

Advice to the Minister for the Environment, Heritage and the Arts from the Threatened Species Scientific Committee (the Committee) on Amendments to the List of 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 **Alpine Bog Community** as a threatened ecological community. The nomination was made available for public exhibition and comment for a period of two months. 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 2 to make it **eligible** for listing as **endangered**;
- Criterion 3 to make it **eligible** for listing as **endangered**; and
- Criterion 4 to make it **eligible** for listing as **endangered**.

2. Name of the ecological community

A nomination was received for the Alpine Bog Community. Alpine bogs are commonly found in the vicinity of alpine fens, and have been identified as being dependent on these (VSAC, 1991a). In order to make identification easier in the field, to recognise the importance of *Sphagnum* species to alpine bogs, and to acknowledge the interdependency of alpine bogs, fens and the natural drainage lines that connect them, the Committee recommends that the name of the ecological community be changed to the “**Alpine *Sphagnum* Bogs and Associated Fens**” ecological community.

3. Description

The Alpine *Sphagnum* Bogs and Associated Fens ecological community generally has sharp boundaries and is easily delineated from other alpine vegetation communities. Many of its plant species rarely occur in other vegetation assemblages. Typical plant species found in the Alpine *Sphagnum* Bogs and Associated Fens ecological community are listed in Table 1 (pp. 15-16). There is some overlap between species found in the ecological community on the mainland and in Tasmania (e.g. *Sphagnum* spp., *Baloskion australe*, *Carex gaudichaudiana* and *Empodisma minus*).

Although it is not always the dominant genus, the Alpine *Sphagnum* Bogs and Associated Fens ecological community can usually be defined by the presence or absence of *Sphagnum* spp., the most common of which is *Sphagnum cristatum* (Kirkpatrick, 1997). The absorptive properties of *Sphagnum* spp. and the underlying peat regulate the lateral spread of moisture within this ecological community and ultimately define its boundaries. A common definition of a ‘*Sphagnum* bog’ ecological community is one where *Sphagnum* spp. cover more than thirty per cent of the ground (Kirkpatrick, 1997). However, there are some sites in the Alpine *Sphagnum* Bogs and Associated Fens ecological community that are dominated by shrubs or *Restionaceae* spp., where *Sphagnum* spp. are only a minor component, and others where *Sphagnum* has been depleted or lost due to disturbance. In these cases, the site may

still be considered to be part of this ecological community if other key species are present (see Table 1) and a peat substratum is evident.

Bogs are found in permanently wet areas, such as along streams, valley edges and valley floors. They are also situated on slopes where soils are waterlogged (Costin et al., 2000; Slattery, 1998). The key to bog formation is a good supply of groundwater and an impeded drainage system that keeps the water table at or near the surface. Under these conditions, the decomposition of organic materials is incomplete, eventually forming the peat that underlies the Alpine *Sphagnum* Bogs and Associated Fens ecological community (Good, 1992).

The Alpine *Sphagnum* Bogs and Associated Fens ecological community contains a number of recognised variants, changing in a predictable progression from the hillsides down to the valley floor. Permanently wet slopes provide suitable habitat for the growth of *Epacris* spp. shrubs. Along with *Sphagnum* spp., these plants form a slightly domed 'raised' bog (Costin et al., 2000). This is a dynamic community which oscillates through a cycle of herbs and shrubs on the hummocks and hollows which characterise this landscape (Good, 1992). At the edges of valleys, *Carex* sedges may replace some shrubs. In these locations, the vegetation forms a flatter, more concave 'valley' bog. In the wettest areas, generally along watercourses or on valley floors, semi-permanent to permanent pools of surface water, commonly referred to as fens, can be found (Good, 1992; Kirkpatrick, 1997; Slattery, 1998). These conditions do not favour the growth of *Sphagnum* spp., so here the ecological community is dominated by sedges (Costin et al, 2000). The vegetation of these fens is distinct from the surrounding bogs, but due to the ecological interdependence of the two communities, they are considered as inseparable in the current context (VSAC, 1991a). It should also be noted that whilst fens do occur within other alpine and subalpine ecological communities, such as *Epacris glacialis* heathland, these other fens are floristically different and are not included with the community currently being considered (McDougall and Walsh, 2007).

In Australia, there is no clear demarcation between alpine and subalpine regions. The Alpine *Sphagnum* Bogs and Associated Fens ecological community can be found across alpine, subalpine and montane environments, often (but not always) above the climatic treeline. The climatic treeline is generally identified as the 10°C isotherm (average summer temperature), which marks the point above which trees do not survive (Costin et al., 2000). From a geographical perspective, alpine and subalpine regions are found above 1600 metres above sea level (asl) on the mainland, and above 800 m asl in Tasmania (Kirkpatrick, 1997; Slattery, 1998).

However, it is important to note that the climatic treeline and the limit of tree vegetation are variable depending on topographic features and localised climatic conditions such as the degree of cold air drainage at individual sites which may prevent the growth of trees. Inverted treelines are common. Consequently, the Alpine *Sphagnum* Bogs and Associated Fens ecological community also occurs at sites with lower elevations, where local conditions and vegetation are equivalent to those of true 'alpine' sites (ESA, 2006). The ecological community is known to exist at 1200 m asl in Victoria and as low as 1000 m asl in parts of the Australian Capital Territory (ACT) and New South Wales (NSW), even though these locations are geographically montane rather than alpine or subalpine.

4. Condition Thresholds

Condition thresholds have not been adopted for the Alpine *Sphagnum* Bogs and Associated Fens ecological community. This is in part because most examples of the community are already protected within the borders of national parks where it was felt that condition thresholds would not provide any additional conservation benefit.

Condition has also been extensively compromised by human use of these mountain areas since European settlement, to the extent that there is often no way to determine what is 'natural' and what has occurred in response to a long history of disturbance (Tolsma, pers comm.). Finally, the massive impacts of the 2003 and 2006 wildfires on the Alpine *Sphagnum* Bogs and Associated Fens ecological community have been such that the community still needs time to recover before condition could be adequately assessed.

5. National Context

The Alpine *Sphagnum* Bogs and Associated Fens ecological community can be found in small pockets across Tasmania, Victoria, NSW and the ACT. *Sphagnum* bogs do occur in other parts of Australia (Whinam et al., 2003). However, these environments are not alpine in nature and as such are excluded from this ecological community.

The Alpine *Sphagnum* Bogs and Associated Fens ecological community occurs primarily within the Australian Alps, the Tasmanian Central Highlands and the Tasmanian Southern Ranges IBRA bioregions. It is also found in a small area of the Bondo subregion of the South Eastern Highlands IBRA bioregion on mainland Australia, and may be present within the Ben Lomond and Tasmanian South East IBRA bioregions in Tasmania. The Interim Biogeographic Regionalisation for Australia (IBRA) divides the Australian continent into 85 bioregions. The IBRA bioregions and sub-regions are the reporting unit for assessing the status of native ecosystems, their protection in the national reserve system and for use in the monitoring and evaluation framework of the Australian Government's current Natural Resource Management initiatives.

Vegetation in Victoria has been classified using a system of Ecological Vegetation Classes (EVCs) to describe the floristics of different plant associations (VDSE, 2005). A similar system is also in use in Tasmania, called TASVEG (Harris and Kitchener, 2005). In addition, recent studies have provided detailed floristic classifications of vegetation types in NSW, and across the mainland alpine and subalpine regions in general (e.g. Keith (2004) and McDougall and Walsh (2007)). These floristic equivalents for the Alpine *Sphagnum* Bogs and Associated Fens ecological community are listed in Table 2 (p.16).

Two components of the Alpine *Sphagnum* Bogs and Associated Fens ecological community have been listed as threatened in Victoria under the *Flora and Fauna Guarantee Act 1988* (FFG Act). These are the "Alpine Bog Community" and the "Fen (Bog Pool) Community" (VSAC, 1991a and 1991b; VDSE, 2007). "*Caltha introloba* Herbland Community", which is also listed under the FFG Act, may also be found within *Sphagnum* bogs, particularly around areas of late-lying snow (VSAC, 1992; VDSE, 2007). In NSW, the "Montane peatlands and swamps of the New England Tableland, NSW North Coast, Sydney Basin, South East Corner, South Eastern Highlands and Australian Alps bioregions" have been listed as an endangered ecological community under the *Threatened Species Conservation Act 1995* (TSC Act) (NSWDECC, 2004). The Alpine *Sphagnum* Bogs and Associated Fens ecological community matches part of this state listing. Finally, "Sphagnum peatland" is listed as 'Rare' under the *Nature Conservation Act 2002* (NC Act) in Tasmania (TFPA, 2007). This is equivalent to

the Tasmanian component of the Alpine *Sphagnum* Bogs and Associated Fens ecological community.

The alpine and subalpine zones are of national importance because wet peatland environments such as the Alpine *Sphagnum* Bogs and Associated Fens ecological community form the areas where many of Australia's key river systems rise. On the mainland, these include the headwaters of many coastal rivers as well as the Murray and Murrumbidgee Rivers, which are vital to many of Australia's major agricultural industries. Inland-flowing alpine streams provide a high proportion of total streamflow in the Murray-Darling Basin, emphasising that these water resources and the environment where they originate are of regional and national significance (Crabb, 2003). In addition, the manner in which bog and fen communities gradually release water from the spring snow melt is critical to the operation of the Snowy Mountains Hydro-electric Scheme (Good, 1992). In Tasmania, the alpine and subalpine zones are also the main source point for a majority of the island's river systems, which are used extensively for the production of hydro-electricity.

Alpine and subalpine peats and fen peats are also considered highly significant from a conservation perspective as they contain pollen and charcoal deposits that provide a botanical and climatic timeline dating back to the late Pleistocene period (Good, 1992). This type of geologic record is of critical importance in providing a picture of past climatic conditions, which in turn greatly assists understanding of ongoing climate change and its effects (Galloway, 2002).

Finally, the Alpine *Sphagnum* Bogs and Associated Fens ecological community includes sites like the Ginini Flats Wetland and Blue Lake, which are of international significance through their listing under the Ramsar Convention on Wetlands (Crabb, 2003). Ginini Flats Wetland is also the largest intact bog and fen community in the Australian Alps. The Directory of Important Wetlands in Australia identifies a further ten alpine bog and fen sites as Nationally Important Wetlands (EA, 2001).

6. Relevant Biology and Ecology

The appearance of the Alpine *Sphagnum* Bogs and Associated Fens ecological community and the mix of plants and animals contained therein are clearly subject to the influences of season, location and level of disturbance. The co-dependency of bogs, fens and the natural drainage lines that connect them is also critical. The local environment and climatic conditions are harsh, such that flora and fauna have had to adapt to limited growing and breeding seasons, and adopt unique regeneration strategies. This treeless region is an important refuge for endemic flora and fauna, many of which are at risk of extinction as factors like global warming continue to marginalise their niche habitats.

As the name suggests, *Sphagnum* spp. are an integral component of the Alpine *Sphagnum* Bogs and Associated Fens ecological community. These plants are known to contribute greatly to peat formation, with many bogs forming on *Sphagnum* derived peat. Like peat, *Sphagnum* has a significant waterholding capacity which is important in modulating water flow and maintaining the hydrology of surrounding environments (Ashton and Williams, 1989). The manner in which bog and fen communities gradually release water from the spring snow melt is critical to the survival of numerous other ecological communities (Good, 1992).

By moderating the rate of water movement, intact *Sphagnum* bog communities have the capacity to reduce the likelihood of soil erosion. This is achieved by slowing and otherwise

interfering with the passage of water so that it moves over a wide front rather than through channels (Ashton and Williams, 1989). Intact stands of *Sphagnum* also act as a natural filter for nutrients, pathogens and sediments, thus playing an important role in maintaining water quality at lower altitudes (McDougall, 1989).

The Alpine *Sphagnum* Bogs and Associated Fens ecological community is home to a rich profusion of endemic flora including *Astelia psychrocharis* (Kosciuszko pineapple-grass), *Dichosciadium ranunculaceum* var. *ranunculaceum* (Wreath Pennywort), *Gingidia algens* (Kosciuszko Aniseed) and *Euphrasia eichleri* (Bogong Eyebright) (Good, 1992; Costin et al., 2000).

The Alpine *Sphagnum* Bogs and Associated Fens ecological community is known to provide significant habitat for a number of endemic and threatened fauna species. These include *Pseudophryne corroboree* (Southern Corroboree Frog), *Pseudophryne pengilleyi* (Northern Corroboree Frog) and *Litoria booroolongensis* (Booroolong Frog) (Mansergh et al., 2002). *Philoria frosti* (Baw Baw Frog) utilises this environment for both breeding and hibernation, and *Sphenomorphus kosciuskoi* (Alpine Water Skink), depends on the alpine bog and fen environment for survival (Good, 1992; Keith, 2004). *Litoria verreauxii alpina* (Verreaux's Alpine Tree Frog) uses the Alpine *Sphagnum* Bogs and Associated Fens ecological community for breeding purposes. Protected under international migratory bird agreements, the *Gallinago hardwickii* (Latham's Snipe) has also been observed in summer in a small number of alpine bogs and wet heathland vegetation (Mansergh et al., 2002). It is also worth noting that wet areas of the Australian Alps also contain a number of endemic invertebrate species, including *Kosciuscola tristis* (Alpine Thermocolour Grasshopper), which is able to change its colour in order to maintain a more constant body temperature (Keith, 2004). Fauna and flora species protected under the *Environment Protection and Biodiversity Conservation Act 1999* are listed in Table 3 (p.17).

7. Description of Threats

Alpine vegetation is particularly susceptible to change in general, along with a range of more specific adverse impacts. This is due in part to the restricted growing season of the alpine and subalpine regions, but also the very fragile nature of some systems, particularly alpine snowpatch vegetation and the Alpine *Sphagnum* Bogs and Associated Fens ecological community (Ashton and Williams, 1989). The biggest threats currently facing this community are fire and the ongoing effects of climate change. Other significant threats include exotic weed invasions, grazing and trampling by non-native animals, tourism and increased human infrastructure. *Sphagnum* harvesting is also an issue in some areas, mainly Tasmania.

Fire

The post-European settlement practice of burning to provide green feed for livestock and supposedly to reduce fuel load has permanently altered the Australian alpine and subalpine landscape. Most of the detrimental changes that can follow a fire, such as loss of vegetation cover and subsequent erosion, are also associated with the impacts of grazing and exotic weed invasion, both of which are addressed elsewhere in this section.

Over 1.4 million hectares of alpine and subalpine country in north-east Victoria, south-east NSW and the ACT were severely burnt by the wildfires of January 2003. Most of the areas covered by the Alpine *Sphagnum* Bogs and Associated Fens ecological community were affected (Gill et al., 2004; Hope et al., 2005). The January 2003 fires were started by a series

of lightning strikes during an intense electrical storm system, the impact of which then combined with the effects of prolonged drought to produce the first major conflagration of the Australia high country since 1939 (Pyper, 2003; Walsh and McDougall, 2004). The impacts of the 2003 wildfires were variable, depending on the particular location, vegetation type, fire intensity and prevailing weather conditions at the time. The result was a landscape mosaic ranging from total destruction to patches that escaped untouched by fire (Crabb, 2003). However, some areas affected by a further major fire in 2006-2007, following the devastation of 2003, indicate that too frequent wildfire is also a threat as some communities need extended periods of time between fire events in order to adequately recover (McDougall, 2007).

Many Australian vegetation types are adapted to or highly tolerant of fire. Responses vary widely depending on fire intensity, frequency and the specific response strategies of individual species. However, whilst regeneration rates of most vegetation types have generally been good following the 2003 fires, the Alpine *Sphagnum* Bogs and Associated Fens ecological community suffered extensive damage. *Sphagnum* and its underlying peats are known to be very fire sensitive (Whinam and Chilcott, 2002; Gill et al., 2004; Hope et al., 2005). As previously noted, *Sphagnum* is of critical importance for this ecological community. *Sphagnum* is almost always dependent on remnant unburnt fragments for regeneration, but in the most severely burnt bogs, *Sphagnum* cover was completely destroyed with the underlying peat burnt down to mineral soils (Walsh and McDougall, 2004). This has resulted in *Sphagnum* being completely lost from some sites at the present time. In contrast to *Sphagnum*, shrubs such as *Epacris gunnii* and *Richea continentis* rely on seedling recruitment to re-establish, with germination times for these species frequently taking as long as eighteen months. In both cases, such delays make post-fire recovery very difficult as the bog environment is left extremely vulnerable to prolonged soil erosion and weed invasion in the interim (Walsh and McDougall, 2004; McDougall, 2007).

The impact of fire on the Alpine *Sphagnum* Bogs and Associated Fens ecological community is long-term. However, evidence from previous smaller fires suggests that whilst post-fire recovery of *Sphagnum cristatum* is frequently negligible for several years, a more rapid recovery rate does follow later (McDougall, 2007). Numerous methods to facilitate post-fire *Sphagnum* recovery are currently being trialled and monitored in both NSW and the ACT in an effort to accelerate the process (Good, 2004; Hope et al., 2005; Thomas, 2007). However, too frequent fire remains an ongoing threat to the Alpine *Sphagnum* Bogs and Associated Fens ecological community, particularly under drought conditions. Climate change will also impact upon both fire risk and fire behaviour.

Climate Change

Climate change must be considered as one of the biggest threats currently facing the Alpine *Sphagnum* Bogs and Associated Fens ecological community, even though the implications and specific details are as yet unclear (Keith, 2004; McDougall and Walsh, 2007; Williams and McDougall, 2007). Most literature supports the proposition that montane regions will become critical refugia for both flora and fauna under enhanced greenhouse scenarios, which will affect 'alpine' bogs found in those areas (Mansergh et al., 2002). Studies of the interactions between climate change and fire behaviour are already underway (Pyper, 2003; Lucas, 2007).

Whilst there are few reports available at this stage that document the effects of climate change on this ecological community specifically, the broader environmental impacts of global warming are more widely appreciated. Australia's alpine and subalpine regions face growing

pressure as a result of warmer temperatures and reduced precipitation. As pressure on water availability increases, so too does the importance of the Alpine *Sphagnum* Bogs and Associated Fens ecological community's functional role in regulating water release and flow downstream.

Those ecological communities currently existing at the limits of their possible range are amongst the most vulnerable to the potential impacts of a changing climate (Mansergh et al., 2002; Whinam et al., 2003). The Alpine *Sphagnum* Bogs and Associated Fens ecological community is a key example of this situation. For many affected species, there is nowhere to go. Even a small increase in mean ambient temperature is likely to result in the loss of more bogs and fens due to changes in snowfall and snowmelt regimes, which will in turn affect groundwater movement. This situation will be further exacerbated by greater demands for water. Over time, a reduction in snowmelt and soil moisture is likely to result in some occurrences of the Alpine *Sphagnum* Bogs and Associated Fens ecological community being replaced by tussock grasslands or wet heath assemblages (Pickering et al., 2004).

Willows and Other Weed Infestations

One of the greatest threats currently facing the Alpine *Sphagnum* Bogs and Associated Fens ecological community is exotic weed invasion. Whilst intact sites appear quite resistant to weed establishment, those already compromised by fire or other impacts such as grazing and trampling become very susceptible. Post-fire studies in the Kosciuszko National Park have found a significant increase in both diversity and average numbers of weeds impacting on bog sites. Whilst some exotic species may prove to be transient, others such as *Juncus effusus* (Soft Rush) are now in such abundance over previously grazed areas like Rocky Valley that they are permanently altering the floristic composition and structural integrity of some bog and fen sites (Walsh and McDougall, 2004; McDougall, 2007).

Salix spp. (Willows) have become a major problem in some alpine areas over recent years. Most willow species are listed as Weeds of National Significance, with *Salix cinerea* (Grey Sallow Willow) considered the most highly invasive. *Sphagnum* environments in alpine Victoria have been particularly affected in the aftermath of the 2003 wildfires (Tolsma, pers comm.). Thousands of seeds blown in from parent trees in surrounding valleys during the massive updrafts associated with the fires were able to establish themselves in burnt bogs above the treeline. Willow control programs are underway but active management continues to be a high priority as new plants will produce viable seed from a very young age. This is already occurring in some areas of alpine Victoria (Coates et al., 2006). Willows, with their deep root systems, high water use and adaptivity to cold, have the capacity to become established and fundamentally alter the structure and hydrology of the Alpine *Sphagnum* Bogs and Associated Fens ecological community (Cremer et al., 1995).

Other weed species commonly found in the Alpine *Sphagnum* Bogs and Associated Fens ecological community include *Mimulus moschatus* (Musk Monkey Flower), *Phleum pratense* (Timothy Grass), *Anthoxanthum odoratum* (Sweet Vernal-grass), *Holcus lanatus* (Yorkshire Fog), and *Hypochoeris radicata* (Cat's Ear) (VDSE, 2005; McDougall and Walsh, 2007). In the absence of strong competition from an intact community, many weeds easily thrive in bare moist peat environments. Disturbed *Sphagnum* bogs have no natural mechanism to enable them to limit weed establishment. Weeds are present in all examples of the ecological community, and all threats that directly influence weed invasion require ongoing prevention and management. The inaccessibility and remoteness of many sites and the nature of these threats will pose a challenge for weed detection, prevention, management and eradication.

Grazing and Trampling by Non-Native Animals

One of the better documented threats to alpine vegetation is the impact of animals introduced to Australia since European settlement. All alpine and subalpine regions on the mainland and in Tasmania were used for summer grazing of domestic cattle from the early 1800s. Grazing in national parks in Tasmania, NSW and the ACT ceased by the 1970s and 1980s, (considerably earlier in some areas, such as 1914 for the Cotter Catchment in the ACT) and finally came to an end in Victoria in 2005 (Kirkpatrick, 1983; Ashton and Williams, 1989; Crabb, 2003; Jacobs, 2005). Although cattle no longer have legal access to the national parks, it is critical that maintenance of fencing continues to be a key management activity as grazing does continue in neighbouring state forests and on private lands. Some occurrences of this ecological community are situated within high country state forests in Victoria and NSW, so these continue to be affected by grazing pressures.

Australian soils and vegetation are very susceptible to the impacts of hard-hooved vertebrates. In particular, *Sphagnum* is easily crushed and broken up by trampling and wallowing, both of which are inevitable around any water course where animals are liable to congregate on a regular basis. Cattle hoof prints are especially enduring in *Sphagnum cristatum* at the edges of pools and streams (McDougall, 2007). Once the *Sphagnum* cover is lost, alpine soils and peat environments are very susceptible to desiccation, incision and soil erosion (Good, 1992). Trampling and wallowing cause channels to form in the disturbed *Sphagnum*, resulting in water exiting the landscape more rapidly than occurs in undisturbed bogs. The formation of channels is in turn detrimental to the fens associated with the bogs. Where *Sphagnum* cover has been impacted by non-native animals, the erosion channels that can result mean the fens drain directly into the stream system.

The impact of non-native animals on alpine communities is long-term, with the effects remaining long after the initial trigger is removed. As an example, grazing was withdrawn from the Mount Kosciuszko summit area in 1944, but even here, the degradation that cattle caused is still clearly visible in some environments (Crabb, 2003). A clear sign of grazing and cattle induced degradation in alpine *Sphagnum* bogs and associated fens is the presence of silty or stony pavements, bare peat and entrenched channels (Wahren et al., 1996). Studies on the Bogong High Plains of Victoria have also shown significant floristic differences between grazed and ungrazed patches of the Alpine *Sphagnum* Bogs and Associated Fens ecological community (McDougall, 1989 and 2007). Here, ungrazed peatland sites were noted to have indistinct drainage lines with a continuous cover of *Sphagnum cristatum*, compared to grazed sites where *Sphagnum* cover was patchy and disjointed, and water drained freely along channels that were well-defined and entrenched.

Even though alpine cattle grazing has ceased in the national parks, its impact remains, and is now perpetuated by the habits of other (largely feral) non-native animals, primarily horses, deer, goats and pigs. These animals also trample delicate vegetation and wallow in pools and waterways, making them an ongoing threat to the structural integrity of the Alpine *Sphagnum* Bogs and Associated Fens ecological community. The threat of damage is substantially increased following a fire, due to improved access into bogs for animals, and the presence of burnt, highly-erodible peat.

With the cattle removed, feral horses are now the largest animals impacting on the national parks, a threat which continues to provoke controversy and which requires complex management strategies (O'Brien and Wren, 2002). Their main impacts include trampling, track formation and erosion. Feral horses are also known to have a detrimental impact on *Sphagnum* growth and integrity, with the resulting vegetation loss ultimately leading to

degradation of the Alpine *Sphagnum* Bogs and Associated Fens ecological community (Dyring, 1990; ACTTAMS, 2007). Similar impacts due to recreational horse-riding may also be expected as the popularity of this pastime increases.

Other non-native animals affect the Australian high country in ways other than grazing and trampling. Predation on native fauna by foxes and feral cats is a serious issue (Mansergh et al., 2002). Feral dogs are another significant problem, especially in areas adjacent to private land, where the national parks are seen as providing a refuge. Whilst there is no evidence of these non-native species impacting directly on the Alpine *Sphagnum* Bogs and Associated Fens ecological community, they do contribute to the collective threat facing the biodiversity of the Australian Alps. Finally, studies indicate that some exotic salmonid species such as trout are impacting on populations of native frogs (*Pseudophryne* spp.), native fish (*Galaxias* spp.) and alpine spiny crays (*Euastacus* spp.) in some high altitude areas, including in the ecological community (Raadik, pers.comm.).

Tourism and Other Human Infrastructure

Tourism, associated infrastructure and other human uses of the area encompass a range of threats affecting the Alpine *Sphagnum* Bogs and Associated Fens ecological community, even though most examples of this community are located within national parks. Recreational demands on alpine and subalpine regions continue to rise as more people visit the area in the summer months, as well as the more traditional winter ski season (McDougall and Walsh, 2007). Trampling of vegetation by walkers not keeping to pathways is a growing problem (Whinam and Chilcott, 2002). Other threats include ski resort developments, associated roadworks, and dams required for the production of hydro-electricity (McDougall and Walsh, 2007). Dams and aqueducts are a significant issue due to their permanent impact on local hydrology, as they can lead to affected bogs and fens being drained and ultimately drying out.

Sphagnum Harvesting

Sphagnum is harvested from the wild for use in the horticultural industry. Most of this currently occurs in Tasmania, with very minor amounts coming from places in Victoria and NSW. Whilst these operations are all small scale, the scarcity of *Sphagnum* peatlands means that the impacts on this ecological community overall have been significant. More than ninety per cent of *Sphagnum* communities are within national parks and are thus unavailable for harvesting, putting increased pressure on those remaining areas (TFPB, 2003; TDPIW, 2007). The Australian Code of Practice for *Sphagnum* harvesting states that harvesting should not be carried out in alpine or subalpine environments. However, illegal harvesting is an increasing problem, and so remains a threat to the Alpine *Sphagnum* Bogs and Associated Fens ecological community (TDPIW, 2007).

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

The Committee judges the Alpine *Sphagnum* Bogs and Associated Fens ecological community to be eligible for listing as **endangered** under the EPBC Act. Justification against the criteria is as follows:

Criterion 1 - Decline in geographic distribution

There are few reliable estimates of the current or pre-European extent of the Alpine *Sphagnum* Bogs and Associated Fens ecological community, despite various studies of the vegetation of the alpine region (Costin et al., 2000; Gellie 2005; McDougall and Walsh

2007). One estimate suggests that current extent is less than half what it was before European use of the region began, and that only around thirty per cent of this could be considered still fully functional. According to these figures, less than fifteen per cent of the pre-European extent of this community remains in a fully functional state (Pickering et al, 2004). Another report estimates that less than half of bog and fen communities originally found within Kosciuszko National Park and the Victorian alpine parks still remain (AALC, 2006).

Further support for the decline of the Alpine *Sphagnum* Bogs and Associated Fens ecological community can be found in the literature. However, in many cases bog and fen communities have been treated as a component of a broader treeless alpine vegetation complex, and this makes accurate measurement very difficult. The use of broad assemblages of several separate ecological communities, also has the potential to mask significant change or decline within any one of those communities. This would be particularly so for those ecological communities which are of small areal extent and which are highly fragmented. The Alpine *Sphagnum* Bogs and Associated Fens ecological community is likely to be a classic example of this situation. The limited area of occupancy for this ecological community can be clearly seen below under Criterion 2.

Overall, lack of data on pre-European extent precludes any detailed estimation of a decline in extent for the Alpine *Sphagnum* Bogs and Associated Fens ecological community. However, a decline can be inferred due to the impacts of the 2003 and 2006 wildfires, which do not appear to have been factored into the figures above. As outlined previously, whilst one extreme fire event can severely impact upon the ecological community, to have two such wildfire events within a decade is devastating.

It has been noted that 68 per cent of the alpine park complex across Victoria, NSW and ACT was burnt in the 2003 fire alone (Gill et al., 2004). This fire burnt all major bog and fen sites in the national parks, with an estimated fifteen per cent completely destroyed (AALC, 2006). The impact of the fire on individual bogs did vary, depending on local conditions. However, in all cases, those impacted bogs are now subject to post-fire disturbance impacts such as increased erosion and heightened susceptibility to weed invasion. Expert opinion is that no bogs within the mainland alpine region now remain in a fully pristine condition. The historic use of alpine regions in Australia for grazing domestic stock has also made it impossible to measure the original extent of the ecological community. Decline is also likely to continue as a response to ongoing climate change.

Although the Committee appreciates that the ecological community is suspected to have undergone a reduction in geographic distribution, there are insufficient data available to judge whether this reduction is very severe, severe or substantial. Therefore, as the ecological community has not been demonstrated to have met each of the required elements of Criterion 1, it is **not eligible** for listing in any category under this criterion.

Criterion 2 - Small geographic distribution coupled with demonstrable threat

As previously stated, there has been no comprehensive measure of the full extent of the Alpine *Sphagnum* Bogs and Associated Fens ecological community. However, there have been several studies that address parts of this ecological community. The Alpine *Sphagnum* Bogs and Associated Fens ecological community is scattered throughout the alpine regions on mainland Australia and Tasmania. The Australian Alps IBRA bioregion covers approximately 826 605 hectares, and the Central Highlands and Southern Ranges bioregions in Tasmania approximately 746 988 hectares and 777 236 hectares respectively (NLWA, 2007a, 2007b and 2007c). These figures do not include an estimated area for the small part of

the Bondo subregion of the South East Highlands bioregion where the Alpine *Sphagnum* Bogs and Associated Fens ecological community has been identified. Therefore, with a total extent of at least 1 650 829 hectares, national extent of occurrence is not limited.

However, as previously stated, the Alpine *Sphagnum* Bogs and Associated Fens ecological community is only a small component of these larger bioregions. The community occurs as small, highly fragmented pockets of isolated remnant vegetation within this range. Based on the recent reports, the actual area of occupancy for this ecological community is estimated to be approximately 8000 hectares on the mainland and 3100 hectares in Tasmania (Balmer et al., 2004; AALC, 2006). The geographic distribution of the ecological community can therefore be considered restricted as it is close to the 10,000 ha indicative threshold.

The threats to this ecological community have been outlined previously, but the most serious are due to the impacts of wildfires, climate change, weed incursions, feral horses and human activities in alpine parks. There are indications that these threats to the Alpine *Sphagnum* Bogs and Associated Fens ecological community are unlikely to diminish in the foreseeable future. In particular, the 2003 and 2006 wildfires will continue to have a long-term impact on its distribution, integrity and capacity for recovery. The impacts of climate change are also ongoing, and will likely increase. All of the threats listed have the capacity to further reduce what is already a restricted geographic distribution.

The Committee considers that the ecological community has a restricted geographic distribution that is under threat. The nature of its restricted distribution makes it likely that a threatening process could cause it to be lost in the near future. Therefore, the ecological community is **eligible** for listing as **endangered** under this criterion.

Criterion 3 - Loss or decline of functionally important species

As previously discussed, *Sphagnum* is a functionally important genus in the Alpine *Sphagnum* Bogs and Associated Fens ecological community. Intact *Sphagnum* bogs and fens hold a large amount of water which is released gradually following the Spring snowmelt. However, if the bogs become degraded, this water holding capacity is frequently reduced or destroyed as a result of erosion and channelling (Ashton and Williams, 1989; Wahren et al., 1996). Such degradation can lead to drying out of bogs, further reducing the integrity of the ecological community and impacting the hydrology of the surrounding area. Given the critical function of the ecological community in water supply, such changes can in turn have repercussions downstream. When bogs and fen communities are drained or start to dry out around the edges due to problems such as drought, exotic weeds are more likely to invade (Ashton and Williams, 1989).

There is strong support for and qualitative evidence of *Sphagnum* decline in bog and fen communities across the alpine regions (Gill et al., 2004; Pickering et al., 2004). As previously discussed, the impact of recent wildfires and the effects of earlier grazing by domestic stock mean that the extent to which this species has actually been lost due to disturbance cannot be accurately measured, although some general estimates are available (Pickering et al., 2004). However, short growing seasons in combination with the community's fragile nature mean that once damage to the vegetation of the Alpine *Sphagnum* Bogs and Associated Fens ecological community has occurred, recovery is very slow. Observations of long-term plots on the Bogong High Plains containing the Alpine *Sphagnum* Bogs and Associated Fens ecological community indicate that visible improvements in *Sphagnum* cover can take over thirty years (McDougall, 2007). This clearly demonstrates the

long-term impacts of damage to this functionally important species, and the lengthy periods required for it to show visible signs of recovery.

The Committee considers the decline of functionally important species in this ecological community is severe and that the restoration of the community to an intact or near-intact state is not likely to be possible in the near future. Therefore, the ecological community is **eligible** for listing as **endangered** under this criterion.

Criterion 4 – Reduction in community integrity

Ultimately, the integrity of the Alpine *Sphagnum* Bogs and Associated Fens ecological community is reduced by detrimental changes to *Sphagnum* cover and the underlying peat soils. That *Sphagnum* loss frequently leads to a reduction in community integrity is supported by several long-term experiments. For example, a small plot on the Bogong High Plains containing the Alpine *Sphagnum* Bogs and Associated Fens ecological community was fenced to exclude cattle in 1945. Ongoing observations have been made since then, with over 60 years of data now collected. Previously grazed areas showed little to no change in condition until 1966, and it was not until the late 1970s that any real increase in vegetation cover over eroded patches was noted (McDougall, 2007). This clearly demonstrates the long term impacts of reduced community integrity, and the lengthy time periods required for recovery to occur.

Similar experimental enclosures were set up in 1980 and 1981 at two sites in the Bogong High Plains (Wahren et al., 1996). The enclosures were designed to protect vegetation, including the Alpine *Sphagnum* Bogs and Associated Fens ecological community, from trampling by cattle. The sites were initially sampled in 1981 and again in 1992. The results showed little recovery, even after 15 years of cattle exclusion.

Weed invasion also has the potential to reduce or destroy the integrity of the Alpine *Sphagnum* Bogs and Associated Fens ecological community. Some exotic weeds such as *Juncus* spp. and willows have the capacity to establish themselves in such abundance that they permanently alter floristic composition and structural integrity, as well as affecting the overall hydrology of the area (McDougall, 2007).

Experts believe that there are no pristine patches of the Alpine *Sphagnum* Bogs and Associated Fens ecological community left on mainland Australia. Most if not all of this ecological community has become degraded to some extent due to the combined impact of multiple threats, including the effects of grazing, trampling and wildfires, all of which would have been magnified by drought conditions and the growing influence of a warming climate over the past few decades (Pickering et al., 2004). As previously discussed, these threats are unlikely to diminish in the foreseeable future, and will continue to have a long-term impact on both the functional integrity of the community and its capacity to recover following extensive damage. Tasmanian bog and fen communities have also been affected by a range of threatening processes, such that degradation is also likely to be widespread, particularly on the Central Plateau.

The effects of the range of threats impacting on the integrity of the Alpine *Sphagnum* Bogs and Associated Fens ecological community are complex, long lasting and may have serious implications for its survival in specific locations. Where degradation has occurred, the recovery of structure and function is likely to take several decades (McDougall, 2007). Furthermore, if *Sphagnum* has been completely lost from a site, both the *Sphagnum* and the bogs which depend on it for the development of permanently moist conditions may become

locally extinct unless new *Sphagnum* plants can be introduced (Walsh and McDougall, 2004). At many sites, this is likely to require active human intervention.

The Committee considers that the change in integrity experienced by the ecological community is such that regeneration is unlikely within the near future, even with positive human intervention. Therefore, the ecological community is **eligible** for listing as **endangered** under this criterion.

Criterion 5 - Rate of continuing detrimental change

Although there are reports of ongoing detrimental changes to this ecological community, no measurements of the rate of change are available other than what has been indicated above. Therefore, the ecological community is **not eligible** for listing under this criterion. However, this is likely to be where the implications and impacts of climate change will become most relevant.

Criterion 6 - Quantitative analysis showing probability of extinction

There is no quantitative analysis available to assess this ecological community under this criterion other than what has been indicated above. Therefore, the ecological community is **not eligible** for listing under this criterion. However, the combination of decline in community integrity and the impact of numerous threats faced by the Alpine *Sphagnum* Bogs and Associated Fens ecological community all indicate that the probability of extinction is increasing.

9. Conclusion

Conservation status

The **Alpine *Sphagnum* Bogs and Associated Fens ecological community** meets:

- Criterion 2 as **endangered** because its geographic distribution is restricted and the nature of its distribution makes it likely that multiple demonstrable threats could cause it to be lost in the near future;
- Criterion 3 as **endangered** because the decline of functionally important species is severe and restoration is unlikely to be possible in the near future; and
- Criterion 4 as **endangered** because the change in community integrity is severe and regeneration is unlikely to occur in the near future even with positive human intervention.

Decision to have a Recovery Plan

The Committee has taken several issues into account when considering the need to develop a recovery plan for the Alpine *Sphagnum* Bogs and Associated Fens ecological community. The Committee noted that this community and its surrounding region are host to a range of interests including numerous nationally threatened flora and fauna species plus other species and ecological communities that may be under consideration by the Committee in the future.

The Committee is aware of a partnership proposal from the Australian Alps Liaison Committee (AALC) that is under consideration by the Department of Climate Change. The proposal is seeking funding for the development of a scoping report for the Australian Alps in

an attempt to identify and combat the effects of climate change and the significant impact these are likely to have on major inland water resources.

The Committee is of the view that this study could be of considerable benefit to the development of a Recovery Plan for the Alpine *Sphagnum* Bogs and Associated Fens ecological community. The proposed study will make a significant contribution to the conservation of not only this ecological community, but also the wider Australian alpine and subalpine zone as a whole. The Committee strongly supports the AALC proposal. The AALC is an interjurisdictional body supported by all relevant State and Territory governments and agencies, which maximises the proposal's likelihood of success. It is expected that all existing management plans and conservation initiatives would be taken into account when developing a Recovery Plan for this ecological community.

10. Recommendation

TSSC recommends that:

the list referred to in section 181 of the EPBC Act be amended by including in the list in the **endangered** category: **Alpine *Sphagnum* Bogs and Associated Fens**; and that there should be a national recovery plan for the Alpine *Sphagnum* Bogs and Associated Fens ecological community.

Associate Professor Robert J.S. Beeton

Chair

Threatened Species Scientific Committee

Table 1. *Typical native plant species found in alpine sphagnum bogs and associated fens*

This list is only indicative of plant species common to alpine bogs and fens, and as such, is not comprehensive. The plants identified below may not occur in every alpine bog, and other species may also be present. (Ashton and Williams, 1989; Kirkpatrick, 1989; Whinam et al., 2001; Harris and Kitchener, 2005; VDSE, 2005; McDougall and Walsh, 2007).

Component	Species Name by Life Form	
	Mainland sites	Tasmanian Sites
BOG	<p>Shrubs <i>Baeckea gunniana</i> <i>Baeckea utilis</i> s.l <i>Callistemon ptyoides</i> <i>Epacris</i> spp. <i>Olearia algida</i> <i>Oxylobium ellipticum</i> <i>Richea continentis</i></p> <p>Herbs <i>Asperula gunnii</i> <i>Brachyscome</i> spp. <i>Caltha introloba</i> <i>Celmisia</i> spp. <i>Epilobium gunnianum</i> <i>Erigeron paludicola</i> <i>Gentianella</i> spp. <i>Gonocarpus micranthus</i> <i>Nertera granadensis</i> <i>Oreomyrrhis ciliata</i> <i>Ranunculus</i> spp.</p> <p>Grasses, Sedges, Rushes <i>Astelia alpina</i> <i>Baloskion australe</i> <i>Carex appressa</i> <i>Carex gaudichaudiana</i> <i>Carex</i> spp. <i>Carpha nivicola</i> <i>Empodisma minus</i> <i>Isolepis</i> spp. <i>Luzula modesta</i> <i>Oreobolus distichus</i> <i>Poa costiniana</i> <i>Poa</i> spp. <i>Restionaceae</i> spp.</p> <p>Ferns <i>Blechnum penna-marina</i></p> <p>Mosses <i>Sphagnum cristatum</i> <i>novozelandicum</i></p>	<p>Shrubs <i>Baeckea gunniana</i> <i>Callistemon viridiflorus</i> <i>Callistemon</i> spp. <i>Epacris</i> spp. <i>Ozothamnus hookeri</i> <i>Ozothamnus rodwayi</i> <i>Richea gunnii</i> <i>Richea scoparia</i> <i>Richea</i> spp.</p> <p>Herbs <i>Acaena novae-zelandiae</i> <i>Asperula gunnii</i> <i>Brachyscome</i> spp. <i>Celmisia asteliifolia</i> <i>Celmisia saxifraga</i> <i>Gunnera cordifolia</i></p> <p>Grasses, Sedges, Rushes <i>Astelia alpina</i> <i>Baloskion australe</i> <i>Empodisma minus</i> <i>Gahnia grandis</i> <i>Gymnoschoenus sphaerocephalus</i> <i>Isolepis</i> spp. <i>Juncus</i> spp. <i>Luzula</i> spp. <i>Oreobolus pumilio</i> <i>Poa labillardierei</i> <i>Schoenus</i> spp.</p> <p>Ferns <i>Blechnum penna-marina</i> <i>Gleichenia alpina</i></p> <p>Mosses <i>Sphagnum australe</i> <i>Sphagnum cristatum</i> <i>Sphagnum falcatulum</i></p>

Table 1 (continued)

FEN	<p>Herbs <i>Brachyscome obovata</i> <i>Deschampsia caespitosa</i> <i>Epilobium gunnianum</i> <i>Lobelia surrepens</i> <i>Myriophyllum pedunculatum</i> <i>Oreomyrrhis ciliata</i></p>	<p>Herbs <i>Gunnera cordifolia</i> <i>Lobelia surrepens</i></p>
	<p>Grasses, Sedges, Rushes <i>Carex echinata</i> <i>Carex gaudichaudiana</i> <i>Carpha nivicola</i> <i>Empodisma minus</i> <i>Isolepis crassiuscula</i> <i>Juncus falcatus</i></p>	<p>Grasses, Sedges, Rushes <i>Baloskion australe</i> <i>Carex gaudichaudiana</i> <i>Carex</i> spp. <i>Carpha alpina</i> <i>Empodisma minus</i> <i>Gymnoschoenus sphaerocephalus</i> <i>Lepidosperma filiforme</i> <i>Poa gunnii</i> <i>Poa labillardierei</i></p>
	<p>Mosses <i>Sphagnum cristatum</i> <i>Sphagnum novozelandicum</i></p>	<p>Mosses <i>Sphagnum cristatum</i></p>

Table 2. Relevant floristic equivalents

Various components of the Alpine *Sphagnum* Bogs and Associated Fens ecological community have been described according to a range of floristic associations.

State/Territory	Classification	Community Name
Victoria	EVC 171	Alpine Fen
	EVC 210	Sub-alpine Wet Heathland
	EVC 221	Sub-alpine Wet Heathland/Alpine Fen Mosaic
	EVC 288-61	Alpine Valley Peatland (Raised Bog)
	EVC 288-62	Alpine Valley Peatland (Valley Bog)
	EVC 917	Sub-alpine Wet Sedgeland
	EVC 1011	Alpine Peaty Heathland
Tasmania	TASVEG MSP	<i>Sphagnum</i> peatland
NSW (Keith, 2004)	Keith Vegetation Class	Alpine Bogs and Fens
Mainland (McDougall & Walsh, 2007)	Community 1	Baw Baw – Lake Mountain Wet Heathland
	Community 2	<i>Richea continentis</i> – <i>Carpha nivicola</i> – <i>Sphagnum cristatum</i> Wet Heathland
	Community 3	<i>Baeckea gunninana</i> – <i>Callistemon pityoides</i> – <i>Sphagnum cristatum</i> Wet Heathland
	Community 8	Fen

Table 3. Species listed under the *Environment Protection and Biodiversity Conservation Act 1999* that are associated with the Alpine *Sphagnum* Bogs and Associated Fens ecological community.

	Species	Common Name	Category
<u>Amphibians</u>	<i>Pseudophryne corroboree</i>	Southern Corroboree Frog	Endangered
	<i>Pseudophryne pengilleyi</i>	Northern Corroboree Frog	Vulnerable
	<i>Philoria frosti</i>	Baw Baw Frog	Endangered
	<i>Litoria booroolongensis</i>	Booroolong Frog	Endangered
	<i>Litoria verreauxii alpina</i>	Alpine Tree Frog / Verreaux's Alpine Tree Frog	Vulnerable
<u>Birds</u>	<i>Gallinago hardwickii</i>	Latham's Snipe	Migratory
			Marine
<u>Plants</u>	<i>Euphrasia eichleri</i>	Bogong Eyebright	Vulnerable

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