Advice to the Minister for the Environment, Heritage and the Arts from the Threatened Species Scientific Committee (the Committee) on Amendment to the list of Threatened Ecological Communities under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)

1. Summary of conservation assessment by the Committee

This advice follows the assessment of information provided by a nomination to list the **Western (Basalt) Plains Natural Temperate Grassland**. The nomination was made available for public exhibition and comment for a minimum period of two months. A technical workshop with expert scientists was held to determine the definition and condition thresholds for this ecological community. The Committee had regard to all public and expert comments that were relevant to the survival of the ecological community.

The Committee judges that the ecological community has been demonstrated to have met sufficient elements of:

- Criterion 1 to make it **eligible** for listing as **critically endangered**;
- Criterion 2 to make it **eligible** for listing as **critically endangered**;
- Criterion 4 to make it **eligible** for listing as **critically endangered**; and
- Criterion 5 to make it **eligible** for listing as **vulnerable**

2. Name of the ecological community

The Committee recommends that the name of the ecological community be changed to the **Natural Temperate Grassland of the Victorian Volcanic Plain**. This name reflects the vegetation type and distribution of the ecological community and also distinguishes the national ecological community from that listed under the Victorian *Flora and Fauna Guarantee Act 1988* as the "Western (Basalt) Plains Grassland Community".

3. Description

General features
The Natural Temperate Grassland of the Victorian Volcanic Plain is a complex and inherently variable ecological community. The species composition and appearance of the ecological community are subject to the influences of season, weather patterns, site and land management practices. These influences may vary the expression of the ecological community over even small distances or from year to year and among seasons.

The ecological community occurs on a large, Quaternary basaltic plain with scattered volcanic cones and stony rises. The soils of the plain are heavy grey to red cracking clays, with black cracking clays common in the low-lying areas (McDougall *et al*. 1994), and tend to be fertile but with a poor drainage capacity (Carter *et al*. 2003). The climate of the Victorian Volcanic Plain is characterised by hot, dry summers and cold winters with frosts. The mean annual rainfall is in the range 500-700 mm, with rainfall being evenly distributed across seasons at most sites (Stuwe 1986).

Vegetative components
The Natural Temperate Grassland of the Victorian Volcanic Plain is a component of a lowland temperate grassland vegetation group that occurs in disjunct areas throughout south-eastern Australia broadly associated with particular IBRA bioregions or subregions (Carter et

al. 2003). The Natural Temperate Grassland of the Victorian Volcanic Plain has affinities with other grasslands that have *Themeda triandra* as a significant element, such as the temperate grasslands of the southern tablelands of NSW and the ACT, the Gippsland Plain and the lowlands of Tasmania. However, the Natural Temperate Grassland of the Victorian Volcanic Plain may be distinguished from these grasslands by its association with Quaternary basalt soils, geographic limitation to the Victorian Volcanic Plain bioregion, and the relatively greater presence of semi-arid elements, such as *Ptilotus* spp. or chenopods in parts of the ecological community's range (Carter *et al*. 2003). There are also affinities with the grasslands of the southern Riverina bioregion. However, semi-arid elements are well represented in the Riverina grasslands and *Themeda triandra* may be present in pockets but is generally not a dominant feature of these grasslands.

The vegetation of the Natural Temperate Grassland of the Victorian Volcanic Plain is mostly limited to a ground layer of grasses and herbs. Large shrubs and trees are absent to sparse. The ground layer is dominated by native tussock-forming perennial grasses with a variety of herbs, mostly from the daisy (Asteraceae), lily (Anthericaceae, Asphodelaceae, Phormiaceae), pea (Fabaceae) and orchid (Orchidaceae) families, occupying the spaces among grass tussocks (Stuwe and Parsons 1977; Stuwe 1986; McDougall *et al*. 1994; Carr 1999; Carter *et al*. 2003).

The main grass species present are Kangaroo-grass *(Themeda triandra),* particularly on drier sites, Wallaby-grasses (*Austrodanthonia* spp.), Spear-grasses (*Austrostipa* spp.) and Tussock-grasses (*Poa* spp.) (Department of Sustainability and Environment 2004a). Low gradient ephemeral and intermittent drainage lines may be dominated by a dense sward of the River Tussock-grass *(Poa labillardierei).* A list of plant species typically found in the ecological community is presented in Table 1.

Faunal components

The ecological community supports a diversity of animal species notably skinks, snakes, birds of prey and ground-dwelling birds (Department of Sustainability and Environment 2004a). The faunal component includes eight nationally threatened species, two of which are now considered to be effectively extinct from the ecological community (Table 2).

Grassland remnants now support very few native mammal species. The groups which have particularly declined in species richness across the Victorian Volcanic Plain (not necessarily just in grassland) include the rodents, macropods and the bandicoots (National Land and Water Resources Audit 2007b). The Fat-tailed Dunnart (*Sminthopsis crassicaudata*) and Common Dunnart (*S. murina*) were the only native mammals recorded in a recent survey of grassland sites in western Victoria (Hadden 2002). Seebeck (1984) noted that the Eastern Grey Kangaroo (*Macropus giganteus*) was formerly abundant on the volcanic plain when it was settled in the 1830s. However, by the 1850s settlers considered kangaroos a nuisance to their livelihood and organised large hunting drives and professional trappers to reduce populations. By the 1930s, kangaroos became scarce, a situation that persisted at least until the 1980s. The only significant populations at that time were restricted to wooded native vegetation remnants or reserves. In addition to hunting, land use practices had reduced the quality habitat for kangaroos over much of the plain. No published information was available to indicate how kangaroo populations have altered since the mid-1980s. Small ground dwelling native mammals are likely to have had a significant functional role in temperate grasslands, as discussed below under "Relevant ecology and biology".

In a regional context, 38 species of bird occur preferentially in this ecological community and another 33 species occur in grassland but are not reliant on it for habitat (National Land and Water Resources Audit 2007b). There was a marked decline in the recording rate of birds that

are reliant on grasslands between successive bird atlas surveys (undertaken in 1977-1981 and 1998-2001).

The invertebrate fauna remains poorly known (Yen 1999). An exception is the Golden Sun Moth (*Synemon plana*), a critically endangered species that feeds on Wallaby-grass tussocks in this ecological community, as well as in the endangered Natural Temperate Grassland of the Southern Tableland of NSW and the ACT (Department of the Environment, Water, Heritage and the Arts 2008).

Key diagnostic characteristics
The key defining attributes for the Natural Temperate Grassland of the Victorian Volcanic Plain are:

- The grassland is mainly associated with Quaternary basalt soils within the Victorian Volcanic Plain IBRA bioregion. Pockets of similar grassland extend into the adjacent Victorian Midlands and South-east Coastal Plain bioregions. These are included in the listed ecological community if they meet the other key diagnostic characteristics and condition thresholds.
- At least one of the following grass genera is the dominant native species in the ground layer: *Themeda* (Kangaroo-grass), *Austrodanthonia* (Wallaby-grass), *Austrostipa* (Spear-grass) and/or *Poa* (Tussock-grass).
- The minimum size of the grassland patch and the maximum cover of woody vegetation depends on the native vegetation remnant within which the grassland patch occurs. The small minimum sizes take into account that land use history has resulted in generally very small and fragmented patches (Department of Sustainability and Environment 2004a) but, despite this, small patches of intact grassland can remain effective for conservation purposes (McCarthy *et al*. 2006). It also takes into account that grassy woodlands may include naturally open gaps amongst trees; where gaps are greater than 0.5 ha, they are considered to be natural temperate grassland.
    - For a native vegetation remnant ≤1 hectare in size, the minimum contiguous size of the grassland patch is 0.05 hectare and the crown cover of shrubs and trees over one metre tall within the grassland patch should not exceed 5%;
    - For a native vegetation remnant >1 hectare in size, the minimum contiguous size of a grassland patch is 0.5 hectare and the density of mature trees within the grassland patch should not exceed 2 trees per hectare

4. Condition Thresholds

Most, if not all, patches of the Natural Temperate Grassland of the Victorian Volcanic Plain now show some degree of disturbance and degradation (Barlow and Ross 2002; Carter *et al.* 2003). Some form of ongoing management is required to maintain or enhance the biodiversity of all remaining patches.

The listed Natural Temperate Grassland of the Victorian Volcanic Plain ecological community comprises those patches that meet the key diagnostic characteristics, above, and the condition thresholds, below, for better quality sites of the ecological community.

- The total perennial tussock cover represented by the native grass genera *Themeda*, *Austrodanthonia*, *Austrostipa* or *Poa* is at least 50%;

OR

- If the total perennial tussock cover represented by the above 4 native grass genera is less than 50%, then the ground cover of native forbs (wildflowers) is at least 50% of total vegetation cover during spring-summer (September to February);

OR

- The cover of non-grass weeds is less than 30% of total vegetation cover at any time of the year.

The conservation value of a patch of the Natural Temperate Grassland of the Victorian Volcanic Plain ecological community is enhanced if it shows any of the following features:

- a high native plant species richness;
- large patch size;
- minimal weed invasion;
- presence of threatened plant and/or animal species;
- presence of natural exposed rock platforms and outcrops; or
- presence of mosses, lichens or a soil crust on the soil surface.

The diagnostic characteristics and condition thresholds generally are based on features which apply all year round, with the exception of the ground cover of native forbs (wildflowers). This feature is best assessed during spring because it is only during this time when many native bulbous species (e.g. lilies, orchids) occur above ground and when most species are flowering. Assessments should be undertaken at this time to best ascertain the biodiversity value of a grassland patch.

5. National Context

Distribution

The Natural Temperate Grassland of the Victorian Volcanic Plain is restricted to western Victoria. It occurs primarily within the Victorian Volcanic Plain IBRA bioregion. Small occurrences may extend into IBRA subregions that are adjacent to the Victorian Volcanic Plain: SCP2 Otway Plain; VM2 Central Victorian Uplands; and VM4 Dundas Tablelands. The Victorian Volcanic Plain bioregion is recognised as one of Australia's 15 National Biodiversity Hotspots (Department of the Environment, Water, Heritage and the Arts 2007).

Relationships to the National Vegetation Information System (NVIS), State vegetation classification and State-listed communities

The classification of the Natural Temperate Grassland of the Victorian Volcanic Plain under NVIS is detailed in Table 3.

Victoria has classified its vegetation using a system of Ecological Vegetation Classes (EVC). The source for the detailed NVIS classifications derive from the EVC system used in Victoria. The Natural Temperate Grassland of the Victorian Volcanic Plain includes two component EVCs from the Victorian Volcanic Plain and adjacent bioregions:

- EVC 132 Plains Grassland; and
- EVC 654 Creekline Tussock Grassland.

Three associations are recognised within EVC 132 in the Victorian Volcanic Plain: 132_61 Heavier-soils Plains Grassland; 132_62 Lighter-soils Plains Grassland; and 132_63 Low-rainfall Plains Grassland. The ecological community may also include patches presently classified as the mosaic unit, EVC 897 (Plains Grassland/Plains Grassy Woodland Mosaic) that, upon ground-truthing, can be reclassified as grassland.

The Bioregional Conservation Status for EVCs 132 and 654 within the Victorian Volcanic Plain bioregion is endangered which, in this context, refers to less than 10% of the former range or pre-European extent remaining.

Victoria also recognises benchmark conditions for each EVC based upon lists of typical native plant species and the diversity and cover of life-forms present (Department of Sustainability and Environment 2004b). Whilst these benchmarks do not equate directly with

the broader condition thresholds detailed above, it is likely that patches which meet the relevant Victorian EVC benchmarks would also be assessed as good quality patches of the Natural Temperate Grassland of the Victorian Volcanic Plain.

The national ecological community also covers the threatened ecological community listed under Victoria's *Flora and Fauna Guarantee Act 1988* as the "Western (Basalt) Plains Grasslands Community" (Scientific Advisory Committee 1991). The major differences between the national and the State-listed ecological communities are:

- The State-listing does not specify condition classes. It could, therefore, include patches excluded from the national ecological community because they are very small and below the minimum size thresholds, as well as more degraded sites that have a lower native plant cover or higher weed content.
- The State-listing does not apply to EVC 654. It corresponds to the *Themeda* grasslands as identified by Stuwe and Parsons (1977) and, therefore, excludes the variant of the national ecological community associated with drainage lines, and typically dominated by River Tussock-grass *(Poa labillardierei)*. EVC 654 represents only a minor extent of the national ecological community (Table 4.)

6. Relevant Biology and Ecology

The Natural Temperate Grassland of the Victorian Volcanic Plain is a dynamic and inherently variable ecological community. It intergrades with adjacent vegetation types notably Plains Grassy Woodland (EVC 55), Plains Grassy Wetland (EVC 125) and Stony Knoll Shrubland (EVC 649). The assemblage of species that characterises the grassland often occurs as an understorey component in adjacent woodland and shrubland. These intergradations can happen over relatively small distances and may be subject to site characteristics, for example drainage patterns of cold air or water.

There is some uncertainty over precisely how much of the original vegetation of the Victorian Volcanic Plain comprised natural temperate grasslands, as distinct from open woodland and shrubland with a similar ground layer composition (Stuwe 1986; Ferguson and Fullagar 1992). It can be particularly difficult to establish clear boundaries between natural temperate grassland and grassy woodland. This difficulty is presently addressed in Victoria by recognising mosaic vegetation units that cannot be readily separated without further detailed ground surveys. EVC 897 Plains Grassland/Plains Grassy Woodland Mosaic is the relevant unit that contains intergrading components of both natural temperate grassland and grassy woodland.

The expression of the ecological community is subject to the influences of seasonality and weather. For instance, the appearance of the ecological community during peak flowering time in spring can markedly differ to that in late summer or autumn. Several grassland species only emerge during spring to early summer and are dormant during the remainder of the year. Similarly, the appearance of the grassland during prolonged drought can differ significantly from that during a wetter season.

The Natural Temperate Grassland of the Victorian Volcanic Plain also shows variation with respect to past land management practices (Barlow 1999; Ross 1999). The severity and frequency of fire, grazing or fertiliser regimes can markedly affect the appearance, species composition and functionality of the grassland. These practices affect the density of the native grass sward and the availability of bare ground, which influence floristic composition, litter deposition and nutrient cycling. The dominant grass species may alter depending on how sensitive particular species are to the grazing and/or burning regime.

Temperate grasslands show a general sequence of decline in floristic composition and soil nutrient balance when subject to persistent disturbance (e.g. grazing, fire, nutrient addition (Groves and Whalley 2002; Langford et al. 2004). Selective grazing and progressive increases in soil fertility favour species more tolerant of disturbed conditions. The native components decline in the following sequence: warm-season grasses typified by Kangaroo-grass that favour soils with a very low available nitrogen content; native herb and wildflower species with the most palatable or sensitive species disappearing first; and finally cool-season grasses such as *Austrodanthonia*, *Austrostipa* and *Poa* species that are more tolerant of disturbed and fertile conditions are lost. This sequence has resulted in many native grasslands formerly dominated by Kangaroo-grasses now being dominated by Wallaby or Spear-grasses (Conn 1993; Mitchell 1994; Eddy *et al*. 1998). Furthermore, as each component declines there are opportunities for exotic weeds or pasture species to establish. The combined impacts of invasion by exotic species and imbalanced soil nutrients becomes increasingly difficult to reverse.

Careful management is required to maintain the biodiversity and conservation significance of remnants of the ecological community (Barlow 1999; Ross 1999). If the native grass sward becomes too dense, the grasses will crowd the inter-tussock spaces, preventing the regeneration of herbs and wildflowers (Morgan 1998). It is these inter-tussock species that are responsible for the high plant biodiversity values of intact grasslands. In the past, grass density was reduced by a combination of native herbivore grazing and wildfires. A prescribed regime that periodically disturbs tussocks using grazing, slashing and/or fire is necessary to maintain biodiversity in the long-term (Morgan 1998).

The Natural Temperate Grassland of the Victorian Volcanic Plain provides habitat for numerous plant and a few animal species that are listed as nationally threatened (Table 2).

Information about the biological roles of the fauna within the ecological community is scant. Small, ground-dwelling native marsupials had significant functional roles in temperate grassy systems (Martin 2003). Their constant diggings disturbed the soil surface and, as a consequence, aerated the soil and incorporated organic matter. The result was the formation of a healthy topsoil with a spongy texture and abundant micro-organism content. A well-developed soil structure, in turn, greatly aids water infiltration into the subsoil and nutrient cycling. The diggings of small marsupials and their concomitant effects on soil structure also assisted seed dispersal and seedling establishment. Reports from explorers and early settlers indicate that the soils of Australian rangelands and grasslands were very different, when first encountered, to their present condition; they also document dramatic declines in the numbers of small marsupials and soil quality following the introduction of European agricultural practices and domesticated stock (Martin 2003).

It can be surmised that other fauna also had important functional roles. For instance, macropods would have grazed the grasslands and may have had some influence on sward density and canopy closure. Early records indicate that the Victorian Volcanic Plain formerly supported large kangaroo populations, mainly of the Eastern Grey Kangaroo (*Macropus giganteus*) (Seebeck 1984). However, their populations have been markedly reduced since, through a combination of active hunting and habitat loss, to remnants that are confined to small pockets of extant native vegetation A guild of grassland birds would have fed on seeds or insects in the sward, possibly contributing to seed dispersal and the regulation of insect herbivore populations. Other insects would have pollinated the wildflower components of the flora. However, the functional roles of many fauna species are no longer so clear, given the marked decline in the extent and quality of grassland as habitat for many animal species.

7. Description of Threats

The main threats to the Natural Temperate Grassland of the Victorian Volcanic Plain ecological community include: vegetation clearance; fragmentation of remnants; inappropriate maintenance practices for remnants on roadside and railway verges; inappropriate grazing or fire regimes; inappropriate herbicide use; the application of fertilisers; and weed invasion (Carter *et al*. 2003; Department of Sustainability and Environment 2004a; National Land and Water Resources Audit 2007a).

Clearing, grazing and burning

Vegetation clearance has been a major contributor to the fragmentation and decline of native grassland in the region. Approximately 92% of the native vegetation of the Victorian Volcanic Plain bioregion has been cleared or otherwise modified (National Land and Water Resources Audit 2007b). This bioregion was readily amenable to grazing and cropping because much of the landscape was naturally treeless or sparsely wooded and did not require much clearing, plus the basaltic soils are highly fertile. However, by the mid-1800s concerns were already being expressed that native vegetation cover was being lost and soils were being compacted by overgrazing (Department of Sustainability and Environment 2004a). Grazing (or mowing) regimes that are persistent or applied during spring/summer, when plants are regenerating and seeding, can lead to the eventual elimination of palatable plant species, such as Kangaroo-grass. Heavy grazing also promotes the establishment of weeds and damages soil structure, causing further detriment to the integrity of remnants. A similar situation applies to fire, where burning that is too frequent or in the wrong season results in the eventual loss of fire-sensitive species.

Agricultural activity has intensified since the 1940s with the widespread adoption of pasture improvement practices and the sowing of exotic pasture species (Carter *et al*. 2003; Department of Sustainability and Environment 2004a; Gibson Roy and Delpratt 2007). As a result of these practices, good quality patches of grassland became restricted to small remnants in areas unsuitable for intensive agriculture, for instance rocky outcrops (Williams 2005). In recent years, however, even these sites have succumbed to intensive development pressures with the introduction of raised bed cropping and the utilisation of rock-crushing machinery (Department of Sustainability and Environment 2004a; Gibson Roy and Delpratt 2007).

The Natural Temperate Grassland of the Victorian Volcanic Plain ecological community also extends into western Melbourne, where it has been extensively cleared for urban development. Remnants that have not been directly impacted by development, such as informal reserves, are indirectly degraded as a consequence of their proximity to houses and industrial sites, and associated rubbish dumping and weed invasion. The constraints which apply to ecological burning practices within urban areas poses additional problems. Clearing and degradation of grassland remnants continues to occur around western Melbourne with those patches closer to urban areas having a higher probability of becoming degraded (Williams *et al.* 2005).

Change to management regimes of remnants

Grasslands also occur as small patches within cemeteries or along roadsides and railways, often as linear remnants. Up until the mid-1980s, maintenance works along roadside and railway verges were based on prescribed burning that helped to maintain remnants in good condition. However, since the 1980s fire has increasingly been replaced by broadscale herbicide use and slashing. These changes have contributed to the widespread degradation of these linear grassland remnants (Carter *et al*. 2003; Department of Sustainability and Environment 2004a). It has been estimated that rural grassland remnants to the west of

Melbourne declined by 29% during 1984 to 2004, mostly due to the loss of roadside remnants from herbicide sprays (Williams 2005).

Weed invasion

About a third of plant species surveyed in the Natural Temperate Grassland of the Victorian Volcanic Plain ecological community are exotic in origin (McDougall *et al*. 1994). The most commonly encountered type of weeds are annuals (e.g. Shivery Grass – *Briza minor*), perennial rosettes (e.g. Cats-ear – *Hypochaeris radicata*) or rhizomatous perennials (e.g. Clover - *Trifolium* spp.). All weed species compete for space and resources in the inter-tussock gaps, and contribute to the reduced biodiversity of native herbs. However, the group of weeds of particular concern to the integrity of the Natural Temperate Grassland of the Victorian Volcanic Plain are perennial exotic grasses because their adverse impacts are potentially long-term and they are difficult to manage. Perennial grassy weeds known to have a high impact on the ecological community include Chilean Needle-grass (*Nassella neesiana*), Phalaris (*Phalaris aquatica*) and Yorkshire Fog (*Holcus lanatus*) (Department of Sustainability and Environment 2004b). Of these, Chilean Needle-grass is considered particularly invasive and hard to control due to its adaptability to a wide range of conditions, large seed production, persistent seedbank and tolerance to various treatments (Muyt 2001).

Level of protection in reserves

Patches of the Natural Temperate Grassland of the Victorian Volcanic Plain are known to occur within 19 reserves (Carter *et al*. 2003; Fitzsimmons and Ashe 2003). However, the total area of grassland that is protected within these reserves is not known. What is known is that certain reserves, (e.g. Craigieburn Grasslands Reserve, Black's Creek Nature Conservation Reserve, Derrimut Grassland Reserve and Cobra-Killuc Wildlife Reserve), contain large grassland remnants.

Most of the Natural Temperate Grassland of the Victorian Volcanic Plain is considered to occur under private land tenure (Department of Natural Resources and Environment 1997). Such remnants are potentially open to the threat of clearing for agricultural purposes or urban development. Whilst reserved grasslands are not as prone to clearing, they remain amenable to other threats, notably weed invasion and inappropriate management for longer-term conservation.

8. How judged by the Committee in relation to the EPBC Act criteria.

The Committee judges the ecological community is **eligible** for listing as **critically endangered** under the EPBC Act. The assessment against the criteria is as follows.

Criterion 1 - Decline in geographic distribution

Estimates of pre-European and present extent are available for EVCs 132 and 654 in or near to the Victorian Volcanic Plain Bioregion (Table 4). These indicate that natural temperate grasslands have undergone a very severe decline of at least 98%. Note that the mosaic EVC 897 (covering the intergradational grassland/grassy woodland vegetation) also is considered to have declined very severely, by over 99% (Table 4).

These EVC-based estimates are consistent with previous estimates of native grassland decline on the Victorian Volcanic Plain. For instance, the Department of Natural Resources and Environment (2000), Barlow and Ross (2002) and Carter *et al*. (2003) all estimated that the grassland had declined by more than 98%.

The estimates in Table 4 do not take condition into account. The proportion of remnants that are of high conservation value is likely to be less than the overall current extent estimated. For example, Barlow and Ross (2002) considered that less than 1000 hectares of the Natural Temperate Grassland of the Victorian Volcanic Plain remains in good condition. If condition is taken into consideration, the decline in extent is likely to exceed 99%.

The Committee considers that the ecological community has undergone a very severe decline in geographic distribution. Therefore, the ecological community has been demonstrated to have met the relevant elements of Criterion 1 to make it **eligible** for listing as **critically endangered.**

Criterion 2 - Small geographic distribution coupled with demonstrable threat

The Natural Temperate Grassland of the Victorian Volcanic Plain was originally scattered across the Victorian Volcanic Plain with some outlying patches in adjacent bioregions. The volcanic plain is extensive, covering approximately 2.3 million ha. The original vegetation was a matrix of *Eucalyptus* woodlands, tussock grasslands and shrublands (National Land and Water Resources Audit 2007b). The grasslands were scattered throughout this extensive plain wherever the landscape was conducive to the development of a grassy sward but not to the establishment of a canopy of large trees or shrubs. Extant remnants of grassland are still scattered across the plain. Consequently, the extent of occurrence for the Natural Temperate Grassland of the Victorian Volcanic Plain cannot be considered to be limited.

However, the area of occupancy has markedly contracted from about 260 000 hectares to about 5000 hectares (Department of Sustainability and Environment 2004c), of which less than 1000 hectares are likely to remain in good condition (Barlow and Ross 2002). The size of individual grassland patches, as indicated by mapping of EVCs 132 and 654 in the Victorian Volcanic Plain Bioregion, also tends to be very small. More than 95% of known patches are under 10 ha in size. It should be noted that small patches of grassland can retain conservation value despite their size (McCarthy *et a*l. 2006). Large remnants over 100 ha, on the other hand, are very rare. The present geographic distribution of the Natural Temperate Grassland of the Victorian Volcanic Plain is judged to be very restricted on the basis of its current area of occupancy and patch size.

The past and ongoing threats to the ecological community are detailed above. The most serious current threats are due to: development pressures from the expansion of greater Melbourne; continued intensification of agriculture through practices such as rock crushing machinery and raised-bed cropping; and lack of knowledge or awareness about how to manage grassland remnants for biodiversity and conservation. There are indications that the threats to the ecological community are unlikely to diminish (Carter *et al*. 2003; Department of Sustainability and Environment 2004a; Gibson Roy and Delpratt 2007).

The Committee considers that the ecological community has a very restricted geographic distribution that is under ongoing threat. The nature of its very restricted distribution make it likely that a threatening process could cause it to be lost in the immediate future. Therefore, the ecological community is **eligible** for listing under Criterion 2 as **critically endangered**.

Criterion 3 - Loss or decline of functionally important species

One functionally important species in the Natural Temperate Grassland of the Victorian Volcanic Plain is Kangaroo-grass. Kangaroo-grass was formerly the dominant grass species over much of the ecological community (Department of Sustainability and Environment 2004a). It has been replaced within many remnants by Wallaby and Spear Grasses (Conn 1993; Mitchell 1994; Eddy *et al*. 1998) as a consequence of disturbance and management regimes. The biology and germination strategies of Kangaroo-grass are relatively well known (e.g. Hagon 1976; Sindel *et al*. 1993) and it can be successfully revegetated, at least over small areas (Greening Australia Victoria 1999; Waters *et al*. 2001).

However, the presence or absence of Kangaroo-grass within a grassland site does not necessarily equate with decline of the ecological community. This is because of the resilient nature of the native sward whereby a given disturbance regime may change the species composition but not dominance by perennial native tussocks (Barlow 199; Ross 1999). It is the loss or decline of the perennial native tussock component, as a whole, that severely impacts upon the ecological community. This issue is properly considered under Criterion 4 "Reduction of integrity", below.

There are insufficient data available to determine the loss or decline of functionally important species within the ecological community. Therefore, it is **not eligible** for listing in any category under this criterion.

Criterion 4 - Reduction in community integrity

There are several lines of evidence demonstrating a reduction in the integrity of the Natural Temperate Grassland of the Victorian Volcanic Plain.

Reduction in integrity through loss of key vegetative components
There are three key vegetative components of the Natural Temperate Grassland of the Victorian Volcanic Plain ecological community that, together, point to a reduction in community integrity.

The first is a functional group comprising the perennial tussock grasses. These dominate the ecological community and define the available cover and inter-tussock spaces that are important for faunal habitat or plant recruitment capability. The response of this group to disturbance follows a sequence of compositional changes (Groves and Whalley 2002; Langford et al. 2004) which indicates this group, as a whole, has some degree of resilience to disturbance. Native perennial tussock grasses do not necessarily disappear outright but change their species composition towards those more tolerant of a given disturbance regime. For instance, persistent grazing can lead to the replacement of Kangaroo-grass with Spear and Wallaby-grasses (Conn 1993; Mitchell 1994; Eddy *et al*. 1998). The result is that the grassland structure is retained though the composition and ecological character of the dominant grass species alters.

The second group is the native forbs and wildflowers that occupy the inter-tussock spaces. This group covers most of the higher plant biodiversity of grasslands. As with the perennial tussock grasses, they exhibit a sequence of decline and change with persistent disturbance such that species most sensitive to a given disturbance (e.g. highly palatable, fire sensitive or poorly competitive) disappear early in the sequence. The net result of a persistent, intensive disturbance regime is a decline in species richness.

The third group comprises the soil crust flora, typically lichens, mosses or fungi that occupy the soil surface. They influence critical functions such as water infiltration, nutrient status and

stability of the soil and are considered good indicators of soil and landscape health (Eldredge 2005). A diverse and extensive soil crust flora indicates low levels of soil disturbance and that the site is relatively intact. A benchmark of 20% cover by soil crusts applies to EVC 132 and 654 in the Victorian Volcanic Plain (Department of Sustainability and Environment 2004b). There is no quantifiable data to determine how much of the ecological community meets this benchmark though it is reasonably suspected to be low, given the nature of agricultural activity in the region.

As a consequence of past management history, most grassland remnants are now degraded, being present in a simplified or native pasture state (Carter *et al*. 2003). This state is characterised by the continued dominance of native tussock grasses but low species richness of the wildflower component, relative to intact grassland state (Langford *et al.* 2004). However, native pastures retain biodiversity value by providing refugia for threatened species or grassland fauna. In the case of the Natural Temperate Grassland of the Victorian Volcanic Plain, past and current threats have reduced the integrity of the ecological community to such an extent that native pastures account for most of what remains.

Reduction in integrity through weed invasion
The degree of weed invasion within the Natural Temperate Grassland of the Victorian Volcanic Plain is high. Most grassland remnants show a considerable weed component (McDougall *et al*. 1994; Barlow and Ross 2002) particularly during spring when annual weeds are most evident (Carter *et al*. 2003). For example, at Derrimut Grassland Reserve, which is considered to be a good quality remnant, more than half of the plant species encountered are exotic weeds (Lunt and Morgan 1999a). Certain weeds present in the ecological community are seriously invasive and very difficult to manage, for example Chilean Needle-grass (Muyt 2001).

Williams (2005) and Williams *et al*. (2005) estimated the decline in area of grassland remnants around western Melbourne between 1985 and 2000. Degradation through weed invasion was responsible for about 40% of the decline (the remainder being mainly due to outright clearing). Degradation occurred to such an extent that remnants are now no longer dominated by native species (and therefore are outside the definition and condition thresholds for the ecological community presented here).

Reduction in integrity through loss of key faunal components
The functional roles of much of the grassland fauna remains largely unknown. One exception is the significant functional role played by small, ground-dwelling mammals, chiefly bandicoots and related species, that maintain the structure and function of the topsoil through their diggings (Martin 2003). (Note that this role applies to a wide range of Australian landscapes, not just grasslands). The digging activities of these small mammals influenced the biological and physical attributes of the topsoil (e.g. by enhancing microbial activity, aeration, water infiltration, nutrient cycling) and, in turn, had concomitant effects on biodiversity.

However, the mammal fauna of the Victorian Volcanic Plain region has declined in terms of both species richness and abundance (Seebeck 1984). This is likely to be a consequence of widespread clearing of native habitat for cropping or improved pastures; the introduction of domestic stock that grazed native cover and competed the soil through trampling; and the spread of feral predators, notably foxes and cats. There has been a particularly high attrition in the species richness of the rodent, macropod and bandicoot groups (National Land and Water Resources Audit 2007b). Eight native mammal species are now considered to be extinct from the bioregion, including small digging mammals such as the Rufous Bettong (*Aepypyrmnus rufescens*), Tasmanian Bettong (*Bettongia gaimardi*) and White-footed Rabbit-rat (*Conilurus albipes*); furthermore, the Eastern Barred Bandicoot (*Perameles gunnii* subsp.

unnamed) is effectively extinct across much of the bioregion except for small managed populations. A survey of the mammal fauna of remnant grasslands by Hadden (2003) recorded only few individuals of two native mammal species, both in the predatory dasyurid group (Fat-tailed Dunnart and the Common Dunnart). No individuals from the bandicoot group were recorded.

The loss of any fauna with such key functional roles would contribute to the overall reduction in the integrity of the Natural Temperate Grassland of the Victorian Volcanic Plain. It is not known whether loss of fauna can be compensated for by human intervention to replenish native fauna or actions that mimic their role in their absence.

Reduction in integrity through fragmentation
The Natural Temperate Grassland of the Victorian Volcanic Plain is undergoing increasing fragmentation of its remnants. The number of native grassland remnants around western Melbourne in 2000 was fewer, and the remnants separated by greater distances, than was the situation in 1985 (Williams *et al*. 2005). Most grassland remnants in this area also are very small in size (McCarthy *et al*. 2006) as noted under Criterion 2, above. As a consequence of fragmentation, grassland remnants are more susceptible to disturbance, less amenable to recovery and more difficult to maintain.

Restorability of the ecological community
A key issue is the extent to which the present degraded state of the ecological community can be reversed towards its original native grassland state. This is problematic because the response of the ecological community to disturbance involves multiple facets – not only loss of native biodiversity but also promotion of weed invasion and changes to soil characteristics. Changes in state become increasingly difficult to reverse as the impacts of persistent disturbance accumulate.

Management strategies are available to maintain or increase the native grass cover of grassland remnants based on appropriate regimes for grazing, fire and weed control (Barlow 1999; Lunt and Morgan 1999a; Lunt and Morgan 1999b; Ross 1999). There also have been efforts to revegetate native grasses by seed, for example Kangaroo-grass, though over small areas only (e.g. Greening Australia Victoria 1999; Waters *et al*. 2001).

Less is known about reintroducing the depauparate native wildflower flora. Transplanting herbs into grassland sites appears to be difficult and has a low success rate (Morgan 1999). However, broadscale direct seeding of native herbs has shown some success in enabling a range of herbs to establish and recruit in remnants (Gibson Roy *et a.l* 2007). The drawbacks to this approach are that it is currently not possible to access sufficient seed supplies for widescale revegetation programs and there are certain species which cannot be re-introduced in this way because their germination strategies are poorly known or not applicable to broadcast seeding. It remains difficult to increase native plant biodiversity in remnants degraded by highly invasive weeds without first enforcing a weed management strategy.

The Committee considers that the change in integrity experienced by the ecological community through the loss of key vegetative components, key faunal components, weed invasion and fragmentation is very severe. Regeneration of the ecological community is unlikely within the immediate future, even with positive human intervention. Therefore, the ecological community is **eligible** for listing as **critically endangered** under this criterion.

Criterion 5 - Rate of continuing detrimental change

The rates of decline of the Natural Temperate Grassland of the Victorian Volcanic Plain ecological community in the western Melbourne and adjacent rural regions were estimated by

comparing changes in extent between 1985 and 2000 (Williams *et al*. 2005). Around western Melbourne, the extent of grassland declined from 7230 ha in 1985 to 4071 ha in 2000. The decline was primarily due to a combination of destruction for urban development (1670 ha) and degradation leading to the dominance of non-native vegetation (1469 ha). The rate of decline for the 15-year period is 43.7% which equates to 29.1% per decade.

In the eastern rural component of the volcanic plain, the extent of grassland is estimated to have declined from 880 hectares in 1984 to 625 hectares in 2004 (Williams 2005). The decline was primarily due to the loss of roadside remnants following the increased use of herbicide spraying as a vegetation management practice along roadsides. The rate of decline over the 20 year period was 29% which equates to 14.5% per decade.

These estimates may underestimate actual decline because the surveys did not include many grasslands under private tenure. The baseline study by Stuwe (1986) experienced difficulty in detecting native grassland on rural properties and focussed on high conservation sites along roadsides and other public land.

The Committee considers that, in the context of its degraded state, very restricted distribution and the nature of continuing threats to the ecological community, the available information indicates a substantial detrimental change over the immediate past. Therefore, it is **eligible** for listing as **vulnerable** under this criterion.

Criterion 6 - Quantitative analysis showing probability of extinction

There are no quantitative data available to assess this ecological community under this criterion. Therefore, it is **not eligible** for listing under this criterion.

9. Conclusion

Conservation status

The Natural Temperate Grassland of the Victorian Volcanic Plain ecological community meets:

- Criterion 1 as critically endangered because its decline in geographic distribution is very severe;
- Criterion 2 as critically endangered because its geographic distribution is very restricted and coupled with demonstrable threats;
- Criterion 4 as critically endangered because the reduction in community integrity is very severe and regeneration is unlikely to occur within the immediate future; and
- Criterion 5 as vulnerable because the rate of continuing detrimental change is substantial.

Decision to have a Recovery Plan

The Committee has taken several key issues into account in its consideration of whether the Natural Temperate Grassland of the Victorian Volcanic Plain ecological community requires the development of a recovery plan. The Committee noted that the Victorian Volcanic Plain: is a National Biodiversity Hotspot; is one of the most intensively cleared agricultural regions of Australia; and is host to a range of Commonwealth interests including more than 25 nationally threatened flora and fauna species plus other species and ecological communities that are, or may be, under consideration by the Committee in the future.

The Committee believes that a broad-scale bioregional plan would make the greatest contribution to the conservation of the large number of threatened species and ecological

communities concerned. This plan should be undertaken with the co-operation of the Victorian government, local governments and Catchment Management Authorities, and take existing conservation initiatives into account.

10. Recommendations

i. The Committee recommends that the list referred to in section 181 of the EPBC Act be **amended by including in the list in the critically endangered** category: Natural Temperate Grassland of the Victorian Volcanic Plain.

ii. The Committee recommends that there be a **bioregional plan for the Victorian Volcanic Plain** as a strategic initiative.

Associate Professor Robert J.S. Beeton

Chair

Threatened Species Scientific Committee

Table 1. Plant species typical of the Natural Temperate Grassland of the Victorian Volcanic Plain ecological community. This list is only indicative of plant species common to the ecological community and is not comprehensive. The plant species listed below may not occur in every grassland patch and a grassland patch may contain other species not listed.

Sources: Department of Environment and Sustainability (2004a; 2004b – Benchmarks for EVC 132 and 654 in the Victorian Volcanic Plain).

Species name	**Common name**
GRASSES AND GRASS-LIKE PLANTS	
Austrodanthonia caespitosa	Common Wallaby-grass
Austrodanthonia duttoniana	Brown-back Wallaby-grass
Austrostipa bigeniculata	Kneed Spear-grass
Austrostipa nodosa	Knotty Spear-grass
Austrostipa scabra	Rough Spear-grass
Carex tereticaulis	Rush Sedge
Centrolepis aristata	Pointed Centrolepis
Centrolepis strigosa subsp. *strigosa*	Hairy Centrolepis
Dichelachne crinita	Long-hair Plume-grass
Distichlis distichophylla	Australian Salt Grass
Eleocharis acuta	Common Spike-sedge
Elymus scaber var. *scaber*	Common Wheat-grass
Hemarthria uncinata var. *uncinata*	Mat Grass
Juncus kraussii subsp. *australiensis*	Sea Rush
Juncus planifolius	Broad-leaf Rush
Lachnagrostis filiformis	Common Blown-grass
Microlaena stipoides var. *stipoides*	Weeping Grass
Poa labillardierei	River or Common Tussock-grass
Schoenus apogon	Common Bog-sedge
Themeda triandra	Kangaroo-grass
Walwhalleya proluta	Rigid Panic
HERBS AND WILDFLOWERS	
Acaena echinata	Sheep's Burr
Asperula scoparia	Prickly Woodruff
Brachyscome basaltica var. *gracilis*	Woodland Swamp-daisy
Calocephalus citreus	Lemon Beauty-heads
Calocephalus lacteus	Milky Beauty-heads
Chamaesyce drummondii	Flat Spurge
Chrysocephalum apiculatum	Common Everlasting
Convolvulus angustissimus	Pink Bindweed
Craspedia glauca spp. agg.	Common Billy-buttons
Crassula helmsii	Swamp Crassula
Dichondra repens	Kidneyweed
Drosera peltata	Pale Sundew
Drosera whittakeri subsp. *aberrans*	Scented Sundew
Eryngium ovinum	Blue Devil
Gonocarpus tetragynus	Rough Raspwort
Goodenia pinnatifida	Cut-leaf Goodenia
Haloragis heterophylla	Varied Raspwort
Hydrocotyle sibthorpioides	Shining Pennywort
Leptorhynchos squamatus	Scaly Buttons
Lobelia pratioides	Poison Lobelia
Microseris sp. 1	Yam Daisy
Microtis unifolia	Common Onion-orchid
Oxalis perennans	Grassland Wood-sorrel
Plantago gaudichaudii	Narrow Plantain
Ptilotus macrocephalus	Feather-heads
Rumex dumosus	Wiry Dock

Senecio quadridentatus	Cottony Fireweed
Senecio tenuiflorus	Narrow-leaf Groundsel
Solenogyne dominii	Smooth Solenogyne
Thelymitra pauciflora s.l.	Slender Sun-orchid
SHRUBS	
Atriplex semibaccata	Berry Saltbush
Maireana enchylaenoides	Wingless Bluebush
Pimelea curviflora s.s.	Curved Rice-flower
Pimelea humilis	Common Rice-flower

Note: The ground layer is the dominant layer for this ecological community. A canopy of trees and large shrubs is typically absent, though it may be present as scattered individuals at some sites.

Table 2. Threatened species listed under the *Environment Protection and Biodiversity Conservation Act 1999* that occur in or near the Natural Temperate Grassland of the Victorian Volcanic Plain.

	Species	**Common name(s)**	***EPBC* Status**
Mammals	*Isoodon obesulus* subsp. *obesulus*	Southern Brown Bandicoot	Endangered
	Perameles gunnii subsp. unnamed *	Eastern Barred Bandicoot (Mainland)	Endangered
Birds	*Pedionomus torquatus**	Plains-wanderer	Vulnerable
Reptiles	*Delma impar*	Striped Legless Lizard	Vulnerable
	Eulamprus tympanum subsp. *marnieae*	Corangamite Water Skink	Endangered
	Tympanocryptis pinguicolla	Grassland Earless Dragon	Endangered
Amphibians	*Litoria raniformis*	Southern Bell Frog, Growling Grass Frog, Warty Bell Frog, Green and Golden Frog	Vulnerable
Insects	*Synemon plana*	Golden Sun Moth	Critically Endangered
Plants	*Carex tasmanica*	Curly Sedge	Vulnerable
	Cullen parvum	Small Scurf-pea	Endangered
	Dianella amoena	Matted Flax-lily	Endangered
	Diuris sp. aff. *chryseopsis* (Basalt Plains)	Small Golden Moths Orchid; Early Golden Moths	Endangered
	Diuris fragrantissima	Sunshine Diuris, White Diuris, Fragrant Double-tails	Endangered
	Dodonaea procumbens	Trailing Hop-bush	Vulnerable
	Glycine latrobeana	Clover Glycine, Purple Clover	Vulnerable
	Lachnagrostis adamsonii	Adamson's Blown-grass	Endangered
	Lepidium aschersonii	Spiny Pepper-cress	Vulnerable
	Lepidium hyssopifolium	Basalt Pepper-cress	Endangered
	Leucochrysum albicans var. *tricolor*	Hoary Sunray	Endangered
	Pimelea spinescens subsp. *spinescens*	Plains Rice-flower, Spiny Rice-flower, Prickly Pimelea	Critically Endangered
	Prasophyllum diversiflorum	Gorae Leek-orchid	Endangered
	Prasophyllum frenchii	Maroon Leek-orchid, Slaty Leek-orchid, Stout Leek-orchid, French's Leek-orchid	Endangered
	Prasophyllum suaveolens	Fragrant Leek-orchid	Endangered
	Pterostylis basaltica	Basalt Greenhood	Endangered
	Rutidosis leptorrhynchoides	Button Wrinklewort	Endangered
	Senecio macrocarpus	Large-fruit Groundsel, Large-fruit Fireweed	Vulnerable
	Senecio psilocarpus	Swamp Fireweed, Smooth-fruited Groundsel	Vulnerable
	Thesium australe *	Austral Toadflax, Toadflax	Vulnerable
	Xerochrysum palustre	Swamp Everlasting	Vulnerable

* Formerly present in the Natural Temperate Grassland of the Victorian Volcanic Plain.

- The Plains-wanderer is now considered extinct in south-western Victoria (Garnett and Crowley 2000).
- The mainland subspecies of the Eastern Barred Bandicoot is now limited to a single natural population on a disturbed site plus individuals translocated into native grassland and woodland.
- All known occurrences of Austral Toadflax in Victoria are now limited to sites outside of the Victorian Volcanic Plain.

Table 3. Classification of the Natural Temperate Grassland of the Victorian Volcanic Plain within the National Vegetation Information System (NVIS).

NVIS Category	**EVC 132**	**EVC 654**
Major Vegetation Group	19 Tussock grasslands	19 Tussock grasslands
Major Vegetation Subgroup	36 Temperate tussock grasslands	37 Other tussock grasslands
Formation (NVIS levels 3/4)	*Themeda* tall tussock grassland	*Poa* tall closed tussock grassland
Association (NVIS level 5)	Dominant stratum = ground (G+) - *Themeda triandra, Austrodanthonia caespitosa, Elymus scaber* var. *scaber* Growth forms = other grass, tussock grass, forb Height class = 3 (tall, 1-2m) Cover code = c (>80% foliage cover)	Dominant stratum = ground (G+) - *Poa labillardierei, Carex tereticaulis, Juncus kraussii* subsp. *australiensis* Growth forms = rush, sedge, tussock grass Height class = 3 (tall, 1-2m) Cover code = d (30-70% foliage cover)

Table 4. Estimates of extent and decline for the Natural Temperate Grassland of the Victorian Volcanic Plain. Source: Department of Sustainability and Environment (2004c).

Victorian Volcanic Plain IBRA bioregion

EVC	**Pre-European (ha)**	**Current (ha)**	**Decline (%)**
132	256,542	5,240	98.0
654	2,547	5	99.8
Total	**259,089**	**5,245**	**98.0**
897	*473,592*	*3,241*	*99.3*

Adjacent IBRA subregions (Otway Plain, Central Victorian Uplands and Dundas Tablelands)

EVC	**Pre-European (ha)**	**Current (ha)**	**Decline (%)**
132	1,632	26	98.4
654	59	0	100
Total	**1,691**	**26**	**98.5**
897	*2,073*	*88*	*95.8*

Legend:
EVC 132 = Plains Grassland;
EVC 654 = Creekline Tussock Grassland;
EVC 897 = Plains Grassland/Plains Grassy Woodland Mosaic. Note: EVC 897 includes both grassland and grassy woodland elements that cannot be resolved from the methodology and scale of mapping available, and without further ground-truthing.

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