GUIDELINES TO PROTECT AND ENHANCE *EUCALYPTUS POROSA* GRASSY WOODLANDS

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EXECUTIVE SUMMARY

There is a lack of knowledge for managing grassy ecosystems in South Australia (Johnson 2003). These guidelines were written to provide assistance to biodiversity assessors and landholders who wish to manage *Eucalyptus porosa* (mallee box) grassy woodlands in an ecologically sensitive manner.

Information is primarily targeted toward existing examples of remnant *Eucalyptus porosa* (mallee box) grassy woodlands. Some information is provided regarding revegetation and establishing a grassy woodland on previously cropped or mechanically disturbed ground, however restoration, natural regeneration and conservation of existing native vegetation is far more efficient ecologically and economically than revegetation. It is also more respectful of existing native vegetation.

Suggestions are also made for landholders who have rough grazed their grassy woodlands in the past and wish to continue to do so, but want to be less damaging and increase the productivity of their native pasture. Information provided is primarily derived from High Density Short Duration grazing studies undertaken by Earl and Kahn (2003) and the Mid North Grasslands Working Group in South Australia.

INTRODUCTION

These guidelines were written at the request of the Goolwa to Wellington, Murray Mallee and Eastern Hills and Murray Plains Local Action Planning groups identified the importance of *Eucalyptus porosa* (mallee box) grassy woodlands within their boundaries.

The guidelines are designed to assist local biodiversity assessors to tailor management options for individual sites and landholders. These guidelines have also been written in a manner that can be directly utilised by discerning landholders.

While written for *Eucalyptus porosa* (mallee box) grassy woodlands these guidelines are equally applicable to other grassy ecosystems within the region.

Johnson (2003) stated there is a general lack of knowledge relating to the management of grassy ecosystems in South Australia. He suggested further study is required in the Eastern Hills to determine the most appropriate management actions for grassy ecosystems. These guidelines should go some way towards encouraging biodiversity assessors and landholders to manage their *Eucalyptus porosa* (mallee box) grassy woodlands in a more sensitive manner. Given appropriate time and resources these guidelines could contribute to a detailed study of grassy woodland management practices in the given area.

DESCRIPTION OF A VEGETATION COMMUNITY

Vegetation Community refers to the assemblage of plants occurring in a given location, and can be described using Specht's Major Vegetation Structural Formations in South Australia (Croft, Pedler and Milne 2005).

Each description is based on the height and projected foliage cover of the tallest dominant layer of vegetation; in this case *Eucalyptus porosa* (mallee box). Sometimes the dominant understorey is also included in the description. In a grassy woodland the understorey would be dominated by grasses or grass-like plants of one sort or another. Importantly, this does not necessarily mean that shrubs would be absent. There may be discrete clumps of shrubs scattered through the landscape, however they will not be a dominant component of the understorey.

Figures 1 & 2. Leaf and fruit of *Eucalyptus porosa* (mallee box).

Note; distinctive intramarginal vein typical of *Eucalyptus porosa* leaf.

Technically, a *Eucalyptus porosa* (mallee box) grassy woodland would be one where the tree layer is 10 – 30m high and the overall projected foliage cover is 10 – 30%. In reality few locations within the study area would contain *Eucalyptus porosa* (mallee box) in this height range. In many areas the height would be less than 10m and the projected foliage cover would drop to 1 – 10%. These communities would be formally referred to as *Eucalyptus porosa* (mallee box) Low Open Woodland. "Low" defines the height of the trees, less than 10m and "Open Woodland" describes the projected foliage coverage, 1 – 10%. For the purpose of this project any occurrence of *Eucalyptus porosa* (mallee box) with predominantly a grassy understorey will be considered to be a grassy woodland.

It is likely in many places that other tree species may grow with *Eucalyptus porosa* (mallee box), and may even be co-dominate, including trees such as *Allocasuarina verticillata* (drooping sheoak), *Callitris gracilis* (southern cypress pine) or other eucalypt species. These guidelines are equally appropriate for such occurrences and may be transferable to other grassy woodland communities in the study area.

Figure 3. *Eucalyptus porosa* (mallee box) grassy woodland with *Lomandra effusa* (scented mat rush) understorey.

WHERE MALLEE BOX GRASSY WOODLANDS ARE FOUND

The location of *Eucalyptus porosa* (mallee box) woodlands within the area covered by these guidelines are shown in Figure 4. The predominantly grassy woodland areas are those situated around Tailem Bend and scattered between Murray Bridge, Monarto and Rockleigh area. As a result of the way data were collected for the map in Figure 5 roadside vegetation is not shown, but does occur within the given area.

The woodland formations occur on shallow, calcareous soils over sheet limestone where average annual rainfall is about 300mm (Boomsma and Lewis 1980).

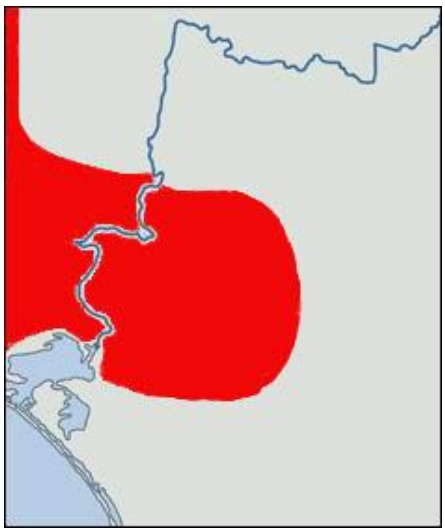


Figure 4. Distribution of *Eucalyptus porosa* (mallee box) woodlands.
Source; Berkinshaw, T. D (2003) *Native Vegetation of the Murray Region, South Australia* - Interactive PC CD-Rom 2003 Edition, , Mid Murray Local Action Planning Association

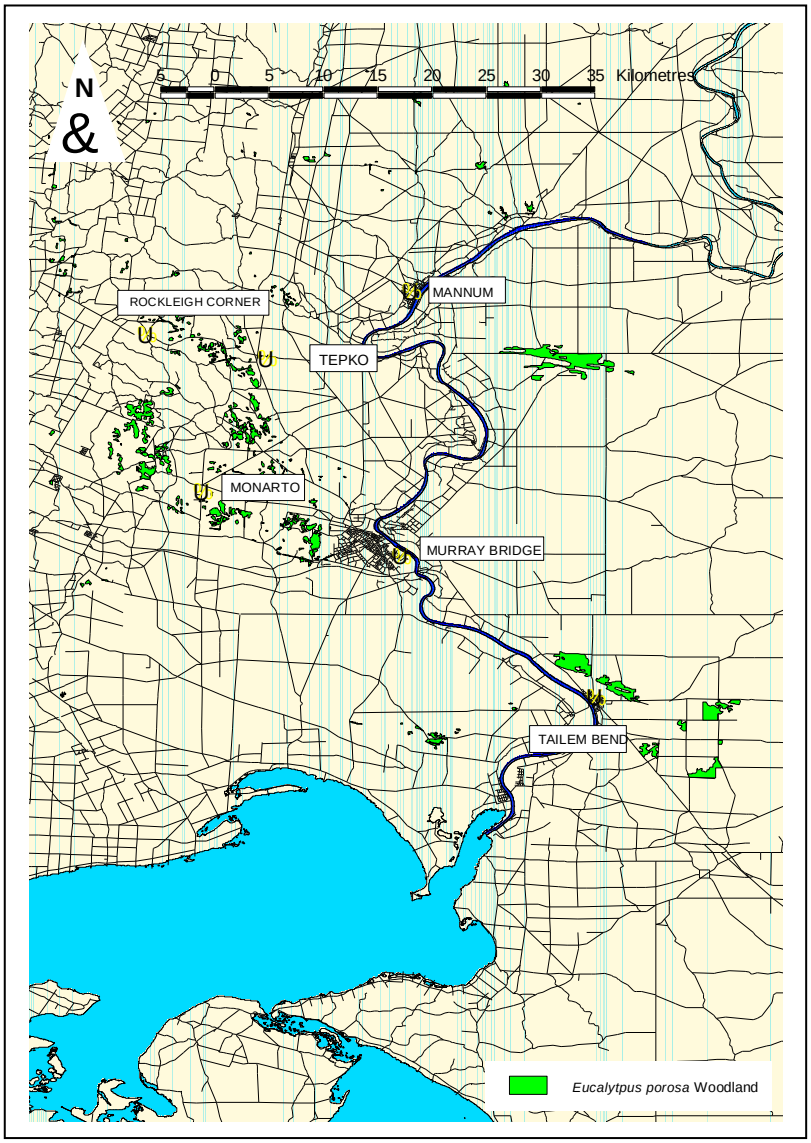


Figure 5. Location of remaining *Eucalyptus porosa* (mallee box) woodlands.
Source Kenny S., Lock, E and Goodwins. (1999) *Western Murray Flats Floristic Vegetation Mapping (GIS)*, Environmental Database of SA (EGI, Department for Environment and Heritage). And Kinnear S., and Gillen J., (1999) *Murray Mallee Floristic Vegetation Mapping (GIS)*, EnvironmentalDatabase of SA (IDA Branch, Planning SA).

WHY MALLEE BOX GRASSY WOODLANDS ARE IMPORTANT

On a national basis temperate woodlands have experienced some of the most dramatic and spectacular examples of landscape and ecosystem collapse with thousands of hectares of woodland being affected by tree dieback and secondary salinity (Yates and Hobbs 2000).

In South Australia only 18% of the original temperate woodlands remain in the agricultural regions, predominantly in small blocks with only approximately 5% reserved for conservation. The remaining 13% being highly degraded and threatened by farm management practices and by secondary affects such as dieback and senescence (Paton *et al* 2000).

Personal experience of the author demonstrates that many people still don't even recognise a *grassy* woodland when they are standing in one, despite concerted efforts of many well known ecologists in South Australia.

Eucalyptus porosa (mallee box) grassy woodlands are a Priority Five vegetation community, meaning they are much depleted and existing remnants are often highly degraded. This community is not well represented in the formal reserve system (Neagle 1995). In the Eastern Mount Lofty Ranges grassy woodlands have been extensively cleared with most surviving examples occurring on private land (Johnson 2003).

Clearly, this vegetation community is important purely for its conservation value, but other reasons exist. Like many grassy ecosystems *Eucalyptus porosa* (mallee box) grassy woodlands are also important for,

- habitat for fauna, particularly declining woodland bird species
- habitat for threatened plants
- refugia of biodiversity
- genetic reservoirs and
- pastoral value (Eddy 2002)

THREATS

A number of threats exist to *Eucalyptus porosa* (mallee box) grassy woodland communities throughout the region. Each location will inevitably have its own combination of threats. It is not possible to detail all threats, however a number of the more common threats are listed below (Johnson 2003, Eddy 2002, Davies 2000 and Yates and Hobbs 1997),

- weed invasion
- further clearance, possibly due to lack of knowledge
- grazing by livestock, feral herbivores and over abundant native species
- over zealous weed control
- road construction and maintenance
- altered fire regimes
- inappropriate revegetation
- fire wood collection
- general lack of understanding from the public and
- disease

Weed invasion

In general, grassy ecosystems have soils of higher fertility. As a result, a range of weed species can more easily become established. Many of the weed species occur naturally in higher nutrient soils in their place of origin. The open structure of this vegetation also permits weed seeds to be spread more readily via animals or by wind. This combined with disturbance to the soil surface in native grassy ecosystems, enables areas to become heavily infested with a range of weed species. In very degraded grassy ecosystems, annual weed species often dominate understorey cover. Management actions that favour the establishment of perennial species may help to reduce weed infestations (Davies 2000).

Data collected from over a decade of vegetation surveying have found that in grassy ecosystems 72% of invasive species are annual and 90% of native species are perennial. To shift the balance toward perennial species, competent assessment of the vegetation is required to ascertain the presence of native annual species before management is undertaken (Davies 2000).

Figure 6. Bridal creeper infestation in a native woodland.

Further clearance

Despite the Native Vegetation Act (1991), clearance of native vegetation still occurs, albeit on a smaller scale, and in many cases possibly due to lack of knowledge. Certain landholder activities can be classified as vegetation clearance, for example burning or grazing regenerating

pasture that has not previously been grazed for 10 years.

Preparation for tree planting in grassy ecosystems may involve ripping the ground or using herbicide (Davies, 2000). Planting trees is not only inappropriate in many cases, but the preparation can be regarded as vegetation clearance.

Grazing by livestock, feral herbivores and over abundant native species

Grazing can sometimes be a useful tool in managing grassy ecosystems, however inappropriate grazing such as over grazing or repeated grazing at the wrong time of year can threaten native vegetation. Inappropriate grazing often reduces the presence of native legumes, lilies, daisies and orchids, and encourages and promotes exotic species that are better adapted to these grazing regimes (Davies 2000).

It is well established and understood that feral herbivores, particularly rabbits, are a threat to native vegetation. They have the capacity to completely remove certain native species from a location, especially when combined with the pressures of stock grazing and native herbivores such as kangaroos. Ongoing control of feral herbivores is essential to the health of native grassy ecosystems.

Over abundant native herbivores such as kangaroos can also be a threat to native grassy ecosystems. Management of native animal species requires specialised knowledge to be applied across the landscape and requires co-operation of all landholders and approval from Dept for Environment and Heritage (DEH) under a strict permit system.

Each landholder should seek professional advice on herbivore control from Animal Plant Control Commission (APCC) or DEH.

Over zealous weed control

Weed control in native vegetation needs to be undertaken in a different manner to that in crops or exotic pasture. The focus needs to be on protecting and enhancing native vegetation rather than on just removing weeds. Over zealous weed control often results in excessive soil disturbance, which advantages weed species, or off target damage where native plants are killed as an unintended consequence, for example due to overspray of herbicide or misidentification.

Figure 7. Native shrub killed as off target damage when spraying for onion weed

Road construction and maintenance

Grassy woodland remnants still exist as roadside vegetation, but are sometimes cleared during road maintenance activities. Road construction and maintenance often leads to an increase in weed abundance due to soil disturbance and introduction of weed seeds on machinery, vehicles and equipment. Diseases of native vegetation can also be introduced in this way for example the soil fungus, *Phytophthora*, is readily transported to new sites by contaminated vehicles.

Figure 8. Damage to roadside due to road maintenance activities.

Altered fire regimes

There is evidence to suggest that fire regimes have been altered since European settlement. Currently, there is a focus on fire suppression to avoid bushfires. Some ecologists suggest that fire has a role in the management of grassy ecosystems. There is much evidence to suggest that Aboriginal people used fire to increase available habitat for grazing wildlife.

Fire is a very complex management tool that few people understand and must be approached with extreme caution. It requires approval from the Native Vegetation Council as it can constitute illegal clearance. Professional advice from a qualified fire ecologist at DEH who has experience in using fire as a management tool in native bushland is essential. It will also be necessary to consult with the local Country Fire Service.

Inappropriate revegetation

Revegetation and tree planting has become a popular activity in many areas. Most people have a preconceived idea of what native vegetation should look like. Unfortunately, few people realise that native vegetation takes many different forms and structures. Generally, grassy woodlands contain widely spaced trees and very few or no shrubs across large areas. Frequently, people incorrectly assume a lack of trees and shrubs in a landscape means that revegetation is required.

Increasing the density of trees and introducing shrubs to grassy woodlands threatens the survival of the grassy woodland and the birds and animals that require open habitat. It has been stated that half of our native bird species are faced with extinction over the next 50 years due to vegetation clearance and fragmentation over past decades (Possingham 2000). Many of our declining bird species specifically require woodland habitats. By inappropriately planting trees and shrubs into grassy woodlands we are hastening the demise of these species in two ways. Firstly, we are removing the last few remaining areas of suitable habitat. Secondly, inappropriate revegetation into existing native vegetation has been shown to advantage aggressive native bird species, such as noisy miners, that actively prevent other birds from entering that patch of bushland (Paton et al 2000). Expert advice should be sought before

revegetation is considered.

Fire wood collection

Dead and fallen timber is known to provide critical habitat for a large number of mammals, birds, reptiles and invertebrates. Unfortunately, many people still have the misconception that dead trees and fallen branches are only useful as firewood or should at least be tidied up.

Leaving dead trees and fallen timber is one of the single most important things that can be done to protect our native wildlife.

General lack of understanding from the public

Whilst there has been somewhat of an increase in public interest in native vegetation, this has not necessarily been the case for grassy woodlands. Sometimes it can be difficult to recognise grassy woodlands as native vegetation, particularly if they are degraded. Few South Australians get to opportunity see or appreciate grassy woodlands in good condition. Generally, native vegetation is perceived as having lots of trees and shrubs close together and some people find it difficult to get enthused about grasses and small plants. It is the native grasses and small plants that have the greatest plant diversity in a patch of bushland. Generally, if one observes a number of small plants or plant species that are not introduced pasture, crop species or common weeds such as salvation Jane, capeweed or potato weed it is possible they are standing native vegetation. If the soil has some level of microphytic crust (assemblages of mosses and lichens easiest seen when wet) it is more likely again to be native vegetation. Observation of either of these criteria will require inspection by someone with sound knowledge of local native species including local experts.

It will take many years and continuing emphasis on the importance of grassy woodlands before the general public appreciate their value and contribution to South Australia's natural heritage.

Disease

Occasionally, native vegetation can suffer from various diseases or other afflictions. Frequently, unhealthy vegetation is a response to many compounding factors, which can't be easily defined. Soil borne diseases may contribute to the poor health of native vegetation. To minimise the risk of introducing or spreading diseases to native vegetation landholders should practice good hygiene principles for their vehicles and equipment ensuring they are clean of dirt and mud and avoiding areas where native vegetation is of poor health. All vehicles and equipment must be cleaned before entering native vegetation and again when leaving.

Summary

Several of these threats are simple to resolve, for example fire wood collection, however most require careful consideration before attempting to ameliorate. We must bear in mind that natural systems are highly complex and that any action taken will often result in unintended outcomes. Removing livestock in order to protect native vegetation usually results in an apparent increase in weeds. This is usually because stock often eat weed species which may not be detected until the animals are removed. In this situation the landholder needs to be prepared to provide suitable resources for treating weeds. Alternatively, it may be better to slowly fence stock out of small areas that can be more easily managed.

Our collective knowledge of how to manage grassy ecosystems is limited. It is only in recent

times that any effort has been put toward developing management strategies for grassy ecosystems and we need to be aware that what works in one region may not necessarily work in another. We must be prepared for unexpected outcomes from our management regimes.

Management of threats that can be tackled by individual landholders are covered later in this document. As a general guideline, and after careful consultation, we should only try new techniques in relatively small, degraded areas. It is then much easier to record and monitor outcomes and address any unforeseen problems that arise. Above all, we should not be afraid of getting it wrong and advising others of adverse outcomes. This is the only way we will improve our knowledge of how to manage grassy ecosystems in South Australia.

MANAGEMENT OF GRASSY WOODLANDS

Eucalyptus porosa (mallee box) grassy woodlands may require different management regimes depending on their past, current and future use. Management can best be undertaken following one of two pathways. One based purely on conservation of native species where the land is not required to generate an income and the other based on a modified grazing regime that aims to advantage native species over introduced species.

The section below, Weed Management in Remnant Vegetation, is applicable to both pathways. Additional information for income generation through continued grazing is provided in the section Grazing Regime Change To Enhance Native Pasture.

WEED MANAGEMENT IN REMNANT VEGETATION

When managing weeds in remnant vegetation, at least in the short term, the primary aim is to prevent further degradation. Any remnant vegetation left in South Australia that is not managed will degrade. It must be actively managed. A landholder who prevents further degradation should consider themself successful. If the condition of the remnant vegetation improves this should be considered a bonus. If the area of vegetation expands this should also be considered a bonus.

PRINCIPLES

As mentioned earlier, weed management in remnant vegetation requires a different approach to that in a crop or garden situation. When bush regeneration principles are put into practice, large areas of bushland can be improved even when time is limited. The larger the area of bushland the more critical bush regeneration principles become.

Weeding efforts should be dictated by the native vegetation not our impatience to create perfect bushland.

Bush regeneration principles should always be followed:

- Work from the good bush outwards,
- Disturb the soil as little as possible and
- Do not over clear weeds.

Detail on how to apply these principles is given below.

Work from the good bush outwards

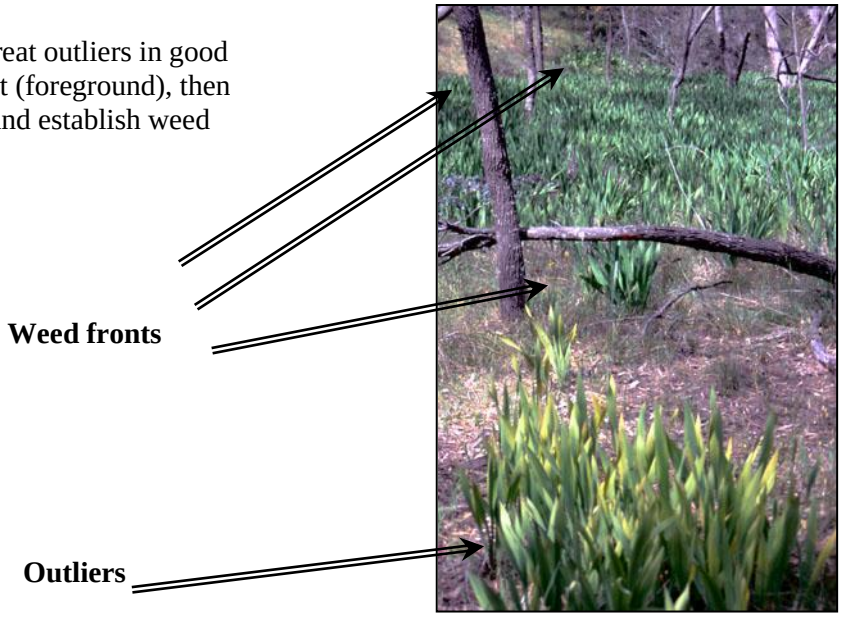
This principle ensures we start from the best quality bushland and work towards the weedier areas. The reasoning for this approach is to ensure good quality bushland remains in good quality by denying weeds the opportunity to set seed and become established. It is much more efficient to manage good bushland than degraded bushland.

For this reason, when working in bushland it is best to concentrate on removing smaller populations of weeds and work towards larger infestations. Once larger infestations are reached, a weed front should be established with work continuing along the weed front. Work should only advance into the infestation once native vegetation has replaced the weeds. Over time the infestation will diminish and become much more manageable.

If we forget this and focus our energy on large infestations we won't see the smaller populations of weeds, ie 1 or 2 plants, remote from an infestation. As we spend more and more time on the

infestation, controlling regrowth, seedlings and other weeds that take their place, these smaller populations grow into infestations in their own right. They also spread seed further into good bushland and expand the area of degradation. Put simply, we allow good bushland to degrade. By spending time eliminating the small outlier populations we can ensure bushland does not degrade. The infestation can be contained and then eventually removed.

Figure 9. Treat outliers in good bushland first (foreground), then consolidate and establish weed fronts.



Sometimes it is necessary to utilise a technique called spot regeneration. Spot regeneration is aimed at protecting the process of natural regeneration. This technique is used when a small valuable patch or single valuable plant is surrounded by weeds and therefore threatened. In this situation weed control activities are centred on enhancing the survival chances of targeted native species. Weeds can be carefully removed over time from the edges of a patch, slowly expanding outward creating a weed front. In any situation it is important not to over clear weeds as this can result in unsustainable levels of follow-up weed control. Often, when large infestations are removed the resultant regrowth of weeds can be extremely difficult to control.

Disturb the soil as little as possible

This does not necessarily mean zero disturbance. Some level of disturbance is unavoidable, however the goal should be to cause as little disturbance as possible. The reason for minimising disturbance is to lessen the opportunity for disturbance loving weeds. Most weeds are advantaged by soil disturbance, while some such as salvation Jane and capeweed are greatly advantaged.

In *Eucalyptus porosa* (mallee box) grassy woodland that are highly degraded due to past stock grazing regimes and have minimal or no microphytic crust it may be useful to use grazing as a management tool, even in areas with conservation as the primary goal, but only occasionally and in a manner which ensures as little disturbance as possible and adheres to strict practices. The use of grazing as a management tool is highly specific to certain situations and is discussed in greater detail in the section Grazing Regime Change to Enhance Native Pasture.

Figure 10. Proliferation of salvation Jane after soil disturbance.

Do not over clear weeds

A common problem when people begin weeding in remnant bushland is over clearance of weeds. It is difficult to curb our enthusiasm for killing weeds, but essential. Weeds should only be cleared at a pace where native vegetation can re-colonise an area. In bushland the emphasis is on native plants not necessarily weeds. A simple question to ask yourself is, "which native plant(s) am I benefiting?" If there are no or very few native plants present you are over clearing.

Over clearance of weeds results in the need for unsustainable levels of follow-up work to control re-growth of the weeds treated, their seedlings or other unexpected weeds that move into the void. To prevent this, work should begin in the highest quality bushland and continue toward an infestation. Once an infestation has been reached and a weed front established, work should continue along the weed front, even if it results in the weed front wandering and meandering for hundreds of metres. Do not over clear weeds. Working into weed fronts often results in excessive soil disturbance and the opportunity for other weeds to take over. The deeper we go into a weed front the less native plants are present. The few natives that do exist are unable to fill the void created by excessive weed removal and, as nature abhors a vacuum, the empty spaces will be filled by more weeds.

In this way very large areas can be managed effectively.

TECHNIQUES

Weeds should be removed using minimum disturbance techniques and include,

- Hand pulling
- Wiping foliage
- Hand spraying
- Cut and swab
- Drill and fill
- Slashing

- Grazing (limited application)

Note: where practical, non-herbicide options should be used in preference to herbicides when dealing with weeds near creeks, drainage lines and dams as herbicide can be toxic to aquatic wildlife. If herbicide use is considered to be unavoidable then one which is considered to be of lower toxicity to aquatic wildlife must be used. Weedmaster Duo and Roundup Biactive are two products considered to be of lower toxicity to aquatic wildlife. Any addition of surfactant to a herbicide will make it harmful to aquatic wildlife.

Hand pulling

This is a very useful technique in small areas, particularly around delicate or threatened plant species, where it is very easy for off target damage to occur, ie native plants accidentally killed by the overspray of weed species. This technique is not suitable on a paddock scale.

Hand pulling needs to be done carefully to ensure no soil is removed or disturbed. Many bushland weeds flourish when soil is disturbed. Appropriate removal can be achieved by placing one hand flat on the ground with the weed between two fingers. As the hand is pressed toward the ground the second hand can carefully remove the weed. If soil is disturbed it should be tamped back in place to minimise the opportunity for another weed to become established. The same principle is used when removing slightly larger weeds like young pine trees. In this situation the weed can be removed by hand with minimal disturbance by placing a foot either side of the stem base, bending the knees and using the legs to pull the plant out gradually. Pulling weeds by hand should only be done when soil is relatively moist. If the soil is too dry, it will be excessively disturbed or the plant may break away from the roots resulting in regrowth from roots left in the ground. When soil is dry, weeds should be cut and swabbed using the method described later in this section.

Wiping foliage

A Weedbrush is extremely useful where isolated broadleaf weeds occur in good quality vegetation. The Weedbrush is light and easy to carry when walking in bushland and weeds can be treated immediately, avoiding the need to return and relocate the weed at a later time. It is also useful when there is high risk of off target damage, eg broadleaf weeds occurring amongst native grasses and lilies.

When using the Weedbrush, 280ml of clean water is mixed with 70ml concentrated Glyphosate. Directions are clearly labelled on the Weedbrush. A small amount of dye marker should also be added. The brush is wiped onto the foliage of individual weeds.

Spraying

Herbicide spraying is often the most efficient method of removing herbaceous weeds. Before using herbicide appropriate safety equipment and training must be undertaken to minimise harm to the operator.

Numerous herbicides are available from local hardware shops, however each herbicide has advantages and disadvantages depending on required results and area to be treated.

Irrespective of which herbicide is used, all people to come in contact with the herbicide must read the label to ensure they are familiar with dosage rates and safety requirements. It should be noted that very little information is available on the long term effects of herbicides. Caution

should always be used.

Great care needs to be taken as it is easy for off target damage to occur when spraying. Before any spraying takes place the areas should be competently searched for native species. When identified they should be marked to ensure they are not sprayed. Sometimes herbicides may be available that will have limited effect of the native species concerned, ie a broadleaf herbicide may be suitable amongst certain native grasses.

Clearly, as the quality of bushland improves and becomes more diverse, there will be a corresponding decrease in opportunities for herbicide spraying, at least on a broad scale. Manual knapsack or hand held spraying may still be acceptable.

Note: It is generally inappropriate to spray larger woody weeds in remnant vegetation. Unacceptably high levels of off target damage usually occur due to spray drifting onto native plants or dripping from the woody weed. Sometimes native plants are entwined in woody weeds.

Note: Spraying should not be undertaken in close proximity to any delicate or threatened species, to ensure these plants do not become victims of off target damage.

Further information on appropriate chemical use and safety should be obtained by contacting your local Weed Officer or Watershed Protection Office.

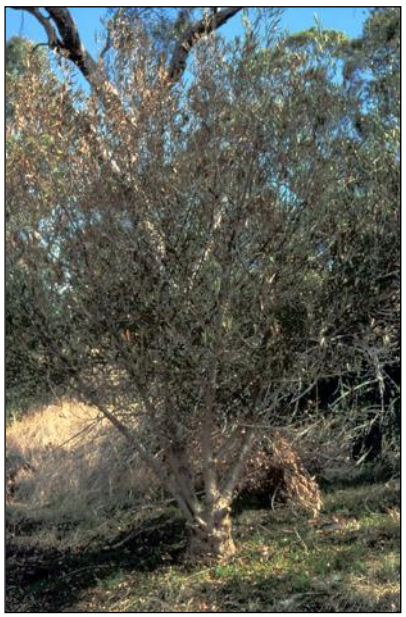
Cut and Swab

This technique is often used when a weed is too large or the soil too dry for hand pulling. This method is best carried out by two people. One cuts the stem close to the ground, the second quickly applies concentrated Glyphosate, or other appropriate herbicide, to the exposed stump. The herbicide needs to be applied immediately, as some weeds begin sealing wounds within seconds, therefore reducing the absorption and effectiveness of herbicide.

Figures 11 and 12. Cut and swab herbicide applicator and its use in the field.

Drill and Fill

The Drill and Fill technique is very useful for larger woody weeds. The drill and fill method can be used on any woody weeds that have a base 4cm in diameter or larger. A cordless drill is used to drill a steep angled hole into the plant's cambium layer (where sap flows just beneath the bark layer). The hole is then immediately filled with concentrated Glyphosate. This is repeated every 2.5 – 5cm until the base of the plant has been circled. The plant drops its leaves within 6 weeks and dies within a few months. It will be necessary to monitor the plant and if it resprouts, the process will need to be repeated. The soil beneath large woody weeds usually contains huge numbers of seeds from the parent plant. These seeds will germinate and if left untreated will become a worse problem than the original plant. It is essential that follow-up control of seedlings is undertaken in subsequent years. Considerable time can be saved by doing this work the following autumn as most seedlings will not survive the hot, dry summer months.



Figures 13 and 14 Base of olive drilled and filled and, left, four weeks after treatment

Note: if the woody weed is a deciduous species, such as desert ash, it can only be drilled and filled while the plant is active, ie spring and summer. As temperatures decrease toward winter deciduous species become dormant and drilling and filling will be ineffective at this time.

There are a number of ecological advantages in using the drill and fill technique over cut and swab. Primarily, habitat structure remains in place. It is possible that birds and other animals utilise the structure provided by these weeds for shelter. The drill and fill technique allows nesting birds to continue raising their young as the weed dies. Cut and swab would result in an abandoned nest. Retaining the structure will give native animals time to re-locate to new areas that provide suitable shelter.

Figure 15. Dead African boxthorn providing habitat for bearded dragon.

Slashing

Slashing can be useful for treating annual weed grasses and preparing rank perennial weed grasses for spraying. Annual grasses should be high slashed (10cm above ground) before seed heads start to develop, typically in late winter and may require follow-up slashing after 2-4 weeks. Depending on the year and rainfall received it may be necessary to follow-up slash several times. As they are annuals, preventing the production of seed will ensure their seed bank will diminish with time. When using this method, care needs to be taken to minimise damage to herbaceous native plants. Slashing can be undertaken using a ride on mower or tractor driven slasher that is free of weed seeds, a brushcutter, or in sensitive areas, hedge shears. Slashing should be done before the annual grasses become tall as studies have shown that the resulting thatch left on the ground can inhibit native plants. The choice of technique will be largely defined by the quality of the bushland and size of area to be slashed. Grazing can be another useful option and addressed later in the guidelines.

Note: when slashing with machinery it is essential the equipment is clean and completely free of weed seeds. Mechanical slashing is frequently responsible for the introduction of new weeds or further spread of existing weeds.

Perennial grasses can be slashed at any time of year, however best results will be obtained during winter and spring. Once slashed, the grasses should be allowed 3 - 4 weeks to develop lush growth and then sprayed. Herbicides usually work best when plants are healthy and actively growing. By removing dry stems and forcing the plant to put on new growth the uptake of herbicide will be improved and resultant success rate will be greatly improved.

Davies (1997) has cautioned that in certain situations slashing may result in an increase of certain broad leaved weeds such as *Plantago lanceolata* (ribwort). Undertaking slashing along weed fronts will minimise their establishment and make follow-up control easier.

Stock grazing

High Density Short Duration (HDSD) grazing can sometimes be a useful tool to assist in the management of larger areas of dense annual weed grasses and other weeds in a **degraded** grassy woodland. In this context it could be used in a staged approach if returning grazed land to conservation.

Grazing often results in increased soil disturbance, which can lead to an increase in the number or abundance of weed species when grazing is not used repeatedly. This can be due to a low level weed being advantaged by the soil disturbance or the introduction of weeds on the animals' coat or in their faeces. Also, small and/or delicate native plants are likely to be damaged by the animals' hooves. Regular use of this technique is likely to result in the permanent loss of many native herbaceous species, such as lilies, orchids and daisies.

Caution is required if using this technique and **should not be confused with grazing native pasture where income generation is required.**

HDSD grazing is not appropriate for long term control of annual grasses in good quality grassy woodlands.

Earl and Kahn (2003) in conjunction with the Mid North Grasslands Working Group undertook a study in the Mid North of South Australia to determine appropriate levels and frequency of grazing for grassy ecosystems that had previously been grazed for income generation in order to

develop a grazing regime that increased native perennial species whilst maintaining and improving income generation. This technique is described further in the section Grazing Regime Change To Enhance Native Pasture.

Native Vegetation Council (NVC) approval is required before previously ungrazed native vegetation is grazed for biodiversity enhancement. Exemption 5(1)(zi) of the Native Vegetation Act may allow grazing of native vegetation. A management plan approved by the NVC will be required prior to grazing together with a condition monitoring program.

PRIORITISING WEED SPECIES AND ACTIONS

When developing a weeding strategy a number of factors should be considered including,

- Population size of weed species
- Potential of the weed to change ecological structure
- Dispersal agent of weed species
- Invasiveness of weed species
- Weed species' life cycle; time to maturity
- Time of year
- Local climate and weather conditions currently experienced.
- Weed habitat value for native fauna

Each site will be different and strategies will need to be developed for individual properties or paddocks.

Population size of weed species

Highest priority should always be given to new weeds that have not been found on the property or paddock before. It is much easier and more effective to remove a single weed that appears innocuous than it is to remove an infestation of the same weed ten years later. Weeds currently impose a $4 – 5 billion cost to the Australian economy (McFadyen 2005). Similarly, it is better to remove a weed with a small population than it is an infestation. For example if a grassy woodland is infested with African boxthorn (*Lycium ferocissimum*), but a few plants of bridal creeper (*Asparagus asparagoides*) are found at the base of a tree it is far more beneficial to eradicate the bridal creeper than to ignore it and achieve only small reductions to the African boxthorn infestation. Bridal creeper is a Weed of National Significance and can rapidly invade high quality bushland.

When an infestation is to be treated, outlying sub-populations should be removed before the main infestation is tackled, to prevent expansion of the overall population. Efforts can then be put toward containment of the main population and eventual elimination.

Potential of the weed to change ecological structure

Next priority should be those weeds that have capacity to change the physical structure of a grassy woodland. Remembering that grassy woodlands should have widely spaced trees with only a few isolated clumps of shrubs or no shrubs at all, a weed that can create dense or impenetrable thickets must be given high priority. Clearly, weeds such as African boxthorn, gorse and olive fit this description.

The potential of some weeds may be less obvious, such as bridal creeper. This weed may not create impenetrable thickets, but it does have a very dense root and tuber system, which effectively forms an impenetrable thicket underground. Even tree species are unable to

germinate and grow amongst this root system.

Dispersal agent of weed species

The ability of a weed to move through a landscape is partially governed by how it is spread. Many bushland weeds require some form of disturbance to become established. Weeds that produce fleshy fruits that are eaten, and therefore spread, by birds and foxes can appear in high quality bushland where no adult plants are present. This range of weeds should be targeted as soon as possible. It is beneficial to control these weeds on nearby roadsides and neighbouring properties.

Invasiveness of weed species

Some species have greater invasive potential than others. Priority should be given to controlling highly invasive species over less invasive species, for example it is more important to remove African weed orchid (often referred to as monadenia) (*Monadenia bracteata*) than soursob (*Oxalis pes-caprae*) even though soursob may cover a large area. It is important to remove or at least contain the more invasive species.

Time to maturity

The time required for a seedling to grow and produce seed is another factor that can be considered when developing a weeding strategy. Ideally weeds should be treated before they produce seed and have a chance to spread further. Many woody weeds take between 18 months and 5 years to produce seed. By understanding the growing cycle of a particular weed we are able to develop better strategies for their removal. For example African boxthorn usually reaches maturity after 2 years. This means that after initial treatment of mature plants a landholder will have up to 2 years to do the necessary follow up work. This large window of opportunity means the landholder can work in another part of the bushland or target a different weed species.

Time of Year

Different weeds are better treated at different times of the year. Knowing a plant's growth cycle or greatest susceptibility to weed control techniques can be used to develop a weeding strategy. This can then be used to target different weeds at different times spreading weed control over 12 months, often allowing much larger areas to worked on.

Generally, herbaceous weeds should be treated at break of season through to early spring. Treatment of bulbous weeds tends to be more successful during flowering, usually spring. Woody weeds can often be treated at anytime of year, but due to work loads and other weeding requirements it is usually beneficial to leave their treatment until late spring/summer. Caution should still be used at these times as conditions may not be suitable. Plants have to be actively growing for herbicide to be effective. Toward the end of summer and early autumn or on particularly hot days woody weeds can begin to shut down and herbicide treatment may be less effective. Similarly, deciduous woody weeds begin to go into dormancy in autumn, therefore treatment will have little effect at this time. Deciduous woody weeds should be treated in spring/early summer.

Local climate and weather conditions currently experienced

When prioritising actions for weed control landholders need to be flexible in their approach and utilise their observation skills. Most people are aware that weather systems in South Australia are far from regular or reliable. We may have several years of below average rainfall followed by a year of above average rainfall. Usually rain falls predominantly in winter, but in some years we can receive heavy rainfall in summer. Many weeds respond dramatically to these unforeseen fluctuations.

It may be necessary to change planned activities to suit weather conditions. For example, there is no point undertaking woody weed control using herbicide if the land is in drought conditions and woody weeds have shut down. Plants must be actively growing for herbicides to be effective. Prolonged summer rain may mean shifting from woody weed control to broad leaved weed control to prevent salvation Jane population explosions.

Weed habitat value for native fauna

In some situations certain woody weeds could be the only source of shelter for native fauna. Caution is required before removing woody weeds in this instance. Careful observation will be required to determine if native fauna are using the weeds. If present, weed control should be undertaken in a staged manner over several years or until native vegetation can replace the weeds. If native vegetation does not show signs of regeneration after 2 – 3 years it may be necessary to plant appropriate tubestock. Choosing a weed control technique that leaves the weed standing may be more appropriate. Caution and accurate record keeping are the most important aspects to successful weed control and bush regeneration.

WEED ACTION PLAN / SCHEDULE

Following is a general guide for a weed action schedule. Activities may vary from time to time depending on the previously mentioned variables. It is important to ensure the activities are achievable and that landholders do not become slaves to weed control. Weed control activities may be done in short 30 minute bursts or by allocating one day a month specifically for weed control in remnant bushland or some other format that suits the individual landholder.

It is also important to build in easy obtainable goals. For example, if there is only a small number of African boxthorn or olive that can be easily eradicated target those weeds first. It can be very rewarding and empowering for a landholder to get some early wins.

SUMMER — Mature woody weed control – drill and fill or cut and swab. Avoid hand pulling weeds over summer as soil will be too dry.

WET SUMMER — Check for germination of broad leaved weeds and treat as necessary. Woody weeds may need to be left until later in the season or the following summer. Check for any new weeds not encountered on the site before.

AUTUMN — Cut and swab woody weed seedlings & juveniles that survived summer. Drill and fill mature woody weeds. Check for and remove isolated occurrences of new weeds.

If planning to use sheep to control annual grasses in winter, ensure appropriate fences have been erected, water points created or a strategy is in place to provide water, (eg a mobile water cart) and approval obtained from the Native Vegetation Council.

WINTER — Spray or hand pull emerging weeds, especially broad leaved weeds. Slash perennial weed grasses in preparation for spot spraying in 4 – 6 weeks. In mid winter slash annual weed grasses (may require follow up slashing in 2 – 4 weeks). Late winter, spray herbaceous weeds, especially bridal creeper if present.

If grazing to control annual grasses in good quality remnant bushland, **ensure approval has been obtained from the Native Vegetation Council.** Place sheep in a quarantine paddock before releasing them into the pre-determined patch of bushland. Sufficient time must be allocated to check the sheep and condition of bushland each day. Landholder must be prepared to remove sheep within a short number of days (possibly only 2 or 3 days later). Monitor and introduce emergency remedies through spring if needed.

SPRING — Spring can be a very busy time of year and it is important not to become over committed to weed control. Rationally think through what is achievable and target areas where the greatest gains can be made for bush regeneration, usually including the most invasive or aggressive weeds first.

Spray bridal creeper, preferably when flowering, but anytime is acceptable. Spray or hand pull herbaceous weeds. Spray previously slashed perennial weed grasses. Check for establishment of any new weeds. Drill and fill woody weeds, especially if they are deciduous.

ALL YEAR ROUND — Take time to enjoy the bushland you have, it should not become a burden. Evaluate techniques and timing and note changes as necessary for the following year.

GRAZING REGIME CHANGE TO ENHANCE NATIVE PASTURE

Native Vegetation Council (NVC) approval is required before changing past stocking rates or animal species to graze native pasture. Exemption 5(1)(zh) of the Native Vegetation Act may allow changes to existing native vegetation grazing practices. A management plan approved by the NVC will be required prior to grazing together with a monitoring program.

This section has been written to encourage landholders who may currently graze native pasture, but wish to improve its condition and ecological value.

Studies have shown that traditional set grazing regimes (low number of sheep kept in a single large paddock over several months) encourage annual grasses (Davies 1997) and exotic pasture that provide large quantities of feed over winter and spring, but have little value over summer and early autumn (Nichols 2001). These exotic pastures are less resilient to fluctuating rainfall and can lead to boom or bust type cycles. Encouraging native perennial grass dominated pasture provides for much greater resilience, improved production and better ecological outcomes. Perennial pastures also respond rapidly to occasional summer rain providing additional green feed for stock.

Changing management practices to encourage native pasture will not eliminate annual grasses or exotic pasture species. If there is history of set grazing there will be an abundance of weed species in the soil seedbank. Continuing grazing, albeit with a changed regime, will still create significant soil disturbance and result in a background level of disturbance loving weeds such as salvation Jane and cape weed. Native pasture under a new grazing regime will never attain the same diversity as a grassy woodland managed purely for conservation purposes, but it will be of considerably greater value to native birds and animals than a pasture dominated by annual grasses and exotic pasture. The Mid North Grasslands Working Group (MNGWG) has demonstrated an increase in sheep production is also possible (Earl and Kahn 2003).

Under natural conditions, grazing animals do not stay in one place and eat. They like to eat fresh grass and herds of animals will move on to fresh pasture almost daily, leaving behind large amounts of fertiliser and grasses which have time to recover before the animals return. Fences restrict animals to one area, where they are forced to eat the same plants for days, and sometimes even months (MNGWG 2004).

High Density Short Duration (HDSD) grazing, sometimes called cell, pulse or crash grazing, involves using a large flock of sheep, or other domesticated stock, to graze a relatively small paddock for a very short period of time; typically 1 – 4 days depending on the size of the paddock and amount of feed available for the stock. The paddock is then rested until pasture has recovered, this will vary from region to region and even between paddocks. The theory is that many sheep in a small paddock leads to high competition for food and limited time for sheep to seek out the more palatable species. They don't have time to be picky! The rest period gives plants a chance to recover and put on more foliage after being grazed.

This is a relatively new form of management and very little information is available for the average landholder. There is no information available for *Eucalyptus porosa* (mallee box) grassy woodlands occurring in the area for which these guidelines are written. Most studies have been undertaken in higher nutrient soils of the eastern states of Australia and concentrate on improving carrying capacity of native pastures. This information is not directly transferable due to *Eucalyptus porosa* (mallee box) grassy woodlands due to their relatively lower nutrient level compared to the eastern states, more fragile and less resilient soils , different composition of plants and productivity levels .

A three year pilot project recently completed by the MNGWG in South Australia goes someway to improving our knowledge on HDSD on lower nutrient soils. This project aimed to show that HDSD grazing could allow native pastures to be grazed for production and profitability and result in improved conservation of native grasslands (MNGWG 2004). Once again, this information can't be directly applied to *Eucalyptus porosa* (mallee box) grassy woodlands, due to similar constraints already mentioned, but may be used as a starting point.

HDSD grazing is not a simple process and requires considerable input from the landholder. Issues to be considered are,

- how much area to HDSD graze (start small to begin with)
- additional fencing to subdivide paddocks (should be low impact on native vegetation, electric fencing may be suitable).
- additional water points (using a mobile water tank/trough in different locations can limit repeated disturbance)
- thorough understanding of a paddock's carrying capacity
- understanding of nutrient values of available herbage
- sufficient time to monitor vegetation
- sufficient time and resources to move stock when necessary.
- sufficient time to continue monitoring vegetation after stock have been removed.

It is critical to closely observe what the animals are eating. As available pasture is depleted the animals must be removed. This period may be very short; 1 – 4 days. Once removed, the paddock must be rested until pasture has recovered and sufficient feed is available for animals to be re-introduced, this may take anywhere from 60 – 180 days or possibly longer on more fragile pastures with shallow soils and rocky slopes. Less rest time will be required during times of high growth and more during the slow growth periods of summer.

Clearly, the obvious question a landholder will ask is, how many sheep do I put on the pasture and what sized area should I limit them to? Due to the recent introduction of this technique and scarcity of information a landholder will have to be cautious and ensure accurate written records are kept. Each site is likely to be different, so what may work for one landholder may turn out to be disastrous for their neighbour.

Advice should be sought to best determine carrying capacity of a piece of land with particular attention paid to the HDSD grazing method. Advice can be sought from Tim Prance of Prograze (a joint initiative of Meat and Livestock Australia and various State government agencies) or from Department of Primary Industries and Resources South Australia (PIRSA). Advice should include,

- Feed Budgets and
- Understanding what processes are important for the area of land concerned.

Prograze course outline can be found on the following internet site,
www.mla.com.au/content.cfm
Tim Prance can be contacted on,
Mobile 0427 812 655
or e-mail prance.tim@saugov.sa.gov.au

It may be best to start by dividing off a small area, for example 5 hectares, from an existing paddock and restrict use of HDSD grazing to this area only. As local knowledge grows, it may be appropriate to increase the number of small paddocks where HDSD grazing is used.

Young trees that have regenerated will require protection from stock before they are introduced for HDSD grazing.

Landholders should be prepared to discuss their successes and failures with other like-minded landholders in the district. It will be these links and written observations that will assist in developing future best practice guidelines for pasture grazing *Eucalyptus porosa* (mallee box) grassy woodlands. It would also be worthwhile visiting the NMGWG's web site for updated information on their project (www.nativegrass.org.au/pastures.htm)

DEFOLIATION OF NATIVE GRASSES

Native Vegetation Council (NVC) approval is required before native vegetation is defoliated for biodiversity enhancement. Exemption 5(1)(zi) of the Native Vegetation Act may allow grazing or burning of native vegetation. A management plan approved by the NVC will be required prior to grazing or burning as will a monitoring program.

If a grassy woodland does not experience some form of defoliation, stands of native grass can become rank, unproductive and in some cases will die, particularly *Themeda triandra* (kangaroo grass) (Eddy 2002) and *Stipa* spp. (spear grasses). These grasses require occasional defoliation to flourish. Defoliation is also required to open up inter tussock spaces between grasses to allow other plants to grow (Eddy 2002).

Defoliation should only be required in areas that are not grazed by stock, kangaroos or feral herbivores and have not been burnt.

Critically, the required frequency of defoliation is unknown, particularly on shallow or low nutrient soils as occur in *Eucalyptus porosa* (mallee box) grassy woodlands. Caution will be required when determining if defoliation is appropriate. Bearing in mind that each location will be different, defoliation may be required at some point between 5 to 15 years. It will be essential to monitor the condition of a grassy woodland over several years before undertaking defoliation and continue monitoring after defoliation. If possible, monitoring should take into account local fauna. Long term accurate observations of birds including time of year, how many and what they were doing when recorded should be considered a minimum.

It will be beneficial to develop links with other landholders in similar situations to share knowledge gained and to learn from each other's successes and failures. It will be these links and written observations that will assist in developing future best practice guidelines for defoliation of native grasses.

A number of options exist for defoliation including,

- burning
- grazing and
- slashing.

It is important to realise that no single technique should be used exclusively. It will be better to alternate between techniques. Following a cautious approach, only a small proportion of a given area should be treated at any one time, for example 5 - 10% of a piece of bushland. The areas treated must be mapped and recorded for future reference.

Management of any negative unforeseen consequences will be much easier over a small area. Treating smaller areas also enables any animals that may be present to escape and seek refuge elsewhere.

By only treating a small area each time a mosaic of different age classes since defoliation will be promoted. This could be achieved over a larger area if neighbouring landholders are willing to co-operate and time defoliation accordingly. A mosaic of different age classes will help to ensure suitable habitat for a wider range of plants and animals.

Treatment should occur after native plants have flowered and set seed. Typically, this gives a window of opportunity between late summer and mid winter.

Burning

If used appropriately and confined to specific areas, fire will defoliate native grasses and may assist in the regeneration of certain native species.

However, fire is a very complex management tool that few people understand. It is essential to seek professional advice from a qualified fire ecologist, who has experience in using fire as a management tool in native grassy woodlands. It will also be necessary to consult with the local Country Fire Service.

It will still be necessary to ensure minimum disturbance of soil and must be considered if fire is the chosen tool. Soil disturbance from fire trucks and fire fighters can be more damaging than sheep.

Timing of fire management should aim to minimise damage to small native herbaceous plants such as lilies. It should not be done when native plants are flowering or setting seed. Late summer to mid winter is likely to be the most appropriate time of year, but confirmation must be sought from a qualified fire ecologist. Appropriate timing may change from year to year depending on weather conditions.

Fire is known to stimulate germination of numerous weed species and landholders must be prepared to undertake any necessary weed control if this occurs. This is another reason to only use fire in small areas.

Grazing

Grazing to defoliate rank native grasses uses the same process as described in the section Grazing Regime Change To Enhance Native Pasture, High Density Short Duration Grazing. A large number of stock are placed within a fenced section of grassy woodland for 1 – 4 days. High degree of input is required from any landholder wishing to use this technique. Late summer to early winter will be the most appropriate time for this to occur.

Stock should be quarantined in a relatively weed free paddock for several days prior to releasing them into the area to be defoliated. This will limit the introduction of weed seeds to the native vegetation.

Landholders should be prepared to undertake additional weed control after the stock have been removed. Broad leaved weeds are likely to be advantaged due to resulting soil disturbance from sheep's hooves.

Slashing

If the area of rank native grasses is relatively small it may easiest to use a small walk behind slasher or brush cutter. Larger areas may be slashed using a tractor driven slasher. Equipment must be clean of weed seeds and plant parts that may regrow before being used to slash in areas of native vegetation. Grasses should not be cut below 10cm height. Slashing can be done in late summer to mid winter. To slash earlier may have a negative impact on the native grasses. To slash later may prevent or minimise the plants' ability to flower and set seed. Slashing later may also be detrimental to other native plants such as lilies. **Do not confuse this defoliation technique with slashing to control annual or perennial weed grasses.**

Regulations regarding required fire fighting equipment must be adhered to regardless of the

official fire danger season.

Landholders should be prepared to undertake additional weed control after slashing. Broad leaved weeds are likely to be advantaged due to resulting soil disturbance and increased light at the soil surface.

Note: Eddy (2002) has listed windrows or mounds of grass clippings as an important consideration, as they can smother and kill native plants. Sometimes bare ground can result, and combined with increased nutrients from the decomposition of grass clipping mounds can lead to potential weed invasion. Eddy (2002) recommends using flail type mowers or removal of the clippings from the site.

HERBIVORE MANAGEMENT

A range of herbivores can have negative impacts on grassy woodlands and restoration projects. Whatever the species of herbivore(s) any control method must be undertaken in a humane and ethical manner. Professional advice should be sought to ensure the most up to date methods are employed.

Rabbits / Hares

The negative impact to native vegetation due to rabbits and to a lesser degree hares is well known throughout South Australia. They have the capacity to drastically alter a landscape and prevent natural regeneration of native species. They also compete with native animals for food and shelter.

The release of the rabbit calici virus has done much to reduce the impact of rabbits on the South Australian landscape, particularly in the drier areas of the state. Unfortunately, like all biological controls, it has not eliminated the problem. It is still essential for landholders and land managers to undertake rabbit control on their properties. Even a low level of rabbits can dramatically impact on native species.

A number of options are available for rabbit control depending on time of year and location of rabbits. All warrens, both active and old, need to be destroyed and regularly monitored to prevent other rabbits or foxes re-opening the warrens.

One of the most humane methods of rabbit and warren control is to use explosives to implode the warren. A qualified professional must be used for this task. The explosive blast will instantly kill all rabbits in a warren and destroy the warren at the same time. This prevents other rabbits from re-opening old warrens and foxes from digging to gain access to the dead rabbits. In remnant bushland it has the major advantage of eliminating rabbits and warrens with minimal soil disturbance.

Note: it is essential to ensure native animals are not using the warrens. Goannas, sleepy lizards, snakes and echidnas are known to frequent rabbit burrows. Sweeping the entrance to a warren and checking tracks left will determine the occupants of the warren. It may take several days of checking to ensure reptiles are not using warrens, particularly in winter. If there is any doubt, alternative methods should be used.

Alternative methods of rabbit control are available and landholders should contact the APCC to obtain the most the appropriate technique for their requirements and a list of suitable

professionals for the job. Wherever possible, the technique that results in the least disturbance should be taken. Baited grain runs applied from a vehicle should be avoided as these usually result in increased weeds due to soil disturbance.

Hares are more difficult to control as they do not create burrows. Hares do not reach the same numbers as rabbits and are generally less of a problem. Of course, if rabbits are removed and food sources increase hares or other herbivores will increase correspondingly. Advice should be sought from APCC for the most appropriate hare control.

Kangaroos

Kangaroos can be an impediment to natural regeneration when their numbers are excessively high. Feral and domestic herbivores must be controlled before attempting to control kangaroos. Discouraging kangaroos by preventing access to water where possible may be all that is required to prevent over grazing of native bushland.

If this fails it may be necessary to address over abundant kangaroo numbers. Approval must be obtained from the Department for Environment and Heritage. Additional advice should be sought from the local APCC.

Snails

In some years snails can be highly damaging to native vegetation and crops. Control is usually undertaken by laying baits, however this can lead to considerable off target damage to native lizards and birds. Baiting snails should only be used as a last resort. Monitoring will be essential and removal of dead snails from bait stations will go some way to limiting off target damage to native animals.

Corellas and Galahs

In some locations corellas and galahs will pull out seedlings. There is evidence to suggest they are attracted to tree guards, particularly milk cartons. The best option is to rely on natural regeneration and avoid planting. If this is unavoidable, it may be necessary to use robust corflute tree guards.

FERAL PREDATORS

Foxes

It is well known that foxes have a serious impact on our native wildlife. After vegetation clearance many ecologists attribute the decline of much of our native fauna to fox predation. Not only do foxes hunt and kill native wildlife they also compete with many for food. Foxes are omnivorous and will often eat fruits and berries. They are also involved in the spread of many weeds via their faeces, for example African boxthorn and blackberry.

To be effective fox control needs to be undertaken with a landscape perspective. It requires the co-operation of all landholders within a landscape and needs to be undertaken over a long time period. It is rarely effective if only one landholder undertakes fox control. As soon as fox control ceases neighbouring foxes will move into the area. Fox control can still be effective on a single property, particularly if a specific outcome is identified, ie protection of a particular bird species during their breeding season. Further advice should be obtained from Animal and Plant

Control Commission.

Cats

Feral cats are known to hunt numerous native birds, reptiles and small animals. Considerable research over many years has tried to find an effective method to control feral cats. To date the only effective method has been to fence a given area with cat proof fences and systematically shoot cats within the fence. Cat proof fencing may also inhibit the natural movement of native faunal species. The main problem with controlling feral cats on a large scale appears to be due to their reluctance to take baits. Further advice should be obtained from Animal and Plant Control Commission.

REVEGETATION

It is widely accepted by most ecologists that blocks of native vegetation are more useful to wildlife than narrow strips, ie roadside vegetation. Similarly, large blocks of vegetation are more useful than smaller scattered patches. Linear strips and small patches of bushland have many edges compared to core habitat. These edges are often degraded and more likely to have a higher proportion of weeds. Paton (2001) suggests that in cleared areas revegetation should cover at least 10 hectares to accommodate home ranges of declining bird species.

Revegetation should aim to increase the size of existing patches of native vegetation. Linking existing remnants or providing stepping stones through the landscape should be of next importance. Linking existing remnants requires substantial commitment from landholders. Links should be as wide as possible, not less than 50m. Barrett (2000) has demonstrated that narrow links or corridors of only 10m width rarely have any benefit to declining bird species and often further threaten these species because narrow corridors tend to encourage over abundant and aggressive birds such as noisy miners.

Any revegetation must be undertaken in a well thought out and considered manner. It would be worthwhile knowing if neighbouring landholders intend to undertake revegetation, where they intend to do it and what size. This information can then be used to determine where the greatest biodiversity benefit would be gained from revegetating a particular property.

Fencing will be required in most situations to protect revegetation, particularly if stock are to be grazed in nearby areas.

BEST PRACTICE REVEGETATION

NATURAL REGENERATION

Natural regeneration is far more efficient, effective and respectful of existing native vegetation. Natural regeneration will usually happen if remnant vegetation is nearby, even if it is skeletal and degraded. Given time and appropriate weed control, native species flourish and new species will appear, either germinating from the soil seedbank, as wind borne seed or via animal droppings. Planting of tubestock or direct seeding is rarely necessary and is usually an expression of our desire to put a human stamp on nature or to meet requirements of funding bodies that are limited to a 12 month cycle. It is impossible for humans to replicate the random arrangement of plants that occur in a natural system.

SECOND BEST PRACTICE REVEGETATION

PLANTING

Planting tubestock or direct seeding into remnant vegetation should be strongly discouraged. Such planting will compromise the integrity of the existing bushland. Efforts need to be directed towards encouraging natural regeneration using bush regeneration techniques. If, after 3 – 4 years of bush regeneration work there is little improvement in bushland condition, it may be appropriate for revegetation to be undertaken.

Revegetation must only occur in areas that have been ploughed or cropped or otherwise cleared in the past, with a minimum 20m buffer between revegetation any existing native vegetation.

Many people are unable to curb their desire for planting tubestock or direct seeding, even though

native vegetation may be degraded or border the areas they wish to return to native vegetation. Degraded vegetation will respond better to bush regeneration techniques than revegetation. It is not the purpose of these guidelines to encourage second best practice methods, as such detailed information regarding timing of preparation, seed collection and propagation have not been supplied. These can be obtained from a number of sources including Project Officers and publications such as What Seed Is That by Neville Bonney.

Situations may arise where a landholder wishes to develop a *Eucalyptus porosa* (mallee box) grassy woodland in an area that has been previously cropped and no native vegetation currently exists with the exception perhaps of a few paddock trees. If there is no native vegetation bordering the area it will be necessary to undertake revegetation. Such action should be viewed as a difficult task that may take many years to achieve. It may be wise to start with a small area or areas that can be easily managed without taking valuable time away from other activities, such as managing existing remnant vegetation. As these small sections of revegetation produce their own seed and begin to resemble a grassy woodland they can be slowly expanded.

Before collecting seed it will be necessary to obtain a seed collecting permit from the Department for Environment and Heritage. Permission is also required from the landholder, which may be a private individual, local council (some reserves and roadsides) or other government agency.

All seed collected for planting must be collected from as close as possible to the planting site. A general guideline is within 5km. Commonsense needs to be exercised when applying this guideline, in some situations there may not be any native vegetation within 5km, in others it may only be 1km. The logical answer is to collect seed from as close as practical and from the nearest similar soil type and topographical area.

It should be remembered that the final structure of any planting for a *Eucalyptus porosa* (mallee box) grassy woodland will have mature trees, **on average**, 10 – 30m apart. Trees should not be regularly spaced and it is acceptable to have a few clumps of trees closer together.

It will be necessary to maintain all plantings with excess trees cut down or drilled and filled. Thinned trees should be left on site to break down naturally and provide additional habitat for wildlife.

Direct Seeding

Mechanical direct seeding allows large areas to be revegetated, but requires large amounts of time to maintain. Mechanical direct seeding requires judicious thinning of juvenile plants within 2-3 years to ensure appropriate spacing between plants. This must be done before the plants flower and produce seed, especially wattles. Failure to do this will result in revegetation that will bear no resemblance to a grassy woodland. If wattles produce seed there is the chance seed will remain in the soil to germinate at a later time frustrating the landholder's efforts to produce a grassy woodland.

Mechanically direct seeded areas can be thinned by spraying with herbicide or the cut and swab method for greater refinement.

Tubestock

Tubestock allows greater control when trying to develop a particular structural arrangement of plants, such as required for a grassy woodland.

Tubestock allows more difficult species to be grown. Smaller plants, such as grasses and daisies, will do best if planted in discrete clumps enabling higher likelihood of pollination and easier weed control in the future.

On the negative side, revegetating with tubestock can be laborious and time consuming and seedlings may be less likely to survive in a dry year.

SPECIES SUITABLE FOR PLANTING

Species listed below are for a general guide only. Recommendations from local experts should be sought to ensure species are appropriate for individual locations, soils and topography.

Tree Species
(Ensure that mature trees will be 10 – 30m apart)

Eucalyptus porosa	mallee box

Other tree species may be used as appropriate to mimic nearby native vegetation including species such as,

Allocasuarina verticillata	drooping sheoak
Callitris gracilis	southern cypress pine
Pittosporum angustifolium (formerly *Pittosporum phylliraeoides*)	native apricot

Shrub Species
(Aim for small sparsely scattered clumps only)

Acacia ligulata	umbrella wattle
Acacia pycnantha	golden wattle
Acacia spinescens	spiny wattle
Bursaria spinosa	sweet bursaria
Dodonaea viscosa	sticky hop bush
Eutaxia microphylla	common eutaxia
Melaleuca lanceolata	dryland tea tree

Understorey species
(Plant in clumps for greater success and ease of maintenance)

Aristida behriana	brush wire grass	*Arthropodium* spp.	vanilla lilies
Danthonia spp.	wallaby grasses	*Bulbine bulbosa*	bulbine lily
Enneapogon nigricans	blackhead grass	*Clematis microphylla*	old man's beard
Stipa spp.	spear grasses	*Dianella* spp.	flax lilies
Themeda triandra	kangaroo grass	*Kennedia prostrata*	running postman
		Lomandra spp.	mat rushes
		Vittadinia spp.	New Holland daisies

PROPERTY ENHANCEMENT FOR NATIVE FAUNA

A range of native fauna have been found in the vicinity of *Eucalyptus porosa* (mallee box) grassy woodlands in the project area. The appendices contain a list of fauna observed during the 2002 Nature Conservation Society of South Australia survey of the Eastern Mount Lofty Ranges.

Landholders can encourage or protect native fauna on their property by changing some their practices. The items listed below have been adapted from Bird Australia's Birds on Farms brochure (Barrett 2000) and include,

- Recreate or enhance local conditions
- Exclude high impact land uses near native vegetation.
- Native vegetation should cover large areas.
- Maintain a range of tree ages
- Leave fallen trees to break down naturally
- Maintain native vegetation around water

Recreate or enhance local conditions

This is best achieved by protecting existing native vegetation. Most native animals prefer original native vegetation; only few species have been advantaged by land clearance and Western-style farming practices. These are now the over abundant native species that many people consider pests, such as certain kangaroo species, corellas and noisy miners. Our declining woodland birds must have native woodland habitat to survive.

Landholders can encourage the expansion of existing patches of native vegetation via natural regeneration or, if expanding into large areas, following the guidelines under the section titled Revegetation. Plants grown from local remnant seed sources must be used.

Exclude high impact land uses near native vegetation.

High impact uses such as ploughing, cropping, fertiliser application and frequent grazing should be excluded near native vegetation. These activities prevent natural regeneration, destroy habitat for wildlife, such as spiders, other invertebrates, lizards and birds and encourage exotic weeds that degrade native vegetation.

Native vegetation should cover large areas.

Native vegetation should be in blocks at least 10 hectares in size. If revegetation is undertaken it should aim to expand existing native vegetation to at least 10 hectares. Landholders wishing to provide links for wildlife should consider planting strips at least 50m wide. Narrow shelter belts and fence line plantings tend to encourage over abundant species that are detrimental to declining species.

Maintain a range of tree ages

A range of tree ages is important to native wildlife and the continuation of native vegetation. Old mature trees often provide valuable nesting or roosting hollows for birds and bats. They tend to have large numbers of insects that can provide food for native animals. Younger plants are required to take over from the old trees when they finally die. Mature trees that are cropped and grazed around will not produce any offspring that will survive. Even single paddocks trees provide valuable habitat, but are not being replaced in many agricultural landscapes in South Australia. Providing 0.5 to 1 hectare free of grazing around single paddock trees will ensure a

range of tree ages is provided into the future.

Leave fallen trees to break down naturally

Leaving fallen trees and branches to break down naturally provides important habitat for a range of animals, including reptiles, birds and mammals such as echidnas. Insects and fungi thrive around fallen timber providing valuable food sources for native animals. Our desire to clean up messy areas has left many landscapes poorer for native animals. Trees or timber that falls near a dwelling or shed could be moved to another part of the property that contains native vegetation.

Do not use fallen trees as firewood, or at least leave half of it to break down naturally. If a landholder requires firewood they should consider planting specifically for it.

Maintain native vegetation around water

Native vegetation will improve the health of property features such as creeks and dams. Native vegetation also provides protected access to water for native birds and other animals. If dams are large and frequented by native waterfowl a landholder could consider building and vegetating a floating island to encourage the birds to breed where they will not be attacked by foxes or cats.

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APPENDICES

MAJOR VEGETATION STRUCTURAL FORMATIONS IN SOUTH AUSTRALIA.

(Croft S., Pedler J. and Milne T (2005) Adapted from Specht 1972, The Vegetation of South Australia, 2nd ed., Government Printer, Adelaide.)

LIFE FORM/ HEIGHT CLASS	**PROJECTED FOLIAGE COVER OF TALLEST STRATUM**			
	Dense (70 – 100%)	**Mid-dense (30 – 70%)**	**Sparse (10 – 30%)**	**Very Sparse (<10%)**
Trees > 30m	Tall closed forest	Tall open forest	Tall woodland	Tall open woodland
Trees 10 – 30m	Closed forest	Open forest	Woodland	Open woodland
Trees 5 – 10m	Low closed forest	Low open forest	Low woodland	Low open woodland
Trees < 5m	Very low closed forest	Very low open forest	Very low woodland	Very low open woodland
Mallee > 3m	Closed mallee	Mallee	Open mallee	Very open mallee
Mallee < 3m	Closed low mallee	Low mallee	Open low mallee	Very open low mallee
Shrubs > 2m	Tall closed shrubland	Tall shrubland	Tall open shrubland	Tall very open shrubland
Shrubs 1 – 2m	Closed shrubland	Shrubland	Open shrubland	Very open shrubland
Shrubs < 1m	Low closed shrubland	Low shrubland	Low open shrubland	Low very open shrubland
Grasses	Closed grassland	Grassland	Open grassland	Very open grassland
Sedges	Closed sedgeland	Sedgeland	Open sedgeland	Very open sedgeland

PLANTS PRIMARILY FOUND IN GRASSY ECOSYSTEMS

Below are two lists of plants that are largely confined, in the agricultural regions of South Australia, to native grasslands and grassy woodlands.

Observing one species from the lists does not mean you are standing in a grassy ecosystem. If the observer is able to identify several of these species it is more likely they are in a grassy ecosystem.

Source; Rick Davies (1997) *Weed Management in Temperate Native Grasslands and Box Grassy Woodlands in South Australia,* Black Hill Flora Centre, Adelaide.

GRASSES AND GRASS-LIKE PLANTS

CYPERACEAE

Lepidosperma curtisiae	little sword-sedge

GRAMINEAE

Aristida behriana	brush wire-grass
Bothriochloa macra	red-leg grass
Chloris truncata	windmill grass
Danthonia auriculata	lobed wallaby-grass
Danthonia carphoides	short wallaby-grass
Danthonia linkii var. *fulva*	leafy wallaby-grass
Dichanthium sericeum ssp. *sericeum*	silky blue-grass
Elymus scabrus var. *scabrus*	native wheat-grass
Enneapogon nigricans	black-head grass
Homopholis proluta	rigid panic
Panicum effusum var. *effusum*	hairy panic
Paspalidium constrictum	knotty-butt paspalidium
Stipa blackii	crested spear-grass
Stipa curticoma	short-crest spear-grass
Stipa gibbosa	swollen spear-grass
Stipa multispiculis	
Stipa setacea	corkscrew spear-grass

JUNCACEAE

Juncus homalocaulis	wiry rush
Juncus radula	hoary rush
Juncus subsecundus	finger rush

LILIACEAE

Lomandra nana	small mat-rush

FLOWERING PLANTS

AMARANTHACEAE	
Ptilotus erubescens	hairy-tails
AMARYLLIDACEAE	
Calostemma purpureum	pink garland-lily
BORAGINACEAE	
Cynoglossum suaveolens	sweet hound's-tongue
CAMPANULACEAE	
Wahlenbergia luteola	yellow-wash bluebell
CHENOPODIACEAE	
Atriplex semibaccata	berry saltbush
Maireana decalvans	black cotton-bush
Maireana enchylaenoides	wingless fissure-plant
COMPOSITAE	
Calocephalus citreus	lemon beauty-heads
Cymbonotus preissianus	austral bear's-ear
Lagenifera huegelii	coarse bottle-daisy
Leptorhynchos elongatus	lanky buttons
Leptorhynchos squamatus	scaly buttons
Leptorhynchos tetrachaetus	little buttons
Olearia pannosa ssp. *pannosa*	silver daisy-bush
Podolepis canescens	grey copper-wire daisy
Podolepis jaceoides	showy copper-wire daisy
Vittadinia blackii	narrow-leaf New Holland Daisy
Vittadinia gracilis	woolly New Holland daisy
GOODENIACEAE	
Goodenia albiflora	white goodenia
Goodenia pinnatifida	cut-leaf goodenia
Velleia paradoxa	spur velleia
LEGUMINOSAE	
Acacia acinacea	wreath wattle
Cullen parvum	small scurf-pea
Templetonia stenophylla	leafy templetonia
LILIACEAE	
Arthropodium fimbriatum	nodding vanilla-lily
Arthropodium minus	small vanilla-lily
Dianella longifolia var. *grandis*	pale flax-lily
Wurmbea latifolia ssp. *vanessae*	broad-leaf Nancy
MALVACEAE	
Sida corrugata	corrugated sida

RHAMNACEAE	
Cryptandra amara var. *amara*	spiny cryptandra
RUBIACEAE	
Asperula conferta	common woodruff
THYMELAEACEAE	
Pimelea curviflora	curved riceflower
Pimelea humilis	low riceflower
Pimelea micrantha	silky riceflower
UMBELLIFERAE	
Eryngium rostratum	blue devil

FAUNA LIST FOR *EUCALYPTUS POROSA* (MALLEE BOX) GRASSY WOODLAND

In 2002 the Nature Conservation Society of South Australia conducted a Flora and Fauna Survey of Grassy Ecosystems in the Eastern Mount Lofty Ranges (Johnson 2003). The lists below were sourced from this survey and these species may be found in *Eucalyptus porosa* (mallee box) grassy woodlands.

MAMMALS

western grey kangaroo	*Macropus fuliginosus*
common brushtail possum	*Trichosurus vulpecula*sum
short beaked echidna	*Tachyglossus aculeatus*
southern freetail bat	*Mormopterus petersi*
white striped freetail bat	*Tadarida australis*at
Gould's wattled bat	*Chalinolobus gouldii*
chocolate wattled bat	*Chalinolobus morio*
lesser long eared bat	*Nyctophilus geoffroyi*
large forest bat	*Vespadelus darlingtoni*
southern forest bat	*Vespadelus regulus*
small forest bat	*Vespadelus vulturnus*

*red fox
*brown hare
*European rabbit
*house mouse
*black rat

* denotes and introduced species.

BIRDS

wedge tailed eagle	Willie wagtail
black shouldered kite	mistletoebird
spotted harrier	diamond firetail
singing bushlark	brown falcon
dusky woodswallow	nankeen kestrel
white backed magpie	laughing kookaburra
sulphur crested cockatoo	sacred kingfisher
galah	welcome swallow
little corella	tree martin
black faced cuckoo shrike	superb fairy wren
white winged triller	red wattlebird
brown tree creeper	spiny cheeked honeyeater
peaceful dove	white plumed honeyeater
crested pigeon	singing honeyeater
common bronzewing	brown headed honeyeater
white winged chough	New Holland honeyeater
little raven	Richard's pipit
Horsfield's bronze cuckoo	varied sittella
pallid cuckoo	grey shrike thrush
magpie lark	rufous whistler
grey fantail	yellow rumped thornbill

yellow thornbill
chestnut rumped thornbill
southern whiteface
spotted pardalote
striated pardalote
weebill
hooded robin
Jacky winter
tawny frogmouth

white browed babbler
mallee ringneck
purpled crowned lorikeet
elegant parrot
blue bonnet
crimson rosella
red rumped parrot
brown songlark

*skylark
*European goldfinch
*common blackbird
*house sparrow
*common starling

* denotes and introduced species.

REPTILES

Flinder's worm lizard	*Aprasia striolata*
marbled gecko	*Christinus marmoratus*
Adelaide snake lizard	*Delma molleri*
eastern stone gecko	*Diplodactylus vittatus*
southern rock dtella	*Gehyra sp.*
tree dtella	*Gehyra variegata*
Bynoe's gecko	*Heteronotia binoei*
barking gecko	*Nephrurus milii*
tawny dragon	*Ctenophorus decresii*
eastern bearded dragon	*Pogona barbata*
eastern spotted ctenotus	*Ctenotus orientalis*
eastern striped skink	*Ctenotus robustus*
three toed earless skink	*Hemiergis decresiensis*
four toed earless skink	*hemiergis peronii*
Bouganville's skink	*Lerista bougainvillii*
Southern four toed slider	*Lerista dorsalis*
spotted slider	*Lerista punctatovittata*
dwarf skink	*Menetia greyii*
common snake eye	*Morethia boulengeri*
sleepy lizard	*Tiliqua ruogsa*
eastern blue tongue	*Tiliqua scincoides*
eastern brown snake	*Pseudonaja textilis*
little whip snake	*Suta flagellum*
Mitchell's short tailed snake	*Suta nigriceps*