MANAGEMENT GUIDELINES

for the Native Grasslands of the Merri Creek

Judy Bush and Tony Faithfull

Merri Creek Management Committee

December 1997

Funded by Environment Australia National Reserve System Program

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Contents

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1. Summary

Western Basalt Plains Grasslands are one of the most depleted and endangered communities in Victoria. They are listed as a threatened community under the Flora and Fauna Guarantee Act (Victoria). One third of Victoria's remaining western (basalt) plains grasslands occur in the Merri Creek catchment in the outskirts of the northern suburbs of Melbourne. They provide important habitat for flora and fauna, some of State and National significance. They also contain sites of Aboriginal archaeological sensitivity and significance. Few of the Merri Creek Grasslands are currently in secure public ownership, and some are threatened by freeway construction or housing development. Preservation of these remaining remnants must involve acquisition, the use of planning controls and other legislative devices, cooperative management agreements, covenants and continuing research, development and implementation of on-ground management actions. Grasslands can be difficult to manage, partly because of the complexity of the community, and partly because of a lack of knowledge about successful and effective techniques. There is also a fear amongst some, based on the fact that so few grassland remnants remain, that they may do the wrong thing, or choose the wrong technique. However it is important to actively manage the grasslands, even if this means making some mistakes, with actions and techniques designed to prevent further deterioration.

The priority management actions that should occur involve:

- managing vegetation densities and competition to provide a mosaic of environments for the diversity of native grasses and forbs, and their dependant wildlife to flourish.
- maintaining the health of the grasslands through regular burning or other biomass reduction strategies to maintain vigour and prevent senescence.
- targeting weed control to protect the native grasslands from particularly invasive weeds.
- protecting the grassland remnants from accidental disturbance and ensuring that any tracks or other facilities required do not impact on the values and integrity of the remnants.
- establishing a 'Merri Plains Grassy Ecosystem Reference Group' with membership from state and local government agencies, conservation groups, MCMC and grasslands researchers. The Group would meet on a regular basis with a key focus of providing management advice to management agencies and groups. The group would collect and review research findings, management actions and monitoring of management actions (both to ensure monitoring is adequate and ongoing, and to feedback monitoring results to review and modify planned management actions).

Management actions must be consistent and ongoing (not just one-off), protect and enhance the flora, fauna and Aboriginal archaeological and landscape values. Regular monitoring is essential to ensure management regimes and actions are effective. Management actions should be reviewed and improved on a regular basis. Management of the Merri Creek Grassland remnants should occur in a regional context, involving all levels of government, community groups, private landowners and interested individuals, with regular input from grasslands researchers.

2. Introduction

This report, as well as a companion pamphlet and poster comprise a project funded by Environment Australia National Reserve System Program to develop and promote grassland management guidelines for the native grasslands of the Merri Creek Catchment. The guidelines contained in this report have been developed for use by land managers and field technicians, to guide them in planning and implementing management actions, their timing and priority. Information contained in the poster is aimed at promoting the beauty and conservation value of grasslands to members of the public and local residents, and includes notes on what to do in a grassland and where to find the grasslands of the Merri Creek. The pamphlet aims to provide information to conservation and friends groups and other interested members of the public about the conservation status of grassland ecosystems generally, and of Merri Creek grasslands.

Native grasslands once covered the basalt plains west of Melbourne through to the South Australian border. They are usually dominated by *Themeda triandra* (Kangaroo Grass) tussocks with sub dominant *Danthonia spp* (Wallaby Grasses) and *Austrostipa spp* (Spear Grasses). Perennial forbs or wildflowers occur in the open patches between the grass tussocks. Some trees such as *Eucalyptus camaldulensis* (River Red Gum) and shrubs such as *Hymenanthera dentata* (Tree Violet) sparsely dot the grasslands. In shallow depressions, grassy wetlands are found, with a large range of species present in varying zones related to depth and duration of inundation. Grasslands provide habitat for native birds, (particularly birds of prey, parrots and ground dwelling birds), mammals (such as kangaroos, wallabies and native rats, as well as the Eastern Barred Bandicoot) and reptiles (particularly snakes and skinks), some of which are now rare and endangered species.

3. Western Basalt Plains Grasslands Conservation Status

After European settlement, grassland ecosystems were devastated by grazing, weed invasion, ploughing, rock removal, fertilisers, rabbits, foxes, cats and urban development.

Native grasslands are amongst the most threatened communities in this country (McDougall and Kirkpatrick 1994).

In 1788 there was approximately 2 million hectares of lowland temperate grassland in south-eastern Australia (Kirkpatrick *et al* 1995). The total area of grassland remnants in reasonable condition was approximately 10,000 hectares in 1992. Thus approximately 99.95% of the vegetation type has been destroyed in two centuries. Unfortunately this destruction is ongoing. For example, between 1986 and 1992, 44% of the western Victorian grassland sites noted by Stuwe (1986) were destroyed, degraded or earmarked for destruction, with half of the remaining sites reduced in quality or area to some extent (Kirkpatrick 1993).

Preservation of the remaining remnants must involve acquisition, the use of planning controls and other legislative devices, cooperative management agreements (eg Donnybrook Quarry Site Management Plan, Boral Australia), covenants and continuing research, development and implementation of on-ground management actions. (Legislation, strategies and policies to protect native grasslands are listed in Appendix 1.)

Almost half of the remaining remnant western basalt plains grassland sites are on private land (Muir 1994). There is an urgent need to set up a grassland reserve system to ensure protection of remaining sites and application of appropriate, well timed management actions to halt further deterioration of the remaining remnants.

4. Native Grasslands of the Merri Creek

One third of Victoria's remaining western (basalt) plains grasslands occur in the Merri Creek catchment in the outskirts of the northern suburbs of Melbourne. The major grasslands remnants in this area are listed below (see also **figure 1**). Bald Hill, Mt Ridley and Craigieburn represent some of the biggest areas of remnant Western (Basalt) Plains Grasslands in Australia; the largest remnants of this community are only in the order of hundreds of hectares.

Victorian National Parks Association (VNPA), Merri Creek Management Committee (MCMC) and Friends of Merri Creek (FOMC) have proposed that these grassland remnants should become units or annexes in a Merri Grassland Park, and that if the individual units are viewed as a single park, with habitat corridor linkages, the conservation of a much wider range of grassland species and sub-communities could be achieved.

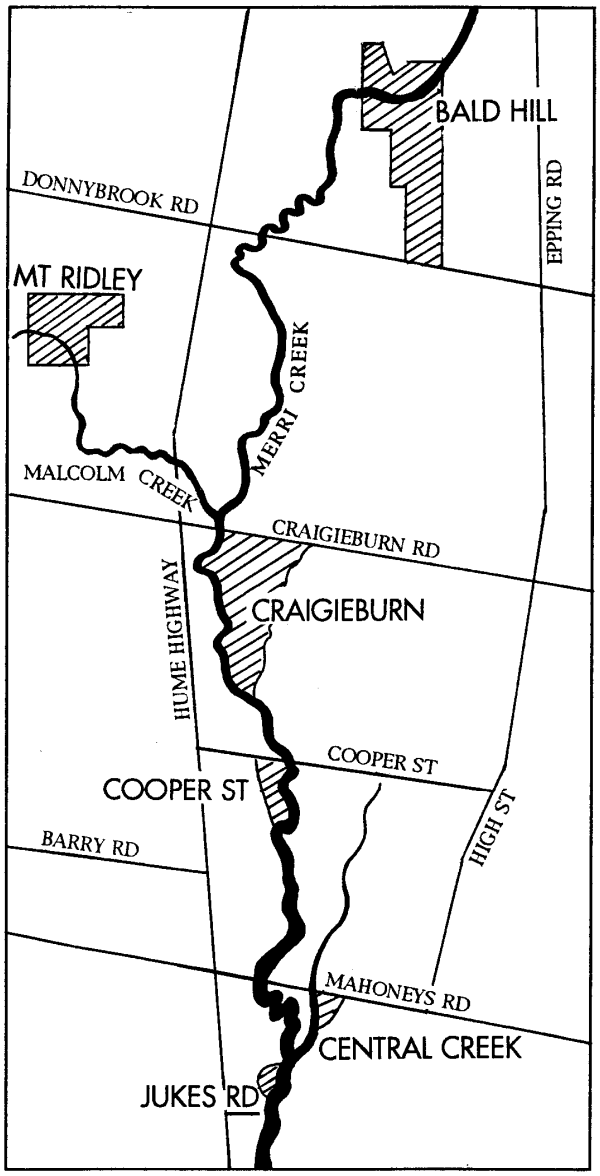

Figure 1. Native Grasslands of the Merri Creek

Bald Hill Grasslands Located in the Kalkallo area, this 600 hectare site extends from Donnybrook Rd to north of Bald Hill. It features areas of stony knoll shrubland and extensive tussock grass as well as sightings of the threatened ground dwelling bird, Plains Wanderer and the Southern Lined Earless Dragon. It is subject to quarry development by Boral Australia, however a management plan is being prepared which will include conservation management over much of the site, including a covenant over the most environmentally important areas.

The flora and fauna of the area has been documented in "Vegetation of the Native Grasslands in the Merri Creek Valley, Outer Melbourne Area" by Frood, (1992) and "Conservation Assessment of Proposed Quarry at Donnybrook, Victoria. Flora and Fauna Attributes and Conservation Management Guidelines" by Larwill *et al* (1994), the latter prepared for Boral Quarries.

Mt Ridley Grasslands North of Mt Ridley Road, Craigieburn, on Malcolm Creek, a tributary of the Merri, is a 150 hectare site of grasslands and grassy woodlands. The site is of state significance. It is privately owned but subject to a local government re-zoning process and is currently being managed sympathetically by the land owners.

The flora and fauna of the area has been documented in "Report on the Flora of Mount Ridley" (Albrecht 1993) and "The Flora and Fauna of the Mount Ridley Grassland and Grassy Open Forest Ecosystems" (Cropper and Cherry 1997) and management guidelines for the area are documented in "Mt. Ridley Flora and Fauna Management Guidelines" (Kern 1996).

Craigieburn Grasslands This 400 hectare site is on the east side of the Merri Creek, immediately south of Craigieburn Rd. The grassland is of National significance and features areas of grassy wetlands which provide habitat for the vulnerable *Carex tasmanica* (Curly Sedge). It will soon be listed on the Register of the National Estate and prior to its election, the Victorian Coalition Government promised to purchase this area as a Flora and Fauna Reserve.

The grasslands are threatened by construction of the F2 freeway, which would connect the Hume Freeway north of Craigieburn to the Western Ring Road near Mahoneys Rd. The current suggested alignment travels across the north east section of the grassland, and would have serious impact on the grassland as a whole, and specifically on the wetland which provides habitat for *Carex tasmanica*.

The flora of the area has been documented in "Vegetation of the Native Grasslands in the Merri Creek Valley, Outer Melbourne Area" (Frood 1992) and in "Conservation Assessment for Craigieburn Grasslands, Craigieburn, Victoria." (Peake *et al* 1996).

Cooper Street Grasslands On the west side of the Merri Creek, immediately south of Cooper St Campbellfield is an 85 hectare site that will also soon be listed on the Register of the National Estate. Two old red gum scar trees beside the creek are reminders of the occupation of the land by the Wurundjeri, the traditional Aboriginal owners. One third of the site (22ha) is in public ownership (Parks Victoria) but the remainder (including the riparian edge) is privately owned and zoned for industrial uses. These grasslands are also threatened by the F2 freeway mentioned above. The current proposed alignment crosses the grassland section in private ownership (to the west of the publicly owned section).

The flora of the area has been documented in "Botanical Assessment of Grasslands Merri Creek - Somerton - Cooper St" (Cheal 1988) and "Vegetation of the Native Grasslands in the Merri Creek Valley, Outer Melbourne Area" (Frood 1992). The flora, fauna and natural history has also been described in "The Cooper St Grasslands" (Parrot Natural History Network, eds, 1990).

Central Creek Grasslands Located along Central Creek, a tributary of the Merri, near Bartrop St, Reservoir is a 13.5 hectare site. It is surrounded by housing and main roads but amazingly, grasslands and wildflowers still manage to survive on this tiny area. It could become a valuable education and tourist resource close to the city. Most of the area is already publicly owned by VicRoads, Parks Victoria and Darebin Council, but some of these authorities are proposing to sell the land for private housing.

The flora and fauna of the area has been documented in "Davidson St Grassland - A Report on the Flora, Fauna, Development Options and Management" (Robinson and Duggan 1994).

Jukes Rd Grassland This small 2 hectare site is located on the Merri Creek in Fawkner. It carries remnants of native grassland plants, including large patches of *Arthropodium strictum* (Chocolate Lily) and *Dianella amoena* (Flax Lily), and beautiful examples of natural rocky terraces which slope from the plains down towards the creek. Currently owned by Parks Victoria, the area is very accessible and could become an interesting grassland reserve for people to visit, study and enjoy.

The flora and some preliminary management ideas have been documented in "Vegetation Survey and Management Plan. Jukes Road, Fawkner." (Mueck 1997).

5. Cultural Heritage Values

The grasslands described in this report were part of the land inhabited by Aboriginal people, the Wurundjeri willam clan, part of the Woiwurung language group. Their land stretched from the Yarra River north to Mt Macedon, and from the Maribyrnong River east to Darebin Creek. The Aboriginal people regularly burnt the grasslands as part of their social responsibilities to 'keep the land clean'. The regular fires controlled the density of Kangaroo Grass (*Themeda triandra*), encouraging green pick for the kangaroos they hunted, and regeneration of the forbs, some of which, such as Murnong (*Microseris lanceolata*), were staples of their diet. Evidence of their occupation of the grasslands remains in the form of stone artefact scatters and scarred trees. Sites located within the Merri Creek Grasslands have already been identified, and predictive models exist which point to other areas of archaeological significance where more sites are likely to be found. It has also been suggested that the grasslands community itself is an Aboriginal artefact because the grasslands evolved and were actively managed through regular firing by the Aborigines (I. Ellender pers. comm.).

The cultural values are based on these existing sites of archaeological significance, as well as regional information and data from previous studies. The cultural values encompass the following:

1. Aboriginal. These values are articulated by the Wurundjeri Tribe Land Compensation and Cultural Heritage Council P/L (the Aboriginal Community of the Merri Creek catchment).
2. Scientific. The Grasslands and the sites within them (whether identified or not) have value in the process of further research and in answering topical research questions.
3. Educational. The sites within the grasslands are valuable in what they can contribute towards a better understanding of the Aboriginal culture, society and heritage by the general community.

Detailed recommendations for conservation and management of areas of Aboriginal archaeological significance or sensitivity are contained in "The Aboriginal Cultural Heritage of the Merri Merri Creek: including the Archaeological Survey for Aboriginal Sites from Craigieburn Road to Hernes Swamp." (Ellender 1997).

6. Management Objectives

The major management objectives for the Western (Basalt) Plains Grasslands are to:

- Conserve / protect through reservation, purchase, covenant or other means as many grassland remnants as possible, especially those considered significant.
- Actively manage remnants to maintain habitat, populations of rare, endangered, threatened or uncommon flora and fauna species, and significant plant and animal communities, and to exclude where possible threatening processes.
- Protect and conserve sites of Cultural Heritage such as areas of Aboriginal archaeological sensitivity.
- Secure significant and viable populations on a region wide basis. Maintain a register of significant species occurring in remnants in the region. Seek to establish populations of appropriate significant plant species.
- Establish and maintain linkages between sites, utilising wildlife corridors, open space and waterways.
- Work in a regional context, involving all levels of government, community groups, private landowners and interested individuals.
- Establish an interpretation program for native grasslands.
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7. Management Issues

Remnants of native grasslands are surrounded by land used for agriculture, industry or housing. As a result, there are numerous threats to the biological values of the grasslands from the neighbouring lands. Grasslands may be under threat from pressure of visitors who are interested in the grasslands themselves.

7.1 Accidental Disturbance or Exploitation

To the uninformed eye, native grasslands can appear no different to the local grazed paddock, or even an area of weeds in need of clean-up and as a result, much damage can result from accidental disturbance or exploitation. The grassland manager must protect the area from damage caused by the following types of actions:

- rock removal
- removal of wood, plants, soil
- excessive seed collection
- invasion of pest plants and animals (often caused by dumping of soil, garden waste, fill, rubbish)
- inappropriate recreation use (vehicles, bicycles, horses, walking dogs, etc)
- soil disturbance
- inappropriate mowing, slashing, grazing or even burning
- contracting management works to unskilled field technicians.

Fencing and signing may contribute to the protection of areas from this sort of damage. A suitably experienced botanist should carry out an on-site assessment to determine the exact location of fencing to decrease the potential for damage to important vegetation, disruption of wildlife corridors or discontinuance of important elements of the current management regime. Fencing must be regularly maintained and repaired (checked at least once every six months) to ensure it continues to provide the level of protection for which it was designed.

There are a variety of types of fences which can limit different sorts of access. Soldier posts or short bollards may prevent car access but not pedestrian or stock access. Cable fencing will prevent vehicle access and is more vandal proof than wire fencing. Light fencing with large signs which can be read from a distance may be all that is required when soil or vegetation disturbance to nearby areas is planned or under way, or as a first attempt to control undesirable vehicle access and rubbish dumping. Stock fencing should be installed where stock grazing is causing damage to the grassland. Fencing should provide stock control where grazing is required for management purposes.

Actions such as ploughing or broadscale insecticide treatments in, or near enough to impact on, the grassland should always be prevented as both actions could be permanently destructive to the biological values of the area (Yen 1993).

7.2 Tracks and paths

Any vehicle access to grassland remnants should be limited; particularly when the heavy clay soils are wet, as vehicles can cause soil compaction and disturbance, and provide a vector for introducing weed propagules. Access to grassland areas should be limited to existing formed tracks. Installation of new tracks or access points may be considered when regular access is needed for maintenance or interpretation or for emergency access, and the provision of the hardened track will cause less damage than the unformed access is already causing. New tracks should only be in areas where vegetation is already disturbed, and the effects of changes to hydrology or flora or fauna habitat should be considered both for location and construction of such tracks. Often the boundary of the remnant is significantly more weed invaded, and may therefore be a practical location for tracks. Suitably qualified botanists or land managers should supervise location and construction. If tracks are built in weedy areas, it is important to maintain "vehicle hygiene" to prevent spreading weeds to other areas.

Uncontrolled access by emergency vehicles during wildfires has caused problems of soil disturbance, compaction and formation of tracks in some grassland areas. This issue needs to be addressed through discussions with Metropolitan Fire Brigade (MFB), Country Fire Authority (CFA), Department of Natural Resources and Environment (DNRE) and the land manager. A fire plan for each site should be developed, addressing MFB and CFA needs, and protecting conservation values. For example, following detailed consultation between grasslands managers and fire fighting authorities, it may be possible for emergency vehicles to either fight fires from the boundary, or use specific tracks only during wildfire events.

7.3 Design of visitor facilities

Education and interpretation programs are an important aspect of the conservation program for native grasslands. Therefore, native grasslands must be managed to accommodate, and encourage visits from members of the public. Visitor facilities must be designed with the dual objectives of maintaining the environmental values of the grassland and presenting an interesting, informative and enjoyable experience for visitors. Within the Merri Creek catchment area, visitor pressure on all the grassland units could be focused by providing an educational focus and visitor facilities at some but not all of the six main grasslands. The Central Creek and Jukes Rd grasslands are both within the urban area and are relatively accessible. When their reservation statuses are clarified, these areas would function well as educational, interpretive parks. Careful design of entrances, carparks, tracks and buildings is necessary to minimise disturbance to the grasslands. Boardwalks through the grasslands would minimise damage to surrounding areas from compaction, water runoff, etc. The other grasslands could have a species and habitat conservation focus, and much more modest visitor facilities.

Beyond the Merri Creek catchment are several established grassland educational centres including Melbourne Zoo, Evans St Grassland at Sunbury and the Open Range Zoo at Werribee. Councils along the Merri Creek are encouraged to use grassland species in creative public domain landscaping, to further enhance community percpetion and recognition of this flora.

7.4 Water Quality and Increased Nutrient Levels

The application of fertilisers has contributed to the loss of much of the original grasslands of the Western Plains. With increased nutrient levels, many exotic species are able to out-compete the native grasses and forbs and weed invasion follows. Increased nutrient levels are also associated with water runoff from agricultural or residential areas. The quality of water entering any grassland reserve should be monitored to ensure continued quality of water entering the grassland. Some rare native species are significantly more sensitive to water enriched with the nutrients nitrogen, phosphorus and potassium (McIntyre 1993). When earthworks are planned near or within a grassland and if there is space available upstream of significant remnant vegetation, sedimentation ponds and wetlands should be constructed to remove excess nutrient and sediment load before the runoff enters the grassland. If insufficient space is available between a construction site and significant remnant vegetation to construct ponds other measures may be required. However it is the responsibility of the construction agency to ensure quality of runoff meets the standards set in the SEPP (State Environment Protection Policy) Schedule 7 and other Environment Protection Authority (EPA) guidelines.

It is important to conserve natural drainage patterns; if drainage lines are disrupted upstream of grassy wetlands or swamps, there may be enormous downstream effects on flow patterns and volume, which will in turn affect the environmental values within the wetland areas.

8. Management Strategies and Actions

8.1 Basic management principles

- Use the smallest and lightest equipment suitable for the job.
- Use equipment that is clean and free of contamination from weed seed or soil.
- Restrict activity only to the work site.
- Don't cause unnecessary vegetation damage or soil disturbance.
- Get baseline data before starting work, so that it is then possible to later assess the effectiveness of management actions.

A management plan should be developed for each site which defines management actions. Development of a management plan will involve identifying, analysing and documenting features and history of the site together with a program of actions to achieve the site management goals. Flora and fauna surveys should be targeted to detect significant species, as well as a broad range of other species. Priorities between conservation and other uses should be detailed. Findings from research should be communicated to land managers and field technicians to allow informed, effective management.

Relocation and restoration are extremely expensive, and their success is yet to be proved. Therefore, protecting and maintaining existing remnants is the only reliable way to ensure survival of native grasslands (Craigie 1993). The priority management actions are to regularly reduce biomass, and to control weeds.

Management myths

If the native grassland still exists, current management must have been working, therefore don't try to fix it; maintain status quo management.

Burning of the same area in consecutive years should never occur.

If in doubt do nothing.

Management myths have developed for several reasons. Land managers and field technicians have had a sincere desire to carry out the 'correct' management actions, but have sometimes been hindered by fear of the consequences of doing the wrong thing, particularly because there are now so few grassland remnants remaining. Grasslands are complex environments, and management actions can have wide reaching effects. The management actions required for protection of grassland flora have often been seen to be very different, or sometimes in conflict with the management actions required for protection of grassland fauna. Some of the myths are based on the accepted techniques and reasoning of several years ago, and more recent research has shown that the above principles are mostly inappropriate. This highlights the need for regular contact between grassland researchers and field technicians, so that researchers can communicate their recent findings, and discuss research ideas, and field technicians can communicate the results of their monitoring, and management problems they may be facing.

8.2 Managing vegetation densities, competition and senescence

Some form of regular biomass reduction in *Themeda triandra* Grasslands is needed to prevent *T. triandra* from out-competing and swamping smaller native species. It is believed that prior to European settlement the Aboriginal people regularly burnt the grasslands, and that the fires performed a biomass reduction function. Grazing by kangaroos and emus, and disturbance by bandicoots were also important factors. Flannery (1994) suggests that prior to Aboriginal settlement of Australia the now extinct grazing macrofauna also provided this function.

T. triandra also requires some form of disturbance (eg burning or grazing) approximately every one to five years (depending on soils and climate) or it will senesce (grow old and die) (C. Hocking pers. comm.). Senescent tussocks can easily be pulled out of the ground, and may have rotten bases. After *T. triandra* has entered the senescence phase, there will only be patchy regeneration following fire (or other disturbance), so it is vital that some form of disturbance is initiated before that time. The rate of aging and death of *T. triandra* appears to be related to soil moisture and depth of soil and appears to be quicker in wetter areas and along drainage lines. In general, *T. triandra* will reach senecence after 8 years if there is no disturbance.

Recent grassland publications (eg Diez and Foreman 1996) suggest that the distribution of grassland species may have been more uniform than their current distribution in remnants would suggest. This difference has been generated by varying site management post-settlement. In particular, smaller narrow linear remnant sites that have been regularly burnt (as in most rail line and road side remnants) tend to be species rich while the larger remnants (most broadacre remnants) that have been regularly grazed tend to be species poor. The implications of this are that if the current management is changed from grazing to fire or vice versa another set of species might be removed from the site. However Lunt (1993) suggests that we need to go beyond the maintenance of the status quo to enhance grasslands, and that by understanding the effects of grazing, burning and even mowing on plants with different life forms we can manipulate biomass without necessarily disadvantaging desirable species.

When planning biomass reduction programs, it is important to feedback results from monitoring to modify and improve management plans. Therefore management plans should not be based on rigid long term schedules, but should be flexible enough to be regularly reviewed and modified. In the absence of site management plans it is important to have a fallback position for biomass reduction.

It is recommended that there should be some form of biomass reduction at least every three years (at least for grasslands dominated by *Themeda triandra*). It has been suggested that a combination of

biomass reduction techniques, rather than use of a single technique may produce better results in terms of managing vegetation densities while still maintaining species diversity.

Reduction of biomass at any one site should be carried out in a patchwork pattern to allow different areas to provide a mosaic of habitat types for different flora and fauna species.

8.2.1 Grazing: Native herbivores, cattle or sheep

Diez and Foreman (1996) suggest that for the Riverine Plain Grasslands of Victoria there is an ideal level of grazing at around 0.6 dry sheep equivalent per hectare (dse/ha). Diez and Foreman (1996) define '1 dry sheep equivalent' as a 45 kg adult dry (as opposed to lactating or pregnant) sheep consuming feed for 12 months (based on Muir and Simpson 1990). One head of cattle is roughly equivalent to 10 dse (White and Bowman 1981).

Diez and Foreman (1996) suggest that it is necessary to provide opportunity for flowering and seed set of native plants by resting paddocks containing significant grassland vegetation between August and November when most of the Riverine Plain's vegetation flower and seed. They identify an ideal situation on the Northern Plains where grazing leads to between 9 and 22% bare ground cover, and native grass overlapping cover 20 - 50%. In drought conditions they suggest that where there is loss of cover, and large amounts of bare ground, stock should be removed rather than risk damage to the vegetation. Grazing during droughts should be avoided, and no grazing should be allowed until the vegetation begins to recover.

Translation of these recommendations to the Melbourne region is outlined below, but soils, rainfall and vegetation differ markedly and more detailed work would need to be done to analyse grazed sites around Melbourne.

For sites such as the Craigieburn Grasslands, it has been suggested that grazing should be gradually reduced to lower levels, and that exclusion plots be established to allow comparison of grazed and ungrazed areas.

However others have suggested that flash high level grazing may be preferable. They argue that although there has been little specific research on the effects of grazing on conservation values, there has been a lot of research in the agricultural area which may provide some information to conservation managers. For example, agriculturalists have found that short periods of heavy grazing allow less selective grazing and therefore may reduce the relative impact on palatable species (T. Barlow, pers. comm.). Such a grazing regime would more closely resemble the quick and intense removal of biomass associated with burning. There is also some research indicating that long term low level grazing may eliminate many invertebrates, whereas localised, high intensity, short term grazing will not have the same impacts (Dall 1997).

Sheep have a lesser impact on grasslands than cattle, both in terms of pugging (sheep's smaller size leads to relatively less extreme pugging of the soil), and because their smaller, drier dung has a lesser smothering impact on native plants compared with cattle; however sheep are more selective than cattle and may therefore have a greater negative impact on some of the more delicate, palatable forbs. If there has been a break in grazing and some of the grasses have formed mature, closed tussocks, sheep will selectively avoid the tussocks and go for the green pick. Therefore they may not contribute to the biomass reduction of the closed tussocks. If sheep are to be reintroduced to such a site, it would be desirable to reduce the biomass of the large tussocks prior to their introduction by other means (burning or slashing).

Action	recommended when	not recommended when	Reference
Grazing with sheep at 0.6 dse/ha (up to 1 - 2 dse/ha depending on productivity of site), rested between September and January and in drought.	Biomass reduction required and site has been regularly grazed in recent historic times	Site does not have a grazing history. Weeds with seeds easily transported by sheep present (eg **Nassella neesiana*)	Diez and Foreman 1996
Grazing: flash grazing in late January after tall upright forbs die down and before they resprout	opening of grass canopy required selection required for tall upright forbs	Weeds with seeds easily transported by sheep present (eg **Nassella neesiana*) If Plains Wanderer present or to be encouraged to return and grazing would lead to less than 6% of the vegetation being higher than 5 cm at any time.	Lunt 1993 (Rokewood Cemetery) Baker-Gabb 1995
Introduction of indigenous grazers eg. Grey Kangaroos	Opening of grass canopy required. Control of numbers by natural emigration, shooting or other means is acceptable. Sufficient food and shelter is available for health of the individuals. Suitable healthy individuals are available.	Roaming dogs present Animals may stray onto nearby roads or agricultural grazing lands, commercial or residential properties. Introduction may cause problems to existing populations of indigenous grazers on the site by competition or disease introduction	

Where stock grazing is thought to be damaging grassland, a small experimental grazing exclusion plot is needed to provide information on the likely effects of excluding stock.

Before being introduced to a grassland site livestock must have clean wool and clean feet and have had clean feed (for the previous 24 hours) to avoid transport of weed seed into the site. No supplementary feeding of stock should occur on grassland sites.

8.2.2 Burning

Fire can be used to reduce biomass of grass species, open up intertussock spaces and trigger regeneration of native forbs. Fire is also necessary for the regeneration of species with hard seeds requiring alternating temperatures or contact with smoke to promote germination (eg. peas, *Convolvulus*, *Dichondra* species). It is also a useful tool in weed control programs (outlined below). A mosaic burning regime should be developed to minimise the impacts on the fauna of a site. A site management plan should be developed that divides the site into sections and then schedules burns for each section at regular intervalsso that the whole site is burnt on a regular basis, probably every 3 years. During dry years there will be less biomass production and so the three year interval may be stretched. Such decisions should be made by experienced land managers in consultation with botanists or grasslands researchers.

For example, the Evans St Management Plan divides the site into 4 sections with 2 sections to be burnt each year according to a schedule supplied, so that the sections are burnt every 2 - 4 years (Ross, 1995). The Waverley Flora Park Management Plan (Pyrke 1993) establishes a mosaic of patch burning based on a map that identifies boundaries of burning units and the years in which they

should be burnt. Early spring is identified as the preferred burning time. Each patch in the mosaic is allocated a fixed burning interval, which ranges from three to eight years. A flexible and reactive burning strategy is needed which takes into account the various factors relevant to any one year (arson, burning as part of weed control etc) (Pyrke 1993).

Research is continuing into the differing effects of burns carried out in different seasons, and of burns with differing intensities. Trials are being carried out in senescent *T. triandra* grassland, using a watering down / overburning technique, to see if the senescent plants may have more potential to reshoot after such a fire. Watering down acts to thoroughly wet the ground; when the area is subsequently burnt, the fire is more likely to simply remove the aerial parts of the plant, without burning out the base of the tussock, which will still be damp. This approach may protect the aging tussocks and encourage greater levels of regeneration. (C. Hocking pers. comm.). However most researchers now agree that it is better to burn an area every three years in any season, than to not burn an area because of uncertainty of outcomes.

The amount of area to be burnt in any one year must balance the need for regular biomass reduction with the amount of resources available for followup weed control. Burning should always be followed by weed control as the bare ground created by the fire provides many opportunities for invasion by weeds. The fire may also trigger germination of soil stored weed seed. Such follow up weed control may need to be intense and should be budgeted for.

Planning burns for conservation areas around Melbourne is an involved process, often requiring permission from several authorities, notification of neighbours, and waiting for the right weather (appropriate wind direction, speed, humidity and temperature).

The Metropolitan Fire Brigade (MFB) have responsibility for areas south of Cooper St, while the Country Fire Authority (CFA) are responsible for areas north of Cooper St.

A permit is usually required before a fire can proceed, and written application should be made to the Bylaws section of the appropriate local council at least two weeks prior to the planned date of the burn. The letter seeking permission to carry out a vegetation management burn should outline the location of the site, the area to be burnt, the reason for the burn, the type of firebreaks to be used, the other authorities to be notified and the staff and equipment to be available to carry out the burn in a controlled way.

Other authorities to notify, usually on the day before the burn are the local police, the MFB or CFA, EPA and other neighbouring land managers or residents. The Bureau of Meteorology can provide a spot forecast for a particular location which details expected temperature, humidity and wind speed and direction. Spot forecasts are available after about 3 pm on the preceding day. If a smog alert is declared, the burn should be postponed. The EPA declare smog alert days after about 3 pm on the preceding day. A specific plan for the burn should be prepared, with areas to be burnt clearly marked. The approach to burning should also be specified, with some consideration given to the most appropriate wind direction to carry the fire, whether smoke will impact on neighbouring properties or utilities, where water tanks can be refilled during the day and where to back burn to aid the operation of the slashed firebreaks. Some consideration should also be given when burning small remnants in residential areas to the likely movement of snakes and other reptiles; try to shepherd snakes away from houses where possible.

Depending on the site, management burning should take place under the following conditions (adapted from Craigie and Stuwe 1992)

- There must be as little vehicle disturbance to the site as possible.
- If there is evidence of the presence of the *Delma impar* (Striped Legless Lizard) or other significant reptiles at the site, soils must be hard, dry and cracked (to provide refuges from the fire for the reptiles).
- Firebreaks should be constructed about 3 m wide, slashed with a clean hand-held whipper snipper or small mower (such as self propelled deutscher type), and slash should be raked onto areas to be burnt with a light garden rake. Never construct fire breaks or carry out fuel reduction by ploughing, scraping or use of herbicides.
- Breaks should be formed at least 10 m from experimental plots or traplines
- Wet breaks with water prior to ignition. Ensure any residual chemicals are thoroughly flushed from water tanks before filling with water.
- Burn only when the wind direction will take smoke away from sensitive industry or heavy traffic. Consider putting signs near areas of traffic alerting drivers to "Slow down, smoke ahead".
- Vehicles must not drive on areas of wet, soft ground.
- "Slip-ons" (ie. slip-on water tank unit mounted on a 4WD tray-truck) can be stationed on firebreaks but must not drive off the slashed firebreaks unless essential in an emergency situation.
- Fire retardant chemicals should be avoided if possible to reduce nutrient input to the soil.
- Tankers are not to be driven onto the site except for in an emergency. If a fire gets away and MFB / CFA attend, request their cooperation and seek to halt the fire at a margin (such as a road) rather than encouraging the fire fighting vehicles to drive over or across the site.
- Maintain follow-up weed control on slashed firebreaks.
- Keep records of burns and monitor changes in vegetation resulting from firebreak construction and prescribed burning.

Continue monitoring of flora and fauna populations to determine the most appropriate fire regime. Revise proposed fire regimes in the light of results of monitoring at this and other sites.

Other equipment required will include fire lighters, either drip torches or flame throwers; water knapsacks; rake hoes and / or hessian beaters. Staff present at the burn should be equipped with goggles and dust masks, leather boots and gloves and should be wearing long sleeves, long pants and woollen hats (or hard hats where there are trees).

The requirement for soil to be dry, hard and cracked will usually lead to a summer or autumn burn. Note that if Tough Scurf-pea (*Cullen tenax*) or indigenous annuals are present, burning in summer prior to seeding should be avoided, to prevent destruction of seed by fire. For plants that regenerate only by seed and not by reshooting root stock, it is important to ensure that seed set has occurred before the area can be burnt.

Burning of the whole site or a large proportion of site in one season should only be carried out when the site is small and has a history of being regularly completely burnt. (Lunt 1993, Larwill *et al* 1994).

Spot spraying should always be carried out following fire as the bare ground provides excellent opportunities for weed invasion. There may also be a flush of germination of weeds from soil stored seed triggered by the fire (eg Gorse and weedy grasses). In long-unburnt and long-grazed grassland at Derrimut, a fire promoted abundant regeneration of exotic species, while few native species regenerated from seed (Lunt 1990). This highlights the fact that fire cannot be used as the primary tool for promoting indigenous species regeneration. However, in some situations where resources

for follow up spraying are unavailable, burning (or some other form of biomass reduction) should still be carried out, to prevent grassland senescence, but this situation should be seen as sub-optimal.

Burning can be used to suppress excess growth of tree seedlings such as *Acacia mearnsii* (Black Wattle), *Acacia melanoxylon* (Blackwood) or *Acacia paradoxa* (Hedge Wattle) when monitoring indicates tree density is significantly increasing.

8.2.3 Mowing / Slashing

Mowing or slashing may be considered when reduction of biomass is needed, or when topping of tall weed species is required to reduce seed set, and burning or grazing is not appropriate. It should never be carried out when the soil is wet (as this will lead to compaction and / or soil disturbance from mowing equipment) or when the site has weeds with standing seed crop which could be spread by mowing equipment (eg. **Nassella neesiana*, (Chilean Needle Grass), **Homeria miniata* (Two-leaf Cape Tulip) Lunt 1993). Slashed plant material should be removed to prevent windrows or piles of cut material forming and suppressing indigenous plant growth. Where biomass is not heavy, the formation of windrows may be reduced by using a horizontal axis mulching type mower. There are also tractor mounted mowers that include a vacuum device that collects cut material (Yarra Bend Park Trust uses such a machine, T. Barlow pers. comm.). It may not be necessary to remove slashed plant material if windrows are not formed when there is limited biomass. Flail mowers, which having a cutting barrel that spins backwards, are able to be used on rocky uneven ground as the cutting barrel moves upwards and is not damaged when it hits a rock. Whipper snippers or brushcutters can also be used in rocky areas.

The slash may be timed to coincide with *Themeda triandra* seed or thatch collection in late December - January. (Refer to Appendix 6 Seed Collection Guidelines.)

8.3 Targeted weed control and associated revegetation

Carr *et al* (1992) define environmental weeds as exotic plants that invade native vegetation, usually adversely affecting the regeneration and survival of the indigenous flora and fauna. Environmental weeds include both non Australian and Australian species, the latter being species that invade native vegetation beyond their pre-European distribution, eg *Acacia baileyana* (Cootamundra Wattle), *Pittosporum undulatum* (Sweet Pittosporum).

Weed invasion is usually associated with prior disturbance, either physical or chemical. Examples include ploughing, digging, overgrazing, vehicle tracks or other soil disturbance, increased nutrient levels through application of fertiliser, or runoff from fertilised areas, pesticide application. Prolonged, repeated or intense disturbance can lead to greater levels of invasion; and the boundaries of native vegetation are usually under more stress and therefore more prone to invasion (Carr *et al* 1992).

The degree of threat that weeds pose to native vegetation has been recognised by the listing of "invasion of native vegetation by environmental weeds" as a threatening process in Schedule 3 of the Flora and Fauna Guarantee Act. Weed invasion of native vegetation can affect both the function and structure of the ecosystem (Carr *et al*, 1992). In native grasslands, weed invasion can lead to altered fire regimes and fuel loads, acceleration of soil erosion, swamping of native plants, prevention of recruitment of native species, and alteration or removal of faunal habitat. Without appropriate management, weeds have the potential to invade and significantly degrade all native vegetation communities in Victoria, including the Western (Basalt) Plains Grassland Community. Weed control in native grasslands is labour intensive and expensive and requires a high level of plant identification and technical skills.

Carr *et al* (1992) cite grasslands and grassy woodlands as the communities most subject to weed invasion. They list 344 weed species of grassland and grassy woodland communities, with 87 of

these being very serious weeds. A list of the most serious grassland weeds of the Merri Creek grasslands can be found in Appendix 2.

8.3.1 Weed control programs addressing site conditions

Different weeds have varying potential to impact on the grasslands' biological values. Priority for control should be assigned to:

- highly invasive weeds.
- weeds that take up space and directly outcompete the native grasses and forbs.
- weeds that are easy and quick to control.

The priority weeds may vary from site to site depending on site conditions. An assessment needs to be carried out at each site to prioritise the weeds to be treated and areas to be treated. Prioritisation should be based on information about the invasiveness of each weed species present, the amount of area currently occupied by each weed and the quality and significance of remnant indigenous vegetation in the area. It is not necessarily the most obvious weeds (eg **Rosa rubignosa*, Briar Rose) that should be the highest priority, as other weeds such as some of the grassy perennial weeds potentially have more serious impact, due to the fact that they are of similar habit and occupy the same stratum as the native grasses and forbs, and therefore have the potential to directly outcompete and replace those native grasses and forbs. The list of serious grassland weeds in Appendix 2 includes a listing of Priority 1 and 2 weeds. These are weeds that are either the most invasive and potentially damaging (many of the perennial grasses) or the easy to control weeds (some of the woody weeds). Annual weeds may not be as threatening to the biological values of the grassland because they do not have the same potential to outcompete and replace the indigenous flora as other classes of weeds. At some sites, removal of ugly weeds such as **Rosa rubignosa* (Briar Rose) and **Cynara cardunculus* (Artichoke Thistle) may be a priority if the site has an educational or interpretive focus, and removal of the weeds will improve the 'image' of the site, and of grasslands as a whole.

An assessment of the soil stored seed bank may provide information on potential future germination flushes and control requirements. Soil stored seed can be assessed by measuring germination of soil samples in greenhouse tests.

Equipment for weed control includes spray backpacks and wick wipers for herbaceous weeds; and for woody weeds cordless drills and spotguns, and an applicator for painting neat herbicide on cut stumps. (Emptied liquid shoe polish bottles are useful although not designed for this purpose. If they are used for this purpose they should be clearly labelled with the type and concentration of herbicide they contain.) It is important that any equipment used to carry or apply herbicide be clean prior to use, and not leaking. Rig spraying should only be used with extreme caution. The treatment's value, in terms of controlling priority weeds, must exceed the likely damage (from spray drift and splashing) to non-target species.

There will generally be a need for regular attention, approximately three times per year. Some weeds are capable of quickly invading an area and outcompeting particularly the more delicate indigenous species.

It can be extremely difficult to differentiate exotic and indigenous grasses during herbicide application. Field technicians should be given opportunities to confirm identification of grasses prior to and during herbicide application. When spot spraying target weed species, teams should work in a grid or band formation to ensure thorough treatment of an area. Spray marker dyes should be used to ensure thorough coverage but not over application of herbicide. It is often easier when spot spraying to target only one or two species to be sprayed, so that the field technicians can focus their identification on differentiating these species from the surrounding native flora. It may often be necessary when targeting exotic grasses to wait until the flowerhead first emerges to be able to positively identify the exotic grasses. Regular monitoring of an area prior to weed control will be necessary to ensure that the herbicide is applied at the ideal time; ie when flowering has just begun

and the plant is actively growing, but prior to seed set. Vegetative characters, such as colour and thickness of leaf blades, shape of the ligule and shape and density of individual tussocks can also be used to help differentiate weedy grasses from native grasses. Field technicians must have excellent plant identification skills and be able to identify all the indigenous plants as well as the targeted weeds. They should also be aware of indigenous plant species that may only be found seasonally. For example, some of the native lilies may not be visible during autumn, and winter visits to the grassland, but may be actively growing and setting seed during spring and summer at the same time as herbicide is being applied.

Grassland researchers agree that it is better to do something than do nothing (V. Craigie, C. Hocking, J. Morgan, I. Shears, pers. comm.). Operators need to be provided with training in plant identification, as well as an overview of the management objectives and issues at each particular site, so that they can make decisions in the field. Sometimes it will be necessary to balance possible low level losses of indigenous plants to achieve control of some invasive species. These decisions must often be made in the field by the operators, without reference to the researchers. This highlights the need for regular communication between researchers and field technicians so both groups are aware of findings and difficulties of the other group.

8.3.1.1 Perennial Grassy Weeds

Most healthy grasslands are relatively resistant to weed invasion, although the edges or boundaries of the remnant vegetation and disturbed areas are more prone to invasion. In a healthy grassland with less than 40% weed invasion, spot spraying of isolated tussocks should be carried out. The gaps produced will usually be filled by growth or recruitment of indigenous species. Where there is more than 40% weed cover, weed control will need to be accompanied by some form of revegetation, either by direct seeding or tubestock planting.

Weed cover less than 40%

Spot spraying of the weeds should be carried out. It is sometimes difficult to identify grasses if flowering material is absent (particularly where **Nassella trichotoma* occur near indigenous *Poa spp,*and where **Nassella spp* occur near indigenous *Austrostipa spp*). When this is the case, spraying could be postponed until the flowerheads appear, at which time the exotic spear grasses are easier to distinguish. If spraying occurs soon after the appearance of the flowerheads, seeds will not form. It may also be difficult to spray mature weed tussocks without affecting native species where weeds and indigenous plants are growing closely together. If the area to be treated is burnt prior to carrying out herbicide application, the fire will remove the dense vegetation cover, both of indigenous and exotic species and allow carefully targeted application of herbicide to the regrowth of the weeds. The fire will stimulate growth and flowering (particularly if the burn is carried out in early spring) of weed and indigenous grass species to facilitate identification and selective spot spraying. The burn should be followed by selective spot spraying with glyphosate (or similar) of perennial tussock weeds. This technique should not be used if the weed cover is greater than 40%, or if bared patches produced after herbicide application would be bigger than 0.4 m diameter. A spring burn should not be carried out if there is evidence of the Striped Legless Lizard present and more than 10% of the site would be burnt. The advantage of this technique is that herbicide application is much easier for the field technicians. Field technicians should inspect the site prior to a burn, and map areas of infestations to be treated and locations of indigenous plants (particularly the smaller forbs such as lilies, etc). This will aid location of plants following regrowth after the fire.

Closed *T. triandra* tussocks tend to suppress germination of **Nassella neesiana.* A fire will trigger germination of **Nassella neesiana* and so act to use up some of the soil stored seed bank of **Nassella neesiana*. However adequate spot spray follow up must be guaranteed to ensure that the level of weed invasion decreases, not increases as a result of the management actions.

Weed cover greater than 40%

In areas where dense weed growth occurs in patches or bands or invasion fronts, or gaps created are larger than 0.4 m diameter, a burn (or other form of biomass reduction) could be followed by one or several applications of Roundup (active ingredient glyphosate) or similar to kill priority weeds, followed by application of *Themeda triandra* mulch at a thickness of approximately 10 cm. (The thickness of mulch may need to be increased if the quantity of seed produced is lower than average.) The mulch should then be removed by burning (or raking). In recent studies, Phillips (in prep) found that the rate of *T. triandra* establishment was greatest, and weed invasion was least when the area was burnt in late summer, the herbicide was applied in Winter, followed by thatching in early Spring and removal of the thatch by burning in early Summer. Phillips (in prep) details techniques for more accurately calculating the thickness of thatch required, based on the quantity and germinability of seed in the thatch. Hocking states that 1000 seeds / m^2 are required to produce 40 successful plants / m^2, which is the minimum density required to resist weed invasion (C. Hocking pers. comm.).This technique aims to re-establish a weed resistant monoculture of *T. triandra* but should not be used when significant plant species are present or when the proportion of weed cover is less than 60%. *T. triandra* mulch should be collected from a site where there are no weed species that are not already present at the target site to avoid introducing a new suite of weed species to the site being restored (Phillips, in prep).

The use of atrazine (the active ingredient in Flowable Gesaprim or Nutrazine) has been advocated for some areas as it selectively controls C3 plants while C4 plants are resistant (McDougall 1988). (C3 and C4 plants have different photosynthetic pathways; atrazine affects photosynthesis in C3 plants but not in C4 plants.) Warm climate, summer flowering grasses such as *T. triandra, Chloris truncata, Bothriochloa macra,* and *Dicantheum sericeum* are C4 grasses and will therefore not be affected by the herbicide, except at very high concentrations. Atrazine is a residual herbicide. Residues of atrazine have been found in ground water in some agricultural areas in USA. However most of these areas have an open sandy soil and residual chemicals would be expected to move through such material. The Western Basalt Plains Grasslands grow on heavy clay soils and residual herbicides tend to bind very strongly to these clays, so problems of residues in ground water would be expected to be limited. In some preliminary trials around western Melbourne, atrazine has been demonstrated to have a half life of eight months, and to show a small amount of movement through the soil (C. Hocking pers. comm.). However there are many indigenous herbs that are in the C3 group. Therefore the use of atrazine should be limited to weed control in *T. triandra* or other C4 grass monocultures, to prevent damage to existing or germinating susceptible native forbs and other C3 grasses such as *Danthonia, Poa* and *Austrostipa spp*. Such areas could include weedy sites where *T. triandra* has been or will be direct seeded using mulch or chaff.

Frenock (active ingredient tetrapion) has often been prescribed for control of **Nassella trichotoma.* However it was shown to be highly mobile in basalt soils compared to glyphosate or atrazine, and affected plants outside target areas (Phillips, in prep). Phillips also found that areas cleared of **Nassella trichotoma* by treatment with Frenock wre quickly invaded by weeds from the ASTERACEAE family (Phillips in prep).

8.3.1.2 Other weeds

It is very difficult to obtain long term control over annual weeds. They are not easily controlled by herbicide, and further research is necessary to investigate burning regimes which may be used for control. It was observed that there was a decrease in the annual weeds present in the first year after a burn on a railway reserve near Geelong. However there was no difference in the level of annual weeds in subsequent years. Thus the short term decrease was not sustained (J. Morgan pers. comm.).

There are a number of widespread weeds over which there are no known effective control techniques that would not severely impact on the native species present. Such widespread weed species include **Romulea rosea, *Avena spp, *Briza spp* and **Aira spp. *Romulea rosea* produces a huge soil stored seed bank, and may inhibit colonisation and regeneration of indigenous species after fire (I.

Lunt, pers comm.). Some workers are trialling control using herbicide wick wipers with varied results (V. Craigie pers. comm.).

If woody weeds are present on site, an assessment should be made of their potential for rapid spread and dominance. Although woody weeds may be more obvious in the landscape than exotic grasses, they may have a lower priority for control, as the weedy grasses may have a greater potential for damage to the grassland. However if woody weeds are identified as a priority because of their likely rapid spread and dominance, (or for image reasons at educational grassland sites) they should be controlled. Species include Boxthorn, Hawthorn, Gorse, Broom, and Artichoke Thistle. For large plants control should be by drill and fill technique: removal of cut material is often costly and may require undesirable vehicle access. The drill and fill technique is usually more successful, particularly for control of boxthorn. The frilling technique (where the bark around the base of the tree is peeled away and the sapwood revealed is painted with herbicide) is only effective on the Brooms. For smaller plants of the above species and for Briar Rose, control and removal of woody weeds may be achieved by cutting and painting the cut stump with herbicides. Glyphosate (undiluted) is effective in most cases for all the above techniques. The herbicide should be applied as soon as possible after the cut or drill hole is made (and certainly within 20 seconds) to ensure effectiveness of the herbicide action. Briar Rose is more difficult to control, and the use of Grazon (active ingredients triclopyr and piclorum) in painting cut stems is being trialed. However this herbicide must be used with extreme care as it is residual and any accidental spillage of even small amounts will affect the potential for regeneration of indigenous species in those areas.

8.3.2 Revegetation and seed collection

Bare patches larger than 0.4 m diameter created as a result of weed control activities should be revegetated to minimise reinvasion with the same or a different suite of weeds. Where possible, direct seeding with *T. triandra* mulch or thatch is a useful technique as the thatch may act to cover bare patches to reduce opportunities for weed seed to blow in and establish, and a dense cover of *T. triandra* can establish. Tubestock or speedlings (seedlings grown in small cells about the size of egg cups) could be planted after weed control. Ensure nursery weeds and slugs are not present in the pots, and use species of local provenance already common on the site to establish structural vegetation to resist weed invasion. (Suitable local provenance is defined as being from areas on the same soil type, within the same vegetation community and within the same catchment. However, for *T. triandra*, recent research may indicate that genetic variation within a site is greater than genetic variation between sites, even sites from different catchment areas (Emslie 1995). Therefore, the concept of local provenance may not be as important for *T. triandra*, although further research is required.)

Collection of seed is controlled by permit and other requirements. Application for permits should be made to DNRE. On private land, the landowner's permission is required. Guidelines for seed collection are detailed in Appendix 6. Seed will be required for restoration activities such as those outlined above where *T. triandra* thatch is used. Collection of seed should also be carried out when a significant population of a species is threatened with destruction, or seed is needed for ex-situ conservation programs such as establishing seed orchards. The limit on the amount of seed collected from any particular population should be strictly adhered to to prevent inadequate recruitment of the remnant population because of a lack of seed.

8.4 Rare species management - remnant populations; reintroductions

8.4.1 Disappearing species

Western (Basalt) Plains Grassland Community is listed as a threatened community under the Flora and Fauna Guarantee Act. This listing recognises the continued depletion and fragile conservation status of this community, as one of the most endangered communities in Victoria (Stuwe 1986). Within this threatened community are a significant number of threatened plant and animal species. According to Muir (1994) there are six animal species at risk (endangered or vulnerable) in Victoria, and one extinct from Victoria. Of the flora, there are twenty species at risk (endangered or vulnerable) in Victoria and one is extinct (see Appendix 3).

There are many more taxa that are considered locally or regionally significant; given the depletion of native vegetation across Victoria, all remnants are considered to be of at least local significance (Mueck 1997).

Rare species must be protected where they are currently found, by sympathetic management focussed on favouring the rare species. Additionally, consideration should be given to finding appropriate sites to reintroduce the rare species where it does not currently occur.

"The discovery of a rare plant in an area of native vegetation has often formed the basis for strong conservation arguments. Unfortunately the converse has also often been true, and without a rare species the case for conservation has been considered weaker" (Gullan *et al* 1990).

Very little (almost nothing) is known about invertebrate conservation and management in Western (Basalt) Plains Grasslands (Yen 1993) . Grasslands are composed of several interacting components. The responses of one component may not necessarily reflect the responses of the others. Invertebrates may be more sensitive to external factors than plants. While the plants characterise the grassland ecosystem, it is important to remember that conservation strategies based purely on plants may not be appropriate for invertebrates.

In south-eastern Australia the conservation of biological diversity in lowland grasslands involves systems based mainly on small remnants. Although some invertebrates are able to survive in very small remnants, the chances of local extinction are greater in smaller patches and the chances of recolonisation are diminished as distances between patches increase and the amount of habitat containing potential colonisers decreases.

Reservation of small remnants alone is inadequate, particularly for some of the invertebrate fauna. Active management of reserves and areas adjacent to reserves, including wildlife corridors is required to ensure long term survival.

To this end more information is required through a coordinated and integrated research and management programme for flora and fauna, including invertebrates. Such a program will only succeed if there is community involvement, and the management of land surrounding remnant grasslands is also addressed (Yen 1993).

Rare species may be threatened by the same processes which are listed as threatening for grasslands as a whole. Other threats may be in the form of invertebrate predation. When invertebrate predation is causing failure of significant plant species to survive as seedlings, spot application of insecticide (not a residual) on a temporary basis should be considered. However insecticide should not be applied if the invertebrates involved or others present on the target plant species are themselves significant, or if spot application density required approaches broadscale treatment. Such treatments have been used at Tuggeranong Railway Easement, ACT to protect a population of *Swainsona recta* (Swainson-pea) (Briggs 1993).

It is important to note that whilst soil disturbance adversely affects some indigenous species, it has been suggested that soil disturbance, including that caused by small mammals may be an important requirement for regeneration of some specific rare species (eg *Lepidium hyssopifolium* (Small

Pepper-cress), *Swainsona swainsonioides* (Downy Swainson-pea) and *Leucochrysum albicans* (synonym *Helipterum albicans* Hoary Sunray) McIntyre 1993, Pyrke 1993).

8.4.2 Reintroductions of species

Coordinate management of each site with other sites in the region to secure regional populations of significant species.

- identify species of regional or higher significance in the site.
- collect seed from regional or higher significance plant species occurring at the site. NB. special permits are required.
- make excess seed or propagated plants available for planting or seeding at other appropriate sites.
- where appropriate establish populations of plant species no longer present at the site, or which may never have occurred at the site from seed or other material collected at similar grassland or grassy woodland sites in the region.
- where appropriate establish populations of animal species no longer present at the site or which may never have occurred at the site from populations collected at similar grassland sites in the region.

According to Muir (1994), the focus of flora reintroductions should be on establishing viable populations of every species of Western (Basalt) Plains Grassland in at least one secure reserve. Priority species for reintroduction are listed in Appendix 5. Such species include herbaceous species that are not or no longer present at the site, or which possibly never occurred at the site. In the latter case, these species should be introduced as part of a program of establishing a secure population of the threatened species.

The selection of the site and the location for reintroduction within the site needs to be carefully chosen. The species to be reintroduced should be selected from a plant community which would originally have occurred at the site, and the site should have suitable microenvironments for the species. The site should be managed in a way which will be sympathetic to the species' needs. If the species would suffer from the proposed burning, grazing or mowing regime at the site, or would unduly constrain future grazing, burning or mowing at the site, it should not be reintroduced to the particular site. If plants of the species are in short supply, the plants should be reintroduced to the site most likely to sustain viable populations of the species. Such sites would have secure land tenure, and favourable management regimes. Frood has suggested that for example, some of the stony knoll areas in the Craigieburn grasslands may be good sites for reintroductions of some of the rare forbs that might be outcompeted by *T. triandra* in the open grassland areas (D. Frood pers. comm.). Priority species for reintroduction can be established at a site by planting of tubestock or other nursery stock if it is available. Direct seeding can be more wasteful of seed, and results can be more uncertain. However for some species it may be the only alternative, if the conditions for propagation are not yet known, understood, or able to be replicated in a nursery environment. Direct seeded plants are often more drought resistant.

Planting of tubestock of trees or large shrubs in appropriate microhabitats to restore woodland tree cover should only be carried out when there is clear evidence of previous tree growth. Tree or shrub establishment may produce areas of thinner grass growth and less soil moisture which could lead to greater habitat diversity; however excessive tree growth may suppress species which require lots of sun and moisture. Therefore the location of planting should be carefully considered to ensure significant herbaceous species are not affected. Tree and shrub species should be selected from the plant community which would have occurred at the intended planting site and tubestock of suitable local provenance should be used. (Suitable local provenance is defined as being from areas on the same soil type, within the same vegetation community and within the same catchment.) Trees or shrubs should not be planted within 100 m of existing trees to avoid affecting potential regeneration of the existing trees.

When there is clear evidence of previous tree growth (the existence of a grassy woodland subcommunity, sometimes shown by old redgum stumps) and the ground storey vegetation is of poor quality, natural regeneration of woodland within 100m of existing mature trees can be encouraged by creating openings in the vegetation for seedling establishment using weed control, grazing or slashing. Seedlings should be protected from grazing by fencing and any slashing should avoid emergent seedlings. Care should be taken that treatments to encourage woodland regeneration do not encourage weed invasion.

8.4.3 Relocation

When a significant population of a significant species is immanently threatened by certain destruction (eg housing development or road construction), individual plants should be relocated (or rescued) from the threatened site. Relocation involves digging up and removing the mature plants and replanting them, either at a secure site or in a seed orchard or nursery environment. A permit to carry out relocations must obtained from DNRE. Relocation should only be used as a last resort as it may lead to the destruction of the source population and a false sense of success (Jones 1993). In fact, relocation of individual plants is often unsuccessful, and relocation of communities almost always unsuccessful (V. Craigie pers. comm.).

8.5 Monitoring

Monitoring at all sites on a regular basis is necessary to ensure management regimes and actions are effective and weed control is targeting priority weeds. A thorough initial survey is required to give baseline information, against which data from subsequent surveys can be compared. Changes on the site identified during monitoring can be used to inform the review and improvement of management actions on a regular basis. Permanent quadrats, transects and photo points should be established to allow collection of data in succeeding years, and comparison of the effects of management actions over the short, medium and longer term. J. Morgan (Latrobe University) is currently preparing guidelines for monitoring, involving the use of agreed, repeatable techniques. He suggests that floristics (species composition and percentage cover) should be assessed every three years using permanent quadrats (suggested size 10 x 10 m). Quadrats should be located to collect information from all subcommunities within the site (eg wetlands, drainage lines, stony knolls, etc). A visual assessment of biomass and other general features should occur on an annual basis.

Surveyed permanent grid points allow accurate location of features or weed outbreaks. They should be established at 50 x 50 m intervals, or 100 x 100 m intervals on larger, open sites. The grid points can be marked using small wooden survey pegs. A 50 x 50 m grid has been established at Cooper St, with the grid points marked by survey pegs. The grid coordinates are stamped onto small aluminium plates which are then nailed to the top of the peg. A 1.5 m starpicket is placed next to the survey peg to make the grid markers easier to locate. It is important to note that maintenance of the grid is necessary: as the heavy clay soils crack in summer and become waterlogged in winter, survey pegs can become loose and may be dislodged. The grid needs to be checked and repaired annually.

The collection of phenological data on grassland species (both indigenous and exotic) would help to build up information on species to better plan future management actions. Phenology studies the correlation of climatic or seasonal factors with reproductive and vegetative development. Information recorded could also include the response of a particular species to an action or treatment. A sample of a sheet for recording such information is included in Appendix 7. Copies of sheets completed by land managers and field technicians of the Merri Creek grasslands (local government, Parks Victoria and MCMC) could be sent to MCMC for compilation and circulation to the proposed ‘Merri Plains Grassy Ecosystem Reference Group’.

8.6 Promotion / Education

Educational and passive recreation uses of Western Basalt Plains Grasslands should be promoted and facilitated in keeping with conservation objectives and in coordination with regional grassland interpretation objectives. Within the Merri Creek catchment, the two southern grassland sites, Jukes Rd and Central Creek are both ideally located within residential areas to be set up as educational, interpretive sites. Although Central Creek Grasslands is in public ownership and the flora of the site is legally protected, the site is threatened by sale of the land for housing. Both sites are also threatened to an extent simply by a lack of active management of the grassland conservation values on the sites. There is an urgent need to secure both sites for grassland conservation and education. The sites have very different examples of grassland communities, and both sites are needed to be able to share the pressures of visitor and educational use. Once land tenure for the sites has been clarified and secured, land management bodies should consider installing limited visitor facilities, including boardwalks and informational signage. A pedestrian / bicycle shared pathway beside the Merri Creek from Craigieburn township south to Mahoneys Rd, to connect with the existing Merri shared path, has been proposed. Such a path would connect, or pass close to four of the six Merri Creek Grasslands and opportunities would exist for providing interpretive signs or other facilities from the path.

The community should be encouraged by the land managers to participate in the management of the site and to view the area as a major conservation asset.

9. Merri Plains Grassy Ecosystem Reference Group

At a meeting in early May 1997, organised by MCMC and attended by representatives of DNRE, local councils, VNPA and grasslands researchers to discuss grassland management priorities and techniques, it was agreed that a 'Merri Plains Grassy Ecosystem Reference Group' be established, in recognition of the fact that no one group involved in grassland management has a complete range of skills and access to all the up-to-date information available. Such a group would meet on a regular basis (once every three - six months) with a key focus of providing management advice to management agencies and groups. The group would review research findings, management actions and monitoring of management actions (both to ensure monitoring is adequate and ongoing, and to feedback monitoring results to review and modification of planned management actions). It was suggested the team would act as an independent review group.

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APPENDIX 1 Legislation

State Acts and Strategies

Flora and Fauna Guarantee Act 1988 (Vic.) provides for the identification, management control and conservation of threatened and potentially threatened species, communities and habitats. It includes a list of species and communities which are threatened and a list of potentially threatening processes. The Minister for Natural Resources and Environment can provide for the legal protection of species and habitat by issuing an Interim Conservation order. This applies to public land or private land for a period of two years.

Western (Basalt) Plains Grassland community has been listed on Schedule 2 of the Flora and Fauna Guarantee Act 1988 as a threatened community. The flora of this community is therefore protected wherever it occurs in that community on public land. Any body (including Government agencies) must obtain a permit before taking (ie destroying, disturbing, trading, moving) this flora. Department of Natural Resources and Environment cannot issue a permit if to do so would threaten the conservation of the community.

As a result of the listing of the Western (Basalt) Plains Grassland community, an Action Statement (No 53) has been prepared for the Western (Basalt) Plains Grassland Community outlining actions required to ensure long-term survival of the community. Department of Natural Resources and Environment, Flora and Fauna Branch is responsible for coordinating implementation of the Action Statement. The outcomes of the Action Statement will be reviewed and revised in 1999.

A number of flora and fauna species that occur in the Merri Creek Grasslands have also been listed on Schedule 2 and are legally protected.

Invasion of native vegetation by environmental weeds has been listed in Schedule 3 (threatening processes).

Planning and Environment Act 1987 (Vic.) establishes the framework for planning the use, development and protection of land in Victoria. It has a number of aims related to environmental protection, social equity and facilitation of appropriate development.

Native Vegetation Retention Amendment to Planning and Environment Act 1987 Applications must be made to DNRE to remove more than 10 ha of native vegetation.

Environment Effects Act 1978 (Vic.) ensures that for public or other works that the Minister for Planning considers could have a significant impact on the environment, an Environmental Effects Statement prepared. Assessment of the effects and methods to mitigate their effects, are then supplied before the project may begin.

Catchment and Land Protection Act 1994 (Vic.) establishes a framework for the integrated management and protection of water catchments within Victoria and encourages the participation of the community in catchment management. Land owners must take all reasonable steps to avoid land degradation, conserve soil, protect water resources and eradicate and/or prevent the spread of pest weeds and animals. The Act also requires the preparation of regional catchment management strategies, declaration of special areas and special area plans. The Act also allows the serving of land use conditions and land management notices on land owners. It lists state prohibited, regionally prohibited and regionally controlled weeds. Agricultural and some environmental weeds are included as listed weeds and responsibilities for control are outlined. (Replaces Vermin and Noxious Weeds Act 1958).

Victorian Conservation Trust Act 1972 outlines the process for applying a Conservation Covenant to a parcel of land. The covenant is attached to the title for perpetuity and specifies allowable actions and prohibited actions. The is administered and monitored by the Trust for Nature (ex Victorian Conservation Trust).

Remnant Grasslands and Grassy Woodlands of the Melbourne Area: An Action Plan for Conservation 1990 Contains an inventory of grassland sites around the Melbourne area with an associated significance rating for each site as well as a list of proposed actions for land of different tenure and significance.

Commonwealth Acts and Strategies

Environment Protection (Impact of Proposals) Act 1974 and Regulations aims to ensure that any action undertaken by a Commonwealth agency, or which requires Commonwealth approval or funding, which affects the environment to a 'significant extent' undergoes an environmental impact assessment.

National Strategy for Ecologically Sustainable Development; Following the United Nations Conference on Environment and Development, the Commonwealth Government developed a National Strategy for Ecologically Sustainable Development. The goal of the strategy is to 'achieve development that improves the total quality of life, both now and in the future, in a way that maintains the ecological processes on which life depends'. One of the guiding principles of the strategy is the precautionary principle, which recognises the limits of our ecological understanding and aims to implement environmental protection even when negative impacts to development are not evident.

Endangered Species Protection Act 1992 aims to promote the recovery of endangered or vulnerable species and prevent other species and communities from becoming endangered. This is to be achieved by co-operative management, public education and land management.

Register of the National Estate Any group can nominate an area for listing on the National Estate. The nomination process involves documenting evidence of biological or historical value. The nomination is assessed by the Heritage Commission and if successful is listed on the National Estate. Listing is an indication of the national importance of the area and gives some protection to the place under Section 30 of the Australian Heritage Commission Act. Commonwealth ministers, departments and authorities are required not to take any action which would adversely affect a place in the Register, unless there is no feasible alternative. If there is no alternative, then all reasonable measures must be taken to minimise any damaging effects.

International Agreements

International Convention on Biological Diversity was signed by over 150 countries at the United Nations Conference on Environment and Development in 1992 and ratified in 1993. As a party to the Convention, Australia is required to identify and monitor important ecosystems, species and genetic components of biological diversity and activities that have negative impacts on biological diversity. In accordance with the convention, Commonwealth Government has developed a draft National Strategy for the Conservation of Australia's Biological Diversity.

Amongst other requirements of signatories, an environmental impact assessment must be carried out before any works are carried out that may threaten the biodiversity of a given area. The assessment must follow the NEPA model which has been adopted by 74 countries worldwide.

The Convention on Wetlands of International Importance Especially as Waterfowl Habitat (Ramsar Convention) 1971 recognises the important role of wetlands as a habitat for birds. While one of its aims is the maintenance of wetlands of International importance, it also aims to promote the training of personnel expert in wetland management, encourage the development of national policies and management frameworks for Ramsar and other wetlands.

APPENDIX 2. Serious Grassland Weeds

Species	Common Name	PRIORITY
PERENNIAL GRASSES		
***Agrostis capillaris**	**Brown Top Bent**	**PRIORITY 2**
***Anthozanthum odoratum**	**Sweet Vernal Grass**	**PRIORITY 1**
***Cortaderia spp**	**Pampas Grass**	**PRIORITY 1**
**Erharta spp*	Veldt Grass	
**Holcus lanatus*	Yorkshire Fog	
***Nassella hyalina**	**Pale Needle Grass**	**PRIORITY 1**
***Nassella neesiana**	**Chilean Needle Grass**	**PRIORITY 1**
***Nassella trichotoma**	**Serrated Tussock**	**PRIORITY 1**
***Paspalum dilatatum**	**Paspalum**	**PRIORITY 2**
***Pennisetum clandestinum**	**Kikuya**	**PRIORITY 2**
***Phalaris aquatica**	**Phalaris, Canary Grass**	**PRIORITY 1**
	Needle Grass	**PRIORITY 1**
ANNUAL GRASSES		
**Avena fatua*	Wild Oat	
**Briza maxima*	Large Quaking Grass	
**Bromus spp*	Brome	
**Gaudinia fragilis*	Fragile Oat Grass	
**Vulpia bromoides*	Squirrel-tail Fescue	
OTHER HERBS		
**Centaurium spp*	Centaury	
***Cynara cardunculus**	**Artichoke Thistle**	**PRIORITY 2**
***Foeniculum vulgare**	**Fennel**	**PRIORITY 2**
**Galium aparine*	Cleavers	
**Homeria flaccida*	One-leaf Cape Tulip	
**Homeria miniata*	Two-leaf Cape Tulip	
**Hypericum perforatum*	St John's Wort	
**Hypochaeris radicata*	Cats Ear	
**Oxalis pes-caprae*	Soursob	
***Picrus echioides**	**Prickly Ox-tongue**	**PRIORITY 2**
**Plantago lanceolata*	Ribwort	
**Romulea rosea*	Onion Grass	
**Trifolium repens*	White Clover	
**Vinca major*	Blue Periwinkle	
**Watsonia meriana* cv. *bulbillifera*	Bulbil Watsonia	
TREES / SHRUBS		
***Crategus monogyna**	**Hawthorn**	**PRIORITY 2**
**Cytisus palmensis*	Tagasaste	
**Cytisus scoparius*	English Broom	
***Genista monspessulana**	**Montpellier Broom**	**PRIORITY 1**
***Lycium ferossicium**	**Boxthorn**	**PRIORITY 1**
**Prunus cerasifera*	Cherry-plum	
**Pyracantha spp*	Firethorn	
**Rosa rubignosa*	Briar Rose	
**Rubus discolor*	Blackberry	
***Ulex europeaus**	**Gorse, Furze**	**PRIORITY 1**

Species listed and associated priority rating based on authors' observations, advice from MCMC Parkland Management Team members.

APPENDIX 3 Western Basalt Plains Species at risk in Victoria

The table below summarises the floral species of the Western Basalt Plains Grasslands at risk or extinct in Victoria (based on Dept of Cons. & Env. 1992, Craigie and Stuwe 1992 and Gullan *et al* 1990). Merri Creek Grasslands sites where the species are found are listed.

cb - Craigieburn; cp - Cooper St; bh - Bald Hill; mr - Mt Ridley; cc - Central Creek.

Species	Common name	status	FFG Act listing	Action S'ment	present at which site
Caladenia pumilia	Dwarf Spider-orchid	extinct			
Diuris X fastidiosa	Proud Diuris	extinct			
Agrostis adamsonii	Adamsons Bent	endangered	L		
Amphibromus pithogastrus	Swollen Swamp Wallaby Grass	endangered	L		cb, cp, bh, mr
Ballantina antipoda	Ballantina	endangered	L		
Cullen parvum	Small Psoralea	endangered	L	31	
Cullen tenax	Tough Psoralea	endangered	L		cb, bh, mr
Diuris fragrantissima	White (Sunshine) Diuris	endangered	L	50	
Euphrasia collina ssp *muelleri*	Purple Eyebright	endangered			
Lepidium aschersonii	Spiny Pepper-cress	endangered	L		
Lepidium hyssopifolium	Small Pepper-cress	endangered	L		
Pterostylis basaltica	Basalt Greenhood	endangered	L		
Pterostylis truncata	Brittle Greenhood	endangered	L	63	
Rutidosus leptorrhyncoides	Button Wrinklewort	endangered	L	28	
Senecio macrocarpus	Large-fruit Groundsel	endangered	L	68	
Swainsona murrayana	Murray Swainson-pea	endangered			
Thesium australe	Australe Toad-flax	endangered	L		
Agrostis aemula var. *setifolia*	Blown Grass	vulnerable			cb, cp, mr, cc?
Amyema linophyllum	Buloke Mistletoe	vulnerable			
Brachyscome debilis	Weak Daisy	vulnerable			
Brachyscome trachycarpa	Inland Daisy	vulnerable			
Bracteantha sp.aff. *subundulata*	Swamp Everlasting	vulnerable			
Carex tasmanica	Curly Sedge	vulnerable			cb, mr
Comesperma polygaloides	Small Milkwort	vulnerable	L		cb
Craspedia aff. *variabilis*	Derrinallum Billy-buttons	vulnerable			
Danthonia richardsonii	Straw Wallaby-grass	vulnerable			
Discaria pubescens	Hairy Anchor Plant	vulnerable	L		
Diuris behrii	Golden Cowslips	vulnerable			
Diuris palustris	Swamp Diuris	vulnerable			
Diuris punctata	Purple Diuris	vulnerable	L		
Glycine latrobeana	Clover Glycine	vulnerable	L		
Isolepis congrua	Slender Club-sedge	vulnerable			
Leptorhynchos waitzia	Button Immortelle	vulnerable			
Pimelea spinescens	Spiny Rice-flower	vulnerable			
Prasophyllum frenchii	Slaty Leek-orchid	vulnerable			
Ptilotus erubescens	Hairy-tails	vulnerable			
Austrostipa gibbosa	Spurred Spear-grass	rare			cb
Austrostipa setacea	Corkscrew Spear-grass	rare			
Desmodium varians	Slender Tick-trefoil	rare			cb, bh
Diuris sp. aff. *lanceolata*	Plains Diuris	rare			
Eucalyptus yarraensis	Yarra Gum	rare			
Ixiolaena sp	Woolly Buttons	rare			
Leptorhynchos elongatus	Lanky Buttons	rare			
Panicum decompositum	Australian Millet	rare			
Poa crassicaudex	Thick-stem Tussock-grass	rare			
Prasophyllum sp. aff. *fuscum*	Basalt Plains Leek-orchid	rare			
Tripogon loliiformis	Rye Beetle-grass	rare			cc
Allocasuarina luehmannii	Buloke	depleted	L		
Callitris glaucophylla	White Cypress-pine	depleted			
Eremophila deserti	Turkey-bush	depleted			

The table below summarises the faunal species of the Western Basalt Plains Grasslands at risk or extinct in Victoria (from Craigie and Stuwe 1992 and Gullan *et al* 1990).

Species	Common name	status	FFG Act listing	Action Statement	present at which site
FAUNA					
Pseudomys australis	Plains Mouse	extinct	L	14	
Ardeotis australis	Australian Bustard	endangered	L		
Dasyurus viverrinus	Eastern Quoll	endangered	L	14	
Perameles gunnii	Eastern Barred Bandicoot	endangered	L	4	
Tympanocryptis lineata pinguicolla	Southern Lined Earless Dragon	endangered	L	35	
Delma impar	Striped Legless Lizard	vulnerable	L	17	
Pedionomus torquatus	Plains Wanderer	vulnerable	L	66	

APPENDIX 4 Significant species of the Merri Creek Grasslands and their occurences

The following table lists significant species (regional, state or national) of the Merri Creek Grasslands, their conservation status and the sites where they have been recorded. Species recorded at only one or two of the sites should be considered to be vulnerable in the catchment, and as such should be targeted for reintroduction to other Merri Creek Grassland sites (see Appendix 5).

Key to symbols in table

Conservation Status

AROTS	Listed as rare or threatened on an Autralia wide basis (symbols shown in uppercase)
VROTS	Listed as rare or threatened on a Victoria wide basis (symbols shown in lower case)

E, e	endangered, at serious risk of disappearing from the wild state if present land uses and other causes continue
V, v	vulnerable, not presently endangered but likely to become so through continued depletion.
r	rare, relatively few known stands
K	poorly known

FFG	Listed as a threatened species under the Flora and Fauna Guarantee Act

Sites		**source of flora survey information**
cb	Craigieburn	Peake *et al* 1996, Frood 1992
cp	Cooper St	Frood 1992
bh	Bald Hill	Larwill *et al* 1994
mr	Mt Ridley	Cropper and Cherry 1997
jr	Jukes Rd	Mueck 1997
cc	Central Creek	Robinison and Duggan 1994

Y	recorded in the most recent flora survey
-	not recorded
M	recorded by MCMC

	AROTS	VROTS	FFG	cb	cp	bh	mr	jr	cc
Adiantum aethiopicum			No	Y	Y	Y	Y	–	–
Agrostis aemula var. aemula			No	Y	Y	Y	–	Y	?
Agrostis aemula var. setifolia		r	No	Y	Y	–	Y	–	?
Agrostis avenacea var. perennis			No	Y	–	–	–	–	Y
Agrostis sp aff adamsonii			No	Y	–	Y	–	–	–
Agrostis venusta			No	–	Y	–	–	–	–
Alisma plantago-aquatica			No	Y	Y	Y	–	–	Y
Allocasuarina verticillata			No	Y	M	Y	–	–	–
Amphibromus archeri			No	–	Y	–	–	–	Y
Amphibromus fluitans		V	No	–	–	–	–	–	–
Amphibromus macrorhinus			No				Y	–	–
Amphibromus pithogastrus	K	e	Yes	Y	Y	Y	Y	–	–
Amphibromus sp. aff. nervosus			No	Y	–	–	–	–	–
Aphelia pumilio			No	Y	–	–	–	–	–
Apium annuum			No	Y	–	–	–	–	–
Arthropodium fimbriatum			No	–	Y	–	–	–	–
Arthropodium milleflorum			No	Y	–	–	–	–	–
Arthropodium minus			No	Y	Y	Y	–	–	–
Arthropodium sp aff strictum			No	–	–	Y	Y	–	–
Asperula aff. conferta			No	Y	–	–	–		–
Asplenium flabellifolium			No	Y	Y	–	–	–	–
Austrostipa aristiglumis			No	–	Y	–	–	–	Y
Austrostipa curticoma			No	Y	–	–	Y	–	Y
Austrostipa gibbosa		r	No	Y	–	–	–	–	–
Austrostipa oligostachya			No	Y	–	–	Y	–	–
Austrostipa rudis			No	Y	–	Y	Y	–	–
Austrostipa stuposa			No	Y	–	–	–	–	–
Baumea arthrophylla			No	Y	–	–	–	–	–
Baumea rubiginosa			No	–	–	–	–	–	–
Bothriochloa macra			No	Y	Y	Y	–	–	Y
Bulbine bulbosa			No	Y	Y	–	Y	Y	–
Bursaria spinosa var. macrophylla			No	Y	Y	Y	–	Y	Y
Bursaria spinosa var. spinosa			No	Y	Y	Y	–	–	–
Caesia calliantha			No	–	Y	–	–	Y	Y
Caesia parviflora var. vittata			No				Y	–	–
Callistemon sieberi			No	–	Y	–	–	M	–
Callitriche brachycarpa	K	r	No				–	–	Y
Callitriche umbonata		r	No	Y	–	Y	–	–	–
Calocephalus citreus			No	Y	Y	–	–	–	–
Calocephalus lacteus			No	Y	Y	Y	Y	–	Y
Carex bichenoviana			No	–	–	–	–	–	–
Carex incomitata			No	Y	–	–	–	–	–
Carex tasmanica	E	v	Yes	Y	–	Y	–	–	–
Carex tereticaulis			No	Y	Y	Y	Y	–	Y
Carpobrotus modestus			No	Y	–	–	–	–	–
Centella cordifolia			No	Y	Y	–	Y	–	–
Centipeda cunninghamii			No	Y	–	–	–	–	–
Centrolepis aristata			No	–	Y	–	–	–	–
Cheilanthes sieberi			No	Y	Y	Y	–	–	Y
Chenopodium pumilio			No	Y	–	Y	–	–	–
Chrysocephalum apiculatum			No	Y	–	–	–	–	–
Chrysocephalum semipapposum			No	Y	–	–	–	–	–
Comesperma polygaloides		v	Yes	Y	–	–	–	–	–
Convolvulus aff. erubescens (Peake et			No	Y	–	–	–	–	–
Convolvulus erubescens			No	Y	Y	Y	–	–	Y
Convolvulus remotus			No	Y	Y	–	Y	–	Y
Correa glabra			No	Y	–	Y	–	–	–
Crassula closiana			No	Y	Y	–	–	–	–
Crassula pedunculariis			No	Y	–	–	–	–	–
Cullen microcephalum			No	–	–	–	–	–	–
Cullen microcephalum s.l. (Hawkesdale			No	Y	–	Y	–	–	–
Cullen tenax		e	Yes	Y	–	Y	Y	–	–
Cymbonotus preissianus			No				Y	–	–
Cynoglossum suaveolens			No	Y	Y	Y	–	Y	–
Danthonia auriculata			No	Y	Y	Y	Y	–	–
Danthonia carphoides			No	Y	Y	Y	Y	–	–
Danthonia procera			No	–	Y	Y	–	–	–

	AROTS	VROTS	FFG	C'burn	Coop	B.H.	Mt R.	J Rd	C Ck
Desmodium varians		r	No	Y	-	Y	-	-	-
Deyeuxia densa			No	-	Y	-	-	-	-
Dianella amoena			No	Y	-	-	-	Y	Y
Dianella caerulea			No	-	-	-	-	-	-
Dianella sp. aff. longifolia (Volcanic			No	Y	-	-	-	-	-
Dichelachne micrantha			No	Y	Y	-	-	-	-
Distichlis distichophylla			No	Y	-	-	-	-	-
Drosera peltata ssp. peltata			No	Y	Y	Y	Y	-	-
Drosera whittakeri			No	-	Y	-	Y	-	-
Elatine gratioloides			No	Y	-	Y	Y	-	-
Eleocharis aff. acuta (Peake et al			No	Y	-	-	-	-	-
Eleocharis atricha			No				Y	-	-
Enneapogon nigricans			No	Y	-	-	-	-	-
Eryngium ovinum			No	Y	Y	Y	Y	-	Y
Eryngium vesiculosum			No	Y	Y	-	Y	-	Y
Eucalyptus ovata			No	Y	Y	Y	Y	-	-
Euchiton sphaericus			No	Y	-	Y	-	-	-
Galium gaudichaudii			No	Y	-	Y	-	-	-
Galium migrans			No	Y	Y	-	-	-	-
Geranium retrorsum			No	Y	Y	Y	Y	Y	Y
Geranium sp. (Peake et al 1996)			No	Y	-	-	-	-	-
Glyceria australis			No	Y	-	Y	-	-	-
Glycine clandestina			No	-	-	Y	-	-	-
Glycine microphylla			No	-	-	Y	-	-	-
Glycine tabacina sensu lato			No	-	Y	Y	-	-	-
Glycine tabacina sensu stricto			No	Y	-	Y	-	-	-
Goodenia pinnatifida			No	-	Y	-	-	-	-
Grevillea rosmarinifolia			No	Y	-	-	-	-	-
Gynatrix pulchella			No	Y	Y	Y	-	-	-
Haloragis heterophylla			No	Y	Y	Y	Y	-	Y
Hemarthria uncinata var uncinata			No	Y	Y	?	-	-	?
Hydrocotyle laxiflora			No	Y	-	-	-	-	-
Hydrocotyle sibthorpioides			No	Y	-	Y	Y	-	-
Hydrocotyle verticillata			No	Y	Y	-	-	-	-
Hypoxis hygrometrica			No	-	Y	-	-	-	-
Hypoxis hygrometrica var.			No	Y	-	-	Y	-	-
Hypoxis vaginata var. brevistigmata			No				Y	-	-
Isoetopsis graminifolia			No	Y	-	-	-	-	-
Isolepis fluitans			No	Y	-	Y	-	-	-
Isolepis hookeriana			No	Y	Y	Y	Y	Y	-
Isolepis platycarpa			No	Y	Y	Y	Y	Y	-
Isolepis victoriensis			No	Y	-	-	-	-	-
Isotoma fluviatilis ssp australis			No	Y	-	-	Y	-	-
Isotoma fluviatilis			No	-	-	Y	Y	-	-
Juncus filicaulis			No	Y	Y	Y	Y	-	-
Juncus homalocaulis			No	Y	Y	Y	Y	-	-
Juncus semisolidus			No				Y	-	-
Lepidium pseudotasmanicum			No	Y	-	-	-	-	-
Lepidosperma curtisiae			No				-	-	Y
Leptospermum lanigerum			No	Y	Y	Y	-	-	-
Lilaeopsis polyantha			No	Y	-	-	-	-	-
Limosella australis			No	-	-	Y	-	-	-
Linum marginale			No	Y	Y	-	-	-	-
Lomandra micrantha			No	Y	Y	Y	-	-	-
Lomandra nana			No				Y	-	Y
Luzula meridionalis var. densiflora			No	Y	-	-	Y	-	-
Mentha australis			No	Y	Y	Y	-	-	-
Mimulus repens			No	Y	-	-	-	-	-
Montia fontana			No	-	-	Y	-	-	-
Muellerina eucalyptoides			No	Y	Y	-	-	-	Y
Myoporum viscosum			No	Y	-	-	-	-	-
Myriophyllum salsugineum			No	Y	-	-	-	-	-
Neopaxia australisica			No	Y	-	Y	Y	-	-
Opercularia ovata			No				Y	-	-
Opercularia varia			No	Y	-	-	-	-	-
Ottelia ovalifolia			No	-	-	Y	Y	-	-
Oxalis radicosa			No	Y	Y	Y	Y	-	Y
Panicum effusum			No	Y	-	-	-	-	Y
Parietaria debilis			No	Y	Y	-	Y	-	-

	AROTS	VROTS	FFG	C'burn	Coop	B.H.	Mt R.	J Rd	C Ck
Pelargonium australe			No	Y	-	-	-	-	-
Pellaea falcata			No	-	Y	-	-	-	-
Pentapogon quadrifidus			No	Y	Y	Y	Y	-	Y
Persicaria hydropiper			No	-	Y	-	-	-	-
Persicaria prostrata			No	-	-	Y	Y	-	-
Pilularia novae-hollandiae			No	-	-	Y	-	-	-
Pimelea humilis			No	Y	Y	Y	Y	-	Y
Plantago aff. gaudichaudii			No	Y	-	-	-	-	-
Plantago aff. gaudichaudii (lowland			No	Y	-	-	-	-	-
Plantago gaudichaudii			No	-	-	Y	Y	-	Y
Pleurosorus rutifolius			No	-	Y	-	-	-	-
Poa labillardieri (Basalt Plains Form)			No	Y	Y	-	-	-	-
Poa rodwayi			No	Y	Y	Y	Y	-	Y
Poa sieberiana var. hirtella			No	Y	Y	Y	-	-	?
Poa sieberiana var. sieberiana			No	Y	Y	-	-	-	?
Potamogeton pectinatus			No	Y	-	-	-	-	-
Potamogeton tricarinatus			No	Y	-	Y	Y	-	-
Pratia irriqua			No	Y	-	-		-	-
Ranunculus amphitrichus			No	-	-	-	-	-	-
Ranunculus diminutus			No	Y	-	-	-	-	-
Ranunculus robertsonii			No				Y	-	-
Rorippa laciniata			No	-	-	Y	-	-	-
Rumex bidens			No	Y	Y	Y	-	-	-
Rumex dumosus			No	Y	Y	Y	Y	-	Y
Schoenus nitens			No	Y	-	-	-	-	-
Scutellaria humilis			No	-	-	Y	-	-	-
Sebaea ovata			No	Y	Y	Y	Y	-	-
Selliera radicans			No	Y	Y	-	-	-	-
Stackhousia aff. monogyna (Western			No	Y	-	-	-	-	-
Stackhousia monogyna			No	-	-	-	-	-	-
Stellaria pungens			No	Y	Y	-	-	-	-
Thelymitra megacalyptra			No				-	-	Y
Tripogon loliiformis		r	No				-	-	Y
Triptilodiscus pygmaeus			No	Y	Y	-	Y	-	-
Velleia paradoxa			No	Y	Y	-	-	-	-
Verbena officinalis			No	-	-	-	-	-	-
Viminaria juncea			No	-	Y	-	-	-	-
Vittadinia cervicularis			No	Y	-	-	-	-	-
Wahlenbergia communis			No	Y	Y	Y	Y	Y	-
Wahlenbergia luteola			No	Y	Y	Y	Y	Y	Y
Wahlenbergia multicaulis			No	Y	Y	Y	Y	-	-
Wahlenbergia stricta ssp. stricta			No	Y	Y	-	Y	-	-
Wolffia australiana			No	-	-	-	-	-	-
Wurmbea dioica ssp dioica			No	Y	-	Y	Y	-	-

APPENDIX 5 Priorities for reintroductions

Significant species (regional, state or national, listed in Appendix 4) that are recorded at only one or two of the Merri Creek Grasslands sites could be considered to be vulnerable in the catchment, and as such should be considered for reintroduction to other Merri Creek Grassland sites.

The National Parks Service in Victoria have produced guidelines for "Species Conservation Planting" stating that species formerly present, or present at such low numbers that their survival is threatened, may be reintroduced to a park. Reintroduction should occur under the following conditions:

- the species has been eliminated as a result of human activity or is no longer reproductive.
- the species is under threat in areas outside the park or reserve.
- trials (where appropriate) indicate successful re-establishment is feasible and the species will not adversely affect existing vegetation.

A detailed work plan must be prepared and permission sought by the Park Manager from the Director of National Parks.

These guidelines require that information is available regarding species formerly present at a site. However this information will not always be available; the historic records of flora occurrences and distributions at particular sites may be limited or non existent. Furthermore, the number and area of secure reserves of Western Basalt Plains Grassland remnants is now so small, that these guidelines may be too restrictive to allow conservation of some of the more rare and threatened species. However, there needs to be a high chance that the species did once occur in the area and within the grassland subcommunity to which it is being reintroduced. An assessment should be made of the ecological and genetic implications of these reintroductions.

Some grasslands and rare plants researchers believe strongly that the focus of reintroductions work should be on establishing plants, that are threatened Australia wide, into secure reserves (R. Parsons pers. comm.). The use of local provenance (or local gene pool) will not always be practical, or even desirable, particularly if remaining local populations of a rare or threatened plant are so small that inbreeding is occurring. Parsons suggests the following species are priority for reintroduction to secure reserves. (The list is not all-inclusive.) All these species are endangered, are listed under the Flora and Fauna Guarantee Act, and have had Action Statements prepared for them (except *Lepidium hyssopifolium*). The Action Statements include details of the species' distribution, conservation status, conservation objectives, management issues and previous management actions and in some cases, intended management actions. Copies of the Action Statements are available from Department of Natural Resources and Environment.

None of the species listed below are currently found in any of the six Merri Creek Grassland sites, although *Lepidium hyssopifolium* has been recorded at the Beveridge Rail Reserve, which may be the only site in the wild where this species is recorded. Beveridge Rail Reserve is located between the Hume Freeway and the Merri Creek, north of Bald Hill. *Thesium australe* is a small forb that is hemiparasitic on the roots of *Themeda triandra*. Although collections in Australian herbaria suggest that *Thesium australe* was once widespread in grasslands, grassy woodlands and sub-alpine grassy heathlands, in Victoria the species is now confined to one area on the Buchan River in east Gippsland. No lowland populations are known to survive.

Priority species for reintroduction

Diuris fragrantissima	Sunshine Diuris	Action Statement No. 50
Lepidium hyssopifolium	Small Pepper-cress	
Rutidosus leptorrhynchoides	Button Wrinklewort	Action Statement No. 28
Senecio macrocarpus	Large Fruit Groundsel	Action Statement No. 68
Thesium australe	Austral Toad Flax	Action Statement No. 56

APPENDIX 6 Seed collection guidelines

Annual permits (under the Flora and Fauna Guarantee Act) to take protected flora from Public Land / Water are issued by the regional office of Department of Natural Resources and Environment. When applying for a permit, details to be supplied include:

- quantity of plants to be taken
- parts of plants (ie seed)
- species to be taken
- intended purpose (ie revegetation)
- geographic areas

No more than 10% of seed material may be collected from any plant, and no more than 25% of plants of any species may be collected in any 30 x 30 m area. Material should be collected from as many parent plants as possible to reduce the risk of inbreeding. If it is suspected that plants have been previously collected from, further collection should not take place. Seed should be sourced from local provenance (ie seed for use in Merri Creek Grasslands should wherever possible be collected from within the Merri Creek catchment), and should be collected from sites with similar conditions as the target site (ie similar geology, aspect, topography, etc).

Records should be kept of the location of seed collection sites, the quantity of seed collected, the date of collection. Records should also be kept of where the seed was subsequently used, the date of seeding and any subsequent treatments (eg burning or other removal of chaff at a later date). Other details of the general status of the seed collection and direct seeding site should be kept, including, weed invasion or evidence of pest animals.

Annual renewal of the permit is not automatic. Details of seed collection records must be sent to DNRE, along with an application detailing planned seed collection activities for the coming year. A special application is necessary to collect seed of rare or threatened species listed under the Flora and Fauna Guarantee Act, or in Gullan *et al* (1990). Seed collection from private land requires the permission of the land owner.

When collecting seed from an area of remnant vegetation, minimise damage to the vegetation. Trampling should be minimised. Be cautious about disclosing the location of rare or threatened species to protect populations from over collection or 'poaching'.

Themeda triandra seed collection

T. triandra seed has an awn on the tip of the seed that twists with changing levels of humidity. This twisting acts to 'drill' the seed into the ground. The awn is relatively easily detached; it is important that seed collection techniques do not damage the seed. Seed usually matures around late December or early January. The seed is mature when it feels hard, with a hard white core.

The seed heads can be cut with a sickle bar mower or with a brushcutter or whipper snipper. The cut material should be raked up and bagged; empty (weed free) wool bales are a convenient bag. The cut material should be stored in a dry place. It can be spread immediately or when needed in weed control and revegetation activities, although recent studies have shown increased levels of germination of seed stored for 10 months prior to spreading on site (Phillips in prep). It should be used within twelve months of collection, although the seed may maintain viability for at least two years. It is not necessary to remove the seed from the seed heads and chaff, and in fact the chaff is a useful 'mulch' to cover bare areas created during weed control activities.

Larger mechanised tractor mounted seed collection devices have been developed. Their use would be limited to areas which are flat, not rocky, and where vehicle access would not create damage. The advantage of using sickle bar mowers or brushcutter is that if the *T. triandra* is mixed in with other species, seed collection can be quite selective, and can avoid other the other species, particularly weed species. However using sickle bar mowers or brushcutter is quite labour intensive.

Guidelines on seed collection, and details for collection of other species are contained in “Flora of Melbourne. A Guide to the Indigenous Plants of the Greater Melbourne Area.”

APPENDIX 7 Phenology record sheet

The aim of this sheet is to gather information about the life cycle of both exotic and indigenous species. The information will help plan and implement management actions to effectively promote the growth of indigenous species, and the control of exotic species. They may also help to indentify window periods when weed control actions such as spraying would not affect indigenous species (for example at periods of dormancy, etc). The form will be reviewed and updated at the next meeting of the Merri Plains Grassy Ecosystem Refernce Group. Land managers and field technicians of the Merri Creek grasslands should use copies of this form to record information. Forms can be sent to MCMC for compilation and circulation to the Merri Plains Grassy Ecosystem Reference Group.

Merri Creek Management Committee, 2 Lee St, East Brunswick, 3057, ph 9380 8199, fax 9380 6989

Species _____ **Date** _____

Status (VROTS/AROTS/FFG) _____

Recorders name **organisation** **address** **phone no.**

_____

Locality Name (based on a prominant landmark eg Cooper St) _____

_____

_____

Land tenure and title (eg Private - Craigieburn Grasslands) _____

Precise locality **(attach a sketch map to help describe location as precisely as possible)** _____

_____

_____

month of germination _____

month of flowering _____

month of seeding _____

period of active growth _____ **to** _____

period of dormancy _____ **to** _____
(above ground parts die back, etc)

plant life cycle (other notes) _____

_____

_____

associated species (both indig & exotic) _____

_____

_____

_____

response to fire _____

_____

_____

other info _____

_____

_____