Guidelines for the Management of Threatened Orchids in the Shire of Nillumbik

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Cover photos: Top: Rosella Spider-orchid *Caladenia rosella,* Bottom left: A cage protecting a population of threatened orchids. Bottom centre: Silurian Striped Greenhood *Pterostylis* sp. aff. *striata*. Bottom right: Wine-lipped Spider-orchid *Caladenia oenochila*. **Below:** Trim Greenhood *Pterostylis concinna.*

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Nillumbik's Conservation Corridors

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1.0 INTRODUCTION

This guide has been prepared to assist landowners in the Shire of Nillumbik to protect and manage threatened orchids occurring on their properties. A significant proportion of Nillumbik's remnant bushland occurs on private land and these areas support threatened plant communities that are under-represented in the regions parks and reserves system. It is therefore vital that efforts are directed towards identifying, protecting and managing threatened orchids in these areas. 'Threatened orchid' refers not only to species that are listed as threatened in Victoria and Australia but includes species that have declined in the region or local area.

For the last several decades, the Nillumbik area has been the focus of some of the most ground-breaking orchid conservation work in Australia. Centred around critically endangered species such as the Rosella Spider-orchid *Caladenia rosella*, this work has seen the development of a wide range of techniques such as grazing exclusion, weed management, species-enrichment plantings, hand-pollination and more recently isolation of mycorrhizal fungi and propagation of threatened orchids. Many of these techniques have been advanced in Nillumbik and are now being used further afield throughout Victoria. This conservation work has progressed to a stage where it is now possible to share it with a wider audience and pass on some practical techniques for in-situ orchid management.

The guide has been designed to be applicable and useful for landowners with a wide range of experience. Some of the techniques described should only be implemented by those with suitable experience or with the assistance of a contracted bushland manager, while other techniques such as fencing can be undertaken with less experience. The guide can also be read by those who may have no intention of managing orchid populations but who wish to gain a deeper understanding about the importance and challenges of orchid conservation.

The guide is comprised of three main sections. Section 2 (Background) provides a background to the orchids of Nillumbik and discusses their ecology and threatening processes. Section 3 (Management Guidelines) describes a set of techniques for management of threatened orchids while Section 4 (Case Study) describes a case study involving an ongoing orchid recovery project implemented by Parks Victoria ranger Cam Beardsell. This recovery project has centred around the management of the nationally endangered Rosella Spider-orchid *Caladenia rosella* and a suite of other threatened orchids on a property at Cottles Bridge. It is a model for orchid conservation that provides many lessons for those aiming to attempt the recovery of a threatened orchid species.

2.0 BACKGROUND

2.1 Overview of Nillumbik's orchid flora

The Nillumbik Shire supports an outstanding diversity of orchids, with approximately 98 species and over a dozen naturally occurring hybrids recorded so far[1]. This is roughly 66% of the total number of species recorded in Greater Melbourne and roughly 26% of the total number of species known in Victoria. The Shire supports at least four orchids that are probably endemic (found nowhere else) as well as containing the majority of the known population for several other threatened species.

This high diversity of orchids is partly explained by the wide diversity of habitats present within the Shire, which includes a combination of dry forest, heathy woodland, wet gullies and riparian corridors. The Shire also occurs near the junction of several bioregions, where the coastal and volcanic plains meet the higher foothills and mountains of the Great Dividing Range. This junction leads to an overlap of species from each of these regions.

The drier box-stringybark and Ironbark forests of Nillumbik contain some of its most significant orchid assemblages. Typically occurring on the more exposed rocky hillcrests and upper slopes, these plant communities contain a suite of species that are characteristic of the drier woodland and forest of central Victoria. Dubbed the 'goldfields alliance' due to similarities with the goldfields of the Stawell-Bendigo-Heathcote area, this encompasses orchid species such as Dusky Caladenia *Caladenia fuscata,* Woodland Plume-orchid *Pterostylis plumosa,* Silurian Striped Greenhood *Pterostylis* sp. aff. *striata*[2], Slender Ruddyhood *Pterostylis aciculiformis***,** Emerald-lip Greenhood *Pterostylis smaragdyna*, Autumn Greenhood *Pterostylis* sp. aff. *revoluta*, Blue Fingers *Cyanicula caerulea* and Blue Fairies *Pheladenia difformis* (Beardsell 2013). This affinity with the goldfields area of central Victoria is one of the notable biodiversity features of Nillumbik and is due to past geographic links and a sharing of similar rainfall and geology.

But the 'goldfield alliance' makes up only part of the orchid diversity of Nillumbik, as the Shire also contains an interesting combination of species characteristic of coastal heathy woodlands, shady

[1] Note that due to frequent changes to orchid taxonomy and uncertainties regarding some past records, this number is only an estimate based on the best available information. See Appendix 1 for full list.

[2] sp. aff. is short for 'species affiliate', and is a botanical term for an undescribed species that is believed to be most closely related to the species name that is cited. Hence *Pterostylis* sp. aff. *striata* is not the same as typical *Pterostylis striata* but is an undescribed species most closely related to it.

gullies, shrubby tall forest and wetlands. Some of these habitats are very restricted within the Shire, but where present support unique communities of orchids. The type of orchids found in a particular location also varies considerably across the Shire, with stark differences between the lower foothills and plains in the south compared to the higher mountain slopes in the north.

The local orchid flora contains a wide range of different genera that include a diverse array of lifeforms. These range from the Greenhoods *Pterostylis* spp. which can form large colonies on the forest floor to the increasingly rare Spider-orchids *Caladenia* spp. that are famous for their often spectacular flowers. Other notable groups include the Helmet-orchids *Corybas* spp., Leek-orchids *Prasophyllum* sp., Gnat-orchids *Cyrtostylis* spp., Bird-orchids *Chiloglottis* spp., Mosquito-orchids *Acianthus* spp., Leopard-orchids *Diuris* spp. and many more that each have unique appearances and ecological preferences.

Plate 1 - Autumn Greenhood *Pterostylis* sp. aff. *revoluta,* a regionally threatened species that was probably once relatively common in dry forest communities.

There is currently one exotic orchid known to be naturalised in Nillumbik, this being the highly invasive South African Orchid **Disa bracteata.* This species has only been recorded at several locations where it was quickly controlled. If landowners record this species they should contact Council immediately.

Orchid tubers (the underground storage organ), many of which are high in starch and protein, were important food plants for the traditional owners of the land, the Wurundjeri. The tubers of many *Diuris* species are reported to be particularly starchy and would very likely have been collected for food. Other groups that would have been targeted include *Pterostylis, Thelymitra* and *Caladenia* (Zola and Gott 1990). It is likely that the Wurundjeri would have managed orchid populations to ensure an ongoing supply of food. Considering that many of our local orchids respond positively to fire when applied properly, it is possible that they would have burnt the bush intentionally to stimulate the growth of orchids and other food plants.

2.2 Orchid ecology

The orchid family, or Orchidaceae, is one of the most successful groups of plants in Earth's history, with a lineage that extends back tens of millions of years. The family is currently believed to be the second largest family of plants in the world with over 20,000 species known and many more thousands remaining undescribed. Orchids are found on all continents except Antarctica and include a huge diversity of lifeforms which have colonised most major habitats.

The success of the orchids is due to several aspects of their fascinating ecology. Unlike most other flowering plants, the seed of orchids lack an endosperm - a tissue inside the seed that provides nutrients to the young plant. Although this may appear to be a limitation, it has allowed orchids to instead produce masses of tiny, microscopic seeds, sometimes numbering over a million per capsule. This dust-like seed has the ability to blow in the wind over large distances, allowing colonisation of habitats far from the parent plant. But because this seed lacks an endosperm, it relies on a symbiotic relationship with various species of mycorrhizal fungi found within the soil. In return for essential nutrients that the orchid receives from the fungi, once it matures the orchid is believed to provide the fungi with certain sugars that it produces through photosynthesis. This partnership with fungi has not only assisted orchids to colonise large areas of the globe but is probably responsible for their ability to evolve and speciate quite rapidly.

Another key aspect of orchid ecology is their complex relationships with invertebrate pollinators. Many orchids produce kairomones (chemicals that can influence biological behaviour) that mimic the pheromones of female thynnine wasps, as well as displaying specially modified flowers that may have physical resemblance to females. This deceives the male wasp into performing what is known as pseudocopulation, where the male attempts to mate with the flower believing it to be a female wasp, only to incidentally pollinate the flower instead. Orchids involved in this relationship include

some of the *Caladenia* and *Chiloglottis.* In another example showing the importance of mimicry, many local pea shrubs such as Bush-peas *Pultenaea,* Parrot-peas *Dillwynia* and Bitter-peas *Daviesia,* yield nectar that is collected by native bees. The *Diuris* have evolved yellow-golden petals that mimic these pea flowers in order to attract the same bee species as pollinators. In other cases some orchids produce an odour resembling decomposing organic matter to attract fungus gnats or vinegar flies (Jeanes & Backhouse 2006). These include our most diverse group the *Pterostylis,* and also the *Corybas.* The latter entices the female fungus gnat for pollination as the orchid resembles a fungus and possibly smells like one too. The bee that pollinates the Rosella Spider-orchid *Caladenia rosella* is believed to wipe the pollen of the orchid over its body intentionally as it contains a kairomone that attracts the female bee (Beardsell 2013). Many orchids have other physical adaptations to encourage invertebrate pollinators, including development of special calli (non-secreting glands) that act as ideal landing pads or guides into the pollinia as well as production of brightly coloured flowers to attract attention.

The orchids of Nillumbik are all ground-dwelling geophytes, with one exception, the epiphytic Butterfly Orchid *Sarcochilus australis* (now possibly locally extinct due to the Black Saturday bushfires). They die-back to underground tubers during the hotter months of the year before re-sprouting following adequate rainfall in autumn-winter. The majority of local species flower in late winter-spring although there is small suite of species that flower in autumn (Dark-tip Greenhood *Pterostylis atrans,* Autumn Greenhood *Pterostylis* sp. aff. *revoluta,* Parsons Bands *Eriochilus cucullatus* and Midge Orchids *Corunastylis* sp.) while a variety of local orchids have flowering times that extend into summer (some of the Sun-orchids *Thelymitra* spp., Hyacinth-orchids *Dipodium* spp, Summer Spider-orchid *Caladenia aestivalis* and Elbow Orchid *Thynninorchis huntianus*).

Certain species of moss and lichen (bryophytes) have been found to play an important role in the growth of many of Nillumbik's threatened orchids. This is particularly the case on the skeletal soils of the drier rocky hills, where moss cover reduces sun and wind exposure, helps to retain soil cover and moisture levels around plants and possibly assists with acquiring nutrients and nurturing mycorrhizal fungi. But the role that bryophytes play in orchid ecology is complex and not well understood. Some moss species may have a negative effect due to their thick growth that smothers orchids while other species only play a beneficial role if properly managed. Further discussion on the role of individual moss species is discussed in Section 3.

Many local orchids respond positively to fire, showing a significant increase in plant numbers and flowering activity in the first few years following a fire event. This is due to a number of factors including return of nutrients to the soil, opening of the vegetation structure which increases sunlight

exposure and possibly an increase in mycorrhizal fungal activity. Important chemicals released by plant roots after surface combustion (e.g. ethylene) or contained in charcoal may also break dormancy or stimulate orchids to grow and flower. However the effect that fire has on orchid species is strongly influenced by other factors, so that fire can be detrimental if it occurs too close to emergence (e.g. too late in autumn) or if followed by below average rainfall or elevated grazing pressure.

In summary, orchid ecology is complex, with many species having highly specialised relationships with uncommon groups of invertebrate, plant or fungi. The more specialised the relationship, the more the orchid is vulnerable to ecosystem disruption, and so these specialist orchids are generally only found in highly intact bushland. For this reason the type and diversity of orchids found in a patch of bush is a strong indicator of the health of the ecosystem.

Plate 2 – Wine-lipped Spider-orchid *Caladenia oenochila,* a species that is endemic and vulnerable in Victoria. Nillumbik still supports a large proportion of the total population but the species has declined substantially in recent years.

2.3 Threatening processes

Of the roughly 98 orchid species recorded within the Shire, approximately 48 are considered to be rare or threatened in Greater Melbourne, 19 are listed as threatened or poorly known in Victoria and/or Australia while six are probably locally extinct (See Appendix 1 for full list). This means that of the remaining orchid flora (roughly 92 species), approximately 73% are considered to be declining or threatened. Many of these species were once common in the region but have declined drastically since European settlement.

So why are so many of our orchid species threatened? As will be explained throughout this guide, most orchids have extremely complex ecological relationships and are therefore very sensitive to environmental change. Many orchids only persist in high quality bushland that has been protected or managed, of which there are increasingly few examples today.

Some of the more common threatening processes are described below. Note that it is often a complex combination of these factors that leads to orchid decline.

Grazing/browsing pressure and predation

Grazing pressure from native and introduced mammalian herbivores is one of the key threatening processes affecting orchids. This includes grazing from a range of native and introduced species such as rabbits, brush-tail possums, hares, deer, kangaroos and wallabies as well as domestic stock such as sheep and cattle. In the early days of European settlement, domestic stock would have been grazed throughout large parts of the Shire, exerting pressure on some orchids. But it was probably only following the explosion of rabbit numbers from the 1860's onwards that many orchid populations would have been locally eliminated by heavy and sustained grazing.

Rabbits continue to be one of the most serious threats to orchids and other understorey vegetation in Nillumbik. They exert heavy grazing pressure on most herbaceous species and impact understorey shrubs and trees by ring-barking older plants and preventing recruitment by eating seedlings. They also contribute significantly to sheet erosion (by baring the ground-layer) and tunnel erosion (through creating warrens) and their digging and scratching of the top soil remove moss cover and benefit the growth of annual weeds. Over time these pressures lead to major changes to the structure and composition of bushland. Bush-blocks in semi-rural parts of Nillumbik (e.g. Dunmoochin) support major populations of rabbits. Since the 1980's, the cover of native groundflora species has dwindled dramatically due to rabbits, all areas by at least 50% and some areas by over 90%. In the latter case, there has been almost total replacement by alien annual species that flower close to the ground and have brief life-cycles. This loss in ground cover has other ramifications, including exposure of ground vertebrates to fox and cat predation. At Dunmoochin, the Slender-

tailed Dunnart *Sminthopsis murina* and Tree Dragon *Amphibolurus muricatus* became locally extinct due to this process.

In the last two decades, the numbers of Eastern Grey Kangaroo *Macropus giganteus* and Black Wallaby *Wallabia bicolor* have increased significantly throughout the Shire. For kangaroos, this increase in numbers has been linked to a decline of hunting practices, an increase in watering points and patterns of land settlement. Sub-division of the broad-acre farms took place throughout the Shire from the 1950's to the 1970's, and these areas largely regenerated into bush-blocks during the 1980's and 1990's. This created a new vegetation pattern within the district that is typically comprised of a five to one ratio of cleared land to bushland. This pattern is highly favourable to kangaroos, which prefer to shelter in bushland during the day and feed in open areas at night. For the Black Wallaby *Wallabia bicolor* the renewal of connectivity/refugia along creeks, the regeneration of bush-blocks and new laws pertaining to the roaming domestic dogs, have all contributed to the increase in numbers.

Both kangaroos and wallabies can have a serious impact on bushland when in large numbers, with kangaroos often grazing herbs and grasses to near ground-level and wallabies heavily impacting the native shrub layer. These impacts are greatly exacerbated during drought conditions, when there is less alternative feed and native understorey can become heavily grazed.

In the last five years, the range and numbers of deer species, particularly Sambar Deer **Rusa unicolor,*[3] has also greatly expanded throughout the Shire, putting additional pressure on remnant vegetation. Sambar Deer can heavily compact the soil and exert heavy browsing pressure on shrub species which may be important pollinator plants for orchids.

In addition to grazing and browsing impacts from mammals, there are several bird and invertebrate species that predate heavily on orchids. Chief among these is the White-wing Chough *Corcorax melanorhamphos,* a communal bird species in the Corcoracidae or mud-nest building family. These birds have probably always foraged on the tubers of orchids, but the numbers of these birds has possibly increased in some areas due to hand feeding by humans and an increase in water supply. Threatened orchids that occur around houses are at greatest risk, as White-wing Chough's may congregate around these areas if hand-fed.

The three most serious invertebrate predators are all introduced species. The Red-legged Earth Mite **Halotydeus destructor* was accidentally introduced into Australia from South Africa in the early 1900's and is a serious agricultural pest. However these tiny mites also feed on many native plants,

[3] Throughout this report, an asterisk symbol (*) refers to an introduced species.

including orchids, and can cause significant damage to plants by lacerating the leaf surface and sucking out the discharging sap. In some cases the spread of mites is benefited by weed invasion, as annual weeds such as Cape Weed **Arctotheca calendula* are known to harbour large mite populations (Frood 2010). The Portuguese Millipede **Ommatoiulus moreletii*, a detritivore that thrives under dense leaf litter, was introduced into Australia in the 1950's. Because this species lacks natural predators it often forms plagues throughout the bush, where individuals graze on the leaves and flowers of orchids and have been known to eliminate entire populations. The third species is the European Wasp **Vespula germanica* that has an indirect impact on orchids through predation and/or competition with key pollinating insects (e.g. Thynnine wasps).

Plate 3 – Red-legged Earth Mites *Halotydeus destructor* feeding on the regionally endangered *Chiloglottis trapeziformis* at Boomers Reserve, Panton Hill. Photo courtesy of James Vincent.

Weed invasion

The invasion of weeds into a native vegetation community can quickly out-compete and eliminate many of the more sensitive orchids. High threat weeds may include shrub species such as Sweet

Pittosporum **Pittosporum undulatum,* Boneseed **Chrysanthemoides monilifera*, Bluebell Creeper **Sollya heterophylla* and non-indigenous wattles **Acacia* sp. that have the ability to take over large areas and exclude native species through shading and competition for water and nutrients. But more commonly the most threatening weeds for our local orchids are the exotic grasses and herbs that have the ability to blanket the ground-layer. This includes a suite of annual species that have short life-cycles and the ability to produce massive amounts of seed in a short period of time, including Squirrel-tail Fescue **Vulpia bromoides*, Large Quaking-grass **Briza maxima*, Lesser Quaking-grass **Briza minor*, Annual Veldt-grass **Ehrharta longiflora*, Hair-grass *Aira* spp., Flick-weed **Cardamine hirsuta* and Mouse-ear Chickweed **Cerastium glomeratum.* It also includes a variety of perennial grasses, some which occasionally function as annuals, including Panic Veldt-grass **Ehrharta erecta*, Sweet Vernal-grass **Anthoxanthum odoratum* and Cock's Foot **Dactylis glomerata.* There is also at least one introduced species of moss that has been recorded impacting orchids in Nillumbik. Neat Feather-moss **Pseudoscleropodium purum* forms large dense mats that can alter soil conditions, smother orchids and prevent recruitment of native species. This moss is mostly found in protected, shady sites and consequently poses the greatest threat to orchids found in these habitats.

Land development

Development of land for housing has led to the clearance of large areas of bushland in Nillumbik, particularly around urban centres such as Eltham, Diamond Creek and Hurstbridge. But while large-scale sub-divisions may lead to loss of significant areas of bushland, the increase in the incidence of low-density housing in core areas of bushland is also a major contributing factor. Although low-density housing has less immediate impact, it often leads to a gradual decline of bushland due to edge effects, increased human activity and fragmentation of core areas. Weeds often spread downhill from human habitation while hydrology may be altered by construction of driveways or other hard surfaces. Recent changes to bushfire regulations also allows landowners to clear large areas of native vegetation around the perimeter of the house, often leading to very significant impacts beyond the house zone. Unless the owners of bush blocks are willing to learn about the surrounding ecology and take some responsibility to manage their bushland, it is very likely that the vegetation will gradually decline over time. Property owners can take positive steps to conserving their bushland by controlling weeds and rabbits, replanting previously cleared areas and minimising disturbance to remnant areas.

Inappropriate fire regimes

Several decades of trial and research have shown that the drier forest and woodland of Nillumbik appear to respond positively to well-planned ecological burning while some orchid species appear to

decline in the long-term absence of fire. It is likely that the Wurundjeri would have managed many areas with fire and that their removal from the land led to a significant alteration to historical burning patterns. Large areas of forest in Nillumbik are currently long-unburnt or have only been affected by fire sporadically over the last century. This may have caused many of the processes associated with fire to be disrupted, such as nutrient cycling, and led to closure of the shrub layer to the detriment of the groundflora. Note that not all native orchids respond well to burning and that the presence of long-unburnt refuges is important in most landscapes. The extreme heat intensity of contemporary bushfires such as occurred on Black Saturday has also been shown to be lethal to most orchids.

Drought conditions and climatic change

Periods of below average rainfall associated with drought conditions are a natural feature of the region. However due to the massive changes that have occurred to native ecosystems since European settlement, drought now exacerbates threatening processes and in some cases may be the final straw that leads to the elimination of an orchid population. The Millennium Drought (roughly 1996-2010) was the most severe in recorded history and led to the decline or extinction of many orchid populations in the region. The decline of orchids during drought is not only caused by plant stress associated with hot temperatures and lack of water, but because grazing/browsing levels become extreme as animals struggle to find food.

In south-eastern Australia droughts are strongly influenced by El Nino events, but human-induced climatic change it is also becoming increasingly influential. With significant reduction in winter-spring rainfall and an increase of average temperatures between 1-3°C predicted by the year 2070, climate change is set to have a serious impact on our native orchids, making it imperative that recovery management is initiated now.

Disrupted ecosystems

Disrupted ecosystems refers to the more complex processes that may result in orchid decline. Many orchids, particularly the Spider-orchids *Caladenia* spp., are strongly dependant on invertebrate pollinators (mostly thynnine wasps, bees and gnats) to cross-pollinate plants and allow natural recruitment. However these invertebrates have their own ecological requirements and may disappear in disrupted or modified ecosystems if conditions become unsuitable. The prime example is the sole pollinator of the Rosella Spider-orchid *Caladenia rosella,* a small native bee of the *Leioproctus* genus, which requires a rich community of native peas and wattles in order to collect enough pollen and nectar as food for its young (Beardsell 2013). If excessive browsing pressure by wallabies or lack of fire leads to loss of these shrubs, it is also likely to eventuate in the loss of the

pollinator and eventually the orchid. Other symptoms of disrupted ecosystems include the complex effects of soil compaction, imbalances in local bird communities, over-growth and closure of native shrubs and changes to moss and liverwort cover.

Plate 4 – The Silurian Striped Greenhood *Pterostylis* sp. aff. *striata* is known from few sites in Nillumbik and is listed as endangered in Victoria.

3.0 MANAGEMENT GUIDELINES

Managing threatened orchids can require considerable knowledge in species identification, plant ecology and bushland management. However there are a range of techniques that less experienced landowners can implement, including documentation and monitoring of plants or fencing of populations to exclude grazing. This guide is intended to cater for a wide range of experience levels, but landowners should not attempt to implement the more complex techniques without appropriate experience or assistance. To allow landowners to determine which management works are achievable, an indication is provided of the level of experience required to implement each of the below techniques.

3.1 Collecting information

The first step is to determine what orchid species are present on the property and in what numbers. This information may already be available if you have been monitoring plants in the past, but otherwise a survey of the property is required. Take a walk over the block throughout different seasons of the year, with particular focus in high quality areas and during spring. To assist in re-locating orchid populations, try and document their occurrence by taking photographs, using a GPS (if you have one), marking locations with flagging tape or tent pegs or drawing a map. Compile a list of orchids found on the property and if possible take some rough plant counts. Store all of this information somewhere safe where it can be retrieved when required.

Experience required: This activity can be undertaken by anyone without prior experience, although assistance may be required to identify species. The best method for identification is to take photos of each of the different types, and if you are unable to identify them using reference books, seek the advice of someone more experienced. Key reference books that provide full colour photographs of most of Nillumbik's orchids include *Wild Orchids of Victoria, Australia* by Jeffrey Jeanes and Gary Backhouse and *Flora of Melbourne, 4th Edition* by Marilyn Bull. Nillumbik Shire has also recently completed the Nillumbik Landcare Network (NLN) online orchid guide which can be found at www.nillumbiklandcare.org.au/.

3.2 Identifying the problem

It is becoming increasingly clear that when it comes to orchid species that are threatened in the region, nearly every population requires some form of management due to widespread threatening processes that operate on all areas of private land, particularly weed invasion and grazing pressure.

But before implementing management it is necessary to identify what the level of the problems are and what needs to be achieved to prevent orchid decline. Some key features to look out for include excessive grazing pressure or predation (requiring fencing or caging), weed invasion (requiring weed control), loss of understorey diversity (requiring species-enrichment plantings) and bare exposed soil around Spider-orchid leaves (in some cases requiring micro-mulching[4] or transplanting moss mats). If you have been monitoring the population in the past, a decline in numbers may indicate that intervention is required. Note that orchid numbers can vary naturally from year to year based on seasonal conditions (i.e. low numbers during a dry year may be followed by higher numbers in the following year due to good rainfall). Another option for identifying threats is to install a motion sensor camera, which could potentially be supplied by Nillumbik Shire Council. This could be used to identify grazing threats at the property, giving an indication of what species are present and in what numbers.

Experience required: most landowners will be able to identify common threatening processes such as excessive grazing pressure, however if possible seek advice from someone more experienced to determine the scale of more complex management issues. If unsure of the identity of weed species, seek advice before implementing control. A guide to identifying weed species in Nillumbik can be found at www.nillumbiklandcare.org.au/.

3.3 Monitoring

Monitoring is essential for any management program in order to determine if orchid numbers are changing, which in turn can help you gauge whether management actions are achieving their aim. There are a variety of methods available for monitoring, several of which are described below.

Photo monitoring

Photo monitoring is one of the easiest ways to monitor orchid populations. This method involves periodically taking a series of photographs of the population and surrounding area to allow comparison of changes over time. If repeated once or twice a year, the resulting photo collection may over time provide an important visual reference that reveals changes to important attributes such as orchid numbers or moss and weed cover. Note that this method has limitations for populations that consist of many scattered plants over a large area, as it can be very time consuming and difficult to relocate and photograph each individual plant.

[4] This term is explained in detail below, but essentially involves laying a very small amount of leaf litter complex around leaves.

Record the location and direction faced for each photopoint and any notes that will help you to relocate the site in future. To further assist with relocating the site, the photopoint should be marked with a stake or other feature.

If the orchid is a colony-forming species such as a Greenhood *Pterostylis* spp. or Helmet-orchid *Corybas* spp., it is probably best to take photos from directly above, making sure to include as much of the population in the photo as possible. For other species such as Spider-orchids *Caladenia* spp. the photo should be taken from the side of the patch. Use the macro setting on the camera if required.

Photos can also be taken of surrounding habitat to provide a visual reference of important habitat features such as shrub or weed cover.

Store your photos in a secure location such as on a computer hard drive, making sure to label each image.

Population counts

Population counts are the most effective method for identifying changes to orchid numbers over time. In order to undertake regular population counts, first mark each of the populations you intend to monitor with a stake or other feature to ensure that you can relocate the site later.

Counting orchid numbers is easier for dense, localised populations but can be difficult if populations consist of many widely scattered plants. Therefore, for dense populations try and get an accurate count, and if there are too many plants to count individually try and get an estimation (e.g. 80-100 plants). For widely scattered populations, an estimate may also be the best option if it is too difficult to record each individual plant during the count (e.g. 15-20 plants over 200m^2).

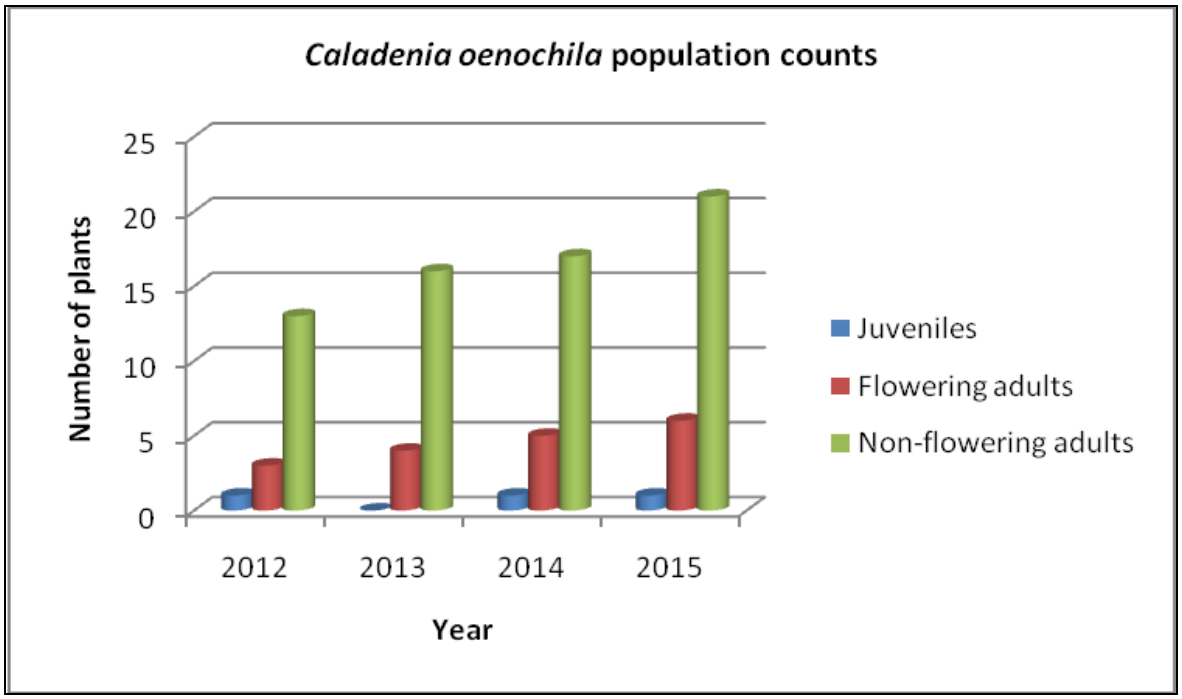
There are several options for counting plants. All plants can either be treated the same, or they can be differentiated based on their life-stage by marking as either 'juvenile[5]', 'non-flowering mature' or 'flowering mature' plants. This latter option will provide more detailed information that may help identify important patterns over time, including variation in flowering activity and recruitment.

Try and repeat counts each year and at a similar time of year, and store all data in a secure location such as on a computer hard drive. There are some simple ways to use this information to construct

[5] Only some orchid species produce distinct juvenile plants, as species that reproduce by production of daughter tuberoids (e.g. many Greenhoods) usually appear 'mature' in the first year. Many *Caladenia* species produce a juvenile leaf for the first 1-3 years that resembles the adult leaf but that is much smaller, often being as short as 10mm long.

graphs using Microsoft Excel, which could potentially provide a useful visual diagram to make it easier to identify patterns across time. Seek advice if you want to learn more about graphing population data.

Plate 5 - a hypothetical example of a population graph, showing results of four years of counts. Graphs can provide an interesting visual diagram making it easier to identify patterns across time.



Recording key habitat information

In addition to the above monitoring techniques, try and record as much information as possible on the surrounding habitat. Important features to make note of include grazing pressure and the cover of moss, native shrubs and weeds. This information may be of value in future.

Experience required: most landowners should be able to undertake some form of monitoring, particularly setting up photopoints. Population counts are only difficult if different species cannot be differentiated, however identifying plants to genus can still be very useful. Any detailed analysis of data will probably require assistance.

3.4 Grazing protection

Grazing and predation pose one of the most serious threats to our local native orchids. There are a variety of options available for preventing grazing pressure, but first it is necessary to identify what

fauna are impacting on orchids so that the right kind of fencing can be selected. Remember that all native fauna are protected and that the aim is not to exclude them from the entire ecosystem. The best kind of fencing or cage will protect a limited area for orchid conservation while still allowing the passage of native fauna through remaining areas.

An important fact regarding caging and fencing smaller areas is that it should only be undertaken if the area can be subject to maintenance at least once a year. Placing a cage or small fence around an area leads to build-up of litter and moss growth, which if unchecked will smother orchids.

Tree Guards

Tree guards are the cheapest way to protect small orchid colonies. Only plastic mesh guards (with holes) should be used, as standard plastic tree guards without holes create a humid greenhouse environment that will kill orchids and favour the growth of weeds. Typical mesh guards are only big enough to protect several plants, unless the guard is cut and joined with others to create a larger guard. In both cases, the guard is secured using a small amount of wooden stakes, taking care not to insert these too close to orchids.

While tree guards are not suitable to protect larger orchid colonies, they have been used to successfully protect threatened orchids at some sites for many years against wallabies, kangaroos, white-winged choughs and possums. In areas with high kangaroo activity it is likely that the guard will occasionally be knocked over and so this should be monitored.

Tree guards should not be installed unless you have the time to maintain the site at least once a year, as leaf litter will build-up inside the guard. Make sure to thin the cover of leaf litter so that it is not smothering orchids and other important plants. Ideally, remove the guard between October-March to allow natural processes to reduce litter and moss cover.

Experience required: most landowners should be able to implement this management strategy.

Wire fencing

Creating small enclosures using chicken wire or other available fencing wire is another protection measure that is relatively cheap and is ideal for protecting small patches of orchids. Many grazing animals do not like to enter smaller enclosures, so that even if the fence is not very tall it may still significantly reduce grazing pressure.

The fencing wire should be encircled around the orchid colony and supported using star pickets or wooden stakes inserted every 1-2 metres around the perimeter. The fence should be approximately

800mm high with a small skirt of 100mm to prevent the incursion of rabbits. In this case, a standard 900mm wide role of chicken wire is ideal, ensuring that the fence is tall enough and that there is available wire for the skirt. The skirt should be folded outwards and pegged to the ground using tent pegs or other suitable wire.

While this kind of fence will not always exclude all herbivores, trials at Cottles Bridge have shown that they can significantly reduce grazing pressure: macropods rarely entered the fences, possum and echidna activity was negligible and white-wing chough activity was greatly reduced (see case study).

Similar to tree guards, small enclosures should be maintained at least once every one to two years, as leaf litter will build-up around the edges of the fence. Make sure to thin the cover of leaf litter so that it is not smothering orchids and other important plants. Landowners should also be prepared to control the flush of weeds that may occur following fencing due to the removal of grazing pressure.

Experience required: constructing small fences is not difficult but requires some practical experience and adequate fitness for the the task. With the right preparation, many landowners should be able to implement this management technique.

Plate 6 – this small enclosure at Cottles Bridge has been highly effective at protecting a variety of orchids as well as other important native herbs. Germination of annual weeds increased in the first winter following fencing which was controlled via hand-weeding. There is a strong contrast between the cover of plants and moss inside and outside the fence.

Steel cages

Steel cages are the most effective way to provide total protection from white-wing choughs, rabbits and other herbivores, but due to the cost and effort involved they are usually only used for highly threatened species.

Similar to tree guards, steel cages should not be installed unless you have the time to maintain them every year, as leaf litter will build-up around the edges while in the absence of grazing annual weeds might proliferate. Make sure to thin the cover of leaf litter so that it is not smothering orchids and other important plants. Another option is to remove the cage between October-March when the orchids are dormant, allowing wind and other natural processes to remove the build up of organic matter.

Experience required: steel cages can be difficult to build without practical experience, however they can be custom built by some local metalwork companies.

Plate 7 – two orchid cages funded by Nillumbik Shire Council that are protecting a colony of orchids.

Post and wire fencing

Larger grazing exclusion fences built from post and wire are ideal for protecting not only orchid populations but the broader vegetation community that orchids depend upon. If constructed properly they can restrict all mammalian herbivores, but they will not prevent impacts from white-wing choughs. For this reason, endangered orchids are often caged even when protected by exclusion fences.

While larger fences are ideal, the associated higher cost can provide limitations for many landowners. But keep in mind that even a small fence of 20-25 square metres has the potential to protect numerous orchid colonies in addition to many other significant plant species.

The design of the fence depends on the fauna it is intended to exclude. To exclude all macropods and deer, the fence will require wire strands at least 1500mm high, with chicken wire mesh extending up to 1100mm (wallabies can climb through fences with lower mesh). For fencing smaller areas, a lower height (e.g. 1100mm high – 1200mm netting minus a 100mm skirt) is often adequate, as kangaroos and deer normally do not enter a constricted area. Fences require a minimum skirt of 100mm around the bottom edge to prevent access by rabbits, which can be pegged to the ground or buried. If the skirt is to be buried, care should be taken to minimise any impacts to important groundflora. A standard roll of 50 metres will provide 150 m^2 of coverage (e.g. sides are 15m x 10m). The enclosure will require a gate or style to facilitate access.

Landowners should be prepared to control the flush of weeds that may occur within the fence due to the removal of grazing pressure. This should be taken into consideration when designing the fence, as the enclosure should not be made too large if resources are not available to manage the area.

Experience required: before deciding on the placement of the fence it is important that someone with botanical identification skills looks over the area and advises on the intended placement. Constructing post and wire fences requires appropriate practical experience but there are many local contractors that can be engaged to carry out the work. Construction of a permanent fence may also require a council permit or landowner permission in some scenarios (e.g. if area is subject to cultural heritage overlays or adjoining neighbouring properties).

3.5 Weed control

Control of invasive weeds is essential around threatened orchids. Exotic trees and shrubs can potentially take over large areas and drastically alter habitat through shading and drying of the soil, while exotic annual herbs and grasses directly compete with native groundflora. Many weeds not

only compete for space, water and nutrients but also alter soil chemistry through allelopathy[6]. Some indigenous species when over-abundant (e.g. Yarra Burgan *Kunzea leptospermoides*, Shiny Cassinia *Cassinia longifolia* and Hedge Wattle *Acacia paradoxa*) can also act in this way.

The type of control varies depending on the target weed, so several techniques are discussed below. For all methods, the key to success is to always follow-up on previous work, as most weeds take at least several years to control due to persistent rootstocks or the presence of extensive seed banks. For further details on weed control methods, seek advice from Council, relevant literature[7] or qualified practitioners.

Woody weed control

Common high threat woody weeds for threatened orchids in Nillumbik include Sweet Pittosporum **Pittosporum undulatum*, Broom **Genista* and **Cytisus* spp., Hawthorn **Crataegus monogyna*, Boneseed **Chrysanthemoides monilifera,* Blue-bell Creeper **Billardiera heterophylla,* Radiata Pine **Pinus radiata,* Plum **Prunus* spp. and Gorse **Ulex europaeus,* while some of the worst woody weeds are non-indigenous native wattles such as **Acacia decurrens, *Acacia baileyana, *Acacia floribunda, *Acacia howittii, *Acacia prominens* and **Acacia iteaphylla.* Many other species cause indirect effects by harbouring vermin (e.g. Blackberry **Rubus anglocandicans,* Japanese Honeysuckle **Lonicera japonica* and Blue Periwinkle **Vinca major*).

For most woody weeds, the best method to control young plants is to pull them out by hand, which is easiest to implement when the soil is moist in winter-spring. For larger plants, the recommended control is to either 'cut-paint', 'drill and fill' or by 'frilling', all of which aim to kill the target species by forcing the plant to take up herbicide[8] into its circulation system. The 'cut-paint' method involves cutting the plant down at ground level and treating the outer trunk with Glyphosate herbicide, while the 'drill-fill' method involves drilling multiple holes around the perimeter of the lower trunk and then injecting a small quantity of Glyphosate herbicide into the holes. 'Frilling' is similar to 'drill-fill' but involves making a number of small cuts around the perimeter of the trunk (usually with a tomahawk) and then treating the wounds with herbicide. For all of the above techniques, it is

[6] Allelopathy is the ability of some plant species to produce certain chemicals to help out-compete neighbouring plants.

[7] A recommended guide is 'Bush Invaders of South-East Australia' by Adam Muyt. A detailed discussion on the ecology and control of many of Nillumbik's weeds is also provided by Frood (2010).

important to apply the herbicide straight after making a cut or drill, as sap flow ceases shortly after stem tissue is damaged.

The best time of year to implement these control methods is during late spring- early autumn when woody species are most active, particularly deciduous species which may not respond to herbicide treatment when they are dormant (e.g. Plum, Hawthorn). These techniques should also be avoided during very hot weather when plant circulation and transport slows significantly, reducing the likelihood of successful control (Muyt 2001).

If the woody weeds are large and make up considerable biomass, they are best removed from the site or burnt nearby to prevent the debris smothering the groundflora and promoting the growth of herbaceous weeds.

Experience required: woody weed control can be undertaken with little experience as long as the target weeds are properly identified. Control of larger stands can require considerable manual labour and so adequate fitness is necessary. There are various contractors in the region who can also be engaged to carry out the work. The application of certain herbicides may require the operator to have an Australian Chemical User Permit (ACUP).

Herbaceous weed control

Common high threat herbaceous weeds to threatened orchids in Nillumbik include Large Quaking-grass **Briza maxima,* Sweet Vernal-grass **Anthoxanthum odoratum,* Veldt-grasses **Ehrharta erecta and *E. longiflora,* Squirrel-tail Fescue **Vulpia bromoides,* Cock's Foot **Dactylis glomerata,* Annual Meadow-grass **Poa annua,* Hair-grass species (mostly **Aira elegantissima*), Chickweed **Stellaria media,* Common Mouse-ear Chickweed **Cerastium glomeratum* and Common Bitter-cress **Cardamine hirsuta.* Many of these species are annuals that have the ability to produce large amounts of seed within several months of germination. Others are also adapted to physical disturbance and so benefit from heavy grazing pressure and soil disturbance caused by rabbits. Squirrel-tail Fescue is particularly adapted to disturbance and heavy grazing, and when grazed to ground level by rabbits is still able to send out seed-heads at almost horizontal angles.

These traits have allowed this set of weeds to become aggressive invaders of ground-layer vegetation, and in many remnants they form dense swards. The cover of herbaceous annuals tends to vary between years, with species such as Large Quaking-grass **Briza maxima* performing best when the region receives above-average rainfall. In these conditions, a high percentage of seed germinates successfully to form vigorous adult plants, whereas in drier years germination and successful seed development may be significantly reduced.

The key to controlling ground-layer weeds is to start in the best quality areas and work outwards (Bradley method). Where possible also start at the top of hills and work downslope, as weed seed is often borne by water movement and gravity. It is important to identify and isolate local point sources for re-infestation (e.g. roadsides).

Start by removing weeds in close proximity to orchid plants by hand, making sure to remove weeds prior to seed development. If time and resources are limited, at the very least hand-weeding to create a buffer of one meter should be carried out around any threatened orchids to reduce direct competition.

Treating larger areas either requires many hours of hand-weeding or adoption of other techniques. Weed burning using a small gas torch is one method commonly used by bushland managers that allows large areas to be treated without the use of herbicide. Weeds should be treated in late winter prior to seed development, but not too early in the season as they may re-shoot from the roots. This is also a time which is usually outside the Fire Danger Period.

Another option is to spot-spray weed swards with low doses of Glyphosate mixed with a suitable surfactant. Trials at Cottles Bridge have experimented using 10 millilitres per 10 litres of water (10% of the normal rate) mixed with 10 millilitres of a surfactant chemical (see case study). This has allowed treatment across large areas that supported a high annual weed cover amongst species-rich native groundflora, without causing significant off-target damage. The key to this technique is to spray at the right time of year, as many annual weeds are not affected by a low dose of Glyphosate unless they are at a certain point of their growth cycle. The most important rule is to spray each weed when they are in a growth-spurt and prior to the initiation of flowering.

The key to controlling ground-layer weeds is to be persistent and follow-up past control work. It can take several years of sustained control each winter-spring before seed banks begin to decline, but eventually the work load will diminish as the seed bank runs out. For instance it has been shown at many sites that consistent control of Large Quaking-grass **Briza maxima* infestations each winter-spring for 3-4 years will lead to almost complete eradication of the weed.

Experience required: if the target weeds can be identified and distinguished from native species, then hand-weeding requires little experience and can be undertaken by most landowners. Weed burning and spot-spraying with herbicide on the other hand should only be implemented by those who have adequate experience to avoid off-target damage. These techniques also require considerable skill and knowledge of plant ecology to ensure effective control. There are various contractors in the region who can always be engaged to carry out the work.

Bulbous weed control

Common high threat bulbous weeds to threatened orchids in Nillumbik include Soursob **Oxalis pes-caprae,* Pale Wood-sorrel **Oxalis incarnata,* Bridal Creeper **Asparagus asparagoides,* Bulbil Watsonia *Watsonia meriana,* Freesia **Freesia* sp. and Angled Onion **Allium triquetrum.*

These weeds can be particularly invasive and difficult to control due to the production of underground corms or tuberous root systems that re-shoot even if the above ground part of the plant is treated. The best method of control is therefore by spraying with a systemic herbicide such as Metsulfuron-Methyl which translocates throughout the entire plant, which needs to be mixed with a penetrant (e.g. 'Pulse' used according to directions) to allow entry through the plant cuticle. The best time to treat plants is when they are just beginning to flower (usually around September-October) as at this stage in their life cycle the older corms have become exhausted while the next generation of corms is yet to develop. Particular care should always be taken when using systemic herbicides as they are toxic to most native species if enough herbicide makes contact with the plant.

Smaller infestations of bulbous weeds can be controlled by digging out each plant, taking care to remove all of the corms.

Experience required: treating these weeds by spraying with herbicide should only be undertaken by those who have the ability to recognise native groundflora so as to avoid off-target damage. There are various contractors in the region who can also be engaged to carry out the work. Removal of small infestations by hand can be carried out with little experience.

3.6 Management of invertebrate predators

The introductory chapters of this guide described the serious impacts caused by Portuguese Millipedes *Ommatoiulus moreletii* and Red-legged Earth-mites *Halotydeus destructor*. The extensive damage inflicted by these two species is often over-looked due to their small size and cryptic life-cycle, however in some cases they have the potential to completely eliminate an orchid population.

Managing this threat is difficult and even experienced practitioners are still searching for effective control methods. While the use of organic pesticides is currently being trialled at sites within Nillumbik, this is not recommended here due to uncertainty regarding its effectiveness and the potential to harm orchids.

If high grazing pressure by invertebrates is noted at a site, the most practical method that can implemented is to prevent excessive leaf litter build-up around orchid patches, as this harbours invertebrate herbivores. Leaf litter build-up is particularly a problem within small enclosures or cages, as organic matter gets trapped around fencing instead of being blown away. To thin litter

cover, carefully rake fingers around orchids patches to remove dense patches of leaves. Deciding how thick the leaf litter should be is dependent on the site – patches with high moss cover don't necessarily need much leaf litter at all whereas if the soil is bare, a cover of 20-30% may be beneficial to protect the soil. Control of herbaceous weeds around orchids may also indirectly reduce populations of Red-legged Earth-mite, which proliferate on some exotic species such as Cape Weed **Arctotheca calendula* (Frood 2010) and Chickweeds **Cerastium* sp. and **Stellaria* sp. In some cases, earth-mites also proliferate in dense patches of common indigenous annuals (e.g. Common Cotula *Cotula australis* and Annual Buttercup *Ranunculus sessiliflorus*).

The other option to manage invertebrate herbivores is to conduct an ecological burn, as this has been shown to reduce harbour for these species. However this should only be undertaken by the more experienced operator (see 3.9 below).

Experience required: while not physically difficult, landowners should only implement this form of micro-management if they have considerable understanding about the ecology of groundflora due to the potential to bare the soil excessively or cause too much disturbance.

3.7 Species enrichment plantings

Many bushland remnants are increasingly losing plant diversity due to the effects of heavy grazing and browsing pressure. While wallabies and deer often eliminate important shrubs such as nectar-rich wattles and peas, large numbers of kangaroos, rabbits and other herbivores take a heavy toll on the herbaceous groundflora. Determining if species enrichment plantings are needed requires considerable experience to be able to identify which local plants have been lost from the system and where they can be propagated from. However if this knowledge is available, efforts should be taken to reinstate any species that have been heavily depleted or locally eliminated by grazing/browsing. Plants should only be grown from local provenance (within approximately 15 kilometres radius) and ideally should be grown in standard forestry tubes.

When planting into intact groundflora, do not dig too close to remnant plants (particularly orchids and other geophytes) and it is recommended to only use a long-handled crowbar (particularly useful in rocky areas) to minimise soil disturbance. This tool has a narrow head and so creates holes that are just wide enough to plant a forestry tube into. Water each hole prior to planting and make sure to water during hot dry weather for the first 1-2 years. The best time to plant is from mid-autumn (following the first decent rains) up until late winter. Planting in spring should only be carried out if time is available for extra watering in the case that dry weather arrives early in the season.

Experience required: this activity should only be carried out by those with adequate experience due to the risk of planting inappropriate species or causing damage to the existing groundflora.

3.8 Increasing soil protection

In some cases, ongoing erosion and grazing disturbances may have removed important elements of the ground layer, including moss mats, leaf litter and top-soil. This is of concern for threatened Spider-orchids *Caladenia* spp. as the plant can become easily desiccated without some protection around the leaf. Although little is known regarding the ecology of mycorrhizal fungi, it is likely that a healthy moss, top-soil and leaf litter layer play an important role in their growth.

One option for providing more protection for Spider-orchid leaves in dry situations (such as exposed hill-crests) is to transplant moss beds around the base of the leaf. Moss species that have been found to play a beneficial role around threatened orchids on the dry hills in Nillumbik include Dry Screw-moss *Pseudocrossidium crinitum*, Common Twine-moss *Triquetrella papillata* and Great Plait-moss *Hypnum cupressiforme var. lacunosum.* Other species have been found to occasionally play a positive role but in some situations to become over-dominant. This includes Broody Swan-neck Moss *Campylopus clavatus,* which occasionally forms dense mats around orchids that can lead to rotting of the leaves, and Juniper Hair-cap *Polytrichum juniperinum.* Mosses should never be transplanted directly around orchids but should be placed several centimetres away. It is often enough to plant several small patches, leaving bare ground in between, and the mosses will naturally sort themselves out to form a continuous mat. When transplanting, never remove mosses from intact areas of bushland, but focus on patches along track edges.

Another method for protecting overly bare soil is to apply a light layer of mulch around leaves. This can include lightly ground eucalypt leaves (from local trees), while a recipe for orchid mulch that has had good results is one part chopped leaves of Drooping Sheoke *Allocasuarina verticillata* mixed with one part eucalyptus leaves and one part ground bark from Red Stringybark *Eucalyptus macrorhyncha*. There is some evidence that this mixture, largely due to the inclusion of Drooping Sheoke, enhances the growth of mycorrhizal fungi.

Experience required: transplanting moss beds should only be implemented by those with adequate experience in ecology and bushland management.

3.9 Ecological burning

As discussed in Section 2.3, some of Nillumbik's orchids appear to decline in the long-term absence of fire (e.g. *Pheladenia difformis*), while others have been found to greatly benefit from a well planned burn (e.g. *Eriochilus cucullatus*, *Caladenia* spp, *Calochilus* spp, *Corunastylis despectans*, *Leptoceras menziesii*, *Lyperanthus suaveolens* and *Thelymitra* spp (Beardsell 2013)). Fire can also lead to increased recruitment and flowering of key pollinator food plants. But the relationship between vegetation and fire is inherently complex, with the success of a burn being highly dependent on other variables. Ecological burns that are followed by below-average rainfall can lead to poor recruitment and subsequent decline of some species, while if no efforts are taken to protect the site, elevated grazing pressure can also have detrimental impacts. This guide will therefore not provide a step by step commentary on how to conduct ecological burns, but describes some key guidelines that should be followed if burning is considered necessary.

Important note: conducting ecological burns should only be implemented with the permission and guidance of the Country Fire Authority (CFA) and Nillumbik Shire Council.

When to burn

Conducting ecological burns in the appropriate season is essential to prevent impacts to flora and fauna. Unless the Fire Danger Period is extended by the CFA due to unusually dry conditions, burning is best undertaken in mid autumn. Burning in late autumn and throughout winter and spring can have detrimental impacts on some orchids (and other flora and fauna) as many are actively growing during this time. The key is to burn as early in autumn as is safe and permitted by the CFA, while fuel is still dry and most geophytes are dormant.

In some cases, smaller burns conducted during winter-spring may be beneficial to control annual grassy weeds. However this should only be implemented if key orchids and other important ecological features can be excluded from the fire and the burn is well planned. Remember that most bird species breed over winter-spring and large burns during this time may disrupt breeding events.

It is impossible to accurately predict the amount of rainfall that will follow a burn, making good planning difficult. However it is recommended that in years when an El Nino event is predicted by the Bureau of Meteorology (BOM), larger burns are postponed for a better year.

Managing fire intensity

It is important that ecological burns are not too intense, both for safety purposes and to prevent impacts to sensitive flora and fauna. One method to reduce intensity is to thin the cover of common shrubs (e.g. *Cassinia* spp., Yarra Burgan *Kunzea* leptospermoides) prior to the burn. These should be

removed from the site or can be thinly scattered across the ground, but do not make large piles as this will concentrate fire intensity within these areas.

Reducing grazing pressure

The flush of vegetative growth that follows a fire event generally attracts a variety of grazing animals, particularly kangaroos and rabbits. The smaller the burn area, the greater the grazing pressure is likely to be, while islands of bushland surrounded by open paddocks are likely to receive the greatest pressure from kangaroos.

There are several ways that grazing pressure can be managed. Fencing the area prior to burning is the most effective, as this can restrict grazing animals entirely. If larger fencing is not a practical option, then smaller fences or guards can be placed around orchids and other significant plants. Control of rabbits through destruction of warrens and baiting before and after the burn will also greatly reduce grazing pressure.

Post-fire weed control

Ecological burning not only stimulates the growth of indigenous plants but also exotic species. This is particularly the case for annual weeds that thrive under disturbance regimes, such as Squirrel-tail Fescue **Vulpia bromoides.* Resources for follow-up weed control should therefore be factored into any ecological burning project. If implemented correctly, fire can be a very useful tool for controlling weeds, as it can stimulate the underground seed banks which can then be controlled. In most cases, effort invested into control during the first 1-2 years following a burn can have significant results.

Orchid management guidelines flow chart

Collect information
What orchids do you have and where are they located

Identify the problem
What threats do the orchids face on my property

Monitor populations
Are my management actions effective

Vertebrate Grazing

- Individual orchids/small colonies
- Low grazing pressure
= TREE GUARD (pg. 21)

- Small/med colonies
- Low/med grazing pressure
= WIRE FENCE (pg. 21)

- Very rare orchids
- High threat from White-winged choughs
= STEEL CAGE (pg. 23)

- Large colonies,
- Mid/high grazing pressure
- Need to maintain broader diversity
=POST AND WIRE FENCE (pg. 24)

Invertebrate Grazing

- Presence of millipedes/Red-legging Earth-mites
= THIN LEAF LITTER (pg. 28)
= HERBACEOUS WEED CONTROL (pg. 26)

Reduction in Pollinators

- Biodiversity greatly reduced
= SPECIES ENRICHMENT PLANTING (pg. 29)

- Grazing of significant pollinator attracting species
= WIRE OR POST AND WIRE FENCE (pg. 21-24)

Competition from Weeds

- Presence of woody weeds
= WOODY WEED CONTROL (pg. 25)

- Presence of Herbaceous weeds
= HERBACEOUS WEED CONTROL (pg. 26)

- Presence of Bulbous weeds
= BULBOUS WEED CONTROL (pg. 28)

Flow chart produced by Meg Cullen

4.0 CASE STUDY - RECOVERY MANAGEMENT OF THE ROSELLA SPIDER-ORCHID AT COTTLES BRIDGE

4.1 Introduction

This case study describes a recovery management program that has been conducted by Parks Victoria ranger Cam Beardsell for over 25 years at a property in Cottles Bridge. The program has centered around the management of the nationally endangered Rosella Spider-orchid *Caladenia rosella* and several other threatened orchids, however it has also included the rehabilitation of two threatened floristic communities and a diverse range of other plant species. The recovery program conducted at this site is the model for best-practice management of threatened orchid species in Nillumbik. When the program commenced in 1990, the total population size of the Rosella Spider-orchid was only 20 individuals and without management would have been extinct within a few years. Plants had ceased to naturally pollinate and no recruitment was occurring. Twenty five years later the population now numbers in excess of 200 individuals and the pollinator has returned. In given years between 50 and 70 plants flower and over half are now naturally pollinated.

The case study begins with a description of the site followed by a history of threatening processes and management works. It then focuses in detail on the last four years of management works, which has seen considerable advances in plant recovery.

4.2 Site description

The management site occurs within the largest core area of bushland in Cottles Bridge and includes an area of approximately two hectares on the upper slopes of a prominent hill-crest. The site includes two floristic communities, including 'Box-Stringybark Woodland (hill-crest)' that occurs on relatively exposed west-facing hill-crests and 'Box-Stringybark Woodland (grassy hill-slope)' that occupies the slightly sheltered south-west facing slopes.

The area of 'Box-Stringybark Woodland (hill-crest)' is dominated by relatively young regrowth of Red Box *Eucalyptus polyanthemos,* Red Stringybark *Eucalyptus macrorhyncha* and Long-leaf Box *Eucalyptus goniocalyx* with an open shrub-layer. The ground layer is sparse and has a high cover of rocks, litter and and moss in association with a rich assemblage of herbs. This encompasses the several threatened orchids found at the site, including Silurian Striped Greenhood *Pterostylis* sp. aff. *striata* and a large population of Rosella Spider-orchid *Caladenia rosella*.

Plate 9 – Box-Stringybark Woodland (Hillcrest) community at the case study site. This community is characterised by relatively young Red Box *Eucalyptus polyanthemos*, Red Stringybark *Eucalyptus macrorhyncha* and Long-leaf Box *Eucalyptus goniocalyx* over an open shrub layer. The ground-layer is sparse with a high cover of leaf litter, rock and moss in association with a rich assemblage of herbs.

'Box-Stringybark Woodland (grassy hill-slope)' is also dominated by Red Box *Eucalyptus polyanthemos,* Red Stringybark *Eucalyptus macrorhyncha* and Long-leaf Box *Eucalyptus goniocalyx* but has an understorey with a relatively dense cover of Shiny Cassinia *Cassinia longifolia* and a grassy ground-layer dominated by the robust tussock-grass Silver-top Wallaby-grass *Rytidosperma pallidum.* This community contains several species that are either absent or rare in the hill-crest community including Hare-orchid *Leptoceras menziesii*, White Caladenia *Caladenia catenata*, Climbing Drosera *Drosera macrantha* and Small Swamp-daisy *Allittia uliginosa* and the threatened Wine-lipped Spider-orchid *Caladenia oenochila* and Woodland Plume-orchid *Pterostylis* sp. aff. *plumosa.*

Bryophyte species (mosses and liverworts) are a very important component of the vegetation within both communities. Following the repeated clearance of the trees for firewood in the last century, the mosses, liverworts and lichens would have been among the first plants to recolonise the ground layer and begin healing the soil through reducing erosion. In the dry forests of the region, bryophytes also

play an important role by reducing exposure to wind and sunlight and maintaining moisture around orchids and other small plants.

Plate 10 – Apple Moss *Bartramia nothostricta*, a rare moss species found within the case study site. This is one of many species of moss and liverwort found at the site that play an important role in protecting the soil and small plants such as orchids.

4.3 History of threatening processes

Prior to the commencement of the management program in the early 1990's, the site had been subject to a variety of disturbances and threatening processes. Clearing of the surrounding bushland for firewood, building and mining materials probably first began in the late 1800's during the early gold-rushes, but intensified in the first half of the 20th century. With the growing city of Melbourne supporting a diverse range of industries that were dependant on coal or wood to power steam engines, the timber in the drier hills of north-east Melbourne was heavily targeted. During the depression of the 1930's, teams of sustenance workers lived in small shacks throughout the bush and cleared trees for firewood which was carted to Melbourne or sent by train from Hurstbridge. Ongoing clearing of the forests continued for the next several decades, with further waves of timber collectors moving in after the Second World War during the early 1950's.

The ongoing clearing of the forest had a drastic effect on native ecosystems. Clearing of canopy trees greatly increased exposure of the ground to rainfall events, leading to widespread sheet erosion and loss of top-soil. In many cases the original shallow layer of top-soil was completely removed, exposing the rocky substrate or clay dominated B-horizon. This process was in time exacerbated by dense re-growth of eucalypts through coppicing or seedling regeneration, leading to significant drying of the soil caused by increased water uptake from the growing trees. Clearing also had a significant impact on the structure of the forest, converting what was originally woodland or open forest to relatively dense re-growth, leading to reduction in sunlight exposure to the forest floor. Further to these processes, significant invasion of rabbits probably began in the late 1800's, exerting additional pressure on understorey vegetation and possibly leading to elimination of some species.

In the early 1960's, the site and surrounding lands were purchased by a landowner who had an interest in preserving the bushland, and over the next decade new residents moved into the area and built houses across the ridge-lines. While early inhabitants had an interest in nature conservation, the development of housing and associated gardens also had a number of negative effects on the vegetation, with one of the most serious issues being the spread of environmental weeds. This began with the planting of non-indigenous native species around garden areas which eventually spread into nearby bushland. An early invader was Blue Bell-creeper **Billardiera heterophylla,* a vigorous climbing sub-shrub that remains one of the worst weeds in the area. Other non-indigenous native garden plants, particularly a small group of Wattles **Acacia* sp., took several decades to eventually begin spreading to become significant weeds.

A suite of exotic grasses, notably Large Quacking-grass **Briza maxima*, Annual Veldt-grass **Ehrharta longiflora* and Squirrel-tail Fescue **Vulpia bromoides*, emanated from the roadsides in the 1970s. Other weeds, notably Chickweeds **Stellaria* and *Cerastium* sp., emanated from around houses in the same period. In the wetter years of the early 1990's, these predominately annual grasses germinated in massive numbers and formed dense swards, invading the surrounding native bushland and causing significant competition for the native groundflora.

Grazing pressure from mammalian herbivores has been an increasing issue over the last several decades. From at least the 1950's onwards, population numbers of Eastern Grey Kangaroo *Macropus giganteus* and Black Wallaby *Wallabia bicolor* were kept in significantly lower numbers due to widespread hunting practices by farmers and local residents and predation by feral and domestic dogs. As late as the 1980's, the numbers of Eastern Grey Kangaroos were in such low numbers in some areas to cause concern for their survival, while Black Wallabies were restricted to the denser gullies of the more forested ranges. But by the 1990's, by-laws were introduced to contain the

roaming of domestic dogs while hunting by local residents gradually decreased due to demographic and cultural changes. This led to an explosion of kangaroo numbers, which began having serious impacts on the native ground layer during the tail-end of the Millennium Drought (around 2007-09). Black Wallabies became permanent residents in the late 1990's while more recently, Sambar Deer *Rusa unicolor* have moved into the area for the first time.

During the course of the Millennium Drought, two locally indigenous species of *Cassinia*, including *C. longifolia* and *C. arcuata,* began to invade the case study site and surrounding bushland. While *C. longifolia* had always been present in low numbers (roughly 20-30 plants per hectare), *C. arcuata* was not observed on the site until the early 2000's (likely brought in by wind-blown seed). Both species, particularly *C. longifolia,* began to take over large areas and form dense thickets. This was probably due to the fact that grazing animals do not like eating *Cassinia* and were grazing out all other competition, while both species are highly drought tolerant and so thrived in the dry conditions while other plant species declined. Both species are surface-rooted and like African Boneseed **Chrysanthemoides monilifera*, can exploit areas with highly skeletal soils. Along with providing cover for rabbits, this attribute is highly detrimental to indigenous groundflora. Closure of the vegetation also caused shading of the ground-layer and reduced the moisture content of the top-soil. The dominant ground cover of Silver-top Wallaby-grass *Rytidosperma pallidum* and Grey Tussock-grass *Poa sieberiana* ssp. *sieberiana* began to disappear from much of the upper slopes of the site due to shading caused by *Cassinia* in combination with high grazing pressure.

Bushland within the case study site and surrounding lands had thus been subject to a variety of threatening process that began with widespread clearing over a century ago. Many plant species would have been locally eliminated while others were reduced to critically low numbers. It was therefore essential that protection and management of threatened species was implemented to prevent further loss of biodiversity.

4.4 Background to the recovery program

Parks Victoria ranger Cam Beardsell moved to a property near the case study site in the early 1980's. Both Cam's property and the case study site supported significant populations of orchids, including over 10 species that are now listed as threatened. Notably, the case study site contained a large and healthy population of the nationally endangered Rosella Spider-orchid *Caladenia rosella*, a species that is now extinct beyond the Shire of Nillumbik.

Cam had been living near the case study site for nearly ten years before it became apparent that orchid species were declining (around 1989). After observing groups of White-wing Choughs feeding on orchid tubers, a study was initiated by Museum Victoria that found that orchid tubers comprised up to 90% of the stomach contents of local chough populations. It was therefore clear that this species was having a considerable impact on local orchid populations. In addition, rabbit number had been escalating in recent years due to a reduction in fumigation and other control techniques implemented by local residents.

These grazing and predation threats initiated the construction of the first orchid cages by the Royal Botanic Gardens. The first cages were relatively large and were designed to protect threatened orchids from grazing and predation by choughs and rabbits. They were placed over scattered colonies of Rosella Spider-orchid, but also protected several other threatened orchid species. Further cages were constructed and placed over the orchids during the following years. Cages were usually removed from October-March to prevent leaf litter accumulation smothering orchids.

Plate 11 – one of the older cages that protects a colony of Rosella Spider-orchid from predation by White-wing Choughs and rabbits.

Between 1987 and 1993, the local area received above average annual rainfall. This stimulated massive growth and spread of several high threat exotic grasses which had only appeared in the area within the last decade, including Large Quaking-grass **Briza maxima*, Squirrel-tail Fescue **Vulpia bromoides,* Panic Veldt-grass **Ehrharta erecta*, Annual Veldt-grass **Ehrharta longiflora* and Sweet Vernal-grass **Anthoxanthum odoratum*. Beginning in the early 1990s and with the assistance of several other field ecologists, Cam began to spend large amounts of time and resources controlling these weeds via hand-weeding and with the use of a gas burner. In the first 3-4 years, over $500 a year was spent on gas for the burners. This work eventually paid off with the removal of grassy weeds from the entire site and depletion of most of the seed bank.

Over the next two decades, general maintenance was implemented including less intensive control of grassy weeds and management of the cages and small fences protecting orchids. The Rosella Spider-orchids were subject to detailed recovery work including regular monitoring, cross-pollination of plants to increase recruitment and transplantation of mosses around orchid leaves to reduce soil erosion. This recovery work led to a gradual increase in the numbers of Rosella Spider-orchid, while elsewhere in the region, wherever the species occurred in unmanaged land it rapidly disappeared.

4.5 Recent work (2011-present)

In 2011, Nillumbik Shire Council funded the construction of four additional 1 x 1 metre cages to protect colonies of Rosella Spider-orchids. Since that time a more intensive recovery program has been ongoing which is documented in detail below.

Fencing

In recent years Cam has constructed several additional fences from chicken wire that are large enough to protect not only orchids but the associated moss, herb and insect communities which play an integral role in orchid ecology. The fences are generally ellipse-shaped and 20-25 metres around the perimeter. The small size of the fence creates an area that is large enough to protect significant areas of groundflora but not too large as to be unmanageable for total weed control. Importantly, it has also been found that fences of this size are less likely to be invaded by macropods, echidnas or choughs. The ideal height of the fences is 800mm (to step over), so a 900mm high roll is required allowing some wire for a small skirt at the bottom.

It has been found that an average 50 metre roll of 900mm high chicken wire costs roughly $250 and is enough for two fences (Note - a 50 metre roll can enclose an area of roughly 150m^2). The fences have been constructed by encircling the wire around the selected location and then supporting it

from the inside with approximately 10-15 star pickets of 1.4 metres height (see Plate 8). The bottom of the fence has been secured to the ground with tent pegs to reduce the chance of rabbits invading the enclosure. Both *Cassinia* species were thinned from where the fences were to be constructed. Advice or approval from Council officers may be needed to undertake this task as native vegetation is normally protected within the Shire of Nillumbik.

Plate 12 – an example of one of the enclosures at the case study site. These are constructed using 900mm high chicken wire supported by approximately 15 star pickets. The bottom of the wire is secured to the ground with tent pegs to reduce the likelihood of rabbits entering the enclosure.

The results of the fencing have been both highly effective and inspiring, with stark differences between inside and directly outside the enclosures. Inside, there has been a significant recovery of moss, lichen and herb cover and widespread recruitment of important herbs. Several of the more common orchid species have greatly increased in number, notably Small Spider-orchid *Caladenia parva* and Greenhoods *Pterostylis* spp. Outside the fences, continued impacts from rabbit and macropods are noticeable, with very low cover of herbs and a structurally simplified ground-layer.

Weed Control

Cam found that there was a significant increase in the cover of exotic annual weeds between winter and spring in the first two years after fencing. The most problematic species were herbs such as Common Mouse-ear Chickweed **Cerastium glomeratum,* Common Bitter-cress **Cardamine hirsuta* and Chickweed **Stellaria media* as well as grasses such as Squirrel-tail Fescue **Vulpia bromoides,* Annual Meadow-grass **Poa annua* and Hair-grass species (mostly **Aira elegantissima*). In early years Large Quaking-grass **Briza maxima* was a significant weed but has now been controlled, while in recent years rabbit grazing has enabled the emergence of Lesser Quacking-grass **Briza minor*.

All of these weeds are annuals that have the ability to produce large quantities of seed. They germinate in big numbers following disturbance, including fire, and with favorable rainfall. However while their seedbanks can be large, the individual seeds are relatively short-lived and only survive in the soil for several years. Cam therefore found that the first year required considerable effort to remove weed cover, while the level of germination was significantly reduced each consecutive year as long as weeds were prevented from dropping any seeds in the previous year. By the third and fourth year, the rate of germination of annuals was very low. All weeds inside fences were controlled by hand-weeding due to the presence of sensitive flora that may have been susceptible to herbicide or weed-burning.

In the last two years (2014-15), Cam has been experimenting with a technique outside the fence to reduce the cover of these annual weeds. Over an area of two hectares the number of annual weeds can be extremely large and so hand-weeding is not a practical or desirable option. Cam therefore began spraying the weeds with a low dose of Glyphosate, at 10 millilitres per 10 litres of water (10% of the normal rate) mixed with 10 millilitres of a surfactant chemical (BS 1000). Using this very low dose, Cam found that he could treat areas that had a high annual weed cover amongst species-rich native groundflora, without causing significant off-target damage. This low dosage is also better for the environment and the budget. The key was to time the spraying at the appropriate time, as these annual weeds are not affected by a low dose of Glyphosate unless they are at a surge in their growth cycle (the most opportune time for the plant to take up the chemical). The most important rule was to spray each weed as they matured but before they began flowering. For Common Bitter-cress **Cardamine hirsuta* and Chickweed **Stellaria media,* once they commenced seed-production it was too late to spray, as these weeds have the ability to finish seed production even if affected by herbicide. The best time to spray these two weeds was therefore usually at the start of August in mild conditions or mid-August during a cooler than average year. This is also a good timing for most exotic grasses but it becomes even more effective for these species as the days warm up over the

next 2-4 weeks. The low-rate herbicide technique is particularly effective for the halo of weeds that commonly occurs beneath Cherry Ballart *Exocarpos cupressiformis* trees.

While controlling annual weeds in the best quality areas, Cam was also targeting high threat weeds that were invading around the fringes of the site. Two very serious weeds, Sour-sob **Oxalis pes-caprae* and Bridal Creeper **Asparagus asparagoides,* were advancing from the adjacent roadside and were sprayed with Metsulfuron-Methyl, a systemic herbicide that is effective for corm-producing weeds. Several large woody weeds were also controlled by ring-barking, including Gosford Wattle **Acacia prominens.*

Species enrichment plantings

Species enrichment plantings were carried out within the fences to reinstate shrubs and non-orchid herbs that had previously been eliminated from the case study site, as well as to provide food plants for the pollinator of the Rosella Spider-orchid (a species of small colletid bee). Dwindling numbers of bees and a decline in the rate of pollination of the orchid was observed from the mid 1980's. Plantings included key pollen and nectar species such as Small-leaf Parrot-pea *Dillwynia phylicoides,* Grey Guinea-flower *Hibbertia obtusifolia,* Hoary Sunray *Leucochrysum albicans,* Sticky Everlasting *Xerochrysum viscosum,* Matted Bush-pea *Pultenaea pedunculata*, Narrow-leaf Bitter-pea *Daviesia leptophylla*, Grass Trigger-plant *Stylidium graminifolium*, Heath Wattle *Acacia brownii*, Woolly Wattle *Acacia lanigera*, Clustered Everlasting *Chrysocephalum semipapposum* (goldfields form), Button Everlasting *Coronidium scorpioides*, Golden Bush-pea *Pultenaea gunnii,* Common Correa *Correa reflexa,* Thin-leaf Wattle *Acacia aculeatissima* and Curved Rice-flower *Pimelea curviflora.* The climbing pea, Purple Coral-pea *Hardenbergia violacea* was planted around the edges of the fences to encourage it to climb through the wire.

Plantings were undertaken between autumn-early spring using a narrow crowbar to minimise soil and plant disturbance. Each was watered over the first summer to ensure survival. At the same time, many other important or rare nectar plants have naturally re-colonised the site due to grazing protection and weed control. These include Creamy Candles *Stackhousia monogyna*, Sweet Hounds-tongue *Cynoglossum suaveolens*, Small Swamp-daisy *Allittia uliginosa*, Blue Pincushion *Brunonia australis*, Blushing Bindweed *Convolvulus angustissimus* spp. *angustissimus*, Pale-flower Cranes-bill *Geranium* sp. 3, Australian Buttercup *Ranunculus lappaceus* and Love Creeper *Comesperma volubile*.

Plate 13 –. The flowering daisies shown in this plate have been planted around colonies of endangered orchids to attract pollinators.

4.6 Conclusion

Weed invasion on the broad-acre scale can be over-whelming. Fences provide the opportunity to obtain total weed control over a smaller area and define a space for ongoing monitoring and discovery. While some may find fences to be aesthetically undesirable, they create a definable workspace and nurture an engaging mindset. The fences become outdoor laboratories as well as flower-gardens. One can observe from within close proximity the pollination by bees, wasps and fungus-gnats, while detailed focus on a defined area allows observation of subtle changes over time.

Ongoing management at the case study site over the last 25 years has resulted in the recovery of some of Nillumbik's rarest plant species. Along the way, there have been important advances in detailed environmental management practices as a result of trial and error, adaptive management approaches and long-term observations of ecological processes.

The threatening processes described for the case study are generally operating throughout most areas of Nillumbik, particularly loss of old trees, soil erosion, grazing pressure and weed invasion. The study therefore provides some important lessons for anyone attempting to implement orchid management programs in the region. Although the program was managed by an experienced

ecologist and bushland manager, there are a number of techniques described that could be applied by the less experienced. But it is important to highlight that management of orchids can take a high level of time and effort, and so landowners should be realistic about what can be achieved on their properties. For a step by step guide to management of threatened orchids, refer to Section 3 of this plan. Remember that even small steps can lead to species survival if well targeted.

Plate 14 – Rosella Spider-orchid *Caladenia rosella*

5.0 REFERENCES

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Appendix 1 – ORCHID SPECIES RECORDED IN THE SHIRE OF NILLUMBIK

The following list of orchid species recorded within the Shire of Nillumbik has been compiled using unpublished reports ((Beardsell 2013), Just & Beardsell (2010)) cross-referenced with analysis of database records. The majority of species have been assigned a regional or local status following Beardsell (2013) with some additions by the authors. Orchid species with VROT status have also been assigned regional status, as some species that may only be rare in Victoria may on the other hand be critically endangered in Greater Melbourne.

Several species on the list have only been recorded in the north of the Shire in Kinglake National Park (e.g. *Caladenia flavovirens, Prasophyllum lindleyanum, Thelymitra carnea, Pterostylis decurva*) but have been included here due to the possibility of turning up elsewhere within the Shire.

The final list shows that approximately 96 orchid species have been recorded within the Shire, six of which are probably locally extinct. Of the remaining 90 species, 18 are rare, threatened or poorly known in Victoria and/or Australia, 65 are rare or threatened in Greater Melbourne (including species that are also listed as rare, threatened or poorly known in Victoria and/or Australia), 19 are of local significant while six are relatively secure in North-east Melbourne.

Orchid taxonomy is frequently changing, leading to separation of new species and in some cases lumping together of others, while further surveys are likely to uncover new interesting findings. The below list should therefore be used as a guide only, as future analysis may result in different estimations.

Key to Status abbreviations:

Legislative status:
EPBC – Listed as threatened under the federal Environment Protection and Biodiversity Conservation Act.
L - Listed as threatened under the Victorian Flora and Fauna Guarantee Act

Victorian Rare or Threatened (VROT):
E - Endangered in Victoria under the Victorian Advisory List
K - Poorly Known in Victoria under the Victorian Advisory List
R - Rare in Victoria under the Victorian Advisory List
V - Vulnerable in Victoria under the Victorian Advisory List

Regional status:
REx – not observed within the Shire for over twenty years and probably locally extinct.
CE - critically endangered flora in the Greater Melbourne (GM)
R1 - regionally endangered flora in GM.
R2 - regionally vulnerable flora in GM.
R3 - regionally rare flora in GM.
R4 - regionally depleted flora in GM.
L1 - locally restricted flora in North-east Melbourne (NEM).
L2 - locally depleted flora in NEM
L3 – other locally restricted flora in NEM
RS – relatively secure flora in NM

Botanical Name	Common Name	Status
Acianthus caudatus	Mayfly Orchid	R2
Acianthus pusillus	Mosquito Orchid	L2
Caladenia aff. fragrantissima (St Andrews)	St Andrews Spider-orchid	E, CE
Caladenia amoena	Charming Spider-orchid	EPBC, L, E, CE
Caladenia australis	Southern Spider-orchid	REx
Caladenia capillata	White Daddy-long-legs	REx
Caladenia carnea	Pink Fingers	L3
Caladenia catenata	White Caladenia	CE
Caladenia clavigera	Plain-lip Spider-orchid	R1
Caladenia congesta	Black-tongue Hood-orchid	REx
Caladenia flavovirens	Summer Spider-orchid	R, CE
Caladenia fuscata	Dusky Caladenia	R1
Caladenia muscata	Musky Caladenia	L2
Caladenia oenochila	Wine-lip Spider-orchid	V, R2
Caladenia parva	Small Spider-orchid	R4
Caladenia praecox	Early Caladenia	R4
Caladenia prolata	Fertile Caladenia	K, CE
Caladenia pusilla	Tiny Caladenia	R4
Caladenia rosella	Rosella Spider-orchid	EPBC, L, E, CE
Caladenia sp. aff. concolor (Nillumbik)	Nillumbik Crimson Spider-orchid	E, CE
Caladenia tentaculata	Mantis Orchid	R2
Caladenia transitoria	Eastern Bronze Caladenia	R4
Caleana major	Large Duck-orchid	R1

Calochilus herbaceus	Leafless Beard-orchid	K, R1
Calochilus paludosus	Red Beard-orchid	R4
Calochilus robertsonii	Purplish Beard-orchid	L2
Calochilus therophilus	Late Beard-orchid	K, R1
Chiloglottis reflexa	Autumn Bird-orchid	R2
Chiloglottis trapeziformis	Dainty Bird-orchid	R1
Chiloglottis valida	Common Bird-orchid	L3
Corunastylis despectans	Sharp Midge-orchid	K, R4
Corunastylis morrisii	Bearded Midge-orchid	R1
Corybas diemenicus	Veined Helmet-orchid	L2
Corybas fimbriatus	Fringed Helmet-orchid	R, CE
Corybas incurvus	Slaty Helmet-orchid	R4
Cryptostylis leptochila	Small Tongue-orchid	R1
Cryptostylis subulata	Large Tongue-orchid	R2
Cyanicula caerulea	Blue Caladenia	R4
Cyrtostylis reniformis	Gnat Orchid	R2
Dipodium punctatum	Purple Hyacinth-orchid	CE
Dipodium roseum	Rosy Hyacinth-orchid	L2
Diuris chryseopsis	Golden Moths	R4
Diuris orientis	Wallflower Orchid	R4
Diuris pardina	Leopard Orchid	L2
Diuris sulphurea	Tiger Orchid	L2
Eriochilus cucullatus	Parson's Bands	L2
Gastrodia procera	Tall Potato Orchid	R3
Gastrodia sesamoides	Cinnamon Bells	R3
Glossodia major	Wax-lip Orchid	L3
Leptoceras menziesii	Hare Orchid	L2
Lyperanthus suaveolens	Brown-beaks	R1
Microtis arenaria	Notched Onion-orchid	L1
Microtis parviflora	Slender Onion-orchid	RS
Microtis rara	Sweet Onion-orchid	R1
Microtis unifolia	Common Onion-orchid	RS
Orthoceras strictum	Horned Orchid	R1
Pheladenia deformis	Blue Fairies	CE
Prasophyllum brevilabre	Short-lip Leek-orchid	R3
Prasophyllum lindleyanum	Green Leek-orchid	V, CE
Prasophyllum odoratum	Scented Leek-orchid	R2
Prasophyllum pyriforme s.s.	Silurian Leek-orchid	E, CE
Pterostylis aciculiformis	Needle Greenhood	K, CE
Pterostylis alpina	Mountain Greenhood	L3
Pterostylis atrans	Dark-tip Greenhood	R3
Pterostylis clivosa	Red-tip Greenhood	R, R2
Pterostylis concinna	Trim Greenhood	R4
Pterostylis curta	Blunt Greenhood	L2
Pterostylis cycnocephala	Swan Greenhood	REx
Pterostylis decurva	Summer Greenhood	REx

Pterostylis falcata	Large Sickle Greenhood	R1
Pterostylis foliata	Slender Greenhood	R2
Pterostylis melagramma	Tall Greenhood	RS
Pterostylis mutica	Midget Greenhood	REx
Pterostylis nana	Dwarf Greenhood	R4
Pterostylis nutans	Nodding Greenhood	RS
Pterostylis parviflora	Tiny Greenhood	L2
Pterostylis pedunculata	Maroon-hood	RS
Pterostylis planulata s.s.	Grampians Rustyhood	R, CE
Pterostylis plumosa	Woodland Plume-orchid	V, R1
Pterostylis smaragdyna	Emerald-lip Greenhood	R, R1
Pterostylis sp. aff. revoluta	Autumn Greenhood	R2
Pterostylis sp. aff. striata	Silurian Striped Greenhood	E, R1
Pterostylis squamata	Common Ruddyhood	R4
Sarcochilus australis	Butterfly Orchid	CE
Spiranthes australis	Austral Ladies' Tresses	R1
Thelymitra antennifera	Rabbit-ears	R2
Thelymitra arenaria	Black & Yellow Sun-orchid	R4
Thelymitra brevifolia	Pepper-top Sun-orchid	L2
Thelymitra carnea	Pink Sun-orchid	CE
Thelymitra flexuosa	Twisted Sun-orchid	R2
Thelymitra ixioides var. ixioides	Spotted Sun-orchid	R4
Thelymitra juncifolia	Rush-leaf Sun-orchid	R4
Thelymitra media	Tall Sun-orchid	L1
Thelymitra megcalyptra	Scented Sun-orchid	R1
Thelymitra pauciflora s.s.	Slender Sun-orchid	RS
Thelymitra peniculata	Horse-tail Sun-orchid	R4
Thelymitra rubra	Salmon Sun-orchid	L2
Thynninorchis huntianus	Elbow Orchid	R2