from ground covers to trees. Furthermore, it is likely that the planting of indigenous vegetation would be more beneficial for bird communities by providing resources more closely resembling those of park remnants. Recher (2003) suggests that retaining all remaining native vegetation should be paramount for future restoration actions.'*

These findings are reflected in the sites of biological significance in Volume 2, which contain remnant native vegetation. (Some also contain wetland habitat.)

A comparable study of birds in suburban Canberra by Ikin *et al*. (2013) drew the following similar conclusion:

> *'Native street trees provide foraging resources for birds that would be reduced or absent in exotic streetscapes* [i.e. dominated by introduced plants], *enabling native streetscapes to support a rich community of birds. Furthermore, native streetscapes increase bird richness and diversity in adjacent reserves. This result has important conservation implications for suburb and reserve management practices. Our study provides evidence that the establishment and retention of native suburban streetscapes is an important management strategy for improved bird conservation.'*

There is therefore good evidence that in residential areas like those of Maroondah, native birds are strongly associated with neighbourhoods dominated by locally indigenous or Australian native trees and shrubs.

A large part of the reason why trees, alone, are not enough to support diverse native birds is that many native bird species need shrubs and small trees for food, nest sites and cover from predators.

Another reason that has become quite important in Maroondah involves the Noisy Miner. Since this study's precursor in 1996–1997, Noisy Miners have become more abundant and widespread in Maroondah. Their aggressiveness in evicting small birds from their territories is so notorious that federal legislation[*] recognises that overabundance of the species is a 'key threatening process' for biodiversity. The syndrome of abundant Noisy Miners displacing other birds tends to be associated with landscapes having eucalypts and little if any understorey, as is common in parks

[*] 'Aggressive exclusion of birds from potential woodland and forest habitat by over-abundant noisy miners (*Manorina melanocephala*)' was listed as a key threatening process under the *Environment Protection and Biodiversity Conservation Act 1999* on 9th May 2014.

and golf courses. Conversely, shrubs and small trees disfavour Noisy Miners and allow smaller birds to take cover from Noisy Miner attack (Ashley *et al.* 2007; Hastings and Beattie 2006).

However, not all shrubs favour diverse bird communities. Shrub species that produce copious nectar tend to cause an increase in aggressive Red Wattlebirds, which then displace a range of small, insect-eating birds. Prolific berry-producers such as cotoneasters, privets and ivy also favour a few (mainly introduced) bird species so much that many other species become displaced.

Now, let us return to the local study by White *et al*. (2005) discussed above. They inferred that part of the reason for finding fewer native bird species in landscapes dominated by introduced plant species is that those landscapes harbour fewer insects that birds eat. In other words, insect biodiversity is suppressed where introduced plant species dominate. Support for that conclusion comes from suburban Perth, where Bhullar and Majer (2000) investigated arthropods (principally, insects and spiders.) Those authors found that indigenous eucalypt species encouraged greater arthropod biomass than planted non-indigenous eucalypts or tree species from overseas. One only needs to turn over a fallen branch or disturb eucalypt leaf litter to see the abundance of invertebrates that rely on such habitat. The invertebrates are also an important part of nutrient cycling and putting organic material into soil.

Lizards are another fauna group affected by the type of vegetation, as evidenced by research by Jellinek *et al.* (2004) in bushland remnants of suburban Hobart. Those authors found that the number of lizard species per site increased significantly as the ratio of native plant species to introduced plant species increased. They confirmed the finding of other investigations that leaf litter is an important factor. Lizards appear to respond to the character of leaf litter from native plant species and also the seasons in which the leaves are shed. Wood litter was also concluded to be important to lizards. These are not surprising findings, given that lizards feed on invertebrates and require cover from predators.

Therefore, to support and encourage diverse communities of native birds, insects and lizards in Maroondah (aquatic habitats aside):

- The best habitat by a substantial margin is natural vegetation (which is mostly in the sites of biological significance in Volume 2);
- Outside bushland, such as in residential areas, amenity parks and golf courses, the best habitat includes eucalypts (particularly locally indigenous eucalypts) with shrubs, small trees and ground cover – but not too many plants that produce copious nectar;
- Retention of leaf litter and fallen timber is important for invertebrates and lizards;
- Park-like landscapes with eucalypts and little if any understorey (e.g. golf courses) are problematic because they encourage Noisy Miners; and
- Predominantly introduced vegetation (or no vegetation at all) displaces native fauna.

There are clear implications for:

- The current tendency to replace native street trees with introduced species such as Crepe Myrtles and ornamental fruit trees;
- The current rapid increase in residential development and consequent reduction in the area available for trees and shrubs;
- The relative level of planning protection that Maroondah City Council provides for indigenous or Australian native vegetation compared with species from abroad (Section 11.1); and
- The types of plants that Maroondah City Council encourages in landscape plans for new subdivisions (Section 11.2.1).

7.2 Mammals

This study found records of twenty-one indigenous species of mammals and seven introduced species. They are listed in Appendix D (p. 129).

7.2.1 Bats

The largest group of mammals are bats, represented by nine indigenous microbats plus the Grey-headed Flying-fox. The flying-fox is not indigenous to the Melbourne region but can now be seen regularly in large numbers over the whole region, despite the species being listed as 'vulnerable'.

The Common Bent-wing Bat is somewhat misnamed as it is now listed as threatened under the *Flora and Fauna Guarantee Act 1988*. It was last recorded in Maroondah in 1974 and may well have died out.

There appears to have been no survey of bats anywhere in Maroondah since 2002, and that survey was localised. There are no records of any microbat species since 2014 but some can occasionally be seen against the sky at dusk. A future survey of bats in Maroondah would fill a substantial gap in knowledge about the municipality's biodiversity. Such a survey is recommended in Section 12.4.1 (p. 103).

7.2.2 Other Indigenous Mammals

The author's sightings of Eastern Grey Kangaroo, Black Wallaby and Echidna have increased in numbers and spatial distribution since the 1997 *Sites of Biological Significance in Maroondah* study. Those species appear to be in no short or medium-term danger of local extinction.

Kangaroos are now even resident at Ringwood Lake Park. Kangaroo numbers have increased so much just to the north of Maroondah that they pose a significant threat to the local survival of some species of flora and possibly fauna. This study found no sign of a similar problem in Maroondah; in fact, the current low levels of grazing are favourable to maximising the diversity of flora species.

The population and distribution of Sugar Gliders appears not to have declined since 1997. They remain present at a number of locations north of a line through central Ringwood and central Croydon.

The Swamp Rat was first observed in Maroondah in 2016. It is now abundant at Bungalook Conservation Reserves in Kilsyth South (Site 66) and was also discovered during this study at nearby Appletree Hill Reserve (Site 70) and Dandenong Creek to the south. The species appears to have arrived from the east. The rats dig extensive networks of tunnels, making them 'ecosystem engineers'. They appear to be diminishing the unnaturally dense growth of Thatch Saw-sedge (*Gahnia radula*) in the areas they have colonised. They do this by chewing the rhizomes underground.

An Australian Water Rat or Rakali was reported during this study on Mullum Mullum Creek near Oliver St, Ringwood, where it was killed by a dog off-lead. The only other record of the species in Maroondah was in 1996 at Yanggai Barring Reserve in Warranwood. The other indigenous rat species, the Bush Rat, is similarly rare and has not been recorded since 1992. However, both these species might be found to be more common if a targeted survey were conducted.

This study found only two confirmed records of Platypus in Maroondah's history, both of which involved animals that had been mauled (apparently by dogs). One of those animals was found dead beside Mullum Mullum Creek at Yarra Valley Grammar School in 2015. The other was found injured in Brushy Creek near Brushy Park, Croydon North in 2013. It is possible that young

Platypus disperse up Mullum Mullum Creek and Brushy Creek when they are evicted from their parents' ranges. Dogs off-lead and possibly foxes make it hard for Platypus to survive in Maroondah.

Until the 1990s, Koalas were observed to move through parts of Maroondah in most years, without persisting for long in any one area. This was consistent with dispersal from the resident population to Maroondah's north, particularly Warrandyte and Wonga Park. Observations in Maroondah declined during the 1990s and the last record found in this study was 1999. The presumed source population to the north has also plummeted, based on observations by wildlife carers in Warrandyte. In fact, the Koala has now died out or become severely reduced in numbers in nearly all of its global range. It is therefore unlikely that Koalas will return to Maroondah in the foreseeable future.

The Spot-tailed Quoll records from North Ringwood in 1980 and Warranwood in 1978 are the last two records of that now-endangered species in the whole Port Phillip and Western Port region.

The only other indigenous mammals in Maroondah are the Common Brushtail Possum and Common Ringtail Possum. Those species are most abundant in residential areas, where they feed on garden plants and sometimes food hand-outs by residents. They mostly eat eucalypt leaves but also other leaves, fruit, flowers and, in the case of the brushtail possum, sometimes birds. They are in such large numbers in some residential areas that they appear to be causing significant harm to the tree canopy (see Section 11.6) and possibly to bird populations. Possums in these residential areas also feed in adjacent sites of biological significance, where they can do maximum ecological harm.

7.2.3 Introduced Mammals

Sambar (a species of deer) are rapidly expanding into northern Maroondah and beginning to cause environmental problems and a traffic hazard. This is part of a problem affecting a large part of Victoria. Sambar browse on plant foliage and small branches. They create wallows on floodplains, thereby damaging vegetation and aquatic ecosystems. Stags damage vegetation in rutting season by ringbarking with their antlers and breaking off branches to 2 m above ground during 'preaching' displays. Warranwood Reserve is currently part of a program to monitor Sambar (and potentially other deer species) in the Jumping Creek catchment.

On the current trajectory, Sambar will present a significant problem that Maroondah City Council will soon have to address, as Manningham City Council has done.

The European Rabbit is another introduced herbivore that can do substantial ecological damage. However, this study's incidental observations of rabbits and their impacts did not reveal significant damage or any apparent change since the 1997 *Sites of Biological Significance in Maroondah* study. Local natural ecosystems are well adapted to the moderate amount of grazing that was once done by larger numbers of indigenous herbivores.

Similarly, local ecosystems are adapted to indigenous predators such as quolls and goannas that died out approximately forty years ago. It has been proposed by Yugovic (2015) and others that the Red Fox is partly replacing the role of the lost predators, limiting the adverse impact that excessive possum populations are now having. Foxes were also observed in this study to be eating native and domestic birds. They probably also reduce the numbers of the introduced Black Rat, Brown Rat and House Mouse, which appear to be quite sparse in native vegetation but abundant around houses.

7.3 Birds

Appendix D (p. 130) lists 152 indigenous bird species and 15 naturalised bird species recorded in Maroondah. Some of the species have not been recorded for many years.

When interpreting bird lists, it is important to draw a distinction between birds that make use of habitat in Maroondah and those which are just seen flying over on their way toward habitat beyond. For example, a Grey Goshawk very occasionally appears in Maroondah (mainly during drought) but the transits are fleeting. Sightings of a Grey Goshawk do not mean that Maroondah plays any material role in the survival of that vulnerable species. Even some migratory wader birds must fly over Maroondah on their way from the northern hemisphere to coastal wetlands such as Western Port but such fly-overs mean nothing for conservation of Maroondah's biodiversity.

Those sorts of visits must be distinguished from more prolonged stays that some bird species make during periods of drought. For example, in the latter years of the Millennium Drought, several waterbird species listed as threatened in Victoria took up temporary residence at the pond outside the Croydon Library. The endangered Blue-billed Duck and the near-threatened Nankeen Night Heron could be seen there any day, and often the vulnerable Eastern Great Egret. The pond acted as a refuge during a time of great stress for waterbirds, so the records of those species at the pond are important even though the species are absent most of the time.

A Powerful Owl that currently has a home range spanning Ringwood North and Donvale is significant because the species is listed as vulnerable in Victoria. Equally importantly, an endangered Barking Owl has been observed in the same area over the past two years.

The Eastern Barn Owl was previously scattered through the outer eastern suburbs of Melbourne but there appears to have been very few records of the species in Maroondah in the past decade – one by the author in Ringwood North in 2017 and a few in Bayswater North in 2018. The Eastern Barn Owl appears to be one of a large number of bird species whose local populations have changed greatly over the past three decades.

Records of the following species have dramatically reduced over that period:

White-necked Heron	Striated Thornbill	Willie Wagtail
Eastern Barn Owl	Bell Miner	House Sparrow
Black-shouldered Kite	White-plumed Honeyeater	European Goldfinch
Silver Gull	Crested Shrike-tit	Mistletoebird
White-throated Needletail	Grey Shrike-thrush	Bassian Thrush

Over the same period, the following species have arrived or dramatically increased:

Crested Pigeon	Rainbow Lorikeet	Noisy Miner
Little Corella	Australian King-Parrot	Scarlet Honeyeater
Sulphur-crested Cockatoo	Pacific (or Eastern) Koel	Pied Currawong

There is a wide diversity of species in each of these two lists, considering their diets, feeding strategies, habitats, body sizes and families. A few of the declines, such as that of the Bell Miner and White-plumed Honeyeater, may be associated with the rise of the Noisy Miner, whose aggressive displacement of other species is discussed in Section 7.1.2 (p. 46). The Rainbow Lorikeet is also aggressive and probably displaces some species. Many of the same increases and declines have occurred in Adelaide, Canberra and Sydney over the same period. However, this study could find no satisfying explanation of why so many, disparate species changed so much, so quickly in multiple cities.

The high mobility of many bird species and the unpredictable, decade-by-decade changes in the species present in Maroondah make it hard to predict which species will never be seen in the

municipality again, even if they have not been seen for many years. Species whose names appear in red in Appendix D are those for which there is a reasonable presumption that they were once resident or at least regular visitors but unlikely to return in the foreseeable future, except perhaps as transients or rare visitors. Twenty-two indigenous species and one introduced species are in that category. However, some of these species may never have been more than vagrants or rare visitors in the first place and some others may return unexpectedly.

7.4 Reptiles

Appendix D (p. 133) lists seventeen indigenous reptile species in Maroondah. It also includes two species that were present in northern Victoria at the time of settlement and have since become naturalised in Maroondah.

Some of the reptile species that have not been recorded in Maroondah for many years may be still present but undetected. There appears to have been no targeted survey of reptiles in Maroondah for decades, other than at two proposed development sites.

Nevertheless, the Lace Monitor or Tree Goanna is so large and conspicuous that it can be confidently presumed to have died out in Maroondah. The Black Rock Skink is much smaller but still conspicuous enough that if it remains, it is odd that it has not been recorded since 1908. Three of the four snake species in Appendix D are also quite likely to have died out in Maroondah, taking into account when they were last reported and, in the case of the White-lipped Snake, the loss of habitat in the area where it was last seen in 1994. The absence of Tiger Snake from the list is surprising as that species has been reported in recent years on the southern bank of Dandenong Creek, just outside Maroondah.

In the author's experience, the indigenous Garden Skink and naturalised Marbled Gecko are common around houses, sometimes accompanied by Weasel Skinks, Blotched Blue-tongue Lizard and Common Blue-tongue Lizard. The Lowland Copperhead is strongly concentrated near streams and wetlands, possibly in part because snake handlers are inclined to release captured animals there.

7.5 Frogs

Appendix D (p. 134) lists ten frog species that have been recorded in Maroondah.

Peron's Tree Frog has been spreading down the Yarra River corridor and up tributaries over the past three decades. It reached Hochkins Ridge Nature Conservation Reserve by 1996 and Warranwood about a decade ago. All other frog species in Maroondah are indigenous.

The Southern Toadlet and Growling Grass Frog appear to have died out in Maroondah, as they have in most of their Victorian ranges. However, the Southern Toadlet persists in Donvale, 1½ km west of Maroondah.

Only one record of the Victorian Smooth Froglet was found (from 1988), but the location is so imprecisely recorded that it could refer to the sizeable population that remains at The 100 Acres Reserve in Park Orchards, just outside Maroondah. That species also occurs at Winton Wetlands in Wantirna, approximately 50 m outside Maroondah, so it is quite possible that it will be detected in Maroondah.

Verraux's Tree Frog is rare in Maroondah, the only record being the author's, from Ringwood North in 2017. The species may have gone undetected elsewhere because the calls can be hard to distinguish from those of young Southern Brown Tree Frogs.

The Striped Marsh Frog is rare in Maroondah, being on the edge of its range. All other frogs in Maroondah appear to be fairly common, though less abundant than during the wetter period prior to the Millennium Drought.

Amphibian Chytrid Fungus (*Batrachochytrium dendrobatidis*) is causing the collapse of numerous frog species around the world. Maroondah's commonest frog species, the Common Froglet, has been shown to be a carrier of the fungus and to thereby threaten the survival of other, more sensitive frog species (Branelly *et al*. 2017). Future substantial declines in local frog species may result.

7.6 Fish

Appendix D (p. 134) lists twelve fish species that have been recorded in Maroondah, of which only four are indigenous. The Short-headed Lamprey has not been recorded since 1968 but might conceivably reappear now that a 'fish ladder' has been built around the artificial 'Dight's Falls' weir in Collingwood. The other three indigenous fish species are likely to remain present in Maroondah, as are most or all of the introduced species.

It is very likely that a number of other fish species occurred in Maroondah's major streams and wetlands prior to European colonisation. The Dwarf Galaxias and River Blackfish are two examples, both of them having died out or severely declined in most streams in the region. The construction of weirs at Dight's Falls and Pillars Landing were serious problems for the survival of most indigenous fish species, followed by stream realignments and the consequent destruction of riparian habitat.

Shortfin Eels deserve special mention. They are born in the Coral Sea near New Caledonia and migrate to Maroondah, often travelling substantial distances over wet ground. They must then return to the Coral Sea to spawn. This must be one of the most amazing migrations of any species in our region. The species was once so abundant as to be a major food source for Aborigines.

The Short-headed Lamprey was recorded in Ringwood in 1968 – the only record of the species in the history of the Mullum Mullum catchment. It seems unlikely that the Short-headed Lamprey will reappear in Maroondah in the foreseeable future.

7.7 Butterflies

Appendix D (p. 135) lists twenty-six butterfly species that have been recorded in Maroondah. Twenty-one species are indigenous to Maroondah and none of them is subject to any listing as a rare or threatened species. One other species – the Cabbage White – was inadvertently introduced to Australia and is now the most abundant butterfly species in Maroondah. Four other butterfly species are native to Australia and have spread into Maroondah due to planting of species that are required as food for the butterfly larvae (caterpillars). Citrus are the larval food for the Orchard Swallowtail and Dainty Swallowtail; Swan Plant for the Monarch Butterfly and palms for the Orange Palm-dart.

Larval food plants are critical determinants of the location and abundance of most of Maroondah's butterfly species. The exceptions are the Caper White (which just blows into Maroondah from its inland home during strong northerly winds) and some of the Browns, whose larvae can eat a range of grass species.

The Moonlight (or Blue) Jewel and the Bright Copper have not been recorded since the 1950s and can be presumed to be locally extinct. The Spotted Skipper and Varied Swordgrass Brown are conspicuous but have not been recorded for over twenty years, so they are either locally extinct

or almost so. The Shouldered Brown may be in the same condition but it is possible that it has gone undetected due to similarity to the Common Brown.

The Imperial Jezebel (formerly known as the Imperial White) needs mistletoe as its larval food plant. As discussed in Section 5.4 (p. 41), Maroondah's mistletoe population dropped by about 95% during the Millennium Drought and cannot recover. As a result, the Imperial Jezebel is also unable to recover. To make matters worse, the Imperial Jezebel favours the species of mistletoe that have suffered the worst decline. The Imperial Jezebel may have already died out in Maroondah.

The Varied Swordgrass Brown may also have died out. Its larval food plant is the Red-fruit Saw-sedge (*Gahnia sieberiana*), which declined greatly during the Millennium Drought and has not recovered.

The Silky Hairstreak has been recorded only once in Maroondah, by the author at Bungalook Conservation Reserves in 2016. It has a symbiosis with a particular species of ant and it requires specific food plants.

The related Imperial Hairstreak (Figure 6) needs particular species of wattles to eat and its larvae must be attended by one of several species of ants. Three colonies were found during this study: beside Dandenong Creek in Heathmont, beside Mullum Mullum Creek in Ringwood and beside Brushy Creek in Croydon. There is circumstantial evidence of a decline in numbers in Maroondah.

The Ringed Xenica was recorded widely and in substantial numbers during the 1997 *Sites of Biological Significance in Maroondah* study. In the present study, it was only found at four locations, in much smaller numbers than in the 1997 study. To a lesser degree, the Klug's (or Marbled) Xenica also appears to have declined substantially in numbers and distribution.

The only indigenous species that are not rare and have shown no signs of decline are the Yellow-banded Dart (or Greenish Grass-dart) and the Common Grass-blue. Both species now live mainly on planted vegetation and are therefore not affected by declining native vegetation.

Figure 6. Silver Wattle with Imperial Hairstreak adult (left) and larva attended by ants (right).

7.8 Other Invertebrates

Butterflies were chosen in this study as convenient proxies for the much larger range of local insects. The substantial decline of so many butterfly species should be taken as a warning of comparable declines in large numbers of other insect species, as has been independently observed in the world's bees. Insects are such a large part of biodiversity, and play such a critical role in the natural world, that the declines should raise considerable concern. This study has not researched the causes of the declines in insects, other than the decline of larval food plants. Therefore, no solutions or implications can be provided here.

It should be kept in mind that this study has not included large numbers of invertebrate species other than insects, such as spiders, worms, yabbies and slugs.

7.9 Habitat Corridors

Habitat corridors are routes favoured by one or more fauna species in their daily, annual or occasional movements around the landscape. These movements sometimes carry pollen, seeds or plant fragments that allow plants to reproduce, disperse or exchange genes. The movements can help native species to survive and/or allow introduced species to spread and potentially displace indigenous species (Bennett 2003). Most flora species and many fauna species of low mobility receive no benefit from corridors; on the contrary, those species may be displaced by other species moving into their habitat via corridors.

The *'Maroondah Habitat Corridors Study'* (Context 2005) mapped what the authors surmised to be habitat corridors on the basis of factors such as linear continuity of tree canopy. However, they presented little evidence about the importance of those factors and no evidence that wildlife actually moves preferentially along the presumed corridors.

The present study did not seek observational evidence of the locations or effectiveness of habitat corridors, either. Instead, we turn to pre-existing studies.

Lorimer *et al*. (2009) documented extensive observations of bird trajectories in Manningham, immediately north of Maroondah. They concluded that streams are the main corridors for birds and 'All streams and gullies, from the most natural to the most modified, function as wildlife corridors, regardless of the width of native vegetation on either side of the stream or gully'. They also found that birds are more numerous, and in a wider range of species, along a semi-natural section of Mullum Mullum Creek than in an adjacent area of much more natural forest. No evidence was found that birds moved along a strip of revegetation even though the strip had been planted to create a wildlife corridor.

A plausible explanation for so many birds favouring stream corridors is that soil moisture and nutrients are concentrated there, supporting maximum photosynthesis that forms the base of the food chain.

Birds in Maroondah are very unlikely to behave differently than in Manningham. We should presume that stream corridors are important for native birds, regardless of how natural they are.

Lorimer *et al*. (2009) did not investigate the effectiveness of vegetated roadsides as corridors but Bennett (2003, Table 5-1) cites evidence from various countries. In that study, the roadside-using species most relevant to Maroondah are kangaroos, echidnas, two non-local parrot species, White-naped Honeyeater, Sugar Glider, Rufous Whistler and the introduced Common Myna.

This study found no research involving railway reserves as potential habitat corridors but one could reasonably presume that a railway reserve would function like a similarly-vegetated road reserve.

8 Summary of Findings re Sites of Biological Significance

8.1 Criteria and Boundaries

'Sites of biological significance' are areas that best embody the things that make nature important, which were summarised in Section 1.3 (p. 3). Within the spectrum from the most important areas to the least, an area must exceed a threshold before it can be classified as a site of biological significance.

The threshold adopted here is based on the state government's criteria titled *'Standard Criteria for Sites of Biological Significance in Victoria'* (Amos 2004). The criteria are detailed and objective, and fall under the following headings:

- *Ecological integrity and viability*: Naturalness and importance in maintaining natural processes such as wildlife migrations;
- *Richness and diversity* of flora, fauna or ecological communities;
- *Rarity or conservation status* of flora, fauna or ecological communities;
- *Representativeness*: The best examples of an ecological community and its range of variability; and
- *Scientific and educational value*.

There are multiple criteria under each heading, totalling 104 in all. The criteria relevant to Maroondah are discussed in more detail in the introduction to Volume 2. They result in sites being rated on a scale of 'Local', 'Regional', 'State' or 'National'. These ratings are intended to reflect the spatial scale over which a site 'makes a substantial contribution to the conservation' of nature. The overall significance rating of a site as a whole is the highest rating under any one criterion.

At the low end of the significance scale, any patch of native vegetation occupying at least 0.25 ha and with 10% or more native understorey cover[*] is rated as 'Local' significance or higher.

In this study, nearly all areas rated as 'Local' significance or above are treated as sites of biological significance. However, at the margin, there is an additional consideration: how appropriate it would be for each site to come under a planning policy in the Maroondah Planning Scheme. The policy in mind here is described in Section 11.1.2.5 on p. 77. There are a few small areas that might barely rate as 'Local' significance but are not classed here as sites of biological significance because they do not warrant any specific recognition in the Maroondah Planning Scheme. Vegetation in those areas already has adequate planning protection through the Significant Landscape Overlay and/or the state-wide regulations regarding native vegetation.

All 109 areas of Maroondah that have been accepted here as sites of biological significance are individually documented in Volume 2. A boundary is given for each site, encompassing all the features that are significant about the site, sometimes rounded out slightly to match clearly defined features such as a fence. For some sites, a separate boundary is given for the area recommended for protection under a planning overlay. As discussed in Section 11.1.2.3 (p. 76), the overlay area may be larger or smaller than the area containing the biologically significant attributes, for a range of reasons.

[*] The 'patch' definition adopted by the standard criteria came from the 'Operation Guidelines': 'A patch is a continuous area of native vegetation that is at least 0.25 hectares in extent and indigenous native understorey cover is 10% or greater'. Understorey includes trees other than canopy species.

8.2 Spatial Distribution and General Features

Figure 7 is an overview map of the 109 sites of biological significance detailed in Volume 2, colour-coded by land use. In this report, the land use category 'nature reserve' refers to land managed principally for nature conservation by Maroondah City Council, Parks Victoria or the Trust for Nature.

The sites of biological significance occupy 12% of Maroondah's area. As discussed in Section 11.1.2.1 (p. 73), a range of planning provisions are recommended to apply to different sites, varying according to the level of significance and other factors. As discussed in Chapter 9 (p. 65), biodiversity values of the remaining 88% of Maroondah should not be ignored.

The sites of biological significance:

- Contain patches of native vegetation and/or aquatic habitat, sometimes along with adjacent treed areas that act as an ecological buffer zone;
- Include all wetlands and above-ground sections of streams;
- Collectively contain all species of flora and fauna that are believed or suspected to be at risk of dying out in Maroondah. Many of those species do not occur outside the sites;
- Vary in significance level but even those at the low end of the spectrum often contain species that are poorly represented in the higher-rated sites. The 'tree reserve' at the corner of Maroondah Hwy and Dublin Rd is a good example. It was heavily mown and treated as an amenity park for many decades, leading it to be not even rated as 'Local' significance in the 1997 forerunner of the present report. However, with cessation of mowing, it has been found to reach 'State' significance. It contains plant species that are rare throughout Maroondah, of which the Sharp Midge-orchid (*Corunastylis despectans*) is only known to persist in Maroondah at one other site.

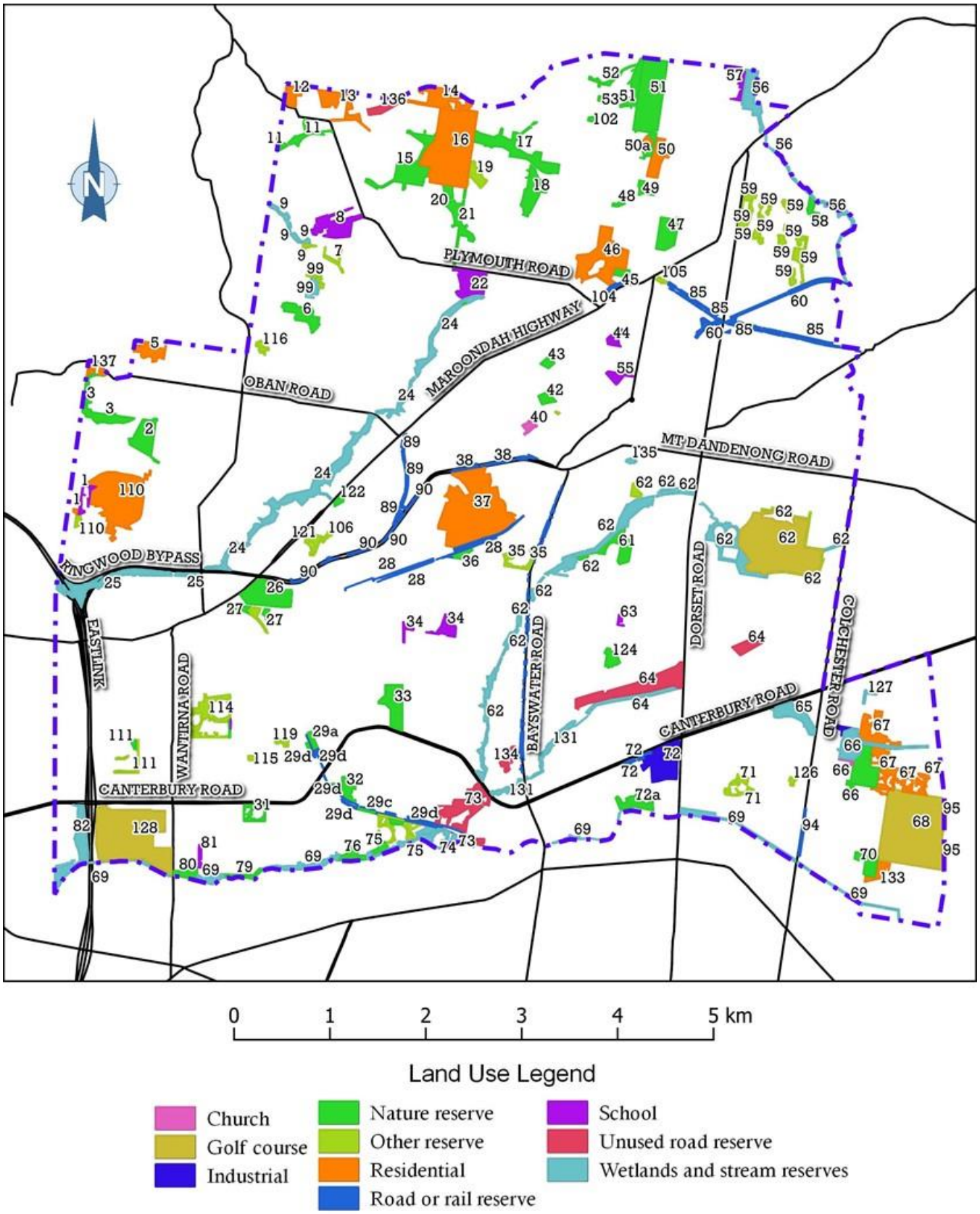

Figure 7. Overview map of the sites of biological significance detailed in Volume 2, colour-coded by land use and labelled by site number. The purple dash-dot line is the municipal boundary.

8.3 Significant Attributes

The attribute that most commonly determines the significance of sites in Maroondah is the presence of a patch of an Ecological Vegetation Class (EVC) listed as endangered. Under the state government's 'standard criteria', any site containing such a patch is rated as State significance, even if the patch is as small as 2,500 m² and has lost most of its original species. 'State significance' does not necessarily mean that the site stands out across Victoria; Rather, endangered EVCs are so scarce that all surviving examples are deemed to make a substantial contribution to the state-wide conservation effort (Amos 2004).

As discussed in Section 4.4 (p. 23), most Ecological Vegetation Classes in Maroondah are listed as endangered. Some of the others are listed as vulnerable. A site that includes a vulnerable EVC in all but very poor ecological condition ('habitat score' less than 0.3) rates as State significance.

The standard criteria for assessing sites of biological significance, just discussed, are rather academic in outlook. They do not consider some of the values that nature offers, which were discussed in Section 1.3 and Table 1 (p. 3). In particular, they do not consider practical 'ecosystem services' or benefits to the economy or human health, wellbeing, childhood development and quality of life. (The state-wide planning controls over vegetation removal also ignore these benefits.) Let us now consider these broader values of nature, as follows:

1. Practical 'ecosystem services'

The wetlands in sites of biological significance reduce water pollution. They also reduce the pulsing of stormwater runoff by detaining water and allowing it to infiltrate the ground. These benefits help the whole catchments of Maroondah and downstream, to a degree that varies from wetland to wetland. On the other hand, feeding of ducks adds so much nutrient to some waterbodies that it can negate the benefits of water purification.

The other local ecosystem services – microclimate moderation, air purification and noise reduction – are much more localised in their benefits. People living, working or recreating in or near sites of biological significance receive these benefits from the sites, but these people are in the minority. Most of the Maroondah community probably receive less benefits of microclimate moderation, air purification and noise pollution from sites of biological significance than from street trees and plants in gardens and small local parks.

2. Financial and economic benefits

In Maroondah, the main economic benefits of vegetation and fauna in sites of biological significance identified in this study relate to property values and employment in vegetation maintenance. However, such considerations are quite peripheral to this study, so no details are provided here.

3. Human attachment to nature

The sites of biological significance are Maroondah's most natural places. Wildflower displays, wildlife and natural landscapes are more abundant and authentically natural in the sites than elsewhere. In these respects, the sites of biological significance offer people the most intense benefits to health, wellbeing, childhood development and quality of life that can be gained through experiencing nature.

However, most of the Maroondah community do not enter sites of biological significance on a daily basis. Those people may get a substantial part of their contact with nature through things around their homes or workplaces, such as their gardens and birds in street trees. The relative roles

of the sites of biological significance and the rest of Maroondah are discussed further in Chapter 9.

Although the Department of Environment, Land, Water and Planning's standard criteria for sites of biological significance do not consider such matters, they act to some degree as a proxy. They place weight on naturalness for ecological reasons and they place weight on threatened flora and fauna, which are concentrated in the most natural environments. The standard criteria take no account of sites' accessibility for people to experience the benefits that the sites offer.

4. Natural heritage

Natural heritage is clearly best embodied by the most natural environments. Most of Maroondah's pre-European plant species are only found in the sites of biological significance. Many fauna species range more widely but most of them could not persist in Maroondah without their core habitat in sites of biological significance.

Therefore, Maroondah's natural heritage relies critically on the sites of biological significance.

For at least part of the Maroondah community, our natural heritage is part of what makes Maroondah 'home'; part of what we have been handed down by earlier generations and what we hope future generations will experience and enjoy.

Sites of biological significance on public land allow all of the community to experience our natural heritage. Sites on private land allow the landowners to feel more intimately involved with their natural heritage.

The Department of Environment, Land, Water and Planning's standard criteria for sites of biological significance act to some degree as a proxy for valuing natural heritage.

5. Caring for species other than our own

This is the focus of the Department of Environment, Land, Water and Planning's standard criteria for sites of biological significance and therefore well reflected in the sites' significance ratings.

In most of Maroondah, the original species of flora and fauna have been permanently exterminated to create agricultural or urban environments. That process continues in parts of Maroondah. There is an ethical view that the hundreds of surviving species deserve not to be completely exterminated; that a small part of Maroondah should be left for them to inhabit. For most of those species, the sites of biological significance are critical to their survival. In the case of at least two species (the Kilsyth South Spider-orchid and the Porphyry Wallaby-grass), a site of biological significance is critical to its survival anywhere on Earth.

8.4 Changes Since 1997

This section of the report compares the extent and condition of sites of biological significance in this study with the findings in the 1997 report, *'Sites of Biological Significance in Maroondah'* (Lorimer *et al.* 1997). The comparisons are somewhat constrained by the limitation that the present study only inspected some sites in a rather cursory way, due to the project budget.

8.4.1 Recognition of Sites

The 1997 report recommended 82 sites to be covered by the current Vegetation Protection Overlay. Of these 82 sites, five (sites 10, 30, 39, 52 and 54) have lost nearly all their habitat and biological significance and have ceased to qualify as sites of biological significance. The remaining 77 sites are retained here but some of them have changed boundaries. In addition, for

practical reasons, one site has been split into four, two sites have been split in two and three abutting sites have been amalgamated into one. These changes have resulted in the original 77 sites becoming 80.

The 1997 report also recognised 50 sites (sites 83–132) as containing habitat that was less significant than the others but still warranting planning protection at a level lower than the Vegetation Protection Overlay. Of those 50 sites, the following 26 are not retained here as sites of biological significance:

- 7 sites (mostly very small) that have lost almost all of their habitat and significance;
- 5 small sites that have lost enough of their habitat that they no longer warrant recognition for their biological significance; and
- 14 sites that do not meet current criteria for sites of biological significance even though they would still qualify under the criteria of 1997.

On the positive side, this report recognises five new sites of biological significance. Four of them have shown no substantial improvement in their habitat but they now warrant recognition because the significance of the habitat has become better recognised. Finally, Croydon Library pond and its surrounds are added as a new site because the habitat has been substantially improved and has been observed to act as a drought refuge for threatened waterbirds.

8.4.2 Extent of Habitat

The amount of change in cover of native vegetation was estimated by comparing information from 2018 (aerial photography and this study's field observations) with information in the 1997 report and aerial photography from 2001. Small changes are hard to detect in this way.

Of the 82 sites recommended in 1997 for the Vegetation Protection Overlay, it is estimated that:

- 24 sites have experienced clear net decreases in the extent of habitat;
- 22 sites have experienced clear net increases; and
- 36 sites have shown no clear change.

However, note that these statistics say nothing about the sizes of the increases and decreases.

Of the additional 50 sites recognised in 1997 plus the five added in this report, it is estimated that:

- 19 sites have experienced clear net decreases in the extent of habitat;
- 18 sites have experienced clear net increases;
- 17 sites have shown no clear change; and
- 1 site's situation is unclear.

Table 6 summarises cases in which at least 0.1 hectare of habitat has been lost. The total is 58 hectares. 52% of the total resulted from residential subdivision of the Croydon District Golf Club course to create 'The Range' housing estate.

Notably, the extensive Warranwood Environmental Living Precinct (Site 16) has not lost a detectable amount of native vegetation. This observation reflects well on the effectiveness of the area's planning provisions and the willingness of the residents to keep their native vegetation.

Table 6. Summary of hectares of habitat destroyed since 1997, categorised by cause.

Site number and location	Ha destroyed
Residential development – clearing of whole sites	
3. 'Barnsdale Forest', 'Oban Woods' and Loughies Tk estates	3.5
39. Sacred Heart Monastery (now Aveo Mingarra), Croydon	1.2
10. Delatite Court drainage line, Warranwood	1.1
101. 'Tandarra' subdivision, Ringwood	0.5
103. 141-149 Holloway Rd, Croydon North	0.4
118. The former Eastern Secondary College, Heathmont	0.2
Residential development and uses – partial clearing	0
59. Croydon District Golf Club	30
65. Skye Court estate, Bayswater North	2.1
46. Richardson Road Residential Precinct, Croydon	1.0
37. Ruthven Avenue – Vasey Concourse Envtl Living Precinct, Croydon	0.8
57. Village School, Croydon North (subdivided to 13 Holloway Rd)	0.8
50. Exeter Ridge Residential Precinct, Croydon North	0.7
64. Healesville Freeway Corridor, Bayswater North (51 Bayfield Rd)	0.6
5. Smedley Rd – Berringa Rd Residential Precinct, Ringwood North	0.5
8. Melbourne Rudolf Steiner School, Warranwood (Dromsally Rise)	0.5
67. Tereddan Drive, Kilsyth South	0.5
78. Alexanders Bush, Heathmont	0.5
107. Jenkins Close, Ringwood North	0.5
123. Vista Avenue, Ringwood East	0.5
110. Loughnans Hill Residential Precinct, Ringwood North	0.2
131. Bungalook Creek Corridor, Bayswater Rd to Canterbury Rd	0.2
Industrial development	0
72. De Felice Development Site, Bayswater North	0.5
School developments (e.g. for buildings, car parks and sports areas)	0
34. Tintern Grammar, Ringwood	1.2
22. Yarra Valley Grammar School, Ringwood	0.6
113. Former Southwood School, Ringwood	0.3
8. Melbourne Rudolf Steiner School, Warranwood	0.2
55. Croydon Primary School	0.2
1. Ringwood Heights Primary School, Ringwood North	0.1
54. Yarra Road Primary School, Croydon North	0.1
120. Heathmont East Primary School	0.1
Road and rail projects	0
30. Eastlink Corridor west of Cadburys, Ringwood	4.8
93. Canterbury Rd (south side), Bayswater North	1.5
25. Mullum Mullum Valley west of New St, Ringwood	0.6
82. Eastlink Corridor Billabongs west of Ringwood Public Golf Course	0.6
91. Mt Dandenong Road roadside (southern side), Kilsyth	0.5
88. Dorset Rd beside 'The Range' estate	0.2
109. Railway corridor, Heatherdale Rd to Eastlink	0.2
TOTAL	58.0

Increases in the extent of habitat have occurred through natural regeneration, planting, and broadening of the crowns of pre-existing trees. It is much easier to quantify the extent of clearing than the slow, incremental development of vegetation. This is particularly true of the countless trees whose crowns have expanded slightly into areas that formerly had no habitat – individually representing a tiny amount but contributing to a substantial total. Therefore, gains cannot be quantified in a similar way to the losses of Table 6. In any case, increases in extent are not very meaningful without consideration of the habitat's condition; e.g. 1 ha of a newly planted revegetation bed is not at all comparable with 1 ha of high-quality habitat cleared.

One example of habitat being added to a site is along Dandenong Creek. Figure 8 shows aerial photographs of the area between the creek and an aged care facility in 2000 and 2018.

Figure 8. Aerial view of revegetation beside Dandenong Ck, Ringwood, in 2000 (top) and 2018 (bottom).

The earlier photograph shows bare clay fill that had recently been dumped on the site during earthworks for the aged care facility. Over subsequent years, some of the eucalypts whose root systems were covered with the clay died. However, revegetation now provides habitat that contains canopy trees, understorey trees, shrubs and groundcover. This habitat expands the site of biological significance that abuts to the east (Scott Street Reserve – Site 80) and reduces fragmentation of habitat along the Dandenong Creek corridor (Site 69).

Another example of expanded habitat is the area of revegetation and artificial wetlands on the southern side of the Ringwood Bypass Road between Warrandyte Rd and New St. The habitat value has improved enough to make this strip meet the criteria for a site of biological significance, so it is added here to site 25. This area has achieved the intention of compensating in part for the habitat destroyed by the bypass road.

8.4.3 Ecological Condition of Vegetation

While comparing aerial photographs like those in Figure 8, it became apparent that the number of large eucalypt crowns has increased in many sites of biological significance. The abundant dead and dying eucalypts that were seen during fieldwork and in recent years are also visible in aerial photographs.

The possible causes of eucalypt decline and deaths are discussed in Section 5.1.5 (p. 34).

Eucalypt deaths and disease represent a decline in the ecological condition of habitat. The same might be said of the decline in the population of some indigenous plant species (Section 5.1.3 on p. 27). However, in many cases, the loss or decline of a plant species in one of Maroondah's sites of biological significance can be attributed to 'extinction debt', i.e. the delayed impacts of past actions. Some examples are given in Section 5.1.3. In other cases, the loss or decline of a species appears to be due to general deterioration of the ecological condition of the habitat, particularly due to drying of the landscape or displacement by highly competitive, non-indigenous plants ('environmental weeds') such as Sweet Pittosporum and Wonga Vine (Section 5.3, beginning on p. 41).

This study did not determine quantitative measures of each site's ecological condition. However, this study's fieldwork observations can be qualitatively compared with the categorisation of each site's vegetation on a scale from 'A' to 'D' by Lorimer *et al.* (1997).

On this qualitative basis, the author's assessment of changes in the ecological condition of the 82 sites recommended in 1997 to be covered by the Vegetation Protection Overlay is as follows:

- 4 sites have been largely or wholly cleared;
- 20 other sites have deteriorated noticeably in ecological condition;
- 12 sites have noticeably improved;
- 8 sites are quite variable between improvements and deterioration;
- 22 sites show no clear change; and
- 16 sites could not be adequately inspected to tell.

However, note that these statistics say nothing about the magnitudes of the improvements or deteriorations.

Of the additional 50 sites recognised in 1997 plus the five added in this report, it is estimated that:

- 7 sites have been largely or wholly cleared;
- 6 other sites have deteriorated noticeably in ecological condition;

- 14 sites have noticeably improved;
- 2 sites are quite variable between improvements and deterioration;
- 15 sites show no clear change; and
- 11 sites could not be adequately inspected to tell.

Council Land

Turning now to sites where Maroondah City Council has actively sought to improve or maintain the ecological condition (or arrest decline), 17 sites have improved, 7 have deteriorated, 13 have not changed noticeably and 5 have had mixed results.

The seven deteriorating sites have each experienced substantial eucalypt deaths and/or drying of floodplains.

A few sites have only been managed by Council as nature reserves in the past five years (approximately) and have shown remarkable improvements in ecological condition. The best examples are Proclamation Park (Site 111) and the 'tree reserve' on the corner of Dublin Rd and Maroondah Hwy (Site 122). In both cases, their ecological condition has improved so much that their significance rating has risen from Local to State.

The introduction of ecological burning has regenerated plant species in some of Council's nature reserves. It has also been found that fire can promote excessive regrowth of the indigenous Thatch Saw-sedge (*Gahnia radula*) and Forest Wire-grass (*Tetrarrhena juncea*), which can be a problem for fire hazard and ecological condition. A very effective response has been found to be following up a burn with cutting of ground flora during the largely dormant period of summer and early autumn. This has been very successful at favouring many small plant species such as orchids. As a result, carefully timed brushcutting has been extended to a number of nature reserves that are not burnt. The outcomes are good for biodiversity and fire protection.

Two main types of problem are associated with habitat having deteriorated despite council's efforts to stop it. The first is the drying of floodplains and the resultant displacement of the original vegetation by introduced plants adapted to less consistently wet conditions – see Section 5.1.3 (p. 27). The following sites have experienced deterioration of ecological condition of riparian (streamside) or floodplain vegetation despite adjacent vegetation improving in condition: B.J. Hubbard Reserve (Site 2), Warranwood Reserve (Site 15), Cherry Tree Grove Reserve (Site 23), Warrien Reserve (Site 47), Hochkins Ridge Drainage Reserve (part of Site 51), Eastfield Park (Site 61) and Connolly Crescent Reserve, Bayswater North (Site 72a).

Eucalypt deaths represent the other prevalent problem associated with habitat having deteriorated despite council's efforts.

Schools

Sites of biological significance within schoolgrounds have mostly deteriorated slightly in ecological condition since 1997. The declines have mostly been associated with increases in non-indigenous plants such as Wonga Vine (*Pandorea pandorana*) and Sweet Pittosporum (*Pittosporum undulatum*).

9 Findings about Biodiversity Outside the 'Significant Sites'

The level of biological significance varies across Maroondah in a continuous spectrum, from the most important areas to the least. While the 'sites of biological significance' in Volume 2 contain the most important habitat for indigenous flora and fauna, the remaining 88% of Maroondah still supports aspects of nature that are collectively important.

9.1 Values of Flora & Fauna Outside the Sites

The following is an assessment of the values of flora and fauna outside the sites of biological significance, categorised as in Sections 1.3 (p. 3) and Chapter 8.3 (p. 58).

1. Practical 'ecosystem services'

All of the ecosystem services discussed in Section 1.3 can be provided by vegetation outside the sites of biological significance, regardless of where the plant species may originate from. In fact, the small proportion of Maroondah occupied by sites of biological significance means that more people benefit from ecosystem services provided by vegetation outside the sites; e.g. shade from street trees and reduction of noise by shrubs in areas of heavy traffic. Even 'green roofs' can provide temperature regulation and noise reduction for large buildings.

These benefits are becoming increasingly important due to climate change, the increasing density of urban development and the associated reduction in vegetation cover noted by Kaspar (2018).

The provision of ecosystem services varies across Maroondah according to the amount and type of vegetation. There is too little vegetated ground in industrial areas and some commercial and residential areas for it to make a substantial contribution toward reduced stormwater runoff, flooding and water erosion. Those same areas tend to have too few trees to receive much shade, wind protection, temperature moderation and air purification compared with more treed areas. The benefits of shrubby vegetation for noise reduction are only realised where noise is a problem – particularly beside busy roads.

2. Financial and economic benefits

The 'Maroondah 2040 Community Vision' speaks of the future community 'living in green, leafy neighbourhoods'. This attests to the desire of many in the community to live in areas with treed and shrubby neighbourhoods, not just sites of biological significance. That desire inevitably translates to higher real estate values in Maroondah's more vegetated neighbourhoods. For many people, birdlife and sometimes other fauna contribute to the attractiveness of 'green, leafy neighbourhoods'.

Maintenance of gardens and trees also generates economic activity and jobs.

3. Human attachment to nature

For most of the Maroondah community, day-to-day contact with nature comes not from sites of biological significance but from gardens, street trees and local parks. The popularity of gardening is one indication of people's desire to interact with nature. Birdwatching and feeding of birds are others. Most people enjoy walking along tree-lined streets beside shrubby gardens, or through a vegetated park, rather than through an unvegetated landscape.

Obviously, plants do not have to be indigenous for people to enjoy them but for some people, it helps. As explained in Section 7.1.2 (p. 45), indigenous plants provide the greatest diversity of

birds, butterflies, lizards and other wildlife for people to enjoy. Plant species from elsewhere in Australia are next-best. Most introduced plant species tend to displace most native wildlife.

Although wildlife is concentrated in the sites of biological significance, many birds, mammals, frogs, butterflies and other insects move out into surrounding neighbourhoods from time to time. These movements bring wildlife into the daily lives of those neighbourhoods.

For these reasons, the primary determinants of how well a particular neighbourhood serves people's attachment to nature are:

- Proximity to sites of biological significance;
- Whether the neighbourhood's vegetation is predominantly indigenous (best), Australian native (second-best) or of foreign species (clear last); and
- The amount and structure of vegetation, as discussed in Section 7.1.2 (p. 45).

4. Natural heritage

Unlike many parts of the world, most of Maroondah has at least a scattering of indigenous trees to retain something of the landscape from centuries ago. This is true even in central Ringwood, with native vegetation along Mullum Mullum Creek next to Eastland and wild eucalypts beside Seymour St south of Costco. These links with our natural heritage are mostly wild but some have been planted.

Few indigenous shrubs or wildflowers grow outside the sites of biological significance. Wild, indigenous trees have perhaps persisted longer than shrubs because more people are willing to retain them and they live longer than shrubs. Even the trees are dwindling due to lack of replacement as they die or are removed.

By contrast, there are several indigenous grass species and a few tiny indigenous wildflowers and creepers that are persisting well on some nature strips or in scattered lawns and gardens. Among the grasses are Clustered Wallaby-grass (*Rytidosperma racemosum*), Common Love-grass (*Eragrostis brownii*) and Mat Grass (*Hemarthria uncinata*). Among the wildflowers are Common Cotula (*Cotula australis*), Spreading Crassula (*Crassula decumbens*), Slender Onion-orchid (*Microtis parviflora*) and the solenogynes *Solenogyne dominii* and *Solenogyne gunnii*. Most of these species are more abundant outside the sites of biological significance than inside; we could call them 'urban-adapted'. While these small plants represent part of our natural heritage, they are rarely noticed.

More noticeable are the birds and possums. Species such as the Laughing Kookaburra, Eastern Rosella and Welcome Swallow are distinctively Australian, if not distinctive of Maroondah. Some bird species, such as the Little Corella, Noisy Miner and Crested Pigeon, are also Australian but absent or scarce from Maroondah prior to European colonisation. Species such as the Australian Magpie, Common Brushtail Possum and Common Ringtail Possum were probably present in Maroondah prior to colonisation but in much smaller numbers than today.

Overall, Maroondah's pre-colonisation flora and fauna are much better represented inside, rather than outside, the sites of biological significance. Nevertheless, the representation outside the sites provides a sketchy connection with Maroondah's past that pervades most of the municipality.

5. Caring for species other than our own

Conserving Maroondah's indigenous flora does not rely significantly on habitat outside the sites of biological significance, notwithstanding the aforementioned urban-adapted species. On the contrary, many properties outside the sites pose threats to indigenous flora, e.g. from nutrient pollution or spread of environmental weeds such as Ivy, Sweet Pittosporum and Cotoneasters.

By contrast, many bird species make extensive use of habitat outside Maroondah's sites of biological significance. For example, various parrot species, honeyeater species, Tawny Frogmouths and Laughing Kookaburras can be readily found in parts of Maroondah with at least a scattering of indigenous or Australian native trees. Some of these birds move in and out of the sites of biological significance and some other individuals live wholly outside the sites. Even those bird species that rely heavily on the sites of biological significance for their habitat often have to move elsewhere at times; e.g. during drought or while waiting until a home range can be claimed within a site.

Garden Skinks and Marbled Geckoes are fairly common outside sites of biological significance; less so Common Blue-tongue Lizards, Blotched Blue-tongue Lizards and Weasel Skinks. Each of these has been seen in parts of Maroondah so far from any site of biological significance that they can apparently live entirely outside the sites.

The Southern Brown Tree Frog is moderately common in the more treed parts of Maroondah, often far from any site of biological significance.

Some indigenous butterfly species are found only or principally within sites of biological significance. By contrast, the Common Brown Butterfly, Australian Admiral Butterfly and Australian Painted Lady Butterfly can readily be seen moving around Maroondah generally, often feeding in gardens or on street trees. The Common Grass-blue Butterfly, Meadow Argus and Greenish Grass-dart are perhaps seen more commonly outside sites of biological significance than inside, and probably much more commonly than prior to European settlement.

Many other indigenous flying insects can be seen both inside and outside sites of biological significance; e.g. hoverflies, native bees, paper wasps and cicadas.

Non-flying invertebrates are less mobile and are therefore less likely to move in and out of sites of biological significance. Some indigenous species are rarely seen outside the sites of biological significance (e.g. many species of ant) and some are common outside the sites (e.g. click beetles and badge huntsman spiders).

9.2 Relationship between the Values and Landscape Features

Some of the values discussed in Section 9.1 are related solely to vegetation (e.g. shade) and others are related to fauna. Section 7.1 (p. 44) provides information about how different types of fauna depend on particular types of vegetation.

Obviously, parts of Maroondah with minimal vegetation provide poor support for any of the values associated with flora or fauna. Pockets of vegetation within those areas can provide limited benefits to the neighbourhood, e.g. by harbouring beneficial insects or providing local residents with limited contact with nature. Areas with minimal vegetation mostly do not have any overlays in the Maroondah Planning Scheme to protect vegetation. The main exceptions are some neighbourhoods west of Wantirna Rd, Ringwood. Areas with minimal vegetation are increasing as housing density increases.

The amount of tree canopy is important for many of the values associated with flora and fauna, such as shade, wind protection, temperature moderation, economic benefits, enjoyment of birds, natural heritage and retaining wildlife in the landscape. Shrubs contribute to noise reduction, visual screening, economic benefits, retaining wildlife in the landscape and encouraging birds and insects for people to enjoy. Grasses and other low-growing plants can reduce noise, generate economic activity and support lizards and a wide range of invertebrates. Any vegetated ground can aid infiltration of stormwater and hence reduce flooding and water erosion.

The Significant Landscape Overlay in the Maroondah Planning Scheme provides a level of protection to trees and large shrubs in most of Maroondah, subject to exemptions. There is also some planning control over removal of Victorian native plants (whatever their size) on properties larger than 0.4 hectares.

In the case of ecosystem services (e.g. shade) and the economic activity associated with vegetation maintenance, it makes little if any difference whether plant species originate from Maroondah, elsewhere in Australia or overseas. Natural heritage and conservation of fauna are mostly associated with Maroondah's indigenous species, followed by species from elsewhere in Australia (excluding 'environmental weeds'). Some foreign plant species may provide substantial benefits in some respects, e.g. shade, but they have mostly negative or neutral effects on values such as natural heritage and enjoyment of birds and butterflies.

10 Philosophical Issues with Practical Implications

Maroondah's environment is changing. Section 5.4 (p. 41) discussed how climate change is causing the rise of some plant species and the fall of others. Page 30 discussed how drainage works and increased impervious surfaces are causing soils to dry out and plant species to die out. Section 7.3 (p. 50) discussed the profound changes that have been occurring in Maroondah's birdlife.

These sorts of changes raise some important philosophical questions around what we regard to be 'indigenous' and how much it matters.

Through prehistory, species shifted their ranges as the environment changed. They also adapted, moved or died out when genetic mutations produced new organisms to compete with the old. Aborigines once hunted across the grassland that has since filled with seawater to become Port Phillip Bay. The plants they saw in Maroondah during the last ice age would have been quite different to when the first Europeans arrived.

Some of the species that died out in Maroondah prior to European colonisation would have moved to nearby areas and may now be moving back into Maroondah. Do we regard such species as 'indigenous' and embrace their return, aided by human-induced changes such as climate change or changed drainage?

For example, last year, Orchard (2017) published sound circumstantial evidence that Sifton Bush (*Cassinia sifton*, formerly regarded as part of *Cassinia arcuata*) was confined to New South Wales at the time of colonisation. Until 2017, Sifton Bush was presumed to be indigenous and widespread in Victoria, often sold in local indigenous nurseries. If it was only in New South Wales at settlement, it may still have been present in Maroondah at various times over the millennia, e.g. as a coloniser of bare ground following major bushfires or floods.

On learning of Orchard's work, some indigenous nurseries immediately removed Sifton Bush from sale, on the basis that it is not indigenous. Another view is that Sifton Bush might be regarded as indigenous if we do not anchor that adjective in a particular moment in history. One could also take into account that Sifton Bush might well be serving useful ecological purposes in Maroondah.

The related Shiny Cassinia (*Cassinia longifolia*) was more convincingly part of Maroondah's flora at the time of colonisation. It was probably confined to drier parts of the landscape, mainly in the north. During and since the Millennium Drought, it has been spreading into other parts of Maroondah. Do we embrace this expansion as part of nature's adaptation to environmental change or do we resist it because Shiny Cassinia is displacing some of the pre-existing indigenous flora in the newly occupied areas?

One might come to a different conclusion about the expansion of Wonga Vine into Maroondah. Wonga Vine occurred naturally in the Dandenong Ranges, a few kilometres east of Maroondah, at the time of colonisation. In the past thirty years, it has spread through Maroondah and beyond, often smothering large numbers of plants in native vegetation and substantially transforming habitat for flora and fauna (p. 40). It represents a significant threat of local extinction of other species, notwithstanding that it may well have been present in Maroondah at some stage prior to colonisation.

One strategy being used by the Victorian Government and others to adapt to climate change is to facilitate the movement of plants and animals around the landscape. Corridors are being created to help species shift their ranges. Species like Wonga Vine may benefit from this strategy, and pre-existing flora and fauna will sometimes die out (at least locally) as a result.

Do we regard such species to be 'indigenous' in their new ranges? Do we embrace the way they are adapting to environmental change, notwithstanding their adverse impacts on pre-existing flora

and fauna? If so, can we reconcile that with the concerted efforts that have been made over decades to resist the range expansions of species such as Sweet Pittosporum?

One might argue pragmatically that conditions are now changing so rapidly and profoundly that it is unrealistic to try to hold on to our natural heritage, and it is more appropriate to facilitate changes to existing ecosystems. However, that argument may lead us to lose more than just our natural heritage and many of the current-day indigenous species in Maroondah. Current indications are that if range shifts are all accommodated, the most aggressive species – such as Wonga Vine, Sweet Pittosporum and Noisy Miner – will establish so strongly in Maroondah that the total number of species will plummet. That would represent a serious reduction in biodiversity.

This outcome will be hard to accept for the many people who have resisted such changes for decades.

The discussion of these philosophical issues has scarcely begun. It has substantial implications for Maroondah City Council and the community. With community support, the council has put substantial resources into trying to retain nature as we have previously understood it, particularly in managing its nature reserves. It is time to review what we should try to keep and what changes we should accommodate, facilitate or resist. Some of the things that such a review could affect include:

- Park management, including the species selected for planting;
- Private land management, including gardening;
- Strategies to reserve or manage public land to conserve nature or facilitate immigration of new species;
- The level of strategic planning protection placed on private land that may serve as habitat corridors;
- The plant species chosen to receive planning protection in the Maroondah Planning Scheme;
- The selection of species in landscape plans associated with planning permit conditions.

11 Actions for Council Consideration

The information in the preceding chapters and in Volume 2 raise issues to which Maroondah City Council may wish to respond, or at least to take into account in related decisions that it has to consider. This chapter is intended to crystallise those issues and suggest responses for Council's consideration as part of its current municipal wide vegetation review. Issues that affect other organisations are covered in Chapter 12.

11.1 Strategic Planning

In essence, strategic planning means the development or revision of a planning scheme. It involves setting and reviewing policies, objectives and rules for land use, land development and 'works'. It produces 'planning provisions' such as land zoning, overlays and planning permit requirements. Strategic planning for the Maroondah Planning Scheme is done partly by the state government through the Victoria Planning Provisions and partly by Maroondah City Council within constraints set by the state government. Community consultation is always involved in strategic planning before it results in the adoption of a planning scheme amendment.

By contrast, statutory planning involves administration of the planning scheme after the strategic planning has been done. For example, strategic planning may create a requirement that a permit is required under a particular circumstance and statutory planning will assess whether a permit will be issued for a particular application, and under what conditions. Strategic planners must take into account how the planning scheme can be best implemented and enforced by statutory planners.

The Victorian *Planning and Environment Act 1987* states that one of the objectives of planning in Victoria is 'to provide for the protection of natural and man-made resources and the maintenance of ecological processes and genetic diversity' (clause 4(1)(b)). As normal in planning, this objective sometimes conflicts with other objectives such as bushfire safety.

The Victoria Planning Provisions (VPPs) aim to provide a state-wide, baseline level of protection of biodiversity across Victoria. They focus on species that are listed as rare or threatened throughout the state. It is left to councils to undertake strategic planning to protect natural assets that are important at regional to local scale, e.g. species or ecological communities that are locally threatened. It is also left to councils to protect the values of nature that are neglected in the VPPs, such as natural heritage or benefits to human health, wellbeing, childhood development and quality of life.

The local-scale biodiversity protection currently provided by the Maroondah Planning Scheme is strongly based on the *'Sites of Biological Significance in Maroondah'* report of Lorimer *et al*. (1997). Those protective measures have lost some of their effectiveness and relevance over the subsequent twenty-two years due to changes in planning law and state government guidelines. One of the purposes of the present study was to guide a path to more effective, up-to-date planning protection for biodiversity.

To guide councils about how to protect biodiversity through strategic planning, the Victorian Government prepared a document in 2017 titled *'Planning for Biodiversity – Guidance'*. That document updates parts of the more substantial 2002 document, *'VPP Practice Note – Biodiversity'*. Any strategic planning undertaken by Maroondah City Council for protecting biodiversity should have regard to those documents and the references therein, as has been done in the following subsections of this report.

At the time of writing, the optimum path for strategic planning to protect biodiversity has been muddied by state-wide planning amendment VC148. The amendment requires substantial parts

of planning schemes to be altered to conform with a new format and standards but it is not yet clear what changes will result in the Maroondah Planning Scheme. Those changes may invalidate some of the suggestions below regarding the use of particular planning provisions to protect biodiversity. An effort has been made here to provide information to assist adapting to the changes.

11.1.1 Establishing Objectives

For strategic planning purposes, Maroondah City Council's objectives and policies regarding biodiversity are stated in the planning scheme within sections on:

- Natural resources in general (section 21.10);
- Sites of biological significance (section 22.04);
- Waterway protection (section 22.01);
- Parts of Warranwood, Croydon Hills and Kilsyth South that lie outside the Urban Growth Boundary (section 22.03 – 'Non Urban Areas'); and
- The Ringwood Activity Centre (section 22.06).

Amendment VC148 requires all of these sections to be revised and integrated into the new Planning Policy Framework (PPF) of the planning scheme. The existing content encompasses most of the broad issues in this report but not those in the following two subsections, nor some of the matters concerning sites of biological significance covered in Section 11.1.2.

11.1.1.1 Connecting People with Nature

The importance of people experiencing nature in their daily lives is discussed in Section 1.3 (p. 3) and recognised in the state government's biodiversity strategy, *'Protecting Victoria's Environment: Biodiversity 2037'*. Bringing nature into people's daily lives yields benefits to health, wellbeing, childhood development and quality of life. Birds and birdsong are important components of our connection with nature, and they are promoted by the presence of locally indigenous and Australian native trees in the suburban landscape, as discussed in Sections 7.1.2 (p. 45) and 9.1 (p. 65).

The planning scheme currently does not recognise these matters. The imminent revision of the Maroondah Planning Scheme to conform with amendment VC148 offers an opportunity to correct this omission.

In particular, it is recommended to recognise the importance of locally indigenous and Australian native trees throughout Maroondah as habitat for birds and other wildlife. Such a recognition would provide a sounder policy basis for protecting habitat in suburbia through the use of schedules to zones and overlays.

Subject to how the imminent revision of the planning scheme proceeds, it may be appropriate to revise the four schedules of the Significant Landscape Overlay (SLO) to include an objective along the lines, 'To recognise the importance of indigenous and Australian native plants in bringing birds into suburbia'. The objective could alternatively be expressed in the PPF with reference to parts of Maroondah where the community is expected to benefit from birdlife.

In addition to protecting existing habitat trees, the recognition of the importance of indigenous and Australian native plants for birds would influence the selection of plant species in landscape plans under the planning scheme (see also Section 11.8).

The increasing amount of high density living in Maroondah is creating a substantial cohort of the community with limited daily interaction with nature. Rooftop gardens and community gardens

are two ways to compensate. They could be fostered by recognising them when the planning scheme is revised to conform with amendment VC148, e.g. through a strategy or action in the new Municipal Planning Strategy. The intention would be to influence larger developments to take the lead of the recent Eastland redevelopment in regard to its community garden and the use of plants around the development. Such measures are intended to benefit people and they may increase biodiversity within a highly urbanised precinct, e.g. by attracting butterflies and native bees. In sufficient numbers, these measures might also support the ecological functions of neighbouring natural habitats such as the Mullum Mullum Creek corridor, e.g. by increasing pollination and food for insectivorous birds.

11.1.1.2 Stormwater Management

Page 30 explains that urbanisation, drainage works and consequent gully erosion pose serious threats to rare plants on floodplains. Those problems also affect the ecology of streams and wetlands, e.g. the habitat for Platypus and fish. The Maroondah Planning Scheme does not currently recognise the problems.

This could be changed when the planning scheme is revised to conform with amendment VC148 by adding an objective along the lines, 'Restore more natural patterns of water runoff and seepage by encouraging on-site stormwater retention and influencing how urban development responds to the capacity of small catchments to cope with peak flows from urban runoff'. Such an objective would fit within clause 22.10-2 of the current planning scheme but it is unclear where the best place or places will be when the scheme is revised.

The primary intention is to protect significant floodplain vegetation and aquatic habitat threatened by changes to climate and hydrology, e.g. the regionally endangered Swampy Woodland EVC (p. 19) and its many vanishing plant species (Section 5.1.3 on p. 28). Planning controls need to be applied not only within the affected habitats but also higher in their catchments – ideally, the whole of Maroondah. The outcomes would not only benefit biodiversity but also support council's efforts to influence subdivisions and land development toward 'Water Sensitive Urban Design'.

11.1.1.3 Wildlife of Streams, Stream Corridors and Wetlands

Streams provide vital habitat for fish, Platypus, Rakali (or Australian Water Rat), waterbirds, aquatic plants and a wealth of invertebrates (p. 44). Native vegetation along streams provides an important base for food chains and corridors for wildlife movement, even if the vegetation is not in a very natural condition (Section 7.9, starting on p. 54). Wetlands provide habitat for wetland birds, frogs and even more aquatic plants and invertebrates than streams (p. 44).

Despite these facts, the only mention of flora or fauna in the Local Planning Policy on Waterway Protection (clause 22.01) relates to canopy vegetation, without regard to whether it is indigenous or not. A specific recognition of wildlife habitat would support the policies already in clause 22.01-3 as well as the application of the Environmental Significance Overlay suggested below.

11.1.2 Sites of Biological Significance

11.1.2.1 Selection of Planning Controls

Most of the sites in the 1997 *'Sites of Biological Significance in Maroondah'* report were given the protection of the Vegetation Protection Overlay (VPO) soon after the report was completed. The state government had only just introduced overlays to the 'new format planning schemes'. Soon after, the government changed its guidance for protecting sites of biological significance

from using VPOs to using Environmental Significance Overlays (ESOs). That became formalised in the 2002 *'VPP Practice Note – Biodiversity'*. However, the VPO remains in place in Maroondah, albeit with some amendments over the years to its provisions.

As a planning tool, a VPO is limited to controlling the removal, destruction or lopping of specified types of vegetation. It cannot require a permit for subdivision, building construction or 'works', even when those activities have substantial adverse consequences for biodiversity. For example, a vegetation protection overlay cannot affect a development that causes runoff or seepage of water, nutrients and pollutants into an adjacent environmentally sensitive site, even if it will kill native vegetation and destroy wildlife habitat. As another example, a VPO cannot influence subdivision design to provide a bushfire buffer within the subdivision rather than forcing an abutting part of a conservation reserve to be cleared for a firebreak to protect the new houses.

An Environmental Significance Overlay (ESO) is not subject to these restrictions.

The state government's document, *'Planning for Biodiversity – Guidance'*, states, 'The ESO has broader applicability than the VPO and is the preferred overlay when seeking to achieve biodiversity outcomes'.

Consistent with this guidance, it is recommended that the existing VPO used for Maroondah's sites of biological significance be largely replaced by the ESO. The most important aspect of this change will be the ability to influence subdivision, building and works, even when those activities do not involve direct vegetation removal.

While the ESO is appropriate for all the sites of biological significance in Volume 2, two separate categories of sites or parts of sites can be distinguished:

- Land whose biological significance relates to aquatic habitat and/or vegetation with indigenous trees and understorey (including buffers to such areas); and
- Land whose biological significance is toward the low end of the scale and relates to a good cover of indigenous and/or Australian native trees, with little indigenous understorey other than common native grasses. An example is the median strip of Mt Dandenong Rd near Dublin Rd.

These two categories differ in the type of habitat, the environmental objectives that can be met and the types of vegetation whose removal should be controlled. The former category does not require control over removal of non-indigenous plant species. The latter category warrants protection of indigenous tree and shrub species as well as the main types of Australian native trees that provide wildlife habitat, such as eucalypts and wattles. (Small trees are included, as they help avoid unnaturally high densities of Noisy Miners.)

Because of these differences, it is recommended that these two categories be given different schedules under the ESO: 'ESO1' and 'ESO2' respectively.

11.1.2.2 Content of Overlay Schedules

Details of the content of the proposed ESO1 and ESO2 schedules are outside the scope of this study. Instead, the following guidance is provided:

- Building, works and subdivision would be dealt with similarly between ESO1 and ESO2;
- A suitable model for both ESO1 and ESO2 would be the Knox Planning Scheme's ESO2;
- Consistent with Section 11.1.1.1 above, ESO1 and ESO2 should include an environmental objective along the lines, 'To maintain and improve the opportunities for the Maroondah community to experience the benefits that natural environments provide for health, wellbeing, childhood development and quality of life';

- ESO1 and ESO2 should give priority to protecting locally threatened plant species, as discussed further in Section 11.1.2.4;
- It is recommended that ESO1 and ESO2 include a requirement to:

  Apply the following three-step approach:

  1. Avoid direct and indirect adverse ecological impacts to sites of biological significance, such as alteration of soil hydrology;
  2. Minimise such impacts where they cannot be avoided; and
  3. Provide compensation for unavoidable impacts;

  Note that this approach parallels the state-wide provisions for protecting native vegetation at clauses 12.01-2S and 52.17 but it has a quite different scope.
- If possible, ESO1 and ESO2 (or a separate policy document) should explain the process for determining the magnitude and nature of acceptable compensation for vegetation losses and (ideally) other impacts such as altered soil hydrology. Note that 'offsets' under clause 52.17 of the VPPs will often not apply, e.g. in the cases of non-Victorian species or properties smaller than 4,000 m². Even when 'offsets' do apply, they will often not compensate for the broader range of impacts covered by ESO1 or ESO2;
- ESO1 would protect locally indigenous plant species, regardless of their stature. It is not proposed to include non-indigenous species because they rarely add to the affected sites' significance and sometimes they detract from it;
- ESO2 would only affect trees and shrubs over 2 m tall (not lower plants) of species that are either:
  - Native to Victoria, excluding Sallow Wattle (*Acacia longifolia* subspecies *longifolia*) and Sweet Pittosporum (*Pittosporum undulatum*). Those two exceptions are significant 'drivers' of habitat deterioration, in the sense discussed in Section 5.3 (p. 41); or
  - Species of *Allocasuarina*, *Angophora*, *Banksia*, *Callistemon*, *Corymbia*, *Eucalyptus*, *Leptospermum*, *Lophostemon*, *Melaleuca* and *Acacia* (other than *Acacia elata*).

  These groups cover almost all the important habitat trees within the proposed ESO2 areas, taking into account the finding of White *et al*. (2005) that indigenous trees are most important, followed by other Australian natives (Section 7.1.2 above). The height threshold of 2 m is low enough to provide protection for understorey that reduces overpopulation of Noisy Miners (p. 46).

The exemption of Sweet Pittosporum from the protection of ESO2 is not only justified by the adverse impacts of the species but also because failing to do so would perpetuate a perverse interaction with the existing SLO schedules, as follows: With the exception of properties larger than 2,000 m² inside the Urban Growth Boundary, Sweet Pittosporum is currently exempt from Maroondah's SLO schedules. As a result, no permit is needed to remove Sweet Pittosporum from the vast majority of private land covered by the SLO except where another planning control requires one. If ESO2 does not provide the same exemption, this environmentally damaging but attractive species will be protected in areas that are recognised as important habitat but not in areas where there is only protection for aesthetic reasons.

Sweet Pittosporum and Sallow Wattle are also proposed to be exempted from the protection of clause 52.17 – see Section 11.1.2.5.

11.1.2.3 Determination of Overlay Boundaries

There are at least five reasons why the boundary of an overlay area to protect a site of biological significance may extend beyond the area known to contain the significant features:

- The features of significance may be vulnerable to actions on adjacent land. For example, a conservation reserve may be at risk from a potential subdivision next door that could alter seepage or runoff into the site and create the need for a firebreak to be cleared within the reserve; or
- It is often preferable to align overlay boundaries with property boundaries to provide surety about what land is affected. However, it would be unreasonable to encumber the whole of a property with an overlay if only a small part of the property possesses, or could affect, biological significance; or
- Residential areas such as Site 37b in Volume 2 can contain a complex matrix of land with a variety of levels of biological significance, even within a single property. It is not always possible to excise lots or parts of lots that have no biological significance, particularly as they may be in backyards that could not be inspected in this study. Including the whole area can be described as a 'precinct approach' and was accepted by the Planning Panel for Knox's 'Sites of Biological Significance' amendment (Knox Amendment C49); or
- An area may be intended to accommodate an expected expansion of significant habitat; or
- In some cases, there are grounds to believe that the significant features may occupy more land than is currently known. For example, at least one Powerful Owl is known to roost on the edge of Warranwood Reserve and its hunting ground is expected to extend into nearby land.

It is also appropriate for an overlay not to cover the whole of a site of biological significance if:

- The excised part of the site is believed to be adequately protected without an overlay; or
- There are specific reasons why the overlay should not be applied to the excised land, e.g. where a decision has been made that it is more important to facilitate the excised land's development than to protect the land's biological significance.

The Victorian Government's *'Planning for Biodiversity – Guidance'* and Planning Practice Notes provide no guidance on how to set overlay boundaries. The government's *'Standard Criteria for Sites of Biological Significance in Victoria'* (Amos 2004) is more helpful despite not specifically addressing overlays. It concludes that a site of biological significance may be delineated to include not just the biologically significant features but also a separately identified 'buffer' area, as appropriate. That is the approach taken here: The description of each site in Volume 2 states which parts are of significance in their own right and which parts (if any) are proposed to be included or excluded because of any of the reasons in the dot points above. That information is intended to avoid anyone doubting the basis for land being included within a site, and to provide guidance to Council or a Planning Panel if they wish to vary the boundaries proposed in Volume 2.

11.1.2.4 Locally Threatened Plants

The Victorian government gives legal protection to species that are rare in Victoria even if those species are not rare or protected interstate or overseas; e.g. *Austrostipa rudis* subsp. *australis* (Section 5.1.4 p. 31). For the same reasons, a municipality can provide protection for species and communities that are rare or threatened in its jurisdiction even if they are not rare in some other jurisdiction. Section 5.1.3 (p. 27) explains the motivation for doing so.

The Maroondah Planning Scheme currently provides only weak recognition of locally threatened plants. That recognition is in the form of an objective in the 'Sites of Biological Significance'

Local Planning Policy, 'To ensure that all species of indigenous flora and fauna remain present in Maroondah' (clause 22.04-2). There are no associated policies to specifically protect locally threatened plants and achieve the objective. In any case, that whole policy may have to be abolished to bring the planning scheme into conformity with amendment VC148.

It is therefore recommended to include in ESO1 and ESO2 an environmental objective such as 'To reduce the threat of local extinction to flora or fauna species in Maroondah'.

As a complementary measure, the associated 'Application requirements' could be augmented with a requirement to provide estimates of population sizes of species listed as 'critically endangered' with dying out in Maroondah. A suggested wording of the new application requirement is to provide: 'The population sizes of any indigenous plant species affected by the application that are critically endangered with dying out in Maroondah, and the potential impacts on those species'.

Ideally, the term 'critically endangered' would be replaced by the broader term 'threatened', with a reference to a schedule of locally threatened species that can be updated without requiring a planning amendment. Planning law may not allow that to happen. In that case, a list of 'critically endangered' species identified in Appendix A of this report will have to suffice.

Some plant species in that list, such as Red Stringybark and White Stringybark, are not at all confined to sites of biological significance. That provides an argument for recognising such species not only in ESO1 and ESO2 but also in the Planning Policy Framework when it is reviewed for amendment VC149.

11.1.2.5 'Sites of Biological Significance' Local Planning Policy

Maroondah's current Local Planning Policy on sites of biological significance (clause 22.04) applies to applications for vegetation removal under the Vegetation Protection Overlay, with a reference to the 1997 report, *'Sites of Biological Significance in Maroondah'*. Not all the sites in the 1997 report are covered by the overlay.

Amendment VC148 may require the existing policy to be abolished. However, its intent could be maintained by integrating it in the proposed ESO1 and ESO2.

11.1.2.6 Exemption of Species from Clause 52.17

Section 11.1.2.2 discussed the perverse interaction that results from having SLO schedules that exempt Sweet Pittosporum and an ESO that does not. A similarly perverse interaction currently exists between the SLO schedules and clause 52.17 (the state-wide controls to protect native vegetation for its environmental values). It is recommended to amend the clause 52.17 schedule to exempt Sweet Pittosporum, because of the perverse interaction and because of the species' adverse environmental impacts in Maroondah (Section 5.3 above).

The Knox Planning Scheme also exempts twenty-three additional species from clause 52.17 because there is no rational reason to require a permit for their removal and in some cases, they have adverse ecological impacts. For most of those species, the arguments that led Knox to exempt them apply equally in Maroondah. It is therefore proposed here to exempt the following species from clause 52.17:

Acacia falciformis – Large-leaf Hickory-wattle
Acacia howittii – Sticky Wattle
Acacia longifolia subspecies *longifolia* – Sallow Wattle
Acacia longifolia subspecies *sophorae* – Coast Wattle
Acacia pravissima – Ovens Wattle

Acacia provincialis (formerly regarded as part of *Acacia retinodes*) – Wirilda
Acacia uncifolia (formerly regarded as part of *Acacia retinodes*) – Coast Wirilda
Callitris rhomboidea – Port Jackson Pine
Corymbia maculata – Spotted Gum
Dichanthium sericeum – Silky Blue-grass
Dysphania pumilio (formerly *Chenopodium pumilio*) – Clammy Goosefoot
Eucalyptus botryoides – Bangalay or Southern Mahogany
Grevillea rosmarinifolia – Rosemary Grevillea
Kennedia rubicunda – Dusky Coral-pea
Melaleuca armillaris – Bracelet Honey-myrtle
Melaleuca decussata – Totem-poles
Myoporum species – Boobiallas
Paspalum distichum – Water Couch
Passiflora cinnabarina – Red Passionflower
Pittosporum undulatum – Sweet Pittosporum
Portulaca oleracea – Pigweed
Syzygium smithii (formerly *Acmena smithii*) – Lilly Pilly

Note that exempting these species from clause 52.17 does not withdraw the protection that the tree species gain from the SLO. Note also that the plants in the list should not all be regarded as 'weeds'; In fact, many of them are quite desirable in a garden. The reason for the proposed exemptions is that they do not materially contribute to biodiversity in Maroondah and hence do not relate to the objectives of clause 52.17.

A counter argument has been put that the proposed exemption increases complexity because it relies on a person removing vegetation to be able to identify the species. However, even without the exemption, clause 52.17 requires the same person to identify the species *and* know whether it is native to Victoria.

11.1.3 Zones

The ESO and VPO can control vegetation removal and the ESO can additionally control subdivision, works and development to some degree but neither overlay can control land use or set minimum lot sizes. Zoning is the primary planning tool to regulate land use and set minimum lot sizes.

The main aspects of zones that relate to biodiversity are:

- Minimum lot sizes, as small lots result in less vegetation in the landscape;
- Allowed land uses;
- Required amounts of garden and private open space;
- Setbacks (i.e. required space between buildings and property boundaries);
- Required amounts of permeable surfaces, which affects the amount of vegetation, seepage and runoff.

Opportunities to rezone land for increased biodiversity protection are rare compared with the occasions when rezoning allows more intensive development to accommodate Melbourne's rapid growth. An example in the latter category is the introduction by successive state governments of new sets of residential zones. The ratcheting down of biodiversity protection that arises from these rezonings makes it important that when they occur, the impact on biodiversity is considered carefully.

Biological significance is only one of many considerations in zoning, so sometimes, zoning works against the interests of biodiversity. For example, properties abutting Warranwood Reserve on the western side of Merrill Crescent (in Site of Biological Significance no. 16) are zoned NRZ3, with no minimum lot size, whereas properties of equal or lower biological significance on the opposite side of the road are zoned NRZ1, with a minimum lot size of 2,000 m².

It is beyond the scope of this report to weigh up biodiversity matters against competing planning objectives. It is hoped that the information in this report will allow that to happen when future rezoning amendments are considered.

11.1.1 Greyfield Redevelopment

Melbourne's population is rapidly expanding and land values have increased greatly. Many of Maroondah's residential areas have a predominance of houses nearing the end of their useful lives, on land that is very sought-after for redevelopment. These areas are called 'greyfields', as distinct from 'greenfield' redevelopments on rural land and 'brownfield' redevelopments on formerly industrial land. The small lot sizes of greyfields is a marked difference from the other types of redevelopment land.

Currently, most redevelopment of these greyfields is occurring piecemeal, one house block after another. A substantial part of the land becomes occupied by driveways. The space available for gardens is fragmented into a tiny area for each house. This pattern is normally repeated until a neighbourhood has an unnecessary amount of driveway pavement, no diversity in housing and no garden big enough to provide space for a substantial tree. The area loses its green and leafy aspect, including the benefits of biodiversity.

These problems are greatly ameliorated when multiple, neighbouring house blocks are amalgamated and redeveloped as a whole. A larger development site allows:

- More flexibility in subdivision design and housing types;
- More efficient alignment of driveways, reducing the space they occupy;
- Incorporation of a common space with trees, birds and sunshine;
- Sometimes paths between streets, for safer and shorter walking and cycling routes;
- Less environmental problems such as urban runoff from excessive paving.

These advantages not only provide the new residents with more nature in their lives but they also reduce off-site impacts on the ecological health of streams and wetlands.

Changing the way greyfields are developed requires incentives for landowners to favour amalgamation of lots over piecemeal, lot-by-lot redevelopment. Most of the incentives that strategic planners are exploring are outside the scope of planning schemes and outside the scope of this report. Nevertheless, it is important to note here that Maroondah City Council and Swinburne University have a pilot program called 'Greening the Greyfields' directed toward fostering the advantages of multi-lot redevelopment.

11.2 Statutory Planning

11.2.1 Planting Guidance

When someone seeks a planning permit, statutory planners often have the capacity to influence what plant species are planted under the conditions of the permit. In some areas, there may be a planning priority to promote the presence of birds or other wildlife, e.g. to enhance the natural

aspects of the neighbourhood character. In such cases, the dot-points on p. 47 provide guidance about suitable plant species and vegetation structure.

Landscape plans prepared as part of the permit process can help conserve local flora by including plant species that are in the 'critically endangered' category of dying out in Maroondah, i.e. species whose names are bold in Appendix A. It must be acknowledged that many of those species are unsuitable for most properties and some are hard to obtain or grow.

11.2.2 Harmonisation of Offsets and other Permit Conditions

When a planning permit is issued for removal of vegetation under a VPO, ESO, SLO or clause 52.17, it is normal for a permit condition to require compensation by way of replanting or an undertaking to improve and maintain existing vegetation. The compensation under clause 52.17 is called 'offsets' and its magnitude and nature are determined by rather tight specifications set by the state government. Compensation under the other planning controls is open to wider discretion.

Some vegetation-related permit applications can simultaneously involve more than one control out of the VPO, SLO, clause 52.17 and (if the recommendations above are adopted) the ESO. Applications for sites of biological significance must also address the 'Sites of Biological Significance' Local Planning Policy. There is no hierarchy of one planning control overriding another; all must be met for a permit to be issued.

In a case involving multiple requirements for 'offsets' or other compensation, those requirements are not necessarily cumulative. For example, if the replanting of twenty trees fulfils the offset requirements under clause 52.17 and it is also adequate to satisfy another control, there is no need to plant two lots of twenty trees just because two controls are involved. On the other hand, the SLO (for example) may require replanting of ten plants with certain visual characteristics but those plants might not simultaneously provide the right kind or amount of compensation, or in the right locations, to compensate for the ecological impacts addressed by the VPO or ESO. A wide variety of situations can arise where offsets and other compensation partially overlap between planning controls. In general, the maximum degree of overlap should be sought to minimise the overall regulatory burden on the permit applicant.

One important way to achieve overlap on sites of biological significance is to favour species that are 'critically endangered' with dying out in Maroondah.

The present study has found no guidance from the Department of Environment, Land, Water and Planning about how to harmonise the various compensation requirements that can arise when multiple planning controls are triggered. Nor was any example found in the Maroondah Planning Scheme or while reviewing the small number of other planning schemes of similar municipalities. Nevertheless, the method or principles for calculating compensation should be written down in a guideline document to provide transparency and consistency, and to safeguard against administrative fiat and corruption.

11.2.3 Mapping Inaccuracies

There is another complication that can arise when dealing with a permit application that involves clause 52.17 as well as a local provision such as an overlay. Sections 2.2 and 4.1 of this volume and the site descriptions in Volume 2 make it clear that the mapping and other information that the Department of Environment, Land, Water and Planning relies upon for biodiversity information is often inadequate or inaccurate in Maroondah. The inaccuracies particularly affect the bioregional boundary and where particular EVCs and plant species occur. These inaccuracies propagate through the Department's derived mapping of 'strategic biodiversity value', 'nature print' and 'strategic management prospects'.

A planning permit application under clause 52.17 via the 'Basic Assessment Pathway' or 'Intermediate Assessment Pathway' can, at the applicant's choice, rely wholly on the Department's mapping of the land in question. Council cannot override that mapping for a clause 52.17 application, even if the mapping is clearly wrong. However, if the vegetation removal also triggers an overlay or the 'Sites of Biological Significance' Local Planning Policy (Section 11.1.2.5), Council is able (indeed, obligated) to use correct information even though it is forced to accept inaccurate information regarding clause 52.17.

In such cases, it is important for Council to explain as early as possible in the application process how these inconsistencies arise and how they must be handled.

There is a recommendation in Section 12.4 below for the Department of Environment, Land, Water and Planning to consider correcting its mapped information where it is known to be inaccurate.

11.2.4 Staff Training

Neither the present report not the state government's mapping of native vegetation can provide all the information about flora and fauna that may be required to assess a planning permit application. An example would be when a proposed subdivision design would result in depriving an adjacent conservation reserve of the seepage it requires, or places a demand on the reserve to clear a firebreak to protect new houses.

It is a lot to ask of a statutory planner to be able to handle all such eventualities. Maroondah City Council has a reasonable breadth of expertise and to some degree, responsibilities can be allocated among staff according to their strengths. Nevertheless, consultation with staff indicated that the statutory planning team could operate more effectively with more training, or ready access to expertise, regarding:

- Plant identification, particularly regarding species whose risk of dying out in Maroondah falls into the 'critically endangered' category;
- Understanding hydrology and the role of maintaining soil moisture availability in native vegetation, particularly in swampy areas; and
- Basics of what land management activities are required to look after vegetation that must be maintained, improved or created under a planning permit condition.

11.3 Locally Threatened Species Strategy

One of the objectives that Maroondah City Council has set in the 'Sites of Biological Significance' Local Planning Policy is 'To ensure that all species of indigenous flora and fauna remain present in Maroondah' (clause 22.04-2 of the Maroondah Planning Scheme). That objective will require concerted effort, given the findings of Section 5.1.3 (p. 27). In addition to the measures discussed in Section 11.1.2.4, there are equally important measures to be taken outside the planning scheme.

It is beyond the scope of this report to devise measures to address any significant number of the threats faced by species of flora and fauna at all the sites where they occur. That could be done by having a separate strategy prepared, as Knox City Council did in the same situation. However, the following two subsections deal with the two highest-priority issues.

11.3.1 Rescuing Plants of Winter-sodden Soil

Section 5.1.3 (p. 27) discusses the dire plight of numerous plant species – listed in Table 5 – that are specifically adapted to floodplain soils that are normally sodden through most of winter and

quite dry in summer. The reason for those species' decline is the drying of the soil due to land development and perhaps climate change.

It is not inevitable that these species will soon die out completely within Maroondah.

In some of the affected habitat, the land might be rehydrated by bringing stormwater in pipes to the surface, as has been done at Wicks Reserve in The Basin and Coomoora Reserve in Keysborough. The paperbark thicket west of the Benson Oval at Eastfield Reserve, Croydon South, is an ideal candidate for such a treatment. So is the former horse pond beside Dandenong Creek downstream of Dorset Rd – part of Site 72 of Volume 2.

Another problem that afflicts locally threatened plants on winter-sodden soils of floodplains is mowing during the flowering and seeding season and when the ground is boggy. Section 11.5 describes an example at Dorset Recreation Reserve in Croydon. In most cases, all that needs to be done to overcome the problem is to adjust mowing schedules and practices, and ensure that the changed practices are adhered to. This has happened at Dorset Recreation Reserve as an outcome of the present study.

Similar changes are being made by Melbourne Water in response to the same problems at Bungalook Conservation Reserves in Kilsyth South.

11.3.2 Planting Locally Threatened Plants

Council's bushland management team have been planting locally threatened plants into reserves to increase population sizes and hence reduce inbreeding. Some of the planted plants were detected in this study's fieldwork and there is evidence that the strategy has worked in some cases. The best example is the planting of three species of Hakea in the council reserve at Bungalook Conservation Reserves in Kilsyth South. The populations of two of those species (*Hakea decurrens* and *Hakea ulicina*) were down to less than ten each, a decade or so ago. Planted individuals then bred with the wild individuals, producing many seed capsules. Ecological burns killed the plants and stimulated the germination and establishment of dozens of new plants, making the species much more secure.

Unfortunately, most other attempts to establish self-sustaining populations of locally threatened species by planting have failed. A plausible explanation for planted species dying without reproducing is that the same factors that caused the species to be scarce or absent from the planting sites prior to planting were still operating after the planting. That would be consistent with the success of plantings in Bungalook Conservation Reserves (where the habitat is quite natural and a complex pattern of ecological processes can be observed) and the failures in less natural environments.

Another cause of failed plantings has been prolonged dry spells during the establishment phase. This has been an increasing problem due to increasing climatic variability. Council's bushland management team is responding to this challenge by changing its practices to a grid planting pattern so that monitoring and watering are easier and more reliable.

While these efforts to save plant species from local extinction are laudable, it is clear that they should not be thought of as a satisfactory alternative to conserving wild populations. When a species dies out in the wild, it is currently unlikely that planting will be able to establish a new, self-sustaining population.

11.4 Management of Nature Reserves

Maroondah City Council has a dedicated 'bushland' team who manage reserves that are wholly or predominantly set aside for nature conservation. Habitat in other reserves is discussed in Section 11.5.

The principle objective of the bushland team is nature conservation, which has improved as a result. The prevalence of environmental weeds has significantly reduced since the 1997 *'Sites of Biological Significance in Maroondah'* report. Some areas that appeared to be just trees over mown lawn twenty years ago now support diverse understorey with many wildflowers – e.g. Dublin Road Reserve in Ringwood (Site 122 in Volume 2). The situation would be much worse without the bushland team, considering the trajectory up to the time the team was created around two decades ago. Some of the credit for the improvements goes to habitat management contractors who assist the bushland team, and 'Friends' groups who operate in some of the reserves.

An important consideration for the bushland team is that Maroondah City Council formally adopted the following targets at its Council Meeting on 24th April 2017:

- 'No net loss of the area and quality of existing native vegetation on 171 hectares of land managed by the City of Maroondah to 2040;
- 'Improved native vegetation quality on an additional 6.7 hectares of land managed by the City of Maroondah by 2025 and a further 13.1 hectares by 2040'.

Funding should be allocated to ensure the targets are met. Monitoring needs to be conducted to check progress. The methods that can be used for monitoring are discussed in Section 11.12.

This report cannot conduct a review of Council's management structures. Nevertheless, it would be remiss not to observe that the bushland team is based at the council depot in Croydon and have limited interaction with Council's environmental planners at the civic centre in Ringwood. Separation between those who plan biodiversity management and those who conduct it on the ground is unfortunate but not uncommon. There has been a parallel situation at Manningham City Council for decades but a decision was recently taken that the environmental planners will be relocated to the depot where the practitioners are located. Conversely, Knox City Council relocated its bushland management staff from the depot to beside the biodiversity planners at the civic centre, which is not far from the depot. The interplay and sharing of skills between the practitioners and planners in Knox is conspicuously greater than in Maroondah or Manningham.

Maroondah's bushland team has vehicles, chemicals and equipment that need to be stored at the depot or somewhere similar. They also have similar needs for safety programs and training to others in the depot, and sharing of skills and experience with other depot staff is important. Environmental planners have parallel reasons to be located at the civic centre and interact with staff there. Perhaps the optimum way of facilitating interaction between the bushland team and the planners is through a scheduled program of occasions to meet and discuss issues in common.

11.5 Management of Other Reserves

Maroondah City Council's 'bushland' team manage council's dedicated nature reserves but there are plenty of areas of significant habitat in other reserves, e.g. Ringwood Lake Park (Site 26 in Volume 2) and Proclamation Park in Ringwood (Site 111 in Volume 2). These other reserves are managed principally for recreational activities. In some cases, such as Proclamation Park, the most significant areas of native vegetation are so well recognised as important that they are managed by specialist contractors. However, in most cases, significant vegetation is either unmanaged or managed for tidiness, causing conservation values to either decline or hang on through benign neglect.

A good example is the floodway at Dorset Recreation Reserve in Croydon, part of Site 62 in Volume 2, as discussed in Section 11.3.1 (p. 81). Of the indigenous plant species growing there:

- Brown-back Wallaby-grass (*Rytidosperma duttoniana*) is not known to grow any closer than Yarra Glen (which was last century);
- The minute trigger-plant called Hundreds and Thousands (*Stylidium despectum*) was also at Bungalook Conservation Reserves until 2016 but there is only one other report of that species occurring closer than 20 km in the past two decades; and
- The Veined Swamp Wallaby-grass (*Amphibromus nervosus*) could only be found at one other site in Maroondah during this study, despite targeted searching.

These plants are part of the most threatened vegetation community in Maroondah – Swampy Woodland – as discussed in Section 5.1.3.

The floodway is therefore very important for biodiversity. The rare plants are very vulnerable to being mown when the ground is boggy or during their reproductive period, October to early December. However, until this study, the rare plants were mowed regularly during the reproductive period in the belief that mowing for the benefit of walkers was more important than conserving the rare plants. An outcome of this study has been a change in the mowing program to accommodate both tidiness and nature conservation.

Another practice associated with the pursuit of tidiness over nature has been the increasing use of herbicide to kill plants around the bases of trees. For example, the last remaining Common Flat-pea (*Platylobium obtusangulum*) at Jubilee Park was one of many indigenous plants killed by herbicide in spring 2018 as part of an effort to change the appearance of the area north of the No. 2 Oval.

The tension between nature conservation and perceived community preferences for tidiness also arises in a number of other reserves, such as Ringwood Lake Park. The balance has tilted substantially toward tidiness in the past year. Even if Council meets the targets it set for maintaining habitat quality in bushland reserves at the Council Meeting of 24th April 2017, there could be an overall deterioration due to the recent increase in mowing and herbicide use on native vegetation outside nature reserves.

11.6 Eucalypt Deaths

As noted in Section 5.1.5, Maroondah City Council is funding a current investigation by the University of Melbourne to identify the causes of widespread eucalypt deaths in Maroondah. Hopefully, the investigation will identify measures that Council and others can take to reduce or reverse the decline of eucalypts. Those measures may require substantial funding.

Without wishing to pre-empt the investigation, the present author notes that many ailing eucalypts show signs of heavy browsing by possums, such as bite-marks on their leaves and dense possum faeces beneath. Even without waiting for the investigation to finish, banding of tree trunks to prevent possums from climbing them would serve the useful purpose of determining whether the trees recover. Recovery can normally be seen within a few weeks if possums are the only cause of foliage loss, as demonstrated in 2017 when bands were used in a trial in the 100 Acres Reserve in Park Orchards, 1½ km outside Maroondah (p. 36). Of course, banding only works if possums cannot access the trees from adjacent trees or shrubs. Even if only one tree in a reserve is banded and seen to recover, that would indicate an excessive possum population which could explain foliage loss over a much larger area. Corrective measures could then be considered, such as reducing connectivity between trees.

11.7 Water Management

As discussed on p. 28, drying out of soils and wetlands due to prolonged drought and urbanisation represents the greatest threat of plant species dying out in Maroondah. Stream ecology and stability are also affected by the unnaturally large fluctuations in flow resulting from too much impervious surface. The most acute concern is in relation to Swampy Woodland and the disappearance of species specially adapted to winter-sodden floodplains, as listed in Table 5 (p. 29).

Section 11.1.1.2 (p. 73) proposes a response that can be taken in the Maroondah Planning Scheme.

Council's civil engineers and others responsible for implementing Council's 'Water Sensitive City Strategy' can also play an important part in responding to these problems by:

- Avoiding unnecessary draining of native vegetation when designing drainage works;
- Stabilising and correcting gully erosion in Maroondah's north, particularly Warranwood Reserve and Hochkins Ridge Nature Conservation Reserve;
- Working with environmental planners to extract stormwater from pipes, purify it and use it to return water to floodplains and wetlands, as discussed in Section 11.3.1 (p. 81); and
- Installing new wetlands to provide habitat and help maintain water table levels between rain events. Shallow gradients at the edges of wetlands are very important for creating diverse aquatic ecosystems and hence for functions such as oxygenation of the water (p. 45).

As discussed in Section 11.8.3, River Club-rush (*Schoenoplectus tabernaemontani*) should not be planted in wetlands.

Council has collaborated with Melbourne Water in a 2018 project involving Dandenong Creek between the Belgrave Railway Line and H.E. Parker Reserve. The pipe that carried the waters of the creek was dug out and the water now flows along a sinuous, artificial channel at the same depth as the former pipe. This process is being called 'daylighting the creek' and it is proposed to be also applied to part of Tarralla Creek in Croydon.

'Daylighting' is likely to be beneficial to some fish and stream invertebrates. The effects on vegetation are uncertain, except that some trees were removed for the Dandenong Creek project and the root systems of some retained trees (including rare Yarra Gums) were damaged to a possibly fatal extent. There is now water passing over a stream bed rather than through a pipe, so one might expect a positive impact on infiltration of water into the floodplain. However, the new water surface is roughly 2 m deeper than the creek's natural level, so the channel may actually lower the water table compared with when the pipe was well beneath the ground. Vegetation on the floodplain may suffer, particularly deeper-rooted species such as the majestic Manna Gums (*Eucalypts viminalis*). Melbourne Water staff advise that no investigation has been done into impacts on the water table or its dependent vegetation.

It is therefore recommended to monitor the health of the trees and other vegetation on the banks of Dandenong Creek beside the 'daylighting' project and for some distance downstream. If adverse impacts from a lowered water table are detected, that finding may influence whether, or how, future 'daylighting' projects are conducted.

It is probably already too late to install groundwater monitoring bores on the Dandenong Creek floodplain to monitor changes in the water table level. It is recommended to do so urgently along Tarralla Creek to obtain baseline data before commencement of the proposed 'daylighting' project there.

11.8 Planting

Council does a lot of planting in a range of situations such as street trees, around community facilities, along streams, in wetlands and in amenity parks. The plants include indigenous species, other Australian species and foreign species, from grass to large trees. The ecological impacts range from positive to negative.

11.8.1 The Trend Toward Smaller Tree Species

As residential density increases and space for trees reduces as a result, the tree cover maintained by Council becomes increasingly important. However, at the same time that residential land is losing its larger trees, Council is replacing the larger street trees that provide habitat with smaller, mainly non-Australian trees such as Crepe Myrtles and ornamental fruit trees. Council's motivation is to reduce the high cost of tree maintenance and root damage to roads and footpaths. As discussed in Section 7.1.2 (p. 45), indigenous trees generally provide better bird habitat than trees from elsewhere in Australia, and foreign species mainly favour introduced bird species.

It seems an appropriate time for Council to review the balance between maintenance costs and environmental costs of street trees. There may also be ways to reduce maintenance costs while retaining more large trees and species that benefit native birds.

11.8.2 Diversity of Tree Species

The arrival of Myrtle Rust fungal disease in Melbourne in 2011 prompted an immediate reaction from some people that tree plantings by organisations such as municipal councils should aim to reverse the long-standing dominance of the myrtle family. The myrtle family includes eucalypts, bottlebrushes, tea-trees, paperbarks, lilly pillies and many smaller genera such as *Angophora*, *Lophostemon*, *Kunzea*, *Thryptomene* and *Baeckea*. Fortunately, Myrtle Rust has not proved to be anywhere near as bad as had been feared.

Maroondah City Council may consider this issue, as other councils have done.

The standard reference for diversification of families in tree plantings is Santamour (1990). It relates to the United States of America, where the flora has not evolved a heavy concentration of tree species in one family, as the Australian flora has done with the myrtle family. The Australian and local flora have been dominated by the myrtle family over millions of years without succumbing to pests and diseases. This may be partly due to the huge diversity within the family. No-one would consider the grass family to be too dominant in lawns, so there is no inherent cause for concern about dominance of an individual family of plants.

With these observations in mind, considerations of landscape values and environmental concerns justify a continuing bias toward the myrtle family for tree planting. In particular, eucalypts are so dominant in the local environment that any significant reduction in their representation in Maroondah could cause substantial ecological disruption and decline of species of birds and insects.

11.8.3 *Correas*

As discussed in Section 5.1.6 (p. 38), the indigenous form of Common Correa (*Correa reflexa* variety *reflexa*) is being displaced by hybrids that are its own progeny, and some of those hybrids have become serious environmental weeds. It would be prudent for Maroondah City Council to not exacerbate these problems by planting Correas within (say) 200 m of nature reserves where wild Correas grow.

11.8.4 Stormwater Treatment Wetlands

Artificial wetlands are increasingly used by councils, Melbourne Water and property developers to remove stormwater pollution, provide wildlife habitat and return water to floodplains. Melbourne Water has published guidelines for how to plant the wetlands and which species to use.

Even without any planting, a newly created wetland rapidly becomes colonised by plants that arrive on the wind or waterbirds. For example, it took less than a year for a wetland constructed in 2017 at Colchester Reserve, Boronia, to become naturally colonised by the locally rare plant species, Swamp Lily (*Ottelia ovalifolia*) and Waterwort (*Elatine gratioloides*), along with various rushes and knotweeds. Wetlands are planted not because they would otherwise be bare but to favour certain species with perceived desirable characteristics for water purification over those that nature would otherwise provide.

Among the species being planted is River Club-rush (*Schoenoplectus tabernaemontani*). It occurs naturally in the Melbourne region, on the edge of the water of major streams (principally, the Yarra River). Before it began being used in planting about fifteen years ago, it was not recorded any closer to Maroondah than the Yarra River, and not in any wetland within at least 20 km of Maroondah. However, since it has been planted in artificial wetlands, it has spread (presumably by waterbirds) into at least four natural wetlands in Maroondah, and many others in the region. In some cases, as in Site 72 of Volume 2, it is aggressively displacing the natural plant and animal species, significantly reducing biodiversity in the affected wetlands.

There are alternative species that can be used for water purification without the harm of spreading into natural environments and disrupting them. River Club-rush should not be planted.

11.8.5 Planting into Forests and Wetlands

The fieldwork in this study detected substantial numbers of plants that had been planted into forests and wetlands in nature reserves during the past few years. They were planted variously by Council, Friends groups and CRISP nursery volunteers. While most species were ecologically appropriate, a significant minority were not. Some, like the River Club-rush discussed above, are not indigenous to Maroondah but were probably presumed to be so: *Baumea articulata*, *Correa* hybrids, *Dichelachne crinita*, *Juncus usitatus* and *Lycopus australis*.

As discussed above, the River Club-rush and the *Correa* hybrids are environmental weeds and should not be planted.

Even if a species is not ecologically hazardous, planting it outside its natural habitats upsets the naturalness of the planting sites and confuses people about where the species grows naturally. If a species does not occur naturally in a particular type of habitat, there is usually a good reason why that habitat type is unsuitable for the species. Planting of indigenous species into nature reserves should therefore stick to species that occur naturally at that site or in vegetation similar to that which is likely to develop. The 1750 EVC mapping in Figure 1 (p. 16) does not provide a reliable indication of the natural vegetation at individual sites because it contains errors and it was never claimed to be spatially precise.

Regardless of species, one needs to pay attention to the density of planting of trees. In local forests, the crowns of mature trees do not overlap because there is only enough sunlight, soil moisture and nutrients beneath a eucalypt's crown to serve one tree. This is the 'crown shyness' discussed on p. 34. The typical diameter of a mature eucalypt in Maroondah is 12 m and the pre-European spacing between eucalypts was probably similar. Yet it is common to see eucalypts being planted at 1–2 m spacing, as in Figure 9. In such cases, the vast majority of the eucalypts must ultimately die, and in the meantime, the trees grow spindly and develop poor structure. The excessive

competition for moisture in summer kills most other perennial plants among them, such as those planted with the eucalypts. The plants that do survive well with the eucalypts are ones that don't have to compete for moisture in summer, i.e. annual species – mainly *Oxalis* species and annual grasses such as *Ehrharta longiflora*.

The problem is worse when eucalypts are planted beneath mature wild eucalypts, which are under enough stress already without humans adding more competition within their root zones.

More generally, planting into natural or semi-natural vegetation should consider the competition that the planted plants will create. Nature does not leave ecological resources unused for very long, so any resources required by your planted plants will be taken away from pre-existing plants.

Figure 9. A revegetation area overplanted with eucalypts.
There is a white sheet of A4 paper to convey scale.

Planting into native vegetation should also take into account that it carries the following risks:

- Digging holes to insert a new plant often digs up existing plants. For example, Warrien Reserve's last remaining Long Purple-flag (*Patersonia occidentalis* – a locally rare species) was dug up to plant a very common species. This problem can be reduced by careful inspection and planning of planting sites by someone with a good knowledge of the flora; and
- Planting carries a risk of introducing soil-borne plant disease to the naturally occurring plants.

11.9 Support for Private Biodiversity Stewardship

Most of Maroondah was cleared before there were any planning controls over vegetation removal and biodiversity conservation. As the decades go by, the owners of properties that have not yet been cleared are incurring steadily greater regulatory obstacles to clearing and costs such as 'offsets' when vegetation is removed. Today, those of us who live on land that has already been

cleared rely on a relatively small number of others to keep their native vegetation for its environmental and community benefits, to compensate for clearing that has occurred elsewhere.

There is an argument based on fairness that if some landowners are expected to provide those benefits for the greater good, they deserve the support of the broader community.

There is also an argument that well-targeted support for private landowners to be good stewards of nature on their land can be a cheap and efficient way of achieving environmental and community benefits.

There are many programs in Victoria for this purpose, such as 'Land for Wildlife', 'Backyard Biodiversity', 'Gardens for Wildlife', grant programs and municipal rate rebate schemes. Some councils, such as Knox City Council, provide owners of significant habitat with assistance from expert council staff about how to care for nature on their land.

The 'Gardens for Wildlife' program was created by Knox City Council and the Knox Environment Society in c. 2005. It has recently become state-wide – see gardensforwildlifevictoria.com. Three councils neighbouring Maroondah already have local 'Gardens for Wildlife' programs running: Knox, Yarra Ranges and Whitehorse. These programs are free for the local community to join and they give participants expert advice, recognition, training, events and networking opportunities.

In addition to the benefits to the local environment and the wellbeing of the participants, 'Gardens for Wildlife' programs engender community spirit and a sense of working with others toward a worthy cause. These kinds of community benefits are increasing in importance because of a general decline in participation in traditional community service groups.

Such a program would fit well in Maroondah. Local community groups would probably be prepared to join with Council to get a local program running.

Knox City Council makes membership of its 'Gardens for Wildlife' program a precondition for residents to apply for 'Biodiversity Buddies' grants. Each year, grants of up to $1,000 (matched by grantees) provide an incentive to undertake the most cost-effective and beneficial management actions in, and adjacent to, sites of biological significance.

Manningham City Council offers similar grants of up to $1,000/year under its Biodiversity Incentive Grants Program. There is no linkage to a program like 'Gardens for Wildlife' but the council provides similar expert advice about how to manage land for the benefit of indigenous flora and fauna.

Along similar lines, Maroondah City Council ran a 'Biodiversity Rate Concession Program' from 2002 to 2012 to provide an incentive for owners of land with significant habitat to care for it.

The various programs outlined above not only provide environmental and social benefits but they can also improve compliance with planning permit conditions that compensate for vegetation removal. That is because the holders of such permits may be required to create or maintain vegetation but they often don't have the understanding or interest in how to really achieve the environmental improvement being sought. A program like 'Gardens for Wildlife' can provide permit holders with encouragement and understanding to fulfil their permit conditions and look after their habitat in the long term. Having done so, a program like a dollar-for-dollar grant program may encourage activities beyond what is required by the permit conditions.

If Council is prepared to consider programs such as 'Gardens for Wildlife', grants and rate concessions, this report can help by providing an up-to-date indication of the importance of biodiversity in Maroondah and which areas of Maroondah to focus on.

11.10 Support for Community Involvement with Nature

Maroondah's many bushland reserves and stream reserves offer wonderful opportunities for people to enjoy nature and its benefit to health, wellbeing, childhood development and quality of life. However, there appears to be a low awareness of most of the reserves and what they contain. In addition, most people who visit a reserve don't have much understanding of what is going on around them. For example, people who approached the author during his fieldwork at Ringwood Lake Park were surprised and fascinated to learn that there were kangaroos and Sugar Gliders living in the park, eels in the water that migrate to and from the Coral Sea, and orchid flowers that imitate the sex-scent of a female insect to lure males for pollination.

A poor level of appreciation of nature can lead to treating it with contempt; e.g. encouraging pet dogs to chase breeding waterbirds or using bushland as a dumping ground for garden rubbish or dog faeces. Better appreciation would not only help nature directly but also garner support for Council's efforts to look after nature and nature reserves. It may even recruit more volunteers to 'Friends' groups, which help Council look after its reserves. That sort of community involvement helps build community spirit, which is under threat from the rise of 'dormitory suburbs' and the general decline in participation in community service groups.

There are therefore many reasons to encourage greater appreciation of nature. The following paragraphs highlight some ideas for doing so.

11.10.1 'Get to Know Your Park' Tours

Some years ago, Maroondah City Council invited people living near certain bushland parks to take a guided tour with one of Council's bushland management staff. It may be worth exploring whether a modification of that concept could provide benefits worthy of the cost.

One variation that could be considered is to run tours at the popular recreational destination of Ringwood Lake Park. The aim would be to attract people not just through advertising in advance but also from among park visitors on the day, many of whom would not be attracted by advertising. The tours would need to be led by someone who is good at communicating about nature. The effectiveness of the tours could be gauged in the same way as Council does for other events but the benefits would be hard to quantify in dollar terms.

If tours at Ringwood Lake Park are deemed a success, tours could be conducted at other reserves. Among the reserves best suited for tours are B.J. Hubbard Reserve, Warranwood Reserve, Warrien Reserve, Eastfield Park, Bungalook Conservation Reserves, H.E. Parker Reserve, Proclamation Park and Mullum Mullum Reserve. The volunteer groups who help Council look after some of those reserves should be invited to contribute, if a tour is conducted in their reserve.

A possible extension of this concept would be to offer guided tours to nearby school communities.

11.10.2 Events for Volunteer Groups

A substantial amount of voluntary work is done in Council's nature reserves by 'Friends' groups and the CRISP indigenous nursery. The groups have an umbrella organisation called Maroondah Bushlinks.

Council supports these groups by providing insurance and advice, running an annual civic reception for volunteers, and offering small grants for administrative expenses. Some years ago, Council also funded two training sessions on plant identification.

A small expenditure by Council on further training of volunteers, particularly about weed control and revegetation, could provide a substantial increase in the effectiveness of the work by volunteers and the fulfillment they get from their work.

There is very little interaction between the volunteer groups other than among some of the group leaders. This means the groups do not learn from each other and their members have little appreciation of how their efforts and their reserve fit into the bigger picture. Bringing the groups together more could improve their effectiveness, build community spirit and increase the volunteers' enjoyment and keenness.

To that end, Council could organise a program in which each group, in turn, runs a tour to showcase their reserve (or nursery) and their activities for the other groups to see. This could be done about three times each year. It would be desirable for a Council officer to attend to discuss any ideas, concerns or matters of interest.

11.10.3 Citizen Biological Surveys

The budget for this study did not extend to surveying the flora and fauna of all reserves and roadsides with native vegetation. It would be desirable to conduct more surveys, not just to fill in the current gaps but to update the data and monitor changes over the years. More information could guide allocation of management resources and avoid actions that inadvertently harm important natural assets.

A program to encourage and enable members of the community to collect data would not only increase the amount of information available but also increase community skills and strengthen the connections between Council, the community and the natural environment. The sum of all these benefits and the benefits that come from connecting people with nature would hopefully outweigh the cost of running the program.

The program would need to include:

- Training of volunteers to collect reliable information according to a consistent protocol in a manner that is safe for themselves and the environment;
- A facility for following up species that the volunteers cannot confidently identify themselves;
- A geo-database to keep the collected data;
- Periodic analysis and reporting of the data to determine what actions may be appropriate for Council or others;
- Periodic get-togethers of the volunteers; and
- Coordination by Council staff for all the above purposes and to communicate important discoveries or issues to relevant other members of staff.

Volunteers should ideally work in pairs or larger groups, for safety and to increase the reliability of data.

11.10.4 Art

Art is outside the scope of this report but it would be remiss not to note the role of art in drawing community attention and conscience to environmental issues. A good example is the chainsaw-carving of two giant Yellow-tailed Black-Cockatoos out of a dead tree outside 82 Long View Rd, Croydon South. The statue was commissioned by Maroondah City Council in 2018. Apart from its attractiveness, it serves the purpose of a totem, drawing the attention of passers-by to nature.

Wetlands and waterways seem to offer good opportunities for similar artworks to draw attention to fish, Platypus, Rakali, Sacred Kingfishers, frogs, rubbish and pollution. Ringwood Lake Park would give such works good exposure.

11.11 Social Licence

This report aims to provide technical information to support sound decisions by Maroondah City Council and others. However, all the technical justification in the world cannot, on its own, ensure community support for decisions made by an organisation such as a municipal council. Community support relies greatly on how much trust the organisation enjoys and how well the organisation's actions are explained.

Therefore, it is recommended that Maroondah City Council concentrate on explaining to the community how it will use the information in this report and give opportunities for the community to be involved. In practice, few people actually take up invitations to be involved in such things except when they feel threatened by changes that haven't been adequately explained and justified. As Maroondah City Council will be aware from the experiences of some other councils, good governance and community harmony benefit when a council is open and engenders trust in its decision-making.

The suggestions in Sections 11.9 and 11.10 would also engender trust in Council and an appreciation that Council's biodiversity activities are worthwhile.

11.12 Monitoring

Monitoring of changes in flora and fauna can help Maroondah City Council adjust its activities as required to optimise outcomes and avoid allowing problems to develop unnecessarily. An example of the use of monitoring is the tracking of vegetation removal under planning permits to see whether strategic planning objectives are being met. Another would be monitoring of biodiversity in nature reserves to see whether Council's resources allocated to management of the reserves needs adjustment.

The following subsections explain Council's options for monitoring and, in Section 11.12.7 (p. 98), how to decide which options to take.

11.12.1 State-wide Monitoring of Planning Controls

The state government's 2017 document, *'Planning for Biodiversity – Guidelines'* recommends a step-by-step approach to strategic planning for biodiversity that includes the following:

> *Step 8: Establish a monitoring system, performance targets and indicators*
>
> Establish a monitoring system and indicators for measuring the effectiveness of the planning scheme tools in achieving biodiversity objectives.

This is more difficult than it may appear. The state government's main planning scheme tool to regulate vegetation removal for biodiversity outcomes is clause 52.17. In 2002, the government set the following 'net gain' target for clause 52.17: 'A reversal, across the entire landscape, of the long-term decline in the extent and quality of native vegetation, leading to a Net Gain'. The only associated monitoring report that could be found during the present study was one titled *'Native Vegetation Net Gain Accounting First Approximation Report'* (DSE 2008). It documented many difficulties that were encountered in the monitoring as well as measures that were expected to improve future monitoring. Its conclusion was that there was a substantial ongoing rate of loss of

native vegetation. The rate of net loss was greatest on private land, estimated to be 9,900 'habitat hectares' per year (+/- 20%). (A 'habitat hectare' is always larger than a normal hectare, to a degree that increases inversely with the average condition of the vegetation.)

The state government in 2013 abandoned the 'net gain' target. The present target for clause 52.17 is 'To ensure that there is no net loss to biodiversity as a result of the removal, destruction or lopping of native vegetation'. Note that the current target excludes vegetation losses from causes such as drought, weed invasion and urban pressures, unlike the former 'net gain' target.

Despite 'Step 8' above, the state government has produced no reporting of the rate of loss of native vegetation under clause 52.17 in the past ten years. This situation is salutary for a municipal council considering its own monitoring.

With this background, the state government's 2016 report titled *'Outcomes Report – Review of the Native Vegetation Clearing Regulations'* included the following:

> Proposed improvement 4: Improve monitoring to determine if the regulations are achieving their objective and make this information publicly available.
>
> Implement by developing a monitoring and reporting plan in partnership with local government, and in consultation with other relevant stakeholders. This plan will include roles and responsibilities and efficient approaches to gather and report on native vegetation clearing and offsetting. Initially the plan will improve monitoring and reporting on:
>
> - permitted native vegetation clearing and offsets that are occurring (including linking clearing and offsets);
> - levels of known non-compliance with the regulations, including with management of offset agreements;
> - gains in native vegetation that is *[sic.]* occurring at offset sites.

If this proposal comes to fruition, the monitoring in Maroondah can include not just clause 52.17 but also local controls such as overlays. That would put Maroondah City Council's monitoring on an equal footing with the state government.

The second dot point above may be of very limited use because changes in known non-compliance could be dominated by changes in the thoroughness of detection.

The stated purpose of the monitoring proposed above is 'to determine if the regulations are achieving their objective', the objective being 'no net loss'. The proposed monitoring cannot support that purpose because it does not include vegetation removal under exemptions or through undocumented illegal clearing. Lack of information about the extent of clearing under exemptions is discussed in the same document as the monitoring proposal.

There is a lesson here: When considering a proposal for monitoring of any kind, it is important to ask, What is the intended ultimate use for the monitoring outputs and can the proposal support that use? It is also important to consider whether the statistical reliability of the monitoring outputs will be adequate for the intended use.

Another deficiency in the state government's monitoring proposal is that it only deals with identified native vegetation, not the matrix of habitat distributed through suburbia (Chapter 9) or the problem of fragmentation of habitat.

11.12.2 Random Plot Monitoring

A possible solution to at least some of the problems identified above comes from an innovative but presently untried and unpublished technique devised by the present author. It is based on the

'iTree Eco' method of the United States Forest Service (www.itreetools.org). It involves recording basic habitat-related information at 200 or more randomly distributed plots across Maroondah. Within the information gathered at each plot is a metric for habitat connectivity, which is missing from the state government's monitoring plans. The plot centres would be located at a subset of the sample points used by Kaspar (2018) to monitor tree canopy cover with iTree, thereby allowing synergies to be achieved between the two types of monitoring.

The data obtained would facilitate not only monitoring but also analysis of the distribution of habitat and changes in habitat values among different parts of Maroondah or different land categories, e.g. according to land zoning or EVC.

As with all iTree monitoring, the tactic of gathering basic data at many random locations is a way of harnessing the power of statistical analysis. Firstly, it overcomes the statistical bias that results from relying on planning permit applications and compliance records. Secondly, it provides statistical measures of uncertainty in the observed changes. Thirdly, it allows exploration of the causes of change by analysing how well the changes correlate with land categories, climate and other parameters. Correlations cannot prove causality but careful analysis – controlled for confounding influences – can be quite powerful; e.g. epidemiology is founded on correlations between observed illness and plausible causes such as smoking.

11.12.3 EAGA Monitoring

A quite different and potentially complementary approach to monitoring has been devised for the Eastern Alliance for Greenhouse Action (EAGA), of which Maroondah City Council is a member. The approach is described by Threlfall *et al.* (2015). It involves measuring any or all of the following 'indicators':

1) The extent of native vegetation in actively managed areas on Council land;
2) Detailed data about every plant species within each of a set of sample plots called 'quadrats';
3) Data about bird species and abundances observed by an expert during a 20-minute period within each of a set of two-hectare areas; and
4) Phenology - the timing each year when seasonal events occur, such as swooping by magpies.

Indicators 1 and 2 relate solely to native vegetation in Council bushland reserves. Threlfall *et al.* (2015) recommend monitoring them very five years. Indicators 3 and 4 could be done anywhere in Maroondah, at recommended intervals of 2–3 years.

Indicator 1 – Extent of Native Vegetation

Measuring the extent of native vegetation in well-defined patches can be done easily from aerial photography in a Geographic Information System. However, there are examples of vegetation which some observers would regard as native vegetation and others would not; e.g. patchy areas of native grass beneath scattered trees. Differences arise even between native vegetation assessors accredited by the Department of Environment, Land, Water and Planning.

Such differences present a particular problem around the edges of many bushland reserves, where the transition between introduced vegetation and native vegetation is very gradual and patchy. Different but equally defensible decisions can be made about where to put the boundary even when a single observer inspects a site on different days within the same season. Much larger variability can result when different people do the observing, or in different seasons (e.g. whether or not wildflowers are flowering among the grass) or in a dry year compared with a wet year.

Uncertainties in boundary locations can cause false indications of change in vegetation extent between monitoring cycles.

An equivalent problem occurs in monitoring the expansion of a patch of native vegetation, which normally occurs gradually in a patchy transitional zone around the edge: At what point in the transition process does vegetation change from being non-native to native, and how do you measure its extent when it is very patchy? The same problem arises when a patch of native vegetation deteriorates in condition and contracts around the edges.

The criteria recommended here for treating a point as being part of the extent of native vegetation are that the point must either:

- Have at least 25% of the total perennial understorey plant cover being indigenous species, as determined by inspecting a 4 m radius around the point; or
- Be within an area beneath three or more native canopy trees where the drip line of each tree touches the drip line of at least one other tree, forming a continuous canopy.

These criteria are adapted from the definition of a 'patch of native vegetation' under clause 52.17 of the planning scheme. They do not solve all the problems above; e.g. the indigenous percentage of understorey cover can change substantially during slashing or brushcutting for fire hazard reduction. Doing all assessments in (say) October will reduce some of the problems.

An important reason to monitor the extent of native vegetation is because Maroondah City Council resolved at the Council meeting on 24th April 2017 to adopt the target, 'No net loss of the area and quality of existing native vegetation on 171 hectares of land managed by the City of Maroondah to 2040'.

Indicator 2 – Quadrats

The quadrats (plots of vegetation) in the EAGA monitoring require a very proficient field botanist and an assistant to spend typically two hours in each quadrat, followed by data entry, quality control and database curation. Excellent botanical skills and avoidance of rushing are required to ensure all species are detected, identified and properly documented. Otherwise the data will vary spuriously between one observer and the next. For the same reason, each survey of a quadrat must be done at the same part of each year's seasonal cycle. When a quadrat is re-surveyed, its location must match the previous survey(s) within a few metres or else the changes observed may reflect the changed location rather than genuine changes in vegetation.

Threlfall *et al.* (2015) recommend two quadrats within each reserve but more may be required in larger reserves. The cost of botanical consultants to do the fieldwork, alone, is therefore substantial. Analysis and reporting of changes between the first and second survey years will take 2–3 times as long as one year's fieldwork and subsequent cycles will take progressively longer, in the present author's experience.

Unfortunately, Threlfall *et al.* (2015) do not provide a method for analysing or reporting changes, so devising such a method will involve additional cost and effort. In addition, there is no suggestion about how, or whether, any observed changes can be attributed to particular causes such as management efforts, drought, climate change or natural fluctuations. The addition of 'control' quadrats could help isolate changes associated with certain factors; e.g. one set of quadrats may be given a particular level of management effort and another set of quadrats could be given a different level of effort. However, the high cost of quadrat work is likely to impede this approach. For these reasons, the balance between the cost and benefit of quadrats is unclear.

Indicator 3 – Monitoring of bird data

The EAGA monitoring of bird data uses the standard 'twenty-minute bird census' method of Loyn (1986), which has many similarities with the quadrat method for plants. It is equally affected by the need for an expert observer at a consistent time of year. Important differences from plant quadrats are that: (a) each twenty-minute bird census is much quicker than a quadrat; (b) birds (being mobile) can vary greatly from one twenty-minute period to another; and (c) bird censuses can be conducted anywhere, not just bushland. Point (b) means that more bird surveys are required than quadrats to gain a statistically robust data set, somewhat counterbalancing the shorter duration of the bird censuses.

As in the case of quadrats, Threlfall *et al.* (2015) do not provide a method for analysing or reporting changes in bird data, or suggestions about how, or whether, any observed changes can be attributed to particular causes. This is particularly important for bird data as there have been numerous large, unexplained shifts in bird fauna over the past two decades; e.g. the spread into capital cities of Crested Pigeon and many parrot species (Australian King-Parrot, Rainbow Lorikeet, Little Corella, …) and the decline of species such as Bell Miner and House Sparrow. As there is no indication that the causes of such changes could be inferred from the bird monitoring data, it is unclear what practical purpose will be served.

Indicator 4 – Phenology

EAGA plans to use the 'ClimateWatch' program (www.climatewatch.org.au) to monitor phenology. This involves people (including the general community) recording the date of specific events such as the first flowers of Golden Wattle or the swooping season of magpies. It is expected that once enough years of data have been gathered from enough people and sites, it will be possible to separate climate-related trends from natural fluctuations that occur between one year and another. The program has been operating Australia-wide since 2009 but no analysis of the data has been conducted to assess whether any trends can be detected yet. Neither ClimateWatch nor Threlfall *et al*. (2015) explain how trends can be separated from natural fluctuations or at what statistical confidence level. That omission may not matter if obvious trends occur over periods significantly greater than natural cycles (e.g. the drought cycle and the natural solar cycle of approximately eleven years).

Summary

The four EAGA monitoring indicators were selected on sound scientific grounds as methods to detect change. However, the selection did not consider:

- Cost;
- Certain practical problems;
- How to disentangle trends in quadrat and bird data from natural or random fluctuations; or
- How to attribute any observed trends to particular causes (although phenology is fairly straightforward, anyway).

11.12.4 Modified Habitat-Hectare Monitoring

As explained by Threlfall *et al*. (2015) and Lorimer (2008), the standard 'Habitat Hectares' method of assessing the habitat value of native vegetation is inappropriate for monitoring change. However, Knox City Council and Manningham City Council are using a modification of the Habitat Hectares method that overcomes the shortcomings of the original method for monitoring.

The modifications were devised by the present author and are described in an unpublished document available from Manningham City Council. The method involves much less time, effort and expertise than quadrats but it provides less detailed data. In other respects, the two methods are similar.

11.12.5 Monitoring of Eucalypt Decline

The death or decline of many eucalypts in Maroondah is discussed in Sections 5.1.5 (p. 34) and 11.6 (p. 84). Photographs vertically upward into the tree canopy of bushland reserves would be a simple and effective way of monitoring changes in eucalypt condition. To apportion the causes of any decline that is observed, it will be important to monitor a range of sites where the prevalence of different candidate causes is known to differ. For example, the impact of possums could be determined by monitoring some trees protected from possums by trunk bands and some trees that are unprotected.

In addition to photographs, notes should be recorded about ancillary indications of causes, such as the density of possum faeces beneath the trees, detection of insect infestations, and the condition of any nearby grass-trees or Common Heath.

The current investigation of eucalypt decline in Maroondah by the University of Melbourne will hopefully recommend a monitoring program.

11.12.6 Pest Animal Monitoring

Section 7.2 (p. 48) explains the important ecological harm that can be done by certain mammal species – both native and introduced. Rabbits are well established in Warranwood, Croydon Hills and Croydon North and are spreading westward into Kilsyth South. Deer are rapidly expanding into northern Maroondah and beginning to cause environmental problems and a traffic hazard. Foxes are abundant throughout Maroondah and their population appears to be stable. The problem of the unnaturally high populations of Common Brushtail Possums and Common Ringtail Possums are threatening eucalypts and perhaps birds, with broader ecological implications. Kangaroos are spreading into Maroondah from large, increasing populations in Warrandyte and Wonga Park but they are still in small numbers in Maroondah.

The value of monitoring these ‘pest animals’ depends on how predictable their future populations will be. For example, there is little point in monitoring foxes beyond the state government’s program because there is no current reason to expect change. The value of monitoring pest animals also depends on how harmful they are and how easily their impacts can be reduced.

Warranwood Reserve is already involved in a program led by Manningham City Council to monitor the abundance and vegetation impacts of deer. The monitoring uses exclosure fences, control plots and wildlife cameras. Volunteers from the Warranwood Reserve Committee of Management are assisting a researcher in the monitoring program. The findings over the next year or two will guide decisions about whether further monitoring is warranted. If damage by deer is found to be serious, the options for reducing it are limited within Maroondah. However, such a finding would increase the impetus for deer control at a larger scale, particularly in areas to the north where the deer are presumably breeding.

Monitoring of kangaroo numbers does not appear to be worthwhile from an ecological perspective at the moment because none of the vegetation inspected in this study shows signs of overgrazing. If such signs appear in vegetation monitoring, kangaroo monitoring could commence on a similar basis to the current monitoring of deer numbers and impacts.

Monitoring of eucalypt decline due to possums and other causes is discussed in Section 11.12.5. Monitoring possum numbers in suburbia is difficult and not justified unless there are plans to reduce the population.

11.12.7 Choosing the Right Monitoring

As noted in Section 11.12.1 (p. 92), Maroondah City Council can maintain an equal footing with the state government's monitoring of native vegetation planning controls by simply extending the planned monitoring of clause 52.17 to include local controls such as overlays. However, that will not deal with vegetation removal that is exempt from planning controls or is illegal and goes undetected. There must also be some uncertainty about how soon the state-wide monitoring system will be fully in place, given that it hasn't happened in the ten years since the need was identified in the 'First Approximation' report discussed in Section 11.12.1.

The iTree monitoring system established by Kaspar (2018), using randomly distributed sample points to measure change in tree cover, will be a useful additional measure. The related (but untested) random plot method described in Section 11.12.2 (p. 93) offers the potential to provide complementary information about habitat values across the municipality. Both these methods allow extraction of statistics for any chosen category of land. For example, vegetation changes inside an overlay area can be compared with changes outside.

An important feature of these methods is that they enable us to statistically separate different contributors to observed changes; e.g. how much of an observed change can be explained by the presence of an overlay as opposed to factors such as tree density or age of housing stock. Another advantage of these methods is that measures of statistical uncertainty can be calculated, alerting us to the level of confidence that we can place in observed changes. To gain these advantages, at least 150 monitoring locations are required, thereby limiting the amount of time and effort that can be spent on gathering data at each one.

Automated detection of trees and structures from remote sensing (lidar and aerial images) is becoming more reliable and holds promise for automating some of the tasks in the random point and random plot monitoring.

The utility of the EAGA monitoring methods (Section 11.12.3) and the modified Habitat Hectares method (Section 11.12.4) for strategic planning is unclear and dependent upon an assessment of exactly what Maroondah City Council hopes to get from the monitoring. It is important to assess any candidate monitoring method against its ability to support a clearly defined ultimate use. Monitoring without a plan for how it will lead to action would risk being of only academic interest, or even useless. It is also important to consider whether the statistical reliability of the monitoring outputs will be adequate for the intended use.

The uses of monitoring by Maroondah City Council will normally relate to things that Council can influence or control, or might need to do so in future. Once such a use is defined, a common obstacle for most indicators and monitoring methods is that they measure changes that are influenced not just by Council but also by extraneous agents, without an ability to apportion contributions.

As an example, Maroondah City Council might choose 'Number of Platypus sightings' as an indicator to be monitored, but that indicator is influenced to an unknown degree by factors outside the council's control, such as drought, Melbourne Water's stream management actions and the effectiveness of the EPA and industry in avoiding water pollution. It would be hard to relate observed changes to something that Council does or should do.

The methods based on randomly distributed plots or points use correlations of their many data points to isolate the influence of a particular change agent from confounding influences. That is

not feasible for quadrats, bird censuses or the modified Habitat Hectares method because they are too labour-intensive for monitoring at a statistically adequate number of locations. For those methods, there is the alternative of designing 'controlled experiments'.

Controlled experiments are perhaps best explained by example. To test the relationship between bushland management funding and changes in habitat condition, a set of quadrats might be set up, all treated the same except for variation in the funding allocated to their management. It might be found that the quadrats with higher funding do consistently better than those with less funding, even though drought or other factors may also affect outcomes. Applicability of this method is limited by the requirement to identify a single 'independent variable' (funding amount, in the example) at the outset and manipulate it differently between monitoring sites that are otherwise the same. There is also a problem that people who manage the vegetation at the monitoring sites may consciously or subconsciously bias their activities toward what they hope the experiment will demonstrate.

Another way to deal with extraneous influences in monitoring data is to monitor actions rather than outcomes. To give an example, the number of person-hours spent on bushland management is a measure of council action whereas the associated outcome may be the amount of improvement in habitat condition. Monitoring council actions is straightforward, very familiar to councils, subject to very little uncertainty and leaves no doubt about how much of it is influenced by the council. However, council actions can be poor indicators of the effectiveness in achieving outcomes.

As an example, Maroondah City Council could easily and accurately monitor 'The area of vegetation that Council manages for nature conservation'. That indicator is a measure of action. However, what matters is whether the action provides acceptable environmental outcomes, which are much more difficult to monitor and confidently attribute to Council.

If monitoring demonstrates a strong correlation between actions of a particular kind (e.g. person-hours spent on bushland management) and corresponding outcomes (e.g. improvement in habitat condition), it may become adequate to monitor just the actions, confident in the expectation that the outcomes will follow.

For some monitoring purposes, it is not as important to isolate how much of observed change is due to Council's actions. For example, Council may wish to detect when habitat condition in bushland reserves is declining, so that funding can be boosted to reverse the decline. Even if the decline may be due to an extraneous factor such as drought, Council may still wish to respond and not be too concerned about apportionment of cause.

'State of the Environment' reporting is another situation where Council may not be particularly concerned about isolating its own relationship to observed changes. That is because the purpose of 'State of the Environment' monitoring is to inform the community about what changes have occurred and which ones deserve attention.

In summary:

- It would be sensible for Maroondah City Council to extend the proposed state-wide monitoring of native vegetation removal to include removal under local planning controls (Section 11.12.1);
- Council has already commenced iTree monitoring of tree cover, which is expected to provide useful information for strategic planning;
- The extension of that monitoring as suggested in Section 11.12.2 offers promise to provide similar information that relates more directly to biodiversity. A trial of the method is recommended;

- It is necessary to monitor the extent of native vegetation in regard to the target set at the Council meeting on 24th April 2017 – 'No net loss of the area and quality of existing native vegetation on 171 hectares of land managed by the City of Maroondah to 2040'. The method discussed in Section 11.12.3 would be appropriate;
- It is also necessary to conduct monitoring of vegetation condition in regard to the same target as well as a second target adopted in the same Council meeting – 'Improved native vegetation quality on an additional 6.7 hectares of land managed by the City of Maroondah by 2025 and a further 13.1 hectares by 2040'. Monitoring of small plots (e.g. the quadrats in the EAGA monitoring) may not be representative of the whole area. The modified 'Habitat Hectares' method described in Section 11.12.4 would be an appropriate method;
- Monitoring of eucalypt decline and its causes will hopefully be guided by the outcome of the current investigation of those things by the University of Melbourne;
- It is recommended to monitor the condition of vegetation beside the Dandenong Creek 'daylighting' project to see if it suffers from a possible lowering of the water table;
- It is also recommended to install groundwater bores to monitor water table levels beside the 'daylighting' project of Dandenong Creek and (urgently) at the proposed project on Tarralla Creek;
- The current monitoring of deer in Warranwood Reserve and nearby parts of Manningham will provide a basis for determining what subsequent monitoring will be worthwhile in Maroondah generally; and
- The advisability of other monitoring will rely on clarity about how it will translate to action, as well as care to ensure the chosen method is statistically robust and provides the required level of attribution of observed changes to things within Council's control.

12 Issues for Bodies other than Council

12.1 Schools

Eleven schools in Maroondah have sites of biological significance within their grounds. In alphabetical order, those schools are as follows (preceded by the relevant site numbers):

114. Aquinas College (a tiny sliver)
55. Croydon Primary School
63. Croydon Special Development School
44. The former Croydon High School
81. Heathmont College
8. Melbourne Rudolf Steiner School
1. Ringwood Heights Primary School
34. Tintern Grammar
57. The Village School
54. Yarra Road Primary School
22. Yarra Valley Grammar

Some other schools have sites of biological significance adjacent or in close proximity.

Some of the sites are in school sanctuaries, which specifically recognise the presence of indigenous flora and fauna. However, even in those cases, the school management and community probably have little appreciation of the significance of the habitat or how to exploit it in the curriculum. That lack of appreciation is likely to be greater in those schools whose sites of biological significance are outside the schoolgrounds or not physically demarcated within the schoolgrounds. It is hoped that the information in Volume 2 will help raise the school communities' appreciation of the sites and their value for childhood development.

To make the best use of the educational resource provided by the habitat within the sites requires: (a) teachers or 'incursion' experts who have a good understanding of indigenous flora, fauna and ecology; and (b) space in the curriculum to include educational experiences in the habitat. Both of these appear to be significant constraints, although the Melbourne Rudolf Steiner School may be an exception. In practice, the opportunities for environmental education appear to be rarely taken.

A related constraint is that the educational experience offered by the sites depends on their ecological condition. The ecological condition of most of the sites within schoolgrounds has deteriorated since the 1997 *Sites of Biological Significance in Maroondah* study. This is not only a constraint on educational opportunities but also an ecological and ethical problem.

'Environmental weeds' are the main cause of ecological deterioration in these sites.

The capacity of school communities to maintain habitat within schoolgrounds has steadily diminished over recent decades. Attendance at school working bees has diminished as people's lives have become busier and the spirit of volunteering for community benefit has waned. Typically, school working bees have no volunteers with expertise in managing native vegetation and the wildlife habitat it forms. There are always other things to spend school funding on than maintenance of habitat.

The former Croydon High School is a special case, now that Melba College no longer uses the site. Maroondah City Council has recently taken over management of the former school's bushland area. There are also uncommon indigenous plants elsewhere on the property.

12.2 Melbourne Water

Melbourne Water owns most of the public land along streams and on floodplains. This land is the habitat of the most threatened cohort of plant species in Maroondah, i.e. specialists of soils that are sodden in winter and dry in summer – see p. 28. Therefore, Melbourne Water's actions play a

critical role in conserving or threatening many of the plant species at the highest risk of dying out in Maroondah. The Swamp Skink, which is listed as vulnerable in Victoria, is confined in Maroondah to Melbourne Water land at Bungalook Conservation Reserves. A number of rare waterbirds also frequent Melbourne Water land and its wetlands.

Some (but not all) of the sites of biological significance on Melbourne Water's land are documented within that organisation.

Despite the high importance of some of Melbourne Water's properties in Maroondah for biodiversity, the significant features are often given little weight compared with engineering objectives or the objective of providing neatly mown expanses.

An example is provided by an area of the retarding basin at Bungalook Conservation Reserves. The site contains several very rare plants, including the world's only known population of a species within the Porphyry Wallaby-grass group (p. 33). The various rare species are all critically reliant on soil that is sodden in winter. The area was mapped in Melbourne Water's 2016 management plan for the site. However, the following year, Melbourne Water excavated a drainage trench through the area to drain it. The year after (2018), at least half the surviving Porphyry Wallaby-grass plants were sprayed with herbicide (along with other rare species) and the survivors were mown just before their annual seed production was ripe. Great ecological harm has been done to a recognised site of National significance.

Another problem at the same retarding basin and one other retarding basin is mowing when the ground is boggy. Doing so results in mud being churned up and rare plants being replaced by wheel ruts and bare ground. Weeds tend to colonise the disturbed ground.

The incompatibility between threatened species conservation and the use of herbicide and mowing to create neat lawns mirrors the situation in Maroondah City Council discussed in Section 11.5 (p. 83).

Sedimentation of retarding basin lakes is a thorny problem for Melbourne Water. As discussed in Section 7.1.1 (p. 44), sediment has accumulated to such a degree at Bungalook Conservation Reserves that little open water remains and biodiversity is suffering. Sediment can contain toxic contaminants such as heavy metals, so it must be dumped at landfill sites licensed to take toxic waste. The cost is almost prohibitive. A solution will hopefully be found before this widespread problem becomes much worse.

Melbourne Water's recent 'daylighting' of Dandenong Creek, and the prospective daylighting of Tarralla Creek, offer promise of improvement of two of Maroondah's streams. Information about the potential for groundwater drawdown, and hence harm to groundwater dependent ecosystems and trees, was sought from Melbourne Water for this study but none could be found. In the absence of such information, it is desirable to monitor the water table depth and the health of vegetation beside the affected streams. Baseline monitoring of Tarralla Creek is recommended immediately, if it has not already begun. See also Sections 11.7 and 11.12.7.

12.3 Railway Corridors

Railway reserves are managed with little regard for protection of rare plants, except for two fenced areas in Heathmont: one north of Heathmont Station and the other opposite The Greenway. Those areas are managed by Maroondah City Council and the Heathmont Bushcare voluntary group, respectively.

It was beyond the scope of this study to survey railway reserves other than where public access is provided. Nevertheless, it was still possible to find two quite rare plant species.

The first is a small patch (perhaps one plant) of the nationally-listed Matted Flax-lily (*Dianella amoena*) near Churchill Rd in Croydon. It is regularly slashed and vulnerable to possible herbicide use. It would be desirable to propagate from the patch and to breed with Maroondah's other two known plants of the species, to avoid inbreeding.

The other rare species found on a railway reserve in Maroondah is a patch of the spear-grass, *Austrostipa rudis* subspecies *australis*, which is listed as rare in Victoria. Hundreds of plants grew immediately east of the Eastfield Rd bridge, on the southern side of the tracks. They had probably existed there for millennia until several years ago, when regular spraying with herbicide began. There are few if any plants of the species left there.

It would be desirable for a targeted survey of rare plants to be conducted in the vicinity of the Matted Flax-lily and the rare spear-grass, to see whether current management practices should be modified in favour of presently undetected rare plants.

12.4 Department of Environment, Land, Water and Planning

12.4.1 Fauna Surveys

As discussed in Section 7.2.1 (p. 48) and Section 7.4 (p. 51), Maroondah's microbats and reptiles are poorly known and there appears to have been very little effort to detect them for decades, at least. A targeted survey for each group of fauna would significantly improve the situation and hopefully lead to measures to ameliorate the apparent decline in species.

12.4.2 Biodiversity Information

Section 2.2 (p. 8) describes the substantial errors that this study found in the flora and fauna data provided by the Department. The Victoria Planning Provisions require local government to have regard to that data when amending and implementing planning schemes. The errors in the data mislead councils and others and lead to bad planning. Unless funding is allocated to correct the errors in the data, the requirement for local government to make use of the data should be tempered with a frank disclosure of the errors and limitations.

The same applies to the mapping of Ecological Vegetation Classes (EVCs), whose substantial errors in Maroondah are described in Chapter 4 (p. 15). Similar errors have been found in other municipalities; e.g. Manningham (Foreman 2004).

The flora data, fauna data and EVC mapping play pivotal roles in assessment of planning permit applications for removing native vegetation. They do this through the 'Native Vegetation Information Management' (NVIM) system. Errors in the data and mapping can substantially affect whether an application is granted, how much cost is involved for the applicant and council, and the cost of 'offsets'. The present regulations are so prescriptive that the capacity of an applicant or council to override faulty information in NVIM is very limited.

Appendix A - Indigenous Plant Species Inventory

This Appendix provides summary lists of the apparently reliable records of indigenous species of mosses, liverworts, ferns and flowering plants in Maroondah. A list of species for which only weak evidence has been found is at the end of this appendix. Some species are annotated to indicate that, rather than being indigenous, they may actually have arrived in Maroondah since colonisation as a result of human agency, as discussed in Section 3.1 (p. 14).

The columns of the lists contain the following information:

Column heading	Description
Code no.	Identifier given to each species by the Department of Environment, Land, Water and Planning.
Names	The scientific names are those adopted by the National Herbarium of Victoria, ordered alphabetically within each major group of plants. Hybrids are only included where they have been formally named. Names in red are here presumed to have died out in Maroondah. **Names in bold** indicate species that can confidently be regarded as 'critically endangered' within Maroondah – see Section 5.1 (p. 25).
Legal status	Legal protective measures, indicated by combinations of these letters: C, E or V: Listed under the federal *Environmental Protection and Biodiversity Conservation Act 1999* as Critically endangered, Endangered or Vulnerable, respectively; L: Listed as threatened under the Victorian *Flora and Fauna Guarantee Act 1988*; e, v, r or k: Listed in the *'Advisory List of Rare or Threatened Plants in Victoria – 2014'* as endangered, vulnerable, rare or poorly known, respectively.
Source	For species not seen in the wild by the present author, the source of the record is indicated with abbreviations as follows: AVH: Australasia's Virtual Herbarium; DGC: David Cameron's list for Melbourne Rudolf Steiner School in c. 1981; GWC: Several lists by Geoff Carr.
Missing since	The year of the most recent record of species that the author could not find growing wild during the current study.
No. SoBS	The number of 'sites of biological significance' (SoBS) in Volume 2 where each species has been recorded in the past 40 years, excluding plantings.
No. reserves	The number of the SoBS that are managed for conservation.
No. plantings	The number of SoBS where each species has been planted and survived to 2018.

Wild, Indigenous Flowering Plants

Code no.	Scientific name	Common name	Legal Status	Source	Missing since	No. SoBS	No. reserves	No plantings
504778	***Acacia acinacea***	**Gold-dust Wattle**				2	0	1
500008	*Acacia aculeatissima*	Thin-leaf Wattle				13	6	1
500018	***Acacia brownii***	**Heath Wattle**				4	2	4

Code no.	Scientific name	Common name	Legal Status	Source	Missing since	No. SoBS	No. reserves	No plantings
500025	*Acacia dealbata*	Silver Wattle				39	17	9
500038	*Acacia genistifolia*	Spreading Wattle				7	4	4
500045	*Acacia implexa*	Lightwood				24	7	8
500056	*Acacia mearnsii*	Black Wattle				82	29	8
500057	*Acacia melanoxylon*	Blackwood				100	31	8
500062	***Acacia mucronata* subsp. *longifolia***	**Variable Sallow Wattle or Narrow-leaf Wattle**				4	2	0
500063	*Acacia myrtifolia*	Myrtle Wattle				44	19	8
500072	*Acacia paradoxa*	Hedge Wattle				45	19	8
500078	*Acacia pycnantha*	Golden Wattle				42	22	7
505140	*Acacia stictophylla*	Dandenong Range Cinnamon Wattle	r			24	10	9
500091	*Acacia stricta*	Hop Wattle				40	16	9
500098	*Acacia ulicifolia*	Juniper Wattle				14	7	10
500100	*Acacia verticillata*	Prickly Moses				47	20	12
500106	*Acaena echinata*	Sheep's Burr				14	6	0
500105	*Acaena novae-zelandiae*	Bidgee-widgee				75	29	3
500107	*Acaena ovina*[1]	Australian Sheep's Burr		AVH	1989	0	0	0
500110	***Acianthus caudatus***	**Mayfly Orchid**				3	1	0
504439	***Acianthus pusillus***	**Small Mosquito Orchid**				6	5	0
500123	*Acrotriche serrulata*	Honey-pots				61	30	1
500174	*Alisma plantago-aquatica*	Water Plantain				35	15	0
500451	***Allittia cardiocarpa***	**Swamp Daisy**			2016	6	4	1
500677	*Allocasuarina littoralis*	Black Sheoak				15	7	19
502875	***Almaleea subumbellata***	**Wiry Bush-pea**				2	1	0
505097	*Alternanthera denticulata*	Lesser Joyweed				17	8	0
500208	***Amphibromus archeri***	**Pointed Swamp Wallaby-grass**				2	1	0
503628	***Amphibromus nervosus***	**Veined Swamp Wallaby-grass**				2	0	0
500220	***Amyema pendula***	**Drooping Mistletoe**				26	11	0
500222	*Amyema quandang*	Grey Mistletoe				3	2	0
500146	*Anthosachne scabra*	Common Wheat-grass				18	6	0
508061	*Aphanes ?australiana*[2]	Piert				1	0	0
500242	***Aphelia gracilis***	**Slender Aphelia**				1	1	0
500243	***Aphelia pumilio***	**Dwarf Aphelia**			1996	1	1	0
500269	*Arthropodium milleflorum*	Pale Vanilla-lily			1983	3	2	0
505126	*Arthropodium strictum*	Chocolate Lily				65	30	0
500278	***Asperula conferta***	**Common Woodruff**				2	2	0
500304	***Astroloma humifusum***	**Cranberry Heath**				11	6	0
503285	*Austrostipa nodosa*	Knotty Spear-grass		AVH	1929	0	0	0
503288	*Austrostipa pubinodis*	Tall Spear-grass				28	13	0
503289	*Austrostipa rudis*[3]	Veined Spear-grass				45	11	0
504940	*Austrostipa rudis* subsp. *australis*	Veined Spear-grass	r			13	7	0
504941	***Austrostipa rudis* subsp. *nervosa***	**Veined Spear-grass**				1	1	0
504942	*Austrostipa rudis* subsp. *rudis*	Veined Spear-grass				75	29	1
503291	***Austrostipa semibarbata***	**Fibrous Spear-grass**				1	1	0
500363	***Banksia marginata***	**Silver Banksia**				13	10	4
500373	***Baumea acuta***	**Pale Twig-rush**				4	3	0
500374	***Baumea arthrophylla***	**Fine Twig-rush**				3	1	0
504229	***Baumea rubiginosa***	**Soft Twig-rush**			2012	2	1	0
500381	***Baumea tetragona***	**Square Twig-rush**				3	2	0

[1] The record of *Acaena ovina* may actually be of *A. echinata*, given how obscure the differences are in Maroondah.
[2] The common *Aphanes* of gardens and disturbed ground in Maroondah appears to match *Aphanes australiana* but a definitive identification is required. Regardless, it may be present only due to human activity.
[3] The present study identified all plants of *Austrostipa rudis* to subspecies level but many prior records have not.

Code no.	Scientific name	Common name	Legal Status	Source	Missing since	No. SoBS	No. reserves	No plantings
504291	*Billardiera mutabilis*	Common Apple-berry				70	31	0
500440	*Bossiaea prostrata*	Creeping Bossiaea				41	22	0
500455	***Brachyscome decipiens***	**Field Daisy**			1996	1	0	0
500456	***Brachyscome diversifolia***	**Tall Daisy**			2008	1	0	0
500508	*Brunonia australis*	Blue Pincushion				24	14	0
500510	*Bulbine bulbosa*	Yellow Bulbine-lily				7	5	0
500512	*Burchardia umbellata*	Milkmaids				43	23	0
500513	*Burnettia cuneata*	Lizard Orchid	r	AVH	1921	0	0	0
505690	*Bursaria spinosa*	Sweet Bursaria				88	31	8
500518	*Caesia parviflora*	Pale Grass-lily				42	27	0
503680	***Caladenia carnea***	**Pink Fingers**				8	5	0
504900	***Caladenia catenata***	**White Caladenia**				2	1	0
500528	*Caladenia clavigera*	Plain-lip Spider-orchid		AVH	1915	0	0	0
500529	***Caladenia congesta***	**Black-tongue Caladenia**				1	1	0
501019	***Caladenia dilatata***	**Green-comb Spider-orchid**	k	AVH	1949			
500541	*Caladenia flavovirens*	Summer Spider-orchid	r	AVH	1927			
504351	*Caladenia fragrantissima*	Scented Spider-orchid	Le	AVH	1949			
	Caladenia gracilis – see *Caladenia moschata*							
500536	*Caladenia iridescens*	Bronze Caladenia		AVH	1946			
500535	***Caladenia moschata***	**Musky Caladenia**			2015	3	2	0
503694	*Caladenia oenochila*	Wine-lipped Spider-orchid	v	VBA	1996	1	1	0
504476	*Caladenia parva*	Small Spider-orchid			1996	2	2	0
504350	*Caladenia patersonii*	Common Spider-orchid	e	AVH	1921			
500543	*Caladenia praecox*	Early Caladenia		GWC	1983	1	1	0
500545	***Caladenia pusilla***	**Tiny Caladenia**			2009	2	2	0
505431	***Caladenia* sp. aff. *venusta* (Kilsyth South)**	**Kilsyth South Spider-orchid**	CLe			1	1	0
503677	*Caladenia tentaculata*	Large Green-comb Spider-orchid		AVH	1941	0	0	0
500547	*Caladenia tessellata*	Thick-lip Spider-orchid	Vv	AVH	1908			
505422	***Caladenia transitoria***	**Eastern Bronze Caladenia**			2016	5	3	0
500585	***Calochilus campestris***	**Copper Beard-orchid**			2016	2	2	0
500587	***Calochilus paludosus***	**Red Beard-orchid**			2005	5	3	0
500589	***Calochilus robertsonii***	**Purplish Beard-orchid**				10	5	0
503805	*Calotis scabiosifolia* var. *integrifolia*	Rough Burr-daisy		AVH	1922			
500603	***Calystegia marginata***	**Forest Bindweed**				1	0	0
500623	*Carex appressa*	Tall Sedge				22	10	12
500627	*Carex breviculmis*	Short-stem Sedge				51	25	0
500638	*Carex fascicularis*	Tassel Sedge				6	4	7
500639	***Carex gaudichaudiana***	**Fen Sedge**				5	3	1
500642	*Carex inversa*	Knob Sedge				13	8	0
500666	*Cassinia aculeata*	Common Cassinia				73	28	6
500668	*Cassinia longifolia*	Shiny Cassinia				32	21	3
500667	*Cassinia sifton*	Drooping Cassinia				80	30	0
500669	***Cassinia trinerva***	**Three-nerved Cassinia**			2015	1	1	0
500671	***Cassytha glabella***	**Slender Dodder-laurel**			1996	3	1	0
500672	*Cassytha melantha*	Coarse Dodder-laurel				28	12	0
500674	*Cassytha pubescens*	Downy Dodder-laurel				37	17	0
500706	*Centella cordifolia*	Centella				38	19	1
505614	***Centipeda elatinoides***	**Elatine Sneezeweed**			1999	2	1	0
500707	*Centipeda cunninghamii*	Common Sneezeweed		AVH	1935			
	Centipeda minima – see *Centipeda elatinoides*							
500711	***Centrolepis aristata***	**Pointed Centrolepis**				4	3	0
500713	*Centrolepis fascicularis*	Tufted Centrolepis			2001	2	2	0
500716	***Centrolepis strigosa***	**Hairy Centrolepis**				4	1	0

Code no.	Scientific name	Common name	Legal Status	Source	Missing since	No. SoBS	No. reserves	No plantings
500726	*Chamaescilla corymbosa*	Blue Stars				15	9	0
500750	*Chiloglottis cornuta*	Green Bird-orchid		AVH	1923			
500753	***Chiloglottis reflexa***	**Autumn Bird-orchid**				3	2	0
500754	***Chiloglottis trapeziformis***	**Dainty Bird-orchid**				1	1	0
504888	*Chiloglottis valida*	Common Bird-orchid				10	8	0
504632	*Chorizandra cymbaria*	Heron Bristle-rush			1992	1	1	0
501606	***Chrysocephalum apiculatum***[4]	**Common Everlasting**				1	1	1
501628	***Chrysocephalum semipapposum***	**Clustered Everlasting**				11	6	6
500788	*Clematis aristata*	Mountain Clematis				42	19	1
507387	*Clematis decipiens*[5]	a small-leafed clematis				25	14	2
	Clematis microphylla – see *Clematis decipiens*							
500797	***Comesperma ericinum***	**Heath Milkwort**				9	5	0
500801	*Comesperma volubile*	Love Creeper				26	16	0
500822	*Coprosma quadrifida*	Prickly Currant-bush				50	24	4
501626	*Coronidium scorpioides*	Button Everlasting				30	15	1
504370	***Correa reflexa* var. *reflexa***	**Common Correa**				39	19	5
502698	*Corunastylis archeri*	Variable Midge-orchid		AVH	1980	0	0	0
502705	***Corunastylis despectans***	**Sharp Midge-orchid**				4	3	0
502715	***Corunastylis morrisii***	**Bearded Midge-orchid**				1	0	0
500838	***Corybas diemenicus***	**Veined Helmet-orchid**				1	1	0
500842	*Corybas unguiculatus*	Small Helmet-orchid		AVH	1899			
500846	*Cotula australis*	Common Cotula				15	7	0
504649	*Craspedia paludicola*	Swamp Billy-buttons		AVH	1897			
504650	***Craspedia variabilis***	**Variable Billy-buttons**			1996	3	2	0
500860	*Crassula decumbens* var. *decumbens*	Spreading Crassula				15	8	0
500862	*Crassula helmsii*	Swamp Crassula				6	3	2
500866	***Crassula sieberiana/tetramera***	**Sieber Crassula**				3	1	0
500883	***Cryptostylis leptochila***	**Small Tongue-orchid**				1	1	0
500884	*Cryptostylis subulata*	Large Tongue-orchid				9	5	0
500524	*Cyanicula caerulea*	Blue Caladenia		AVH	1927			0
504074	*Cycnogeton alcockiae*	Water-ribbons			1996	2	1	0
504073	*Cycnogeton procerum*	Water-ribbons		AVH	1903			2
500908	*Cynoglossum australe*	Austral Hound's-tongue		AVH	1948			0
500910	***Cynoglossum suaveolens***	**Sweet Hound's-tongue**				4	3	0
500112	*Cyrtostylis reniformis*	Small Gnat Orchid			1988	2	2	0
500989	***Daucus glochidiatus***	**Austral Carrot**			1996	2	2	0
500996	*Daviesia latifolia*	Hop Bitter-pea				11	4	4
501000	*Daviesia leptophylla*	Narrow-leaf Bitter-pea				45	17	3
501016	***Deyeuxia densa***	**Heath Bent-grass**				2	1	0
501023	*Deyeuxia quadriseta*	Reed Bent-grass				67	27	1
505084	***Dianella amoena***	**Matted Flax-lily**	ELe			3	1	0
504420	*Dianella longifolia* var. *longifolia*	Pale Flax-lily				55	24	11
504413	*Dianella revoluta* var. *revoluta*	Black-anther Flax-lily				80	31	2
501030	*Dianella tasmanica*	Tasman Flax-lily				25	13	7
501033	*Dichelachne crinita*[6]	Long-hair Plume-grass			2001	2	0	1
503792	*Dichelachne rara*	Common Plume-grass				37	17	0

[4] There is a 1911 specimen of *Chrysocephalum apiculatum* from Ringwood. The solitary plant discovered in Ringwood in 2018 may have escaped from a garden.

[5] While *Clematis decipiens* can confidently be regarded as indigenous in northern Maroondah, it has spread greatly since 2000 and is now threatening the survival of many indigenous plants in its expanded range.

[6] *Dichelachne crinita* is dubiously indigenous in Maroondah. A solitary plant sometimes appears before dying without replacement, except where the species has been planted.

Code no.	Scientific name	Common name	Legal Status	Source	Missing since	No. SoBS	No. reserves	No plantings
503791	*Dichelachne sieberiana*[7]	Plume-grass				14	6	0
501036	*Dichondra repens*	Kidney-weed				46	20	0
505931	*Dillwynia cinerascens*	Grey Parrot-pea				62	28	1
504889	*Dipodium roseum*	Hyacinth Orchid				36	21	0
501061	***Diuris behrii***	**Golden Cowslips**	v		2008	1	0	0
505423	*Diuris chryseopsis*	Golden Moths		AVH	1968	2	1	0
501079	*Diuris orientis*	Wallflower Orchid				11	6	0
501081	*Diuris × palachila*	a hybrid Diuris	r	AVH	1915	0	0	0
501080	*Diuris pardina*	Leopard Orchid				9	4	0
501084	*Diuris punctata* var. *punctata*	Purple Diuris	Lv	AVH	1924	1	0	0
501085	***Diuris sulphurea***	**Tiger Orchid**				6	4	0
501110	*Drosera aberrans*	Scented Sundew				34	17	0
501102	*Drosera auriculata*	Tall Sundew				45	22	0
501103	*Drosera binata*	Forked Sundew		AVH	1945			
528663	***Drosera hookeri***[8]	**Branched Sundew**				6	3	0
	Drosera peltata subsp. *peltata* – see *Drosera hookeri*							
501108	***Drosera pygmaea***	**Tiny Sundew**			2005	4	2	0
501122	***Echinopogon ovatus***	**Common Hedgehog-grass**				5	3	1
501138	*Elatine gratioloides*	Waterwort				5	1	0
501139	*Eleocharis acuta*	Common Spike-rush				7	2	1
501146	*Eleocharis sphacelata*	Tall Spike-rush				11	3	0
501155	***Empodisma minus***	**Spreading Rope-rush**				8	6	0
501681	***Epacris gunnii***	**Ace of Spades**			1995	1	1	3
504478	*Epacris impressa* var. *impressa*	Common Heath				67	28	2
504444	*Epilobium billardiereanum* subsp. *billardiereanum*	Robust Willow-herb			2012	1	0	0
504445	*Epilobium billardiereanum* subsp. *cinereum*	Variable Willow-herb				13	7	0
504447	*Epilobium billardiereanum* subsp. *intermedium*	Robust Willow-herb				4	4	0
501179	*Epilobium hirtigerum*	Hairy Willow-herb				42	17	0
501185	*Eragrostis brownii*	Common Love-grass				36	11	0
501219	***Eriochilus cucullatus***	**Parson's Bands**			2010	3	2	0
501240	***Eryngium vesiculosum***	**Prickfoot**				3	1	0
515932	*Eucalyptus × brevirostris*	a hybrid eucalypt	r[9]			2	1	0
503733	*Eucalyptus cephalocarpa*	Mealy Stringybark				66	22	5
501281	***Eucalyptus globoidea***	**White Stringybark**				18	7	2
503732	*Eucalyptus goniocalyx*	Bundy, Long-leaf Box				82	28	1
501294	***Eucalyptus macrorhyncha***	**Red Stringybark**				70	25	0
501297	*Eucalyptus melliodora*	Yellow Box				40	13	4
501304	*Eucalyptus obliqua*	Messmate Stringybark				87	31	1
501307	*Eucalyptus ovata*	Swamp Gum				72	24	3
504335	*Eucalyptus polyanthemos* subsp. *vestita*	Red Box				29	9	8
503828	*Eucalyptus radiata* subsp. *radiata*	Narrow-leaf Peppermint				92	30	4
501315	***Eucalyptus rubida***	**Candlebark**				15	5	1
504463	*Eucalyptus viminalis* subsp. *viminalis*	Manna Gum				14	7	11

[7] It is quite possible that all records of *Dichelachne sieberiana* in Maroondah actually belong to *D. rara*.

[8] It is presumed here that all past written records of *Drosera peltata* subsp. *peltata* are referable now to *Drosera hookeri*. Further investigation is warranted.

[9] The *'Advisory List…'* wrongly indicates that *E. × brevirostris* is a hybrid between *E. macrorhyncha* and *E. muelleriana*. Examination of the National Herbarium of Victoria specimens from Lilydale and Warrandyte shows that they are *E. macrorhyncha × E. obliqua*. *E. muelleriana* does not occur at these localities or the type locality.

Code no.	Scientific name	Common name	Legal Status	Source	Missing since	No. SoBS	No. reserves	No plantings
501326	***Eucalyptus yarraensis***	**Yarra Gum**	r			2	0	0
501465	*Euchiton involucratus*	Common Cudweed				27	12	0
501466	*Euchiton japonicus*	Creeping Cudweed				23	11	0
501471	*Euchiton sphaericus*	Star Cudweed				7	2	0
504472	*Euphrasia collina* subsp. *trichocalycina*	Purple Eyebright	r	AVH	1935	0	0	0
501350	*Exocarpos cupressiformis*	Cherry Ballart				98	33	0
501353	*Exocarpos strictus*	Pale-fruit Ballart				6	2	0
501394	*Gahnia radula*	Thatch Saw-sedge				104	33	0
501395	*Gahnia sieberiana*	Red-fruit Saw-sedge				18	10	9
501409	*Galium gaudichaudii*	Rough Bedstraw			1996	7	3	0
504459	*Gastrodia sesamoides*[10]	Cinnamon Bells				8	6	0
503826	*Gentianella polysperes*	Early Forest-gentian	r	AVH	1922			
501427	*Geranium homeanum*	Northern Crane's-bill				2	1	0
501431	*Geranium potentilloides*	Cinquefoil Crane's-bill				17	9	0
501434	*Geranium solanderi* group[11]	Austral Crane's-bill				10	4	0
505346	*Geranium* sp. 5	Naked Crane's-bill				1	1	0
501445	*Glossodia major*	Wax-lip Orchid				16	8	0
501451	*Glyceria australis*	Australian Sweet-grass				9	5	0
501455	*Glycine clandestina*	Twining Glycine				20	11	0
503741	***Glycine microphylla***	**Small-leaf Glycine**				2	1	0
501481	***Gompholobium huegelii***	**Common Wedge-pea**				15	7	2
501484	***Gonocarpus humilis***	**Shade Raspwort**			2001	2	2	0
501486	***Gonocarpus micranthus* subsp. *micranthus***	**Creeping Raspwort**			2012	8	2	1
501489	*Gonocarpus tetragynus*	Common Raspwort				90	33	0
501496	***Goodenia elongata***	**Lanky Goodenia**				8	8	1
501503	***Goodenia humilis***	**Swamp Goodenia**				5	2	0
501504	*Goodenia lanata*	Trailing Goodenia				31	17	0
501507	*Goodenia ovata*	Hop Goodenia				61	24	15
505076	*Goodia lotifolia*	Common Golden-tip			1995	2	2	5
501524	***Gratiola peruviana***	**Austral Brooklime**			1996	3	1	0
503747	***Gratiola pubescens***	**Glandular Brooklime**				11	3	0
503853	***Gynatrix pulchella***	**Hemp Bush**				5	1	8
505070	***Hakea decurrens***	**Bushy Needlewood**				7	5	7
501568	***Hakea nodosa***	**Yellow Hakea**				13	7	9
501573	*Hakea teretifolia* subsp. *hirsuta*	Dagger Hakea		AVH	1891			
501574	***Hakea ulicina***	**Furze Hakea**				10	6	11
501596	*Hardenbergia violacea*	Purple Coral-pea				45	20	3
501654	*Hemarthria uncinata* var. *uncinata*	Mat Grass				21	10	0
505437	***Hibbertia empetrifolia* subsp. *empetrifolia***	**Tangled Guinea-flower**				3	1	3
501671	***Hibbertia obtusifolia***	**Grey Guinea-flower**				4	3	0
501675	*Hibbertia riparia*	Erect Guinea-flower				21	9	1
501360	***Hookerochloa hookeriana***	**Hooker Fescue**				7	5	2
501705	*Hovea heterophylla*	Common Hovea				42	21	0
501718	***Hydrocotyle callicarpa***	**Small Pennywort**				2	1	0
501720	*Hydrocotyle foveolata*	Yellow Pennywort				8	6	0
501722	*Hydrocotyle hirta*	Hairy Pennywort				10	8	0
501723	*Hydrocotyle laxiflora*	Stinking Pennywort				7	3	0

[10] There are confirmed records of *Gastrodia sesamoides* from Maroondah and many records that do not distinguish between *G. sesamoides* and *G. procerum*. The latter species may occur in Maroondah, as it does nearby.

[11] *Geranium* sp. 2 is sometimes segregated from *G. solanderi* but not here.

Code no.	Scientific name	Common name	Legal Status	Source	Missing since	No. SoBS	No. reserves	No plantings
501728	*Hydrocotyle sibthorpioides*	Shining Pennywort			1996	2	0	0
501741	*Hypericum gramineum*	Small St John's Wort				62	26	0
501743	***Hypericum japonicum***	**Matted St John's Wort**				4	1	0
501756	***Hypoxis hygrometrica***[12]	**Golden Weather-glass**				8	3	0
	Hypoxis species – see also *Pauridia*							
501760	*Imperata cylindrica*	Blady Grass				14	9	0
501761	*Indigofera australis*	Austral Indigo				14	8	7
501772	*Isolepis cernua*	Nodding Club-rush				4	3	0
501775	***Isolepis fluitans***	**Floating Club-rush**				2	1	0
501777	*Isolepis hookeriana*	Grassy Club-rush				9	5	0
501779	*Isolepis inundata*	Swamp Club-rush				42	18	0
501780	*Isolepis marginata*	Little Club-rush				7	4	0
501783	*Isolepis platycarpa*	a club-rush				15	8	0
501793	***Isotoma fluviatilis* subsp. *australis***	**Swamp Isotome**				4	1	0
501803	*Juncus amabilis*	Hollow Rush				49	18	1
501808	*Juncus australis*	Austral Rush				13	3	0
501810	*Juncus bufonius*	Toad Rush				34	17	0
501817	***Juncus filicaulis***[13]	**Thread Rush**				1	0	0
501818	***Juncus flavidus***	**Yellow Rush**				1	1	0
–	*Juncus fockei~holoschoenus*[14]	a rush				22	6	0
501820	*Juncus gregiflorus*	Green Rush				45	20	2
501821	***Juncus holoschoenus***[15]	**Joint-leaf Rush**				1	0	0
501830	*Juncus pallidus*	Pale Rush				70	26	2
501831	*Juncus pauciflorus*	Loose-flower Rush				22	11	0
501833	*Juncus planifolius*	Broad-leaf Rush				27	12	0
501834	*Juncus prismatocarpus*	Branching Rush		AVH	1932			
501835	*Juncus procerus*	Tall Rush				34	13	3
501838	*Juncus remotiflorus*[16]	Diffuse Rush		AVH	1951			
501841	*Juncus sarophorus*	Broom Rush				56	23	1
501843	*Juncus subsecundus*	Finger Rush				44	20	0
501847	***Kennedia prostrata***	**Running Postman**				15	5	2
507040	*Kunzea ?leptospermoides*[17]	Yarra Burgan	k			75	29	3
500149	***Lachnagrostis aemula***	**Purplish Blown Grass**			2004	3	2	0
504219	*Lachnagrostis filiformis*	Common Blown Grass				38	19	0
501861	*Lagenophora gracilis*	Slender Lagenophora				26	14	0
501863	***Lagenophora stipitata***	**Common Lagenophora**				18	11	0
502762	*Laphangium luteoalbum*	Jersey cudweed				7	4	0
501893	*Lemna disperma*	Common Duckweed				12	3	0
501919	*Lepidosperma elatius*[18]	Tall Sword-sedge				16	13	0
501920	***Lepidosperma filiforme***	**Common Rapier-sedge**				3	3	0
504699	*Lepidosperma gunnii*	Slender Sword-sedge				36	18	0

[12] Most records of *Hypoxis hygrometrica* in Maroondah do not indicate which variety but var. *hygrometrica* certainly occurs and var. *villosisepala* is represented by herbarium specimens up to 1944.

[13] The sole record of *Juncus filicaulis* in Maroondah is represented by a pressed specimen collected in this study. Until it can be compared with specimens at the National Herbarium of Victoria, there remains a chance that it is actually an aberrant form of *Juncus subsecundus* or a hybrid between the two species.

[14] This entry is for the many plants in Maroondah that have pointed seed capsules but are more robust than is generally accepted for *J. fockei*. A taxonomic revision is needed.

[15] The author has found only a single plant that fits all the expected characters of *Juncus holoschoenus*, including blunt-topped seed capsules.

[16] The solitary record of *Juncus remotiflorus* from Maroondah must be either a misidentified hybrid or a fluky transient occurrence.

[17] See p. 33.

[18] It is not unusual in Maroondah to find plants intermediate between *Lepidosperma elatius* and *L. laterale*.

Code no.	Scientific name	Common name	Legal Status	Source	Missing since	No. SoBS	No. reserves	No plantings
501923	*Lepidosperma laterale*[18]	Variable Sword-sedge				40	21	1
501926	***Lepidosperma longitudinale***	**Pithy Sword-sedge**				1	1	0
500540	*Leptoceras menziesii*	Hare Orchid		AVH	1897	0	0	0
505610	*Leptorhynchos squamatus* subsp. *squamatus*	Scaly Buttons		AVH	1935			
501947	*Leptorhynchos tenuifolius*	Wiry Buttons				24	9	4
501956	*Leptospermum continentale*	Prickly Tea-tree				75	25	1
501958	***Leptospermum lanigerum***	**Woolly Tea-tree**				4	3	2
501965	*Leptospermum scoparium*	Manuka				24	15	5
504391	*Leucopogon virgatus* var. *virgatus*	Common Beard-heath				30	14	3
501997	*Levenhookia dubia*	Hairy Stylewort		AVH	1901			
501998	*Levenhookia sonderi*	Slender Stylewort	r	AVH	1948			
502017	*Linum marginale*	Native Flax				16	5	0
502024	*Lobelia anceps*	Angled Lobelia				26	13	1
504703	***Lobelia gibbosa***	**Tall Lobelia**			2004	6	5	0
504704	***Lobelia simplicicaulis***	**Narrow Lobelia**		[19]	2005	1	1	0
504709	*Lomandra filiformis* subsp. *coriacea*	Wattle Mat-rush				90	31	0
504710	*Lomandra filiformis* subsp. *filiformis*	Wattle Mat-rush				55	25	0
504714	*Lomandra longifolia* subsp. *longifolia*	Spiny-headed Mat-rush				36	20	9
504713	*Lomandra longifolia* subsp. *exilis*	Cluster-headed Mat-rush				27	16	0
502048	*Lomandra multiflora* subsp. *multiflora*	Many-flowered Mat-rush				5	3	0
502051	***Lomatia ilicifolia***	**Holly Lomatia**				1	1	1
502063	*Ludwigia peploides* subsp. *montevidensis*	Clove-strip				1	1	0
503841	*Luzula meridionalis*[20]	Common Woodrush				16	9	0
502087	*Lyperanthus suaveolens*	Brown-beaks				10	5	0
502092	*Lythrum hyssopifolia*	Small Loosestrife				39	17	0
502133	*Mazus pumilio*	Swamp Mazus			2000	1	1	0
502147	*Melaleuca ericifolia*	Swamp Paperbark				41	16	7
504933	*Melicytus dentatus*	Tree Violet		AVH	1903			
502167	*Mentha laxiflora*	Forest Mint		AVH	1935			
502179	*Microlaena stipoides* var. *stipoides*	Weeping Grass				107	35	1
503887	***Microseris walteri***	**Murnong**				5	4	0
502258	***Microtis arenaria***	**Sand Onion-orchid**			2003	2	1	0
502185	*Microtis atrata*	Yellow Onion-orchid		AVH	1926			
502187	*Microtis parviflora*	Slender Onion-orchid				41	20	0
502188	*Microtis rara*	Sweet Onion-orchid		AVH	1929	0	0	0
502189	*Microtis unifolia*	Common Onion-orchid				6	3	0
504309	*Montia fontana* subsp. *chondrosperma*	Water Blinks				4	1	0
502233	***Muellerina eucalyptoides***	**Creeping Mistletoe**				12	6	0
502251	*Myriophyllum amphibium*	Broad Water-milfoil		AVH	1892			
503867	***Myriophyllum crispatum***	**Upright Water-milfoil**				4	1	0
503873	***Myriophyllum simulans***	**Amphibious Water-milfoil**			2012	2	0	1
502299	*Olearia argophylla*	Musk Daisy-bush				2	0	2
502307	***Olearia glandulosa***	**Swamp Daisy-bush**				1	1	0
502312	*Olearia lirata*	Snowy Daisy-bush				22	14	9
502316	*Olearia myrsinoides*	Silky Daisy-bush				28	14	1
504781	*Olearia phlogopappa* subsp. *continentalis*	Dusty Daisy-bush			2016	2	2	0

[19] *Lobelia simplicicaulis* is known in Maroondah only by a specimen of Ruth Jackson from Kilsyth South.

[20] All three varieties of *Luzula meridionalis* (*viz densiflora*, *flaccida* and *meridionalis*) occur in Maroondah but too few records distinguish them to be able to present statistics for each.

Code no.	Scientific name	Common name	Legal Status	Source	Missing since	No. SoBS	No. reserves	No plantings
502341	*Opercularia ovata*	Broad-leaf Stinkweed				22	12	0
502344	*Opercularia varia*	Variable Stinkweed				54	25	0
503521	***Ornduffia reniformis***	**Running Marsh-flower**				2	1	0
502370	*Orthoceras strictum*	Horned Orchid		AVH	1944	0	0	0
502375	***Ottelia ovalifolia* subsp. *ovalifolia***	**Swamp Lily**			1996	1	0	0
507311	*Oxalis exilis/perennans*	Wood-sorrel				68	26	0
501616	*Ozothamnus ferrugineus*	Tree Everlasting				70	29	7
501620	***Ozothamnus obcordatus***	**Grey Everlasting**				3	1	1
501624	***Ozothamnus rosmarinifolius***	**Rosemary Everlasting**				2	1	0
502426	*Parsonsia brownii*[21]	Twining Silkpod				2	2	0
502435	***Patersonia fragilis***	**Short Purple-flag**				2	2	0
502437	*Patersonia occidentalis*	Long Purple-flag				12	5	6
504081	*Pauridia glabella*	Tiny Star		AVH	1935			
504584	***Pauridia vaginata* var. *vaginata***	**Yellow Star**			1994	5	3	0
502446	***Pelargonium inodorum***	**Kopata**				5	3	0
502456	***Pentapogon quadrifidus* var. *quadrifidus***	**Five-awned Spear-grass**				11	4	0
503919	*Persicaria decipiens*	Slender Knotweed				36	17	1
502628	*Persicaria hydropiper*[22]	Water-pepper				11	6	0
502630	*Persicaria lapathifolia*[22]	Pale Knotweed		VBA	1989	2	2	0
503938	***Persicaria praetermissa***	**Spotted Knotweed**				4	3	0
502637	***Persicaria subsessilis***	**Hairy Knotweed**				1	1	0
502463	***Persoonia juniperina***	**Prickly Geebung**				12	7	0
500531	*Pheladenia deformis*	Bluebeard Caladenia		AVH	1926			
502497	*Phragmites australis*	Common Reed				27	10	0
504829	*Pimelea axiflora* subsp. *axiflora*	Bootlace Bush		AVH	1923			
504145	***Pimelea curviflora* var. *sericea***	**Curved Rice-flower**				2	2	0
502523	*Pimelea humilis*	Common Rice-flower				58	28	0
504819	***Pimelea linifolia* subsp. *linifolia***	**Slender Rice-flower**				5	1	0
502566	*Plantago varia*	Variable Plantain				14	7	0
528676	*Platylobium infecundum*	a flat-pea	e			14	8	0
502569	*Platylobium obtusangulum*	Common Flat-pea				72	30	0
528675	*Platylobium reflexum*	a flat-pea	r	AVH	1945			
502590	*Poa ensiformis*	Purple-sheathed Tussock-grass				34	20	10
504694	*Poa labillardierei* var. *labillardierei*	Common Tussock-grass				16	7	19
502602	*Poa morrisii*	Soft Tussock-grass				68	27	1
502609	*Poa rodwayi*[23]	Velvet Tussock-grass		AVH	1960	0	0	0
504835	*Poa sieberiana* var. *sieberiana*	Grey Tussock-grass				35	14	1
502610	***Poa tenera***	**Slender Tussock-grass**				25	14	0
502643	*Polyscias sambucifolia*	Elderberry Panax				19	9	0
502650	*Pomaderris aspera*	Hazel Pomaderris				6	2	10
502660	*Pomaderris lanigera*	Woolly Pomaderris			1989	1	1	1
502670	*Pomaderris prunifolia* var. *prunifolia*	Plum-leaf Pomaderris				2	1	3
502671	***Pomaderris racemosa***	**Cluster Pomaderris**				6	4	2
507704	*Poranthera microphylla*	Small Poranthera				70	28	0

[21] *Parsonsia brownii* first appeared in Maroondah in 2001 at 'Uambi' and then in recent years at Appletree Hill Reserve, where it is now abundant and smothering many indigenous species. It has presumably spread from its natural range (e.g. Dandenong Ranges). See Chapter 10 (p. 32).

[22] Botanists are unsure whether *Persicaria hydropiper* and *P. lapathifolia* are native to Victoria.

[23] There is disagreement among botanists about whether Victorian plants that have been identified as *Poa rodwayi* are actually forms of *P. morrisii*.

Code no.	Scientific name	Common name	Legal Status	Source	Missing since	No. SoBS	No. reserves	No plantings
505274	***Potamogeton cheesemanii***	**Small-fruit Pondweed**			1996	2	0	0
502688	***Potamogeton crispus***	**Curly Pondweed**			2006	2	0	0
502690	*Potamogeton ochreatus*	Blunt Pondweed				11	4	0
502699	*Prasophyllum australe*	Austral Leek-orchid		AVH	1944			
502703	***Prasophyllum brevilabre***	**Short-lip Leek-orchid**			1999	1	1	0
504154	*Prasophyllum colemaniae*	Lilac Leek-orchid	extinct	AVH	1921			
502708	*Prasophyllum flavum*	Yellow Leek-orchid		AVH	1920			
	Prasophyllum frenchii – see *Prasophyllum pyriforme*							
502702	*Prasophyllum lindleyanum*	Green Leek-orchid	v	AVH	1921			
502717	*Prasophyllum odoratum*	Fragrant Leek-orchid		AVH	1944			
502710	*Prasophyllum pyriforme*	Silurian Leek-orchid	k	AVH	1990	1	1	0
504845	*Prostanthera lasianthos* var. *lasianthos*	Victorian Christmas-bush				21	12	9
504873	***Pterostylis alpina***	**Mountain Greenhood**			2016	3	2	0
502807	***Pterostylis atrans***	**Dark-tip Greenhood**			2003	1	1	0
504728	*Pterostylis chlorogramma*	Green-lined Greenhood	VLv	AVH	1921			
505293	***Pterostylis clivosa***	**Red-tip Greenhood**	r			2	1	0
502789	***Pterostylis concinna***	**Trim Greenhood**				1	1	0
502791	*Pterostylis curta*	Blunt Greenhood				5	3	0
504877	*Pterostylis falcata*	Large Sickle Greenhood		AVH	1970	1	1	0
502796	*Pterostylis foliata*	Slender Greenhood		AVH	1922			
502798	*Pterostylis grandiflora*	Cobra Greenhood	r	GWC	1982	1	1	0
502800	*Pterostylis × ingens*	Sharp Greenhood	r			1	1	0
504131	*Pterostylis melagramma*	Tall Greenhood				21	13	0
502805	***Pterostylis nana***	**Dwarf Greenhood**				4	3	0
502806	*Pterostylis nutans*	Nodding Greenhood				29	15	0
504033	*Pterostylis parviflora*	Tiny Greenhood				3	2	0
502810	*Pterostylis pedunculata*	Maroon-hood				7	5	0
502811	*Pterostylis plumosa*	Bearded Greenhood		AVH	1933			
502816	***Pterostylis squamata***	**Rusty-hood**		AVH	1983	1	1	0
504857	***Pultenaea forsythiana***	**Eastern Prickly Bush-pea**				4	3	1
504138	*Pultenaea gunnii* subsp. *gunnii*	Golden Bush-pea				54	25	5
502864	***Pultenaea pedunculata***	**Matted Bush-pea**				1	0	0
502871	***Pultenaea scabra***	**Rough Bush-pea**			1997	4	4	5
504862	*Pultenaea sericea*	Heathland Bush-pea		AVH	1902			
502086	*Pyrorchis nigricans*	Red-beaks		AVH	1932			
502890	***Ranunculus glabrifolius***	**Shining Buttercup**				2	1	2
502893	*Ranunculus inundatus*	River Buttercup			1992	1	1	0
502894	*Ranunculus lappaceus*	Australian Buttercup				6	4	0
502956	*Rubus parvifolius*	Small-leaf Bramble				14	7	0
502968	***Rumex brownii***	**Slender Dock**			2010	2	1	0
504938	***Rytidosperma* aff. *caespitosum* (South-west Swamps) – Kilsyth South form**	**Porphyry Wallaby-grass**	k			1	1	0
500961	*Rytidosperma caespitosum*	Common Wallaby-grass				8	5	0
500963	***Rytidosperma duttonianum***	**Brown-back Wallaby-grass**			2016	1	0	0
504409	*Rytidosperma fulvum*	Leafy Wallaby-grass				53	22	0
500965	*Rytidosperma geniculatum*	Kneed Wallaby-grass				15	5	0
500967	*Rytidosperma laeve*	Smooth Wallaby-grass				34	17	0
	Rytidosperma monticola/erianthum[24]	**a wallaby-grass**				6	2	0
500973	*Rytidosperma pallidum*	Silvertop Wallaby-grass				78	31	0

[24] This entry is for plants intermediate between *Rytidosperma monticola* and *R. erianthum* but probably better placed with the former due to slender glumes, short lemma lobe bristles and the presence of scattered lemma hairs between the two rows.

Code no.	Scientific name	Common name	Legal Status	Source	Missing since	No. SoBS	No. reserves	No plantings
500974	*Rytidosperma penicillatum*	Slender Wallaby-grass				79	30	0
504404	*Rytidosperma pilosum*	Velvet Wallaby-grass				43	20	0
500976	***Rytidosperma indutum* (*procerum*)**	**Tall Wallaby-grass**			2014	1	1	0
500977	*Rytidosperma racemosum* var. *racemosum*	Clustered Wallaby-grass				68	26	1
500979	*Rytidosperma semiannulare*	Tasmanian Wallaby-grass				35	15	0
504379	*Rytidosperma setaceum*	Bristly Wallaby-grass				70	29	1
500981	*Rytidosperma tenuius*	Purplish Wallaby-grass				63	26	0
503039	*Schoenus apogon*	Common Bog-rush				75	29	0
503055	***Schoenus lepidosperma***	**Slender Bog-rush**				4	4	0
503048	***Schoenus maschalinus***	**Leafy Bog-rush**			2000	2	1	0
503056	***Schoenus tesquorum***	**Soft Bog-rush**				4	2	0
507136	*Senecio campylocarpus*	Floodplain Groundsel	r			1	0	0
503107	*Senecio glomeratus*	Annual Fireweed				32	18	0
504959	*Senecio hispidulus*	Rough Fireweed				45	23	0
503115	*Senecio linearifolius*	Fireweed Groundsel			1996	2	2	0
503119	***Senecio minimus***	**Shrubby Fireweed**				38	16	0
507176	*Senecio phelleus*	Stony Fireweed				2	1	0
505244	*Senecio pinnatifolius* var. *lanceolatus*	Lance-leaf Groundsel		AVH	c. 1900			
503126	*Senecio prenanthoides*	Beaked Fireweed				27	17	0
503124	*Senecio quadridentatus*	Cotton Fireweed				48	24	0
503125	*Senecio runcinifolius*	Tall Groundsel				0	0	0
507175	***Senecio squarrosus***	**Leafy Fireweed**		AVH	1984			
503149	***Sigesbeckia orientalis* subsp. *orientalis***	**Indian Weed**				2	1	0
503169	***Solanum aviculare***	**Kangaroo Apple**				3	2	0
503179	*Solanum laciniatum*	Large Kangaroo Apple				24	14	3
503195	*Solenogyne dominii*	Solenogyne				9	5	0
503196	*Solenogyne gunnii*	Solenogyne				8	5	0
504725	***Sphaerolobium minus***	**Globe-pea**				9	4	0
503223	*Spiranthes australis*	Ladies' Tresses			1996	1	0	0
503224	*Spirodela punctata*	Thin Duckweed			2011	4	1	0
503235	*Spyridium parvifolium*	Australian Dusty Miller				23	12	10
503244	*Stackhousia monogyna*	Candles				20	11	0
503250	***Stellaria flaccida***	**Forest Starwort**			2010	1	0	0
504972	*Stylidium armeria*	Grass Trigger-plant			2003	1	0	0
503303	*Stylidium armeria/graminifolium*[25]	Grass Trigger-plant				49	25	1
503304	***Stylidium despectum***	**Hundreds and Thousands**				2	1	0
504971	*Stylidium graminifolium*	Grass Trigger-plant				5	3	0
	Stylidium inundatum – see *Stylidium despectum*							
503348	*Tetrarrhena juncea*	Forest Wire-grass				27	12	0
503351	*Tetratheca ciliata*	Pink-bells				21	13	3
503308	***Thelionema caespitosum***	**Tufted Blue-lily**				8	4	1
503362	*Thelymitra aristata*	Great Sun-orchid		AVH	1929			
505916	*Thelymitra brevifolia*	Peppertop Sun-orchid			2015	1	1	0
503364	***Thelymitra carnea***	**Salmon Sun-orchid**				1	0	0
503368	*Thelymitra flexuosa*	Twisted Sun-orchid		AVH	c. 1980	0	0	0
503372	***Thelymitra ixioides/juncifolia***[26]	**Dotted Sun-orchid**				8	6	0
504999	***Thelymitra media***	**Tall Sun-orchid**			2003	2	1	0
505914	*Thelymitra peniculata*	Trim Sun-orchid				18	8	0
503384	***Thelymitra rubra***	**Salmon Sun-orchid**				7	4	0

[25] *Stylidium armeria* was separated from *S. graminifolium* so recently that most records do not distinguish, but both occur in Maroondah – sometimes side by side.

[26] Maroondah's population of dotted sun-orchids seems intermediate between *T. ixioides* and *T. juncifolia*.

Code no.	Scientific name	Common name	Legal Status	Source	Missing since	No. SoBS	No. reserves	No plantings
503373	*Thelymitra × truncata* complex	Short Sun-orchid		GWC	1998	0	0	0
503387	*Themeda triandra*	Kangaroo Grass				88	33	7
503399	*Thysanotus patersonii*	Twining Fringe-lily				18	10	0
504998	*Thysanotus tuberosus* ssp. *tuberosus*	Common Fringe-lily				10	6	0
503421	*Tricoryne elatior*	Yellow Rush-lily				58	25	0
503449	*Triglochin striata*	Streaked Arrow-grass				13	8	0
503468	*Typha domingensis*	Cumbungi				20	9	0
503470	*Typha orientalis*	Cumbungi				22	10	0
503478	***Utricularia australis***	**Yellow Bladderwort**			1996	1	0	0
503479	***Utricularia dichotoma***	**Purple Bladderwort**			2001	2	1	0
502641	*Utricularia tenella*	Pink Bladderwort		AVH	1897			
503503	***Veronica calycina***	**Hairy Speedwell**			1996	6	3	0
502415	***Veronica derwentiana***	**Derwent Speedwell**				3	3	6
503506	*Veronica gracilis*	Slender Speedwell				9	3	2
503512	*Veronica plebeia*	Trailing Speedwell				5	4	0
503514	*Veronica subtilis*	Thread Speedwell		AVH	1947			
503523	***Viminaria juncea***	**Golden Spray**			2012	4	1	1
503526	*Viola betonicifolia*	Showy Violet			1996	2	2	0
505056	*Viola cleistogamoides*	Hidden Violet		AVH	1901			
505058	*Viola hederacea*	Ivy-leaf Violet				53	26	0
503555	*Wahlenbergia gracilenta*	Annual Bluebell		GWC	1983	0	0	0
503558	*Wahlenbergia gracilis*	Sprawling Bluebell				18	7	0
503557	***Wahlenbergia gymnoclada***	**Naked Bluebell**				3	2	0
503560	***Wahlenbergia multicaulis***	**Tadgell's Bluebell**				2	0	0
503559	*Wahlenbergia stricta* subsp. *stricta*	Tall Bluebell				12	7	0
503578	*Wolffia australiana*	Tiny Duckweed			2011	3	0	0
504082	*Wurmbea dioica* subsp. *dioica*	Common Early Nancy				17	9	0
503588	*Xanthorrhoea minor* subsp. *lutea*	Small Grass-tree				63	27	0
504561	*Xanthosia dissecta*	Cut-leaf Xanthosia				34	18	0
503763	*Xerochrysum palustre*	Swamp Everlasting	VLv		1996	1	0	3

The following additional species of flowering plants have also been reported but without adequate confidence or verification to be relied upon:

Scientific name	Common Name	Locations
Acacia verniciflua	Varnish Wattle	in a garden on Smedley Rd, Ringwood North
Acrotriche prostrata	Trailing Ground-berry	at Cheong Wildflower Sanctuary
Ajuga australis	Austral Bugle	
Amphibromus ?neesii	Southern Swamp Wallaby-grass	near Bungalook Ck, just west of Dorset Rd
Calystegia sepium subsp. *roseata*[27]	Large Bindweed	could be anywhere along a perennial creek
Drosera macrantha	Climbing Sundew	could only occur near the northern border
Eucalyptus cypellocarpa	Mountain Grey Gum	a south-facing slope near Ringwood Bypass
Poa clelandii	Matted Tussock-grass	Bungalook Conservation Reserves
Poa sieberiana var. *hirtella*	Grey Tussock-grass	
Thelymitra arenaria	Forest Sun-orchid	
Pimelea flava	Yellow Rice-flower	at Cheong Wildflower Sanctuary

[27] In the author's experience, all plants of the common, weedy bindweed of Maroondah's stream banks are found on close inspection to be hybrids between the indigenous *Calystegia sepium* and the introduced *C. silvatica*. The sole record of the indigenous species may not have been sufficiently carefully considered to check for hybridisation.

Wild, Indigenous Ferns and Fern Allies

None of the species listed below has any specific legal protection.

Code no.	Scientific name	Common name	Source	Missing since	No. SoBS	No. reserves	No plantings
500129	*Adiantum aethiopicum*	Common Maidenhair			31	15	0
500232	*Anogramma leptophylla*[28]	Annual Fern	AVH	1904			
500288	*Asplenium flabellifolium*	Necklace Fern	DGC	1981	1	0	0
500347	*Azolla rubra*	Pacific Azolla			5	0	0
500404	***Blechnum cartilagineum***	**Gristle Fern**		1996	1	0	0
500407	***Blechnum minus***	**Soft Water-fern**			3	3	0
501098	***Blechnum parrisiae***	**Common Rasp-fern**			1	1	0
500887	***Calochlaena dubia***	**Common Ground-fern**			10	6	0
500730	***Cheilanthes austrotenuifolia***	**Green Rock Fern**		2012	4	3	0
500895	*Cyathea australis*	Rough Tree-fern			18	10	0
501691	*Histiopteris incisa*	Bat's Wing Fern			1	0	0
501752	***Hypolepis glandulifera***	**Downy Ground-fern**			1	0	0
501751	***Hypolepis muelleri***	**Harsh Ground-fern**		2001	2	2	0
501753	***Hypolepis rugosula***	**Ruddy Ground-fern**			1	1	0
502014	*Lindsaea linearis*	Screw Fern			28	14	0
502345	*Ophioglossum lusitanicum*	Austral Adder's-tongue	AVH	1903			
502503	*Phylloglossum drummondii*	Pigmy Clubmoss	AVH	1912			
502645	***Polystichum proliferum***	**Mother Shield-fern**			10	5	1
502777	*Pteridium esculentum*	Austral Bracken			90	38	0
502779	*Pteris tremula*[29]	Tender Brake			7	6	0
503098	***Selaginella uliginosa***	**Swamp Selaginella**		2012	4	1	0

Indigenous Mosses and Liverworts

Because mosses and liverworts are so hard to survey thoroughly, and because there is so little prior data, the risk of each species dying out in Maroondah can rarely be inferred from this study's data. The exceptions are the two species with names in bold text below – they are more readily detected and clearly quite rare. Some of the species on the list may have already died out in Maroondah but they might also be able to re-colonise spontaneously.

None of the species listed below has any specific legal protection.

'GC' in the 'Source' column below refers to a 1982 list of mosses, liverworts and lichens at Hochkins Ridge Nature Conservation Reserves by Garry Cheers.

[28] A 1904 specimen of *Anogramma leptophylla* is labelled 'Croydon', but that name was applied to land extending well outside Maroondah at that time, including current-day Wonga Park, where the species has been collected.

[29] *Pteris tremula* has rapidly increased in abundance in Maroondah in the past two decades and was not recorded prior to 2000. It may have spread from its natural range (e.g. Dandenong Ranges) or escaped from gardens, or both. See Chapter 10 (p. 33) about whether to regard such species as indigenous.

Code no.	Scientific name	Common name	Source	Missing since	No. SoBS	No. reserves
Mosses						
506694	*Barbula calycina*	a moss			1	1
506049	*Barbula crinita*	a moss			1	1
506076	*Brachythecium rutabulum*	Rough-stalked Feather-moss			2	2
506077	*Brachythecium salebrosum*	Smooth-stalk Feather-moss	AVH	1998	0	0
506079	*Breutelia affinis*	Common Breutelia			9	6
506095	*Bryum argenteum*	Silver Moss			1	1
506121	*Calliergonella cuspidata*	a moss			5	4
506137	*Campylopus clavatus*	Broody Swan-neck Moss			34	22
506140	*Campylopus introflexus*	Heath Star Moss			30	20
506144	*Campylopus pyriformis*	Dwarf Swan-neck Moss			1	0
506154	*Ceratodon purpureus* subsp. *convolutus*	a moss			1	1
506191	*Dawsonia longiseta*	Small Dawsonia			3	3
506201	*Dicranoloma billarderi*	a moss			8	6
506214	*Didymodon torquatus*	Beard Moss			2	1
506225	*Ditrichum difficile*	a moss			3	2
506260	*Eurhynchium praelongum*	Common Feather-moss			5	4
506281	*Fissidens bifrons*	a pocket-moss			3	3
506285	*Fissidens megalotis*	a moss			1	1
506283	*Fissidens taylorii*	a moss			1	1
506329	*Funaria hygrometrica*	Common Fire-moss			3	3
506109	*Gemmabryum dichotomum*	Broody Bryum			1	1
506363	*Gymnostomum calcareum*	a moss	AVH	1951		
506387	*Hypnum cupressiforme*[30]	Common Hypnum			29	19
506413	*Lembophyllum divulsum*	String-of-Pearls	AVH	1995		
506431	*Leptostomum inclinans*	a moss	AVH	1995		
506487	*Orthodontium lineare*	Cape Thread-moss			1	1
506493	*Orthodontium tasmanicum*	a moss	GC	1982	1	1
506557	*Polytrichum juniperinum*	Common Juniper-moss			10	5
506588	*Ptychomnion aciculare*	Paper Moss, Pipe-cleaners			10	9
506609	*Racopilum cuspidigerum* var. *convolutaceum*	a moss			6	6
506659	*Rhaphidorrhynchium amoenum*	a moss			2	2
506621	*Rhynchostegium tenuifolium*	Feather Moss			5	4
506099	*Rosulabryum billarderi*	Common Thread-moss			22	15
506103	*Rosulabryum capillare*	Capillary Thread-moss			3	2
506661	*Sematophyllum homomallum*	a moss			6	6
506678	*Tayloria octoblepharum*	Dung Moss	GC	1982	1	1
506692	*Thuidiopsis furfurosa*	Golden Weft-moss			31	20
506703	*Tortula muralis*	Wall Screw-moss			0	0
506731	*Triquetrella papillata*	a moss			3	1
506745	*Wijkia extenuata*	Spear Moss			4	3
506751	*Zygodon menziesii*	a moss	AVH	1951		
Liverworts						
506040	***Asterella drummondii***	**Licorice Strap**	GC	1982	1	1
506447	*Chiloscyphus semiteres*	Green Worms			35	21
509385	*Fossombronia* species	a liverwort			4	1
506315	***Frullania falciloba***	**a liverwort**			1	1
506450	*Lunularia cruciata*	Moonwort			10	9
506459	*Marchantia berteroana*	a liverwort			1	1
506634	*Riccia bifurca*	a liverwort			1	1
506679	*Telaranea centipes*	a liverwort	GC	1982	1	1

[30] Two varieties of *Hypnum cupressiforme* were collected during the current study: var. *cupressiforme* and var. *lacunosum*. Too few records have been identified to varietal level to provide separate statistics.

The National Herbarium of Victoria holds thirty-nine specimens of mosses and liverworts collected by a visiting Tasmanian bryologist, Richard Austin Bastow, on 8th November 1892. Although the specimens are of species normally found in rainforests and tall, wet forests, the herbarium staff have mapped them in Croydon on the basis that the collector stated the locality of most of them was 'Croydon – behind the landslip'. All but one of the remaining specimens were labelled 'Mount Corram', which the staff could not locate but they presumed the specimens were all collected in Croydon because they were all on the same day and matched the same sort of habitat requirements. The one label that differs gives the location as 'Dandenong Range, Croydon', revealing that this visiting Tasmanian in 1892 had a rather inflated concept of the extent of 'Croydon'. Croydon would have been the last village he reached before the Dandenong Ranges. The largest documented landslide in Australia's history had occurred the previous year on Mt Dandenong, from Kalorama to Montrose (Ritchie & Hunt 2000; Middelmann 2007; Lillydale Express, August 1891), and this is presumably the landslip to which Bastow referred. The reference to 'Mount Corram' seems likely to be a corruption of Mount Corhanwarrabul, which was the name of the settlement that was renamed Mount Dandenong the following year. Mount Dandenong still has rainforest habitat suitable for the species collected by Bastow. Therefore, none of Bastow's specimens are treated in this report as being from Maroondah.

Appendix B - Inventory of Naturalised Flora

The table below lists all non-indigenous species of plant species that have been recorded in Maroondah's natural and semi-natural vegetation, excluding species that the author believes were either planted or transient, with no material impact.

The table is to be interpreted the same as Appendix A except for the additional feature that underlining is used to highlight the names of species posing the most serious threats to indigenous flora – the main 'drivers', in the sense of Section 5.3 (p. 41).

Code no.	Scientific name	Common name	Source	Missing since	No. SoBS	No. reserves
Flowering Plants						
500014	*Acacia baileyana*	Cootamundra Wattle			28	15
500028	*Acacia decurrens*	Green Wattle			5	4
500031	*Acacia elata*	Cedar Wattle			22	14
500036	*Acacia floribunda*	White Sallow-wattle			14	8
500044	*Acacia howittii*	Sticky Wattle			8	8
505015	*Acacia iteaphylla*	Flinders Range Wattle			2	2
500053	*Acacia longifolia* subsp. *longifolia*	Sallow Wattle			42	24
500077	*Acacia pravissima*	Ovens Wattle		2005	2	2
503649	*Acacia prominens*	Gosford Wattle			3	3
504209	*Acacia provincialis*	Wirilda		2015	1	1
500084	*Acacia saligna*	Orange (or Golden Wreath) Wattle		2012	2	1
504210	*Acacia uncifolia*	Wirilda		2012	1	0
504389	*Acer negundo*	Box Elder			8	5
502975	*Acetosa sagittata*	Rambling Dock			1	1
502966	*Acetosella vulgaris*	Sheep Sorrel		2016	8	6
503638	*Agapanthus praecox* subsp. *orientalis*	Agapanthus			21	13
500153	*Agrostis capillaris*	Brown-top Bent			54	25
500164	*Aira caryophyllea*	Silvery Hair-grass			15	8
500165	*Aira cupaniana*	Small Hair-grass		2004	1	1
500166	*Aira elegantissima*	Delicate Hair-grass			12	7
500179	*Allium triquetrum*	Angled Onion			25	13
503632	*Anredera cordifolia*	Madeira Vine			1	1
500236	*Anthoxanthum odoratum*	Sweet Vernal-grass			59	28
500253	*Arbutus unedo*	Irish Strawberry Tree			15	9
500255	*Arctotheca calendula*	Cape Weed			11	5
503774	*Aristea ecklonii*	Blue Stars			1	1
500265	*Arrhenatherum elatius*	Onion Twitch, False Oat-grass			1	1
505377	*Asparagus aethiopicus*	Sprengeri Fern			4	4
500274	*Asparagus asparagoides*	Bridal Creeper			17	8
500276	*Asparagus scandens*	Asparagus Fern			17	10
500318	*Atriplex prostrata*	Hastate Orache			10	6
500340	*Avena barbata*	Bearded Oat			10	6
500346	*Axonopus fissifolius*	Narrow-leafed Carpet-grass			1	1
500384	*Bellis perennis*	English Daisy			9	4
503202	*Billardiera fusiformis*	Bluebell Creeper			17	10
500488	*Brassica fruticulosa*	Twiggy Turnip			4	2
500495	*Briza maxima*	Large Quaking-grass			51	24
500496	*Briza minor*	Lesser Quaking-grass			19	9
500498	*Bromus catharticus*	Prairie Grass			30	18
500500	*Bromus diandrus*	Great Brome			18	11
500501	*Bromus hordeaceus*	Soft Brome			9	4

Code no.	Scientific name	Common name	Source	Missing since	No. SoBS	No. reserves
504662	*Cabomba caroliniana*	Fanwort	AVH	1989	1	1
508176	*Callistemon ?citrinus*	a bottlebrush			1	1
500574	*Callitriche stagnalis*	Pond (or Common) Water-starwort			16	10
500605	*Calystegia silvatica* and hybrids	Greater Bindweed			8	4
500612	*Cardamine flexuosa*	Wood Bitter-cress			5	5
505022	*Cardamine hirsuta*	Common Bitter-cress			4	3
500634	*Carex ?disticha*	Brown Sedge		1996	1	0
504619	*Carex punctata*	a sedge		2012	1	0
500687	*Catapodium rigidum*	Fern Grass			9	6
502451	*Cenchrus clandestinus*	Kikuyu			28	14
500702	*Centaurium erythraea*	Common Centaury			44	21
500705	*Centaurium tenuiflorum*	Branched Centaury			7	5
500719	*Cerastium glomeratum*	Common Mouse-ear Chickweed			21	9
500946	*Chamaecytisus palmensis*	Tree Lucerne		2012	7	3
500736	*Chenopodium album*	Fat Hen		1995	3	1
500756	*Chloris truncata*	Windmill Grass			0	0
505405	*Chlorophytum comosum*	Spider Plant			8	6
504359	*Chrysanthemoides monilifera* subsp. *monilifera*	Boneseed			26	13
500776	*Cicendia filiformis*	Slender Cicendia			3	1
500777	*Cicendia quadrangularis*	Square Cicendia			4	3
500779	*Ciclospermum leptophyllum*	Narrow-leaf Celery			2	2
500782	*Cirsium vulgare*	Spear Thistle			39	19
500803	*Conium maculatum*	Hemlock	VBA	2004	0	0
500823	*Coprosma repens*	Mirror-bush			15	10
500824	*Coprosma robusta*	Karamu		1992	1	1
504393	*Cordyline australis*	New Zealand Cabbage Tree			13	10
507640	*Correa baeuerlenii*	Chef's Cap Correa			2	2
508257	*Correa glabra*, cultivars & hybrids	non-indig. Correa			13	10
500825	*Cortaderia selloana*	Pampas Grass			17	12
504765	*Cotoneaster franchetii*	Grey Cotoneaster			2	2
500843	*Cotoneaster glaucophyllus* var. *serotinus*	Cotoneaster			32	19
500844	*Cotoneaster pannosus*	Cotoneaster			28	17
503690	*Cotoneaster simonsii*	Himalayan Cotoneaster			14	11
500848	*Cotula coronopifolia*	Water Buttons		1996	6	3
500858	*Crassula alata* var. *alata*	Three-part Crassula	VBA	2002	1	0
505186	*Crassula multicava* subsp. *multicava*	Shade Crassula		2004	7	6
500867	*Crataegus monogyna*	Hawthorn			20	12
500869	*Crepis capillaris*	Smooth Hawksbeard			20	11
500875	*Crocosmia × crocosmiiflora*	Montbretia			18	13
500876	*Crowea exalata*	Small Crowea			2	2
500901	*Cymbalaria muralis* subsp. *muralis*	Ivy-leaf Toad-flax			0	0
504554	*Cynodon dactylon* var. *dactylon*	Couch			32	19
500912	*Cynosurus echinatus*	Rough Dog's-tail			12	8
500916	*Cyperus congestus*	Dense Flat-sedge			1	1
500918	*Cyperus eragrostis*	Drain Flat-sedge			33	16
500947	*Cytisus scoparius*	English Broom			12	7
500948	*Dactylis glomerata*	Cocksfoot			48	23
503148	*Danthonia decumbens*	Heath Grass			3	2
500988	*Daucus carota*	Carrot			5	3
503118	*Delairea odorata*	Cape Ivy			7	7
505561	*Dianella caerulea* var. *producta*	Tall Flax-lily			1	1
501048	*Digitaria sanguinalis*	Summer-grass			1	1
505502	*Dimorphotheca fruticosa*	Dimorphotheca		1999	1	1

Code no.	Scientific name	Common name	Source	Missing since	No. SoBS	No. reserves
501077	*Dittrichia graveolens*	Stinkweed			3	0
501095	*Dodonaea viscosa*	Sticky Hop-bush			1	1
500748	*Dysphania pumilio*	Clammy Goosefoot			1	0
501118	*Echinochloa crus-galli*	Common Barnyard Grass			10	5
501123	*Echium plantagineum*	Paterson's Curse		2006	1	1
501126	*Egeria densa*	Dense Waterweed			3	3
501128	*Ehrharta erecta* var. *erecta*	Panic Veldt-grass			55	26
501129	*Ehrharta longiflora*	Annual Veldt-grass			24	12
505732	*Einadia nutans* (matted form)	Nodding Saltbush			1	0
501176	*Epilobium ciliatum*	Glandular Willow-herb			7	4
501210	*Erica lusitanica*	Spanish Heath			29	14
501706	*Erica quadrangularis*	Angled Heath			1	1
500812	*Erigeron bonariense*	Tall Fleabane			5	3
501212	*Erigeron karvinskianus*	Seaside Daisy			12	8
500810	*Erigeron sumatrensis*	Fleabane			28	20
505295	*Eriobotrya japonica*	Loquat			7	6
509283	*Eucalyptus* species	naturalised eucalypts			0	0
501332	*Euphorbia peplus*	Petty Spurge			15	10
501356	*Festuca arundinacea*	Tall Fescue			21	13
501363	*Festuca rubra*	Red Fescue			2	2
501370	*Foeniculum vulgare*	Fennel		2012	5	1
504306	*Fraxinus angustifolia* subsp. *angustifolia*	Desert Ash			21	13
501378	*Freesia alba × leichtlinii*	Freesia			8	5
503684	*Freesia laxa* subsp. *laxa*	Anomatheca			1	1
501379	*Fumaria bastardii*	Bastards Fumitory			2	1
501380	*Fumaria capreolata*	Ramping Fumitory	VBA	2006	0	0
501382	*Fumaria muralis* subsp. *muralis*	Wall Fumitory			5	4
501402	*Galium aparine*	Cleavers			38	17
501412	*Galium murale*	Small Bedstraw			2	1
504336	*Gamochaeta purpurea*	Spiked Cudweed			10	7
501421	*Genista linifolia*	Flax-leafed Broom			6	4
501422	*Genista monspessulana*	Montpellier Broom			23	14
501426	*Geranium dissectum*	Cut-leaf Crane's-bill			5	1
501428	*Geranium molle* var. *molle*	Dovesfoot			1	0
505338	*Geranium robertianum*	Herb Robert			1	1
503751	*Geranium yeoi*	Geranium			1	1
–	*Geranium yeoi* × ?	a hybrid geranium			1	1
501438	*Gladiolus undulatus*	Wild Gladiolus			11	7
501452	*Glyceria declinata*	Manna Grass			3	1
505206	*Grevillea* hybrids and cultivars				12	11
507155	*Grevillea juniperina*	Prickly Spider-flower			2	2
501541	*Grevillea lavandulacea*	Lavender Grevillea			1	1
507157	*Grevillea robusta*	Southern Silky Oak			6	5
505748	*Hakea salicifolia* subsp. *salicifolia*	Willow-leaf Hakea			20	13
501599	*Hedera helix*	Ivy			47	23
505983	*Hedychium gardnerianum*	Ginger Lily			1	0
502511	*Helminthotheca echioides*	Ox-tongue			19	10
501692	*Holcus lanatus*	Yorkshire Fog			45	24
505578	*Homalanthus populifolius*	Bleeding Heart			7	6
501744	*Hypericum perforatum* subsp. *veronense*	St John's Wort			2	0
501745	*Hypericum tetrapterum* var. *tetrapterum*	Square-stem St John's Wort			10	5
501747	*Hypochaeris glabra*	Smooth Cat's Ear		2000	2	1
501748	*Hypochaeris radicata*	Cat's Ear			59	28

Code no.	Scientific name	Common name	Source	Missing since	No. SoBS	No. reserves
501759	*Ilex aquifolium*	Holly			10	6
501762	*Ipomoea indica*	Lear's Morning-glory			2	2
503784	*Iris pseudacorus*	Yellow Flag			1	1
500936	*Isolepis levynsiana*	Tiny Flat-sedge			13	7
505948	*Jasminum polyanthum*	Pink (or Winter) Jasmine			11	10
501802	*Juncus acutus* subsp. *acutus*	Sharp Rush	GWC	2003	0	0
501806	*Juncus articulatus*	Jointed Rush			22	11
501811	*Juncus bulbosus*	Bulbous Rush			1	0
501813	*Juncus capitatus*	Dwarf Rush			6	3
501823	*Juncus imbricatus*	Folded Rush			2	0
501828	*Juncus microcephalus*	Tiny Rush			1	1
501844	*Juncus tenuis*	Slender Rush			2	0
501848	*Kennedia rubicunda*	Dusky Coral-pea			3	1
501860	*Lactuca serriola*	Prickly Lettuce			13	8
501869	*Lapsana communis* subsp. *communis*	Nipplewort			1	0
501895	*Leontodon saxatilis*	Lesser Hawkbit			26	13
501896	*Lepidium africanum*	Common Pepper-cress			1	1
502002	*Ligustrum lucidum*	Large-leafed Privet			18	11
502003	*Ligustrum sinense*	Chinese Privet		2004	0	0
504689	*Ligustrum vulgare*	European Privet			4	3
502018	*Linum trigynum*	French Flax			26	13
507270	*Lolium × hybridum*[31]	Hybrid Rye-grass			3	1
502035	*Lolium multiflorum*	Italian Rye-grass			3	1
502036	*Lolium perenne*	Perennial Rye-grass			14	7
502037	*Lolium rigidum*	Wimmera Rye-grass	VBA	2004		
502053	*Lonicera japonica*	Japanese Honeysuckle			34	19
502058	*Lotus corniculatus*	Bird's-foot Trefoil			4	3
502060	*Lotus subbiflorus*	Hairy Bird's-foot Trefoil			17	10
502061	*Lotus uliginosus*	Greater Bird's-foot Trefoil			3	2
500223	*Lysimachia arvensis*	Pimpernel			26	11
500224	*Lysimachia minima*	Chaffweed			1	0
502091	*Lythrum junceum*	Mediterranean Loosestrife		1996	1	1
502118	*Malus pumila*	Domestic Apple			9	5
502122	*Malva parviflora*	Small-flowered Mallow	VBA	2006	1	0
502134	*Medicago arabica*	Spotted Medic		1999	2	1
502137	*Medicago lupulina*	Black Medic			3	2
502140	*Medicago polymorpha*	Burr Medic			7	3
502145	*Melaleuca armillaris*	Bracelet Honey-myrtle			3	3
502154	*Melaleuca parvistaminea*	Rough-barked Honey-myrtle			1	1
502163	*Melissa officinalis*	Lemon Balm			1	1
502168	*Mentha × piperita*	Peppermint or Lemon Mint			4	4
502169	*Mentha pulegium*	Pennyroyal		2012	1	0
502171	*Mentha spicata*	Spearmint		2004	1	1
505868	*Mercurialis annua*	Annual Mercury			1	1
502213	*Modiola caroliniana*	Carolina Mallow			8	3
502247	*Myosotis sylvatica*	Wood Forget-me-not			10	8
505789	*Nandina domestica*	Sacred Bamboo			3	3
503282	*Nassella neesiana*	Chilean Needle-grass			1	0
502263	*Nassella trichotoma*	Serrated Tussock		c. 2010	1	0
502947	*Nasturtium microphyllum*	One-row Watercress			1	1
502948	*Nasturtium officinale*	Watercress			12	7

[31] Rye-grasses of various cultivars and hybrids are regularly planted along Maroondah's stream banks. They are often intermediate between *Lolium perenne*, *L. multiflorum* and the hybrid between them, *L. × hybridum*.

Code no.	Scientific name	Common name	Source	Missing since	No. SoBS	No. reserves
503906	*Oxalis corniculata*	Creeping Wood-sorrel			2	1
502383	*Oxalis incarnata*	Pale Wood-sorrel			28	16
502384	*Oxalis latifolia*	Large-leaf Wood-sorrel		1996	1	1
502387	*Oxalis pes-caprae*	Soursob			15	10
502388	*Oxalis purpurea*	Large-flower Wood-sorrel			4	2
502399	*Pandorea pandorana*[32]	Wonga Vine			40	23
500169	*Paraserianthes lophantha* subsp. *lophantha*	Cape Wattle		2012	3	2
502430	*Paspalum dilatatum*	Paspalum			40	19
502431	*Paspalum distichum*	Water Couch			14	9
502432	*Passiflora caerulea*	Brazilian Passion-flower			1	0
502433	*Passiflora cinnabarina*	Red Passion-flower		2016	1	1
503932	*Passiflora tarminiana*	Banana Passionfruit			4	4
528484	*Persicaria capitata*	Pink-head Knotweed			1	1
502633	*Persicaria maculosa*	Persicaria			4	3
505547	*Persicaria odorata*	Vietnamese Mint			1	1
502476	*Phalaris aquatica*	Toowoomba Canary-grass			15	9
502510	*Phytolacca octandra*	Red-ink Weed			2	0
502372	*Piptatherum miliaceum*	Smilo Grass, Rice Millet			1	0
505796	*Pittosporum tenuifolium*	Kohuhu			2	1
502543	*Pittosporum undulatum*	Sweet Pittosporum			58	27
502553	*Plantago coronopus*	Buck's-horn Plantain			7	2
502561	*Plantago lanceolata*	Ribwort			50	22
502562	*Plantago major*	Greater Plantain			17	12
505196	*Plectranthus ecklonii*	Blue Spur-flower			1	1
502580	*Poa annua*	Annual Meadow-grass			14	8
502599	*Poa infirma*[33]	Early Meadow-grass				
502611	*Poa trivialis*	Rough Meadow-grass			2	2
502622	*Polycarpon tetraphyllum*	Four-leafed Allseed			7	4
502624	*Polygala myrtifolia*	Myrtle-leaf Milkwort		1999	2	2
503954	*Polygonum arenastrum*	Wireweed			2	0
504000	*Polygonum aviculare*	Wireweed, Hogweed			7	4
502640	*Polypogon monspeliensis*	Annual Beard-grass			3	2
502679	*Populus alba*	White Poplar			1	1
501113	*Potentilla indica*	Indian Strawberry			6	5
502757	*Prunella vulgaris*	Self-heal			36	16
502758	*Prunus cerasifera*	Cherry-plum			37	21
502759	*Prunus laurocerasus*	Cherry Laurel		1997	2	2
502775	*Psoralea pinnata*	Blue Psoralea		1996	2	1
504878	*Pyracantha angustifolia*	Orange Firethorn			2	0
503955	*Pyracantha crenulata*	Nepal Firethorn	VBA	2000	1	1
502884	*Quercus robur*	English Oak		1998	6	2
502897	*Ranunculus muricatus*	Sharp Buttercup			8	4
502906	*Ranunculus repens*	Creeping Buttercup			27	14
502917	*Raphanus raphanistrum*	Wild Radish			8	4
505294	*Rhaphiolepis indica*	Indian Hawthorn			6	4
502939	*Ricinus communis*	Castor Oil Plant			1	1
502942	*Romulea rosea*	Common Onion-grass			35	18
502949	*Rorippa palustris*	Yellow Marsh-cress			1	0
502950	*Rosa rubiginosa*	Sweet Briar			14	6

[32] The first record of *Pandorea pandorana* in Maroondah was in 1990 at Hochkins Ridge, where it had been absent during two prior botanical surveys. Its population has since exploded and it is often smothering indigenous plants and seriously affecting the whole ecology of native vegetation. See also Chapter 10 (p. 33).

[33] *Poa infirma* is so similar to *Poa annua* that separate statistics cannot be provided.

Code no.	Scientific name	Common name	Source	Missing since	No. SoBS	No. reserves
502959	*Rubus anglocandicans*[34]	Blackberry			67	27
502969	*Rumex conglomeratus*	Clustered Dock			19	10
502970	*Rumex crispus*	Curled Dock			26	13
502985	*Sagina apetala*	Common Pearlwort			3	2
502989	*Salix babylonica / sepulcralis*	Weeping Willow			2	1
502990	*Salix cinerea*	Grey Sallow			2	2
503038	*Schoenoplectus tabernaemontani*[35]	River Club-rush			4	2
503132	*Senecio vulgaris*	Common Groundsel			2	1
503133	*Setaria parviflora*	Slender Pigeon Grass			7	4
503134	*Setaria pumila* subsp. *pumila*	Pale Pigeon-grass			1	1
503163	*Sisyrinchium iridifolium*	Striped Rush-leaf			10	3
503995	*Solanum mauritianum*	Tobacco-bush			5	2
505322	*Solanum nigrum*	Black Nightshade			27	18
503168	*Solanum nodiflorum*	Glossy Nightshade			9	6
503187	*Solanum pseudocapsicum*	Madeira Winter-cherry			2	1
503194	*Soleirolia soleirolii*	Baby's Tears			6	5
503199	*Soliva sessilis*	Jo Jo			5	2
505712	*Sonchus asper*	Rough Sow-thistle			13	7
503204	*Sonchus oleraceus*	Sow-thistle			49	24
503209	*Sparaxis tricolor*	Harlequin-flower			1	0
503226	*Sporobolus africanus*	Rat-tail Grass			4	2
503240	*Stachys arvensis*	Stagger Weed			4	2
503251	*Stellaria media*	Chickweed			10	5
503260	*Stenotaphrum secundatum*	Buffalo Grass		2016	1	1
500297	*Symphyotrichum subulatum*	Aster-weed			26	17
500115	*Syzygium smithii*	Lilly Pilly			6	5
509122	*Taraxacum* sp.	Dandelion			30	17
503366	*Torilis arvensis*	Spreading Hedge-parsley			7	6
503416	*Tradescantia fluminensis*	Wandering Jew			28	20
503417	*Tragopogon porrifolius*	Salsify		2004	2	0
503425	*Trifolium campestre* var. *campestre*	Hop Clover			2	1
503427	*Trifolium dubium*	Suckling Clover			18	8
503428	*Trifolium fragiferum* var. *fragiferum*	Strawberry Clover			4	4
503435	*Trifolium repens* var. *repens*	White Clover			27	13
503440	*Trifolium subterraneum*	Subterranean Clover			4	1
504006	*Tropaeolum majus*	Nasturtium			7	6
503469	*Typha latifolia*	Great Reedmace			3	2
503471	*Ulex europaeus*	Gorse (Furze)			20	11
503496	*Verbena bonariensis*	Purple-top Verbena			7	4
503502	*Veronica arvensis*	Wall Speedwell			5	3
503511	*Veronica persica*	Persian Speedwell			6	4
504042	*Viburnum tinus*	Laurustinus			10	8
503516	*Vicia hirsuta*	Tiny Vetch			11	7
505053	*Vicia sativa* subsp. *nigra*	Narrow-leaf Vetch			18	9
503519	*Vicia tetrasperma*	Slender Vetch			2	2
503524	*Vinca major*	Blue Periwinkle			8	6
503531	*Viola odorata*	Fragrant Violet			14	10
503544	*Vulpia bromoides*	Squirrel-tail Fescue			28	17
503549	*Vulpia myuros*	Rat's-tail Fescue			7	3

[34] Several other species of blackberry have been recorded once each in Maroondah, without any specimen being lodged with the National Herbarium of Victoria. Such records cannot be given much weight.

[35] Wild plants of *Schoenoplectus tabernaemontani* were first recorded in Maroondah in 2012, following extensive plantings in local wetlands. The species is steadily displacing indigenous wetland plants, some of them rare.

Code no.	Scientific name	Common name	Source	Missing since	No. SoBS	No. reserves
503562	*Watsonia meriana* var. *bulbillifera*	Bulbil Watsonia			18	11
505762	*Westringia fruticosa*	Coast Rosemary			3	3
503599	*Zantedeschia aethiopica*	White Arum Lily			14	10

Conifer

502539	*Pinus radiata*	Monterey Pine			53	25

Ferns

–	*Cyathea cooperi*	Cicatrice Tree-fern			1	1
501039	*Dicksonia antarctica*	Soft Tree-fern			2	2
505575	*Nephrolepis cordifolia*	Fishbone Fern			2	1
–	*Pteris cretica*	Cretan Brake			1	1
502779	*Pteris tremula*	Tender Brake			1	1
503097	*Selaginella kraussiana*	Garden Selaginella			2	1

Mosses

506074	*Brachythecium albicans*	Whitish Feather-moss			3	3
506575	*Pseudoscleropodium purum*	Neat Feather-moss			22	15

Appendix C - Inventory of Fungi and Lichens

The following list of fungi in Maroondah was extracted from the Atlas of Living Australia on 25th October 2018. It contains 118 species. The records of *Amanita muscaria* and *Cladia retipora* have been updated here to include the author's 2018 observations, and *Aseroe rubra* has been added on the basis of the author's observations in c. 2000.

Common name	Scientific name	Years
Agaricus xanthodermus	Yellowing Mushroom	2000–2009
Agrocybe		2015
Aleuria aurantia	Orange Peel Fungus	1963
Amandinea punctata		1899
Amanita muscaria	Fly Agaric	1996–2018
Amanita ochrophylla		1936
Amanita phalloides	Death Flycap	2006–2013
Amanita xanthocephala		1998–2000
Antrodiella citrea		1969
Aseroe rubra		c. 2000
Austroparmelina conlabrosa		1899
Boletus satanas		2012
Buellia		1899
Byssomerulius		1953
Calicium victorianum		1985
Cantharellus concinnus		2010
Ceriporia		1953
Cladia aggregata		1899
Cladia retipora		1951-2018
Cladonia cariosa		1951
Cladonia cervicornis subsp. *verticillata*		1885
Cladonia confusa		1951
Cladonia corniculata		1885
Cladonia floerkeana		1985
Cladonia macilenta		1951–1957
Cladonia praetermissa		1985
Cladonia rigida		1885–1951
Clathrus archeri	Devil's Fingers	1952–1999
Coprinellus		2015–2018
Coprinus comatus	Lawyer's Wig	1989–2011
Cordyceps brittlebankii		?
Corticium utriculicum		1972
Cyphelium		1985
Daldinia		2015
Descomyces		1993
Dichomitus leucoplacus		1953
Flavoparmelia rutidota		1899
Fuscoporia		1972
Geastrum floriforme		1966
Geoglossum glutinosum		1993
Geoglossum nigritum		1971
Gloeophyllum		2018
Glomus macrocarpum		1971
Gymnopilus		2015
Hexagonia vesparia		1948
Hjortstamia crassa		1969
Hygrocybe		2016
Hymenochaete separata		1972
Hymenogaster		1985
Hymenopellis radicata		2003–2011
Hyphodontia flavipora		1969–1972
Hyphodontia lanata		1972

Common name	Scientific name	Years
Hypocreomycetidae		2013
Hypogymnia billardierei		1899–1901
Hypogymnia subphysodes		1901–1951
Lactarius		1985
Lamprospora		1935
Lecanora		1899
Lecidea		1899
Lepiota		1970
Lepista nuda	Wood Blewit	1993–2004
Leratiomyces		2018
Lycoperdon scabrum		1967
Macrolepiota clelandii	Bush Parasol	2013
Marasmius		2015
Micromphale		1988
Morchella conica		1997
Omphalotus nidiformis		2000
Pannoparmelia angustata		1899
Pannoparmelia wilsonii		1899
Paraporpidia leptocarpa		1885
Parmotrema perlatum		1920
Peniophora crustosa		1972
Perenniporia ochroleuca		1969
Perenniporia		1953–1972
Pertusaria		1885
Phaeolus schweinitzii	Dyer's Mazegill	1995–2004
Phallaceae		2016
Phlebia subceracea		2004
Phlebiella		1972
Phlebopus marginatus		2001–2013
Phycomyces		2015
Phylloporus clelandii		2013
Physisporinus		1954
Pisolithus arhizus		2013
Pisolithus marmoratus		2016
Plectania melastoma		?
Podoscypha petalodes subsp. *floriformis*		1960
Podoscypha petalodes		2001
Polyporus arcularius		1951
Postia pelliculosa		2012
Protoglossum		1967
Punctelia subrudecta		1899
Radulodon calcareus		1972
Ramalinaceae		1899
Ramboldia laeta		1899
Ramboldia stuartii		1901
Ramsbottomia crechqueraultii		?
Raveneliaceae		1977
Rhizocarpon geographicum		1899
Rhizochaete filamentosa		1969
Rhizopogon luteolus	Yellow False Truffle	1970
Rhizopogon roseolus		1966–1970
Russula		2016
Sarcodontia		1973
Schizophyllum commune	Split Gill	?
Scleroderma		1981
Scutellinia vinosobrunnea		?
Scytinostroma		1972
Sphaeronaema		?
Stereum hirsutum	Hairy Curtain Crust	2004
Stereum illudens		1953

Common name	Scientific name	Years
Stereum ochraceoflavum		1953
Trametes versicolor	Turkeytail	2016
Tremella fuciformis		2004
Ustilaginales		2001
Venturia inaequalis		1925
Xerula		2011
Zelleromyces striatus		1967

Appendix D - Fauna Inventory

The following tables list Maroondah's wild vertebrate species and butterflies, excluding presumed aviary escapees.

Within each major group of fauna, species are ordered according to the taxonomic sequence presently used by the Department of Environment, Land, Water and Planning.

The columns of the lists contain the following information:

Column heading	Description
Code no.	Identifier given to each species by the Department of Environment, Land, Water and Planning.
Names	An asterisk before a species' common name indicates that it has arrived in Maroondah since European colonisation. Red text indicates there is a reasonable presumption that the species was once resident or at a least a regular visitor but is unlikely to return in the foreseeable future, except perhaps as transients or rare visitors.
Legal status	Protective measures under Australian law, indicated by combinations of these letters: C, E or V: Listed under the federal *Environmental Protection and Biodiversity Conservation Act 1999* as Critically endangered, Endangered or Vulnerable, respectively; L: Listed as threatened under the Victorian *Flora and Fauna Guarantee Act 1988*; c, d, e, n or v: Listed in the *'Advisory List of Threatened Vertebrate Fauna in Victoria – 2013'* as critically endangered, data-deficient, endangered, near-threatened or vulnerable, respectively.
Treaties (for birds only)	International treaties regarding migratory species. 'B' refers to the 'Bonn Agreement'; 'C' to the China-Australia Migratory Bird Agreement; 'J' to the Japan-Australia Migratory Bird Agreement; and 'R' to the Republic of Korea – Australia Migratory Bird Agreement.
Missing since	The year of the most recent record of species not detected during 2017–2018.
No. SoBS	The number of 'sites of biological significance' (SoBS) in Volume 2 where each species has been recorded in the past 40 years, excluding plantings.

Mammals

Code no.	Common name	Scientific name	Legal Status	Missing since	No. SoBS
5136	Platypus	*Ornithorhynchus anatinus*		2015	1
11003	Short-beaked Echidna	*Tachyglossus aculeatus*			9
11008	Spot-tailed Quoll	*Dasyurus maculatus maculatus*	ELe	1980	0
11162	Koala	*Phascolarctos cinereus*		2007	4
11113	Common Brushtail Possum	*Trichosurus vulpecula*			17
11138	Sugar Glider	*Petaurus breviceps*			4
11129	Common Ringtail Possum	*Pseudocheirus peregrinus*			16
11265	Eastern Grey Kangaroo	*Macropus giganteus*			6
11242	Black Wallaby	*Wallabia bicolor*			7
11280	*Grey-headed Flying-fox	*Pteropus poliocephalus*	VLv		0

Code no.	Common name	Scientific name	Legal Status	Missing since	No. SoBS
11324	White-striped Freetail Bat	*Tadarida australis*		2012	7
11349	Gould's Wattled Bat	*Chalinolobus gouldii*		2014	1
61341	Common Bent-wing Bat	*Miniopterus schreibersii*	L	1974	0
11335	Lesser Long-eared Bat	*Nyctophilus geoffroyi*		2002	3
11334	Gould's Long-eared Bat	*Nyctophilus gouldi*		2002	1
11811	Eastern Broad-nosed Bat	*Scotorepens orion*		2002	1
11381	Large Forest Bat	*Vespadelus darlingtoni*		1990	1
11378	Southern Forest Bat	*Vespadelus regulus*		2002	2
11379	Little Forest Bat	*Vespadelus vulturnus*		2002	2
11415	Australian Water Rat, Rakali	*Hydromys chrysogaster*			2
11412	*House Mouse	*Mus musculus*			2
11395	Bush Rat	*Rattus fuscipes*		1991–92	1
11398	Swamp Rat	*Rattus lutreolus*			2
11409	*Brown Rat	*Rattus norvegicus*		1991–92	2
11408	*Black Rat	*Rattus rattus*			2
528552	*Red Fox	*Vulpes vulpes*			18
11523	*Fallow Deer	*Cervus dama*		1983	0
11527	*Sambar	*Cervus unicolor*			2
11510	*European Rabbit	*Oryctolagus cuniculus*			19

Birds

Code no.	Common name	Scientific name	Legal Status	Treat-ies	Missing since	No. SoBS
10216	Blue-billed Duck	*Oxyura australis*	Le		2014	1
10203	Black Swan	*Cygnus atratus*			1995	1
10202	Australian Wood Duck	*Chenonetta jubata*				25
10948	*Northern Mallard	*Anas platyrhynchos*				3
10208	Pacific Black Duck	*Anas superciliosa*				29
903490	*Pacific Black Duck/Mallard Hybrid	*Anas superciliosa × platyrhynchos*			2008	
10211	Grey Teal	*Anas gracilis*				3
10210	Chestnut Teal	*Anas castanea*				3
10215	Hardhead	*Aythya australis*	v			1
10061	Australasian Grebe	*Tachybaptus novaehollandiae*				7
10062	Hoary-headed Grebe	*Poliocephalus poliocephalus*			2015	1
10101	Darter	*Anhinga novaehollandiae*				2
10100	Little Pied Cormorant	*Microcarbo melanoleucos*				8
10099	Pied Cormorant	*Phalacrocorax varius*	n		2015	1
10097	Little Black Cormorant	*Phalacrocorax sulcirostris*				5
10096	Great Cormorant	*Phalacrocorax carbo*				2
10106	Australian Pelican	*Pelecanus conspicillatus*				2
10188	White-faced Heron	*Egretta novaehollandiae*				20
10189	White-necked Heron	*Ardea pacifica*				4
10187	Eastern Great Egret	*Ardea modesta*	Lv	C,J		3
10977	*Cattle Egret	*Ardea ibis*		C,J	1978–89	0
10192	Nankeen Night Heron	*Nycticorax caledonicus hillii*	n			3
10179	Australian White Ibis	*Threskiornis molucca*				13
10180	Straw-necked Ibis	*Threskiornis spinicollis*				5
10181	Royal Spoonbill	*Platalea regia*	n		1976	0
10182	Yellow-billed Spoonbill	*Platalea flavipes*				4
10232	Black-shouldered Kite	*Elanus axillaris*				5

Code no.	Common name	Scientific name	Legal Status	Treat-ies	Missing since	No. SoBS
10230	Square-tailed Kite	*Lophoictinia isura*	Lv		2013	0
10228	Whistling Kite	*Haliastur sphenurus*				1
10226	White-bellied Sea-Eagle	*Haliaeetus leucogaster*			2011	0
10221	Brown Goshawk	*Accipiter fasciatus*				6
10220	Grey Goshawk	*Accipiter novaehollandiae novaehollandiae*	Lv		2013	0
10222	Collared Sparrowhawk	*Accipiter cirrhocephalus*				0
10224	Wedge-tailed Eagle	*Aquila audax*				2
10239	Brown Falcon	*Falco berigora*			2008	0
10235	Australian Hobby	*Falco longipennis*				2
10237	Peregrine Falcon	*Falco peregrinus*				1
10240	Nankeen Kestrel	*Falco cenchroides*				1
10046	Buff-banded Rail	*Gallirallus philippensis*				3
10058	Purple Swamphen	*Porphyrio porphyrio*				8
10056	Dusky Moorhen	*Gallinula tenebrosa*				13
10059	Eurasian Coot	*Fulica atra*				8
10014	Painted Button-quail	*Turnix varia*			2016	0
10144	Black-fronted Dotterel	*Elseyornis melanops*			1995	2
10133	Masked Lapwing	*Vanellus miles*				17
10125	Silver Gull	*Chroicocephalus novaehollandiae*				1
10957	*Rock Dove	*Columba livia*			2010	5
10989	*Spotted Dove	*Spilopelia chinensis*				42
10034	Common Bronzewing	*Phaps chalcoptera*				18
10035	Brush Bronzewing	*Phaps elegans*			2000	0
10043	*Crested Pigeon	*Ocyphaps lophotes*				13
10031	Diamond Dove	*Geopelia cuneata*	Ln		1980s	0
10267	Yellow-tailed Black-Cockatoo	*Calyptorhynchus funereus*				17
10268	Gang-gang Cockatoo	*Callocephalon fimbriatum*				13
10273	Galah	*Eolophus roseicapillus*				22
10272	Long-billed Corella	*Cacatua tenuirostris*			2012	0
10271	Little Corella	*Cacatua sanguinea*				17
10269	Sulphur-crested Cockatoo	*Cacatua galerita*				19
10254	Rainbow Lorikeet	*Trichoglossus haematodus*				35
10256	*Scaly-breasted Lorikeet	*Trichoglossus chlorolepidotus*			1990	1
10258	Musk Lorikeet	*Glossopsitta concinna*				17
10260	Little Lorikeet	*Glossopsitta pusilla*				2
10259	Purple-crowned Lorikeet	*Glossopsitta porphyrocephala*				1
10281	Australian King-Parrot	*Alisterus scapularis*				22
10282	Crimson Rosella	*Platycercus elegans*				36
10288	Eastern Rosella	*Platycercus eximius*				41
10295	Red-rumped Parrot	*Psephotus haematonotus*				0
10337	Pallid Cuckoo	*Cacomantis pallidus*			2012	1
10338	Fan-tailed Cuckoo	*Cacomantis flabelliformis*				10
10342	Horsfield's Bronze-Cuckoo	*Chrysococcyx basalis*				3
10344	Shining Bronze-Cuckoo	*Chrysococcyx lucidus*				4
10347	Pacific (or Eastern) Koel	*Eudynamys orientalis*				0
10348	Channel-billed Cuckoo	*Scythrops novaehollandiae*			1983	0
10248	Powerful Owl	*Ninox strenua*	Lv			2
10246	Barking Owl	*Ninox connivens connivens*	Le			1
10242	Southern Boobook	*Ninox novaeseelandiae*				3
10249	Eastern Barn Owl	*Tyto delicatula*				1
10313	Tawny Frogmouth	*Podargus strigoides*				12
10317	Australian Owlet-nightjar	*Aegotheles cristatus*				1
10334	White-throated Needletail	*Hirundapus caudacutus*	v	C,J,R	2016	3

Code no.	Common name	Scientific name	Legal Status	Treat-ies	Missing since	No. SoBS
10335	Fork-tailed (or Pacific) Swift	*Apus pacificus*		C,J,R	2015	0
10319	Azure Kingfisher	*Alcedo azurea*	n		1988	0
10322	Laughing Kookaburra	*Dacelo novaeguineae*				33
10326	Sacred Kingfisher	*Todiramphus sanctus*				3
10558	White-throated Treecreeper	*Cormobates leucophaeus*				2
10560	Red-browed Treecreeper	*Climacteris erythrops*			1980s	0
10529	Superb Fairy-wren	*Malurus cyaneus*				20
10565	Spotted Pardalote	*Pardalotus punctatus punctatus*				32
10976	Striated Pardalote	*Pardalotus striatus*				2
10488	White-browed Scrubwren	*Sericornis frontalis*				18
10494	Large-billed Scrubwren	*Sericornis magnirostris*			1999	0
10504	Speckled Warbler	*Chthonicola sagittatus*	Lv		1909	0
10465	Weebill	*Smicrornis brevirostris*			2000	4
10475	Brown Thornbill	*Acanthiza pusilla*				35
10484	Buff-rumped Thornbill	*Acanthiza reguloides*			1980s	0
10486	Yellow-rumped Thornbill	*Acanthiza chrysorrhoa*			2012	4
10471	Yellow Thornbill	*Acanthiza nana*			2012	2
10470	Striated Thornbill	*Acanthiza lineata*				19
10638	Red Wattlebird	*Anthochaera carunculata*				49
10637	Little Wattlebird	*Anthochaera chrysoptera*				13
10645	Noisy Friarbird	*Philemon corniculatus*			2008	0
10603	Regent Honeyeater	*Anthochaera phrygia*	CLc		1917	0
10633	Bell Miner	*Manorina melanophrys*			2004	14
10634	Noisy Miner	*Manorina melanocephala*				36
10605	Lewin's Honeyeater	*Meliphaga lewinii*			1990–96	1
10614	Yellow-faced Honeyeater	*Lichenostomus chrysops*				2
10617	White-eared Honeyeater	*Lichenostomus leucotis*				1
10625	White-plumed Honeyeater	*Lichenostomus penicillatus*			2015	14
10583	Brown-headed Honeyeater	*Melithreptus brevirostris*				1
10578	White-naped Honeyeater	*Melithreptus lunatus*			2015	3
10630	Crescent Honeyeater	*Phylidonyris pyrrhoptera*			1910	0
10631	New Holland Honeyeater	*Phylidonyris novaehollandiae*				5
10591	Eastern Spinebill	*Acanthorhynchus tenuirostris*				27
10586	Scarlet Honeyeater (Myzomela)	*Myzomela sanguinolenta*				1
10377	Jacky Winter	*Microeca fascinans*			2014	1
10380	Scarlet Robin	*Petroica boodang*				3
10381	Red-capped Robin	*Petroica goodenovii*			1980s	0
10382	Flame Robin	*Petroica phoenicea*			2015	1
10384	Rose Robin	*Petroica rosea*			1990	1
10383	Pink Robin	*Petroica rodinogaster*			1990	1
10392	Eastern Yellow Robin	*Eopsaltria australis*				6
10421	Eastern Whipbird	*Psophodes olivaceus*			1897	0
10436	Spotted Quail-thrush	*Cinclosoma punctatum*	n		1924	0
10549	Varied Sittella	*Daphoenositta chrysoptera*				3
10416	Crested Shrike-tit	*Falcunculus frontatus*			1996	3
10398	Golden Whistler	*Pachycephala pectoralis*				11
10401	Rufous Whistler	*Pachycephala rufiventris*				7
10408	Grey Shrike-thrush	*Colluricincla harmonica*				11
10365	Leaden Flycatcher	*Myiagra rubecula*				1
10366	Satin Flycatcher	*Myiagra cyanoleuca*		B		1
10369	Restless Flycatcher	*Myiagra inquieta*			1980s	0
10415	Magpie-lark	*Grallina cyanoleuca*				37
10362	Rufous Fantail	*Rhipidura rufifrons*		B	2000	1
10361	Grey Fantail	*Rhipidura albiscapa*				23

Code no.	Common name	Scientific name	Legal Status	Treat-ies	Missing since	No. SoBS
10364	Willie Wagtail	*Rhipidura leucophrys*				19
10424	Black-faced Cuckoo-shrike	*Coracina novaehollandiae*				18
10430	White-winged Triller	*Lalage sueurii*			1908	0
10671	Olive-backed Oriole	*Oriolus sagittatus*				14
10544	Masked Woodswallow	*Artamus personatus*			2012	0
10545	White-browed Woodswallow	*Artamus superciliosus*			2012	1
10547	Dusky Woodswallow	*Artamus cyanopterus*				4
10702	Grey Butcherbird	*Cracticus torquatus*				50
10705	Australian Magpie	*Cracticus tibicen*				51
10694	Pied Currawong	*Strepera graculina*				31
10697	Grey Currawong	*Strepera versicolor*				17
10930	Australian Raven	*Corvus coronoides*			2006	4
10954	Little Raven	*Corvus mellori*				46
10693	White-winged Chough	*Corcorax melanorhamphos*			1996	1
10995	*House Sparrow	*Passer domesticus*			2006	6
10994	*Eurasian Tree Sparrow	*Passer montanus*			1976	0
10653	Zebra Finch	*Taeniopygia guttata*			2007	0
10662	Red-browed Finch	*Neochmia temporalis*				8
10997	*European Greenfinch	*Chloris chloris*				3
528559	*European Goldfinch	*Carduelis carduelis*				6
10564	Mistletoebird	*Dicaeum hirundinaceum*				4
10357	Welcome Swallow	*Hirundo neoxena*				23
10360	Fairy Martin	*Petrochelidon ariel*				0
903569	Australian Reed Warbler	*Acrocephalus australis*			2015	4
10522	Little Grassbird	*Megalurus gramineus*				1
10509	Rufous Songlark	*Cincloramphus mathewsi*			1907	0
10525	Golden-headed Cisticola	*Cisticola exilis*				4
10574	Silvereye	*Zosterops lateralis*				17
10779	Bassian Thrush	*Zoothera lunulata*			2000	0
10991	*Common Blackbird	*Turdus merula*				45
10992	*Song Thrush	*Turdus philomelos*			2015	3
10999	*Common Starling	*Sturnus vulgaris*			2016	27
10998	*Common Myna	*Acridotheres tristis*				46

Reptiles

Code no.	Common name	Scientific name	Legal Status	Missing since	No. SoBS
5134	Common Long-necked Tortoise	*Chelodina longicollis*	d		9
5135	*Murray River Turtle	*Emydura macquarii*	v		1
12126	*Marbled Gecko	*Christinus marmoratus*			1
12283	Lace Monitor or Tree Goanna	*Varanus varius*	e	1976	0
12682	Eastern Three-lined Skink	*Acritoscincus duperreyi*		1890	0
12407	Swamp Skink	*Lissolepis coventryi*	Lv		1
62938	Black Rock Skink	*Egernia saxatilis intermedia*		1908	0
62430	White's Skink	*Liopholis whitii*		1931	0
12450	Delicate Skink	*Lampropholis delicata*			2
12451	Garden Skink	*Lampropholis guichenoti*			12
12444	McCoy's Skink	*Anepischtos maccoyi*		1992	1

Code no.	Common name	Scientific name	Legal Status	Missing since	No. SoBS
12683	Glossy Grass Skink	*Pseudemoia rawlinsoni*	v	2013	1
12452	Weasel Skink	*Saproscincus mustelinus*			1
12578	Blotched Blue-tongued Lizard	*Tiliqua nigrolutea*			5
12580	Common Blue-tongued Lizard	*Tiliqua scincoides*			0
12973	Lowland Copperhead	*Austrelaps superbus*			4
12665	White-lipped Snake	*Drysdalia coronoides*		1994	2
12699	Eastern Brown Snake	*Pseudonaja textilis*		1906	0
12650	Eastern Small-eyed Snake	*Rhinoplocephalus nigrescens*		1970s	0

Frogs

Code no.	Common name	Scientific name	Legal Status	Missing since	No. SoBS
13134	Common Froglet	*Crinia signifera*			23
13033	Victorian Smooth Froglet	*Geocrinia victoriana*		1988	0
13058	Southern Bullfrog, Pobblebonk	*Limnodynastes dumerilii*			6
13061	Striped Marsh Frog	*Limnodynastes peronii*		2014	5
13063	Spotted Marsh Frog	*Limnodynastes tasmaniensis*			10
13125	Southern Toadlet	*Pseudophryne semimarmorata*	v	1890	0
13182	Southern Brown Tree Frog	*Litoria ewingii*			20
13204	*Peron's Tree Frog	*Litoria peronii*			2
13207	Growling Grass Frog	*Litoria raniformis*	VLe	1988	0
63906	Verreaux's Tree Frog	*Litoria verreauxii verreauxii*			0

Fish

Code no.	Common name	Scientific name	Legal Status	Missing since	No. SoBS
4696	Common Galaxias	*Galaxias maculatus*			2
4711	*Goldfish	*Carassius auratus*		2004	2
4713	*Carp or European Carp	*Cyprinus carpio*		1997	0
4718	*Roach	*Rutilus rutilus*		2000	1
528546	*Tench	*Tinca tinca*		1988	0
5060	Flathead Gudgeon	*Philypnodon grandiceps*		2000	1
4603	Short-headed Lamprey	*Mordacia mordax*		1968	0
4651	Shortfin Eel	*Anguilla australis*		2011	7
4680	*Brown Trout	*Salmo trutta*		1988	0
4725	*Oriental Weatherloach	*Misgurnus anguillicaudatus*		2000	2
4771	*Mosquitofish or Eastern Gambusia	*Gambusia holbrooki*			5
4888	*Redfin	*Perca fluviatilis*			1

Butterflies

Code no.	Common name	Scientific name	Missing since	No. SoBS
521347	Splendid Ochre, Symmomus Skipper	*Trapezites symmomus soma*		5
520137	Dispar (or Barred) Skipper	*Dispar compacta*	1996	2
521328	Doubleday's Skipper, Lilac Grass-skipper	*Toxidia doubledayi*		2
521162	Bright Shield-skipper	*Signeta flammeata*	2007	0
520451	Spotted Skipper, Spotted Sedge-skipper	*Hesperilla ornata ornata*	1995	1
520755	Yellow-banded Dart, Greenish Grass-dart	*Ocybadistes walkeri sothis*		7
519920	*Orange Palm-dart	*Cephrenes augiades sperthias*		0
520857	*Orchard Swallowtail or Orchard Butterfly	*Papilio aegeus*	1996	1
520856	*Dainty Swallowtail	*Papilio anactus*		6
19024	Imperial Jezebel	*Delias harpalyce*		4
519857	Caper White	*Belenois java teutonia*		2
19038	*Cabbage White	*Pieris rapae*		18
19069	Varied Swordgrass Brown	*Tisiphone abeona albifascia*	1996	2
19032	Ringed Xenica	*Geitoneura acantha*		18
19028	Klug's (or Marbled) Xenica	*Geitoneura klugii*		8
19030	Common Brown	*Heteronympha merope merope*		29
19027	Shouldered Brown	*Heteronympha penelope*	1996	1
520538	Meadow Argus	*Junonia villida*		5
19035	Australian Painted Lady	*Vanessa kershawi*		11
19037	Australian (or Yellow) Admiral	*Vanessa itea*		4
520094	*Monarch or Wanderer Butterfly	*Danaus plexippus*	2011	0
520867	Bright Copper	*Paralucia aurifer*	1956	0
520504	Moonlight (or Blue) Jewel	*Hypochrysops delicia*	1953	0
520535	Imperial Hairstreak	*Jalmenus evagoras*		2
521095	Silky Hairstreak	*Pseudalmenus chlorinda zephrys*	2016	1
521411	Common Grass-blue	*Zizina otis labradus*		13

Bibliography

Abhijith K.V., Kumar P., Gallagher J., McNabola A., Baldauf R., Pilla F., *et al*. (2017). Air pollution abatement performances of green infrastructure in open road and built-up street canyon environments – A review, *Atmospheric Environment* **162**, 71–86.

Akbari H. (2002). Shade trees reduce building energy use and CO2 emissions from power plants. *Environmental Pollution* **116**: S119–S126.

Amos N. (2004). *Standard Criteria for Sites of Biological Significance in Victoria*. Victorian Government, Department of Sustainability & Environment, Melbourne. iv + 53 pp. (Despite the nominal date of 2004, this document was actually published in May 2005.)

Ashley L.C., Major R.E. and Taylor C.E. (2009). Does the presence of grevilleas and eucalypts in urban gardens influence the distribution and foraging ecology of Noisy Miners? *Emu* **109**: 135–142.

Beier P. and Noss R.F. (1998). Do habitat corridors provide connectivity? *Conservation Biology* **12**(6), 1241–1252.

Bennett A.F. (2003). *Linkages in the Landscape: The Role of Corridors and Connectivity in Wildlife Conservation*. IUCN, Gland, Switzerland and Cambridge, UK. xiv + 254 pp.

Bhullar S. and Majer J. (2000). Arthropods on street trees: a food resource for wildlife. *Pacific Conservation Biology* **6,** 171–173.

Bot A. and Benites J. (2005). *The Importance of Soil Organic Matter – Key to Drought-Resistant Soil and Sustained Food Production*. FAO Soils Bulletin 80, UN Food and Agriculture Organisation, Rome.

Bowman D.M.J.S. (2008). The impact of Aboriginal landscape burning on the Australian biota. *New Phytologist* **140**(3), 385 – 410.

Braaker S., Ghazoul J., Obrist M.K., Moretti M. (2014). Habitat connectivity shapes urban arthropod communities – the role of green roofs. *Ecology* **95**(4), 1010–1021.

Branelly L.A., Webb R.J., Hunter D.A., Clemann N., Howard K., Skerratt L.F., Berger L. and Schelle B.C. (2017). Non-declining amphibians can be important reservoir hosts for amphibian chytrid fungus. *Animal Conservation* **21**, 91–101.

Bull M. and others (2014). *Flora of Melbourne*, 4th edition. Hyland House. 608 pp.

Cahill D.M., Rookes J.E., Wilson B.A., Gibson L. and McDougall K.L. (2008). *Phytophtora cinnamomi* and Australias biodiversity: impacts, predictions and progress toward control. *Australian Journal of Botany* **56**: 279–310.

Catterall C.P., Green R.J. and Jones, D.N. (1989). Occurrence of birds in relation to plants in a subtropical city. *Aust. Wildl. Res*. **16,** 289–305.

Chawla L. (2015). Benefits of nature contact for children. *Journal of Planning Literature* **30**: 433–452.

Context (2005). *Maroondah Habitat Corridors Strategy*. Report to Maroondah City Council. 147 pp.

Croydon Conservation Society (1988). *Trees and Wildflowers of Croydon 1988*, a 20-page booklet.

Croydon Conservation Society (1995). *Trees and Wildflowers of Croydon 1995*, a 32-page booklet.

DELWP (2016). *Outcomes Report – Review of the Native Vegetation Clearing Regulations*. Victorian Department of Environment, Land, Water and Planning, Melbourne, Victoria. 16 pp.

DELWP (2017). *Planning for Biodiversity – Guidance*. Victorian Department of Environment, Land, Water and Planning, Melbourne, Victoria. 22 pp.

DEPI (2014). *Advisory List of Rare or Threatened Plants in Victoria – 2014*. Victorian Department of Environment & Primary Industries, Melbourne, Victoria. 56 pp.

DSE (2008). *Native Vegetation Net Gain Accounting First Approximation Report*. Victorian Department of Sustainability and Environment, East Melbourne, Victoria. 21 pp.

DSE (2013). *Advisory List of Threatened Vertebrate Fauna in Victoria – 2013*. Victorian Department of Sustainability and Environment, Melbourne, Victoria. 17 pp.

Foreman P. (2004). *Manningham BioSites – Manningham City Council Sites of (Biological) Significance Review*. Manningham City Council, Doncaster, Victoria. 196 pp. + 64 maps.

Franklin D. (2012). Nature the nurtures. *Scientific American* **306**(3): 24–25. Also available online at www.scientificamerican.com/article/nature-that-nurtures.

Fromm E. (1964). *The Heart of Man: Its Genius for Good and Evil*. Harper and Row, New York.

Fromm E. (1973). *The Anatomy of Human Destructiveness*. Holt, Rinehart and Winston, New York.

Gill T. (2014). The benefits of children's engagement with nature: a systematic literature review. *Children, Youth and Environments* **24**: 10–34.

Gott E. (2008). Indigenous use of plants in south-eastern Australia. *Telopea* **12**(2), 215–226.

Hastings R.A. and Beattie A.J. (2006). Stop the bullying in the corridors: Can including shrubs make your revegetation more Noisy Miner free? *Ecological Management & Restoration* **7**: 105–112.

Heisler G.M. and Grant R.H. (2000). Ultraviolet radiation in urban ecosystems with consideration of effects on human health. *Urban Ecosystems* **4**: 193–229.

Ikin K., Knight E., Lindenmayer D.B, Fischer J. and Manning A.D. (2013). The influence of native versus exotic streetscape vegetation on the spatial distribution of birds in suburbs and reserves. *Diversity and Distributions* **19**: 294–306.

Jellinek S., Driscoll D.A. and Kirkpatrick J.B. (2004). Environmental and vegetation variables have a greater influence than habitat fragmentation in structuring lizard communities in remnant urban bushland. *Austral Ecology* **29**, 294–304.

Jones D.J., Elliot W.R. and Jones S.R. (2015). *Pests, Diseases, Ailments and Allies of Australian Plants*. Reed New Holland, Chatswood, NSW. 448 pp.

Jurskis V. and Turner J. (2002). Eucalypt dieback in eastern Australia: a simple model. *Australian Forestry* **65**: 87–98.

Kaspar J. (2018). *Maroondah Canopy & Landscape Analysis 2011 to 2016*, report to Maroondah City Council.

Lorimer G.S. (1995). *Warranwood Reserve Management Plan*, for Maroondah City Council.

Lorimer G.S. (1997). *Warrien Reserve Management Plan*, for Maroondah City Council.

Lorimer G.S. (1997). *Loughies Bushland Management Plan*, for Maroondah City Council.

Lorimer G.S. (1997). *Bushland Management Plan for Wombolano Park*, for Maroondah City Council.

Lorimer G.S. (1997). *Bushland Management Plan for Hubbard Reserve*, for Maroondah City Council.

Lorimer G.S. (1998). *Power Street Reserve Management Plan*, for Maroondah City Council.

Lorimer G.S. (1998). *Oban Road Reserve Management Plan*, for Maroondah City Council.

Lorimer G.S. (1998). *Mulgrave Way Reserve Management Plan*, for Maroondah City Council.

Lorimer G.S. (1998). *Heathmont Railway Reserve Management Plan*, for Maroondah City Council.

Lorimer G.S. (1998). *Grandfill Reserve Management Plan*, for Maroondah City Council.

Lorimer G.S. (1998). *Eastfield Park Bushland Management Plan*, for Maroondah City Council.

Lorimer G.S. (1998). *Cherry Tree Reserve Management Plan*, for Maroondah City Council.

Lorimer G.S. (1998). *Birts Hill Reserve Management Plan*, for Maroondah City Council.

Lorimer G.S. (1998). *Alto Reserve Management Plan*, for Maroondah City Council.

Lorimer G.S. (2004). *Bushland Management Plan for Hubbard Reserve, 2004*, for Maroondah City Council. 28 pp.

Lorimer G.S. (2000). *Hochkins Ridge Flora Management Plan*, Volumes 1-3, for Maroondah City Council.

Lorimer G.S. (2001). *Warranwood Reserve Management Plan 2001*, for Maroondah City Council. 33 pp.

Lorimer G.S. (2002). *Flora Management Plan for Mt Dandenong Rd Median, Croydon & Ringwood East, 2002*, for Maroondah City Council. 19 pp.

Lorimer G.S. (2007). *Monitoring of Bushland Reserves in Knox – 2007 Review*, for Knox City Council.

Lorimer G.S. (2008). *Landscape-scale Monitoring of Native Vegetation Condition in Manningham*. Manningham City Council, Doncaster, Victoria. 25 pp.

Lorimer G.S. (2011). Melbournes plant life – past and present. *The Victorian Naturalist* **128**(5), 175–181.

Lorimer G.S., Reid J.C., Smith L.P. and Moss H. (1997). *Sites of Biological Significance in Maroondah*. Maroondah City Council, Ringwood. 2 volumes, c. 300 pp.

Lorimer G.S., Baker S. and Lockwood D. (2009). *Wildlife Movement and Habitat Needs in Manningham*. Manningham City Council, Doncaster, Victoria. 27 pp.

Lorimer G.S. and Carr G.W. (2013). *Management Plan for the Kilsyth South Spider-orchid, 2013*. Report to Maroondah City Council. iii+78 pp.

Loyn R.H. (1986). The 20-minute search - A simple method for counting forest birds. *Corella* **10**, 58–-60.

Loyn R.H., Runnalls R.G., Forward G.Y. and Tyers J. (1983). Territorial bell miners and other birds affecting populations of insect prey. *Science* **221**: 1411–3.

MacDougall A.S. and Turkington R. (2005). Are invasive species the drivers or passengers of change in degraded ecosystems? *Ecology* **86**, 42–55.

Maroondah City Council (2016). *Maroondah Sustainability Strategy 2016–2020*. 27 pp.

Middelmann, M. H. (Editor) (2007) *Natural Hazards in Australia – Identifying Risk Analysis Requirements*. (see Chapter 8 – Landslide.) Geoscience Australia, Canberra.

NRE – Department of Natural Resources and Environment, Victoria (2002). *Victorias Native Vegetation Management – A Framework for Action*. Melbourne. 59 pp.

Oates A. and Taranto M. (2001). *Vegetation Mapping of the Port Phillip & Westernport Region*. Arthur Rylah Institute for Environmental Research (now part of the Department of Environment, Land, Water and Planning). Note that the true date of release was 2002.

ONeill J.J. (1995). *Description of the Physical Environment of the City of Maroondah*, a report to Maroondah City Council. 8 pp.

Orchard A.E. (2017). A revision of *Cassinia* (Asteraceae: Gnaphalieae) in Australia. 7. *Cassinia* subgenus *Achromolaena*. *Australian Systematic Botany* **30**, 337–370.

Omasa K., Tobe K. and Kondo T. (2002). Absorption of Organic and Inorganic Air Pollutants by Plants. In: Omasa K., Saji H., Youssefian S., Kondo N. (eds), *Air Pollution and Plant Biotechnology*. Springer, Tokyo.

Ow L.F. and Ghosh S. (2017). Urban cities and road traffic noise: Reduction through vegetation. *Applied Acoustics* **120**: 15–20.

Paget A.N. (1987). *Birts Hill Reserve Vegetation Management Plan*. Report for Croydon Conservation Society. 43 pp.

Recher, H.F. (2003). The need for a vision. *Pacific Conservation Biology* **9**, 3–8.

Ritchie L. and Hunt G. (2000). Landslips – a moving story: A municipality's perspective. *Australian Journal of Emergency Management* **15**(4), 28–32.

Santamour F.S. (1990). Trees for Urban Planting: diversity, uniformity, and common sense. *Proceedings of the 7th Conference of the Metropolitan Tree Improvement Alliance*, pp. 57-65.

Scott C. (2018). *Maroondah City Council Vegetation Planning Policy Review*. Report to Maroondah City Council by Claire Scott Planning.

Taylor A.F. and Kuo F.A. (2005). Is contact with nature important? Chapter 8 of *Children and Their Environments: Learning, Using and Designing Spaces*, C. Spencer and M. Blades, Eds. Cambridge University Press, New York.

Threlfall C., Harrison L., van der Ree R., Williams N. and Jones C. (2015). *EAGA Biodiversity Monitoring Framework 2015. Part II – Indicator Implementation Guide*. Report to the City of Boroondara. 39 pp.

White J.G., Antos M.J, Fitzsimons J.A. and Palmer G.C. (2005). Non-uniform bird assemblages in urban environments: The influence of streetscape vegetation. *Landscape and Urban Planning* **71**, 123–135.

Wilson O.E. (1984). *Biophilia*. Harvard University Press.

Yugovic J. (2015). Do ecosystems need top predators? A review of native predator-prey imbalances in south-east Australia. *The Victorian Naturalist* **132**, 4–11.