Treeless vegetation of the Australian Alps

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Abstract: Based on 1222 floristic quadrat samples, 56 plant communities were identified in treeless vegetation in the Australian Alps of south-eastern Australia. (c. 35º 30´–38ºS, 146°–149°E). The study encompassed vegetation from above the upper limit of trees on mountain tops (i.e. the truly alpine environment) and below the inverted treeline in subalpine valleys. Generally, grasslands develop on deep humus soils, heathlands occur on shallower or rocky soils, and wetland communities are found in places of permanent or intermittent wetness. Duration of snow cover, lithology, altitude and exposure are also important determinants of the spatial arrangement of communities. Broadly, communities within a geographic region are more closely related to each other than to communities of similar structure or dominants from other geographic areas. Many communities are either very localised or are widespread with a small area of occupancy. Fourteen communities are probably eligible for listing as threatened, either alone or as aggregates with associated communities.

A total of 710 native taxa from 82 families has been recorded. There is a high level of endemism – 30% of taxa are ± restricted to treeless vegetation in the Australia Alps and a further 14% are ± restricted to treeless vegetation but occur in mountain areas outside the Australian mainland (e.g. Tasmania and New Zealand). Thirteen taxa are listed in the *Environment Protection and Biodiversity Conservation Act 1999* as threatened and a further 18 taxa are identified that may be eligible for listing as threatened nationally. 131 non-native taxa have been recorded in natural vegetation.

Treeless vegetation has been intensively utilised since European settlement, initially as summer pastures for cattle and sheep but more recently as water catchments for electricity production and as tourist attractions both in winter and summer. Many communities are slowly recovering from past pressures and from the fires of 2003, which burnt most of the area for the first time since 1939. The treeless vegetation of the Australian Alps faces an uncertain future because of increased pressure from tourism and the unknown impacts of global warming.

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Introduction

The Australian Alps can be loosely defined as the mountains and plateaux of the Great Dividing Range and surrounds that receive persistent winter snowfall. In this sense, the Alps extend from Lake Mountain in Victoria to Namadgi National Park in the Australian Capital Territory, and include the highest summits of mainland Australia (c. 35º 30´–38ºS, 146°–149°E). A feature of the Australian Alps is the absence of trees on many mountain tops at the highest elevations and in some lower valleys and plains.

The treeless vegetation of the Australian Alps is floristically outstanding – almost 60% of taxa in some parts are restricted to high mountain areas (McDougall 1997). The distinctness of the flora has long attracted botanical interest. Noted botanists and naturalists such as Baron Ferdinand von Mueller, Richard Helms, Joseph Maiden, James Stirling and Alfred Tadgell had made numerous collections of the high mountain flora by the early 20th Century, well in advance of many other ecosystems of south-eastern Australia (Willis 1989, Gillbank 1990, Willis & Cohn 1993, Costin et al. 2000). The treeless vegetation of the Australian Alps also has a long history of ecological studies on plant–disturbance interactions (e.g. Carr & Turner 1959b, Wimbush & Costin 1979, Williams & Ashton 1987), and possesses some of the longest running ecological monitoring experiments in Australia (e.g. Wahren et al. 1994, Scherrer 2004). Treeless communities in the Alps were the subject of some of the earliest community classification in Australia (e.g. Costin 1954, McVean 1969, McDougall 1982, Walsh et al. 1984, Helman & Gilmour 1985) and large-scale vegetation mapping based on such classifications (Victoria Conservation Trust 1982–85, Walsh et al. 1984).

Despite the level of botanical interest and the various floristic classifications produced, a single classification of treeless vegetation in the Australian Alps has been hamstrung by State boundaries and regional differences in classification systems. Kirkpatrick (1989) attempted to synthesise available data (including that from Tasmania) but did not have floristic data from most treeless areas in Kosciuszko National Park, and some data were missing from Victorian data sets. Keith (2004) provided a synopsis of alpine and subalpine communities in New South Wales and the Australian Capital Territory but that work was very broad-scale. In this paper we present a classification of treeless vegetation of the Australian Alps, based on available data from Victoria (McDougall 1982,

Walsh et al. 1984), the Australian Capital Territory (Gilmour et al. 1987, Helman et al. 1988), New South Wales (Ecology Australia 2003), and 361 new floristic quadrats sampled by us in and around Kosciuszko National Park.

Study area

The study area was defined by the extent of treeless vegetation in the high mountains of south-eastern Australia. It extends from Lake Mountain in Victoria to Namadgi National Park in the Australian Capital Territory (Fig. 1), a distance of about 350 km, and ranges in elevation from about 1000 m on Mt Whitelaw (Baw Baw National Park) to 2229 m on Mt Kosciuszko (Kosciuszko National Park). Based on available vegetation mapping, there are about 160,000 ha of treeless vegetation in the Australian Alps, c. 70,000 ha in Victoria (McDougall 1982, Walsh et al. 1984, Mueck and McCormick 2002) and c. 90,000 ha in NSW and the ACT (Thomas et al. 2000).

The study encompasses vegetation from above the upper limit of trees on mountain tops (i.e. the truly alpine environment) and below the inverted treeline in subalpine valleys. Generally, the elevation of treelines increases with decreasing latitude, and so, for example, the upper treeline at Mt Howitt in Victoria (latitude 37° 10') is about 1600 m a.s.l. whilst the upper treeline at Mt Jagungal in NSW (36° 08') is about 1900 m a.s.l. Alpine vegetation is effectively absent from the ACT, which has a maximum elevation of 1911 m on Mt Bimberi. In many places, the upper treeline is continuous with the lower treeline. The lower elevational boundary of treeless vegetation is often indistinct, extending in narrow strips down valleys and onto isolated rocky outcrops. No attempt was made to constrain the study area altitudinally. However, the majority of samples are from the larger patches of treeless vegetation rather than linear valley strips. Naturally treeless vegetation also occurs to the east of the Great Dividing Range in NSW, on the Monaro and coastal escarpment. Whilst some of this may have floristic affinities to the vegetation described in this paper and be treeless for similar ecological reasons, no survey was done by us outside the Australian Alps and available data from these areas were not used.

Most treeless vegetation is within National Park, although small portions are in other tenures, including privately owned land. Ski resorts in NSW are within Kosciuszko National Park while in Victoria, six of the skiing areas are within specially designated alpine resorts surrounded by the Alpine and Baw Baw National Parks. The Mt Buffalo skifields are incorporated into the Mt Buffalo National Park.

Environmental determinants

The Australian Alps are a series of elevated plateaux, ridges and isolated mountain tops of uncertain origin (Ollier 1987). Much of the Alps lie along the Great Dividing Range, which separates the Murray and coastal watersheds, but there are numerous peaks and landforms such as Mt Bogong, Mt Buffalo, Mt Baw Baw and all of the mountains of the Australian Capital Territory that are offset. The Alps are characterised by low temperature. Sub-zero temperatures of the past have helped shape the landscape (through localised glaciation and the fracturing of rock) and continue to influence the patterns of vegetation today (e.g. by limiting tree establishment and thus creating treelines). Glaciation in the last Ice Age was confined to a small area in the vicinity of Mt Kosciuszko, although periglacial forces were responsible for many of the notable rock features elsewhere, such as block streams (Peterson 1971). The Australian Alps are geologically diverse (Ollier & Wyborn 1989). The Kosciuszko Main Range area is predominantly granitic whereas much of the Bogong High Plains in Victoria are underlain with metamorphic material (gneiss and schist). Limestone, basalt, other igneous and various sedimentary rocks are locally exposed. Soils tend to be highly organic and acidic.

The topography of the Australian Alps – often a combination of steep slopes and broad, flat valleys – has a profound effect on local weather conditions. When coupled with spatial variation in drainage, soil depth and rock type, it is not surprising that the corresponding vegetation patterns are extremely complex. Some of the major factors influencing patterns of vegetation are described below.

Frost. Sub-zero temperatures may occur at any time of the year and are common during plant growing seasons. Frost may also be localised. Cold air tends to accumulate in valleys at night producing a large differential in air temperature between valley bottom and ridge top (Williams 1987). In such situations, plants growing in valleys encounter more frosts than those growing upslope. The relative tolerance of high mountain plants to a high frequency of frost is unknown but it is clear that snow gums (*Eucalyptus pauciflora* sens. lat.) and some shrubs are intolerant, at least in their juvenile stages. It is this that creates the inverted treelines in the Australian Alps, with the trees and tall, closed heathland on the upper slopes and ridges and the grasslands and low heaths occurring in the valley bottoms, the opposite of the pattern on the high peaks (Harwood 1980, Slatyer 1989). Frost is also probably responsible for inhibiting the establishment of the many non-native species that are inadvertently brought to the Alps (Mallen-Cooper 1990). The development of needle ice in moist, bare soils (Fig. 2) limits the establishment of many alpine species and may influence the balance between shrubs and herbs in some plant communities (Williams 1992).

Snow. Snow in itself has little bearing on mountain plants. Differences in the duration of snow cover, however, have a profound effect on plant distribution and vegetation pattern. At the lowest elevations, a persistent cover of snow is rare, and plants experience much longer periods of frost exposure in winter than those at higher elevations. Many of the species from these lower elevation areas also occur

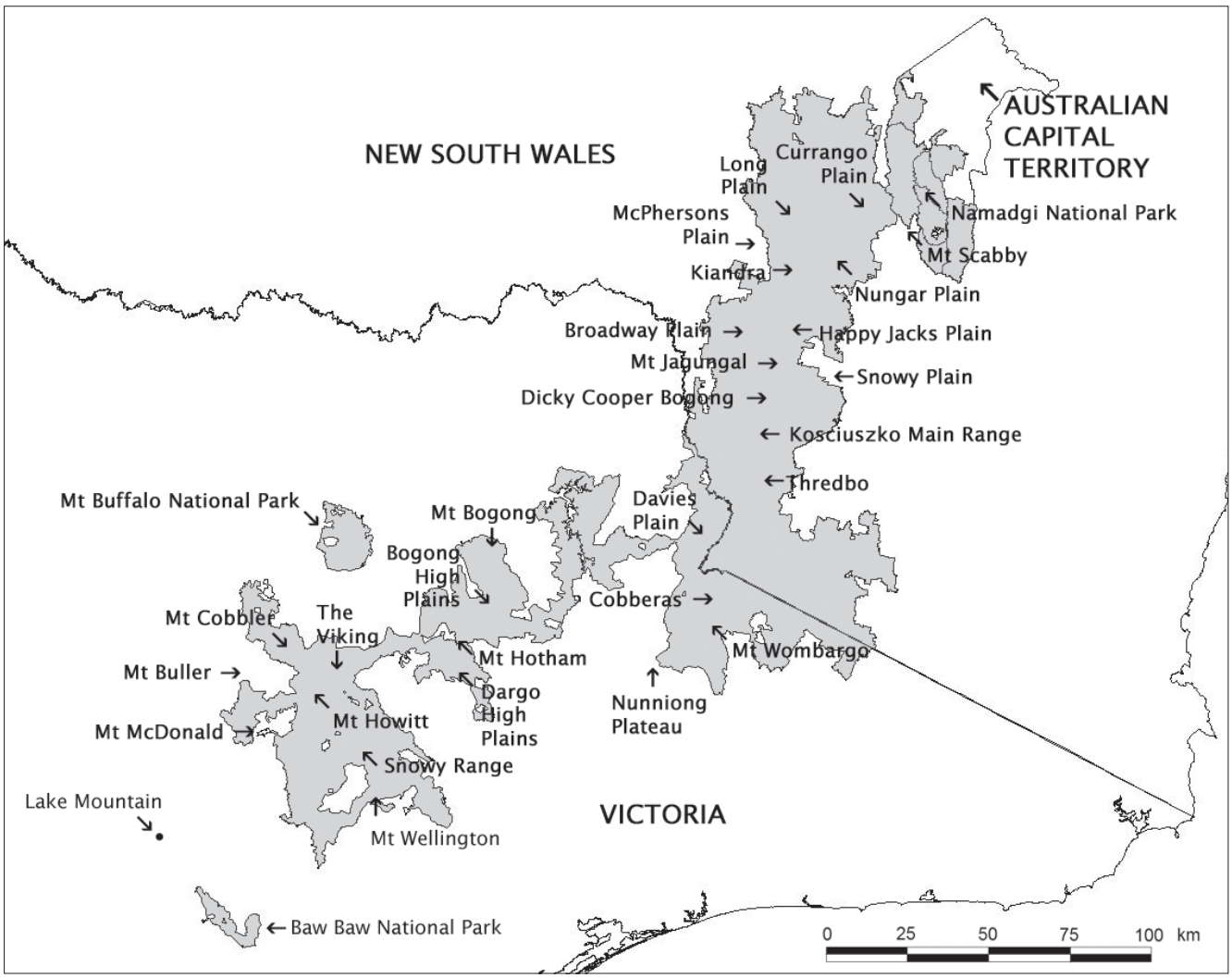

Fig. 1. Key sites mentioned in the text: Lake Mountain; Baw Baw National Park (includes Erica, Mt Whitelaw), Mt McDonald (The Bluff), Mt Buller (Mt Stirling), Mt Cobbler, Mt Wellington (Bennison Plains), Mt Howitt (Crosscut Saw, Howitt Plains, Mt Speculation), Snowy Range, The Viking, Mt Buffalo National Park (Hospice Plain, Mt Buffalo), Bogong High Plains (Basalt Hill, Cope Creek, Falls Creek, Mt Cope, Mt Fainter, Mt Feathertop, Mt Jim, Mt McKay, Mt Nelse, Pretty Valley, Spion Kopje), Mt Bogong, Dargo High Plains (Gow Plain, Lankeys Plain), Mt Hotham (Dinner Plain, Mt Loch), Davies Plain, Cobberas (Mt Cobberas), Nunniong Plateau (Brumby Point), Kosciuszko Main Range (Blue Lake, Charlottes Pass, Carruthers Peak, Guthega, Guthrie Creek, Hedley Tarn, Lake Albina, Mt Blue Cow, Mt Kosciuszko, Mt Lee, Mt Townsend, Mt Twynam, Perisher, Ramshead Range, Rawsons Pass, Spencers Creek, Upper Snowy River), Mt Wombargo, Thredbo (Dead Horse Gap), Snowy Plain (Botherum Plain), Mt Jagungal (Bogong Plain), Broadway Plain (Emu Plain, Ogilvies Creek, Pretty Plain, Toolong Plain), Currango Plain (Blue Waterholes, Cave Creek, Cooleman Plain, Seventeen Flat), Kiandra (Mt Selwyn, Yarrangobilly Caves), McPhersons Plain (Sparkes Plain, Tomneys Plain), Long Plain, Nungar Plain (Boggy Plain, Gulf Plain, Tantangara Dam), Mt Scabby (Mt Kelly, Mt Murray, Scabby Ranges), Namadgi National Park (Grassy Creek, Mt Bimberi, Mt Gingera, Sheep Station Creek), Dicky Cooper Bogong (Munyang Creek), Happy Jacks Plain. The shaded area is National Park tenure.

at the highest elevations so it seems likely that they are not reliant on snow cover. At higher elevations, however, snow tends to accumulate in drifts on south and east facing slopes, blown there by the prevailing west to north-west winds and protected from melting in spring by the reduced solar irradiation of those aspects. On the Kosciuszko Main Range and the Bogong High Plains, snow in these sites commonly endures until mid-summer. These snowpatches have produced a distinct array of plant communities and contain several species confined to this environment, which is characterised by a shortened growing season, abundant water while the snow is melting, and dry conditions once snow has melted.

Wind. The high ridges and summits of the Australian Alps are often subjected to strong wind, which comes predominantly from a westerly direction. The effect of this can be seen in wind-pruned trees and shrubs and the sorting of gravel and fines on the eastern side of bare patches of soil. On exposed ridges of shattered sedimentary rock, where the snow is commonly blown off into snowpatches, an open dwarf heathland forms. This community is best developed in the Kosciuszko area (where it is called windswept feldmark) but vegetation of similar structure and plant form can be found in the highest mountains of Victoria. The dominant shrubs of this community are pruned by the wind on their windward side and layer on the protected leeward side, gradually moving across the ridge at a rate calculated to be about 1 cm / year (Barrow et al. 1968).

Water. The perenniality of a water supply is a major determinant of plant distribution in the Australian Alps. Apart from the direct supply from rain, water may come from springs, snowmelt or from capillary movement of water across absorbent peaty substrates. Some springs are perennial but others dry during summer or autumn, the timing perhaps depending on rainfall and snow cover in previous years. All soils are sodden at the time of snowmelt but most dry quickly after. Within a given area, snow melts at different rates depending on snow depth, altitude and aspect. That deposited on lee slopes of the highest mountains may provide a supply of water to plants at the base of the snow pack well into summer. All of these factors mean that the treeless country is a mosaic of wet and dry habitats (and everything between). Many plants and communities have a specific hydrological niche. Patch death of plants has been observed in times of drought (Wimbush and Costin 1979). The long-term impact of periodic drought is, however, unclear.

Geomorphology. Although landforms of the treeless high country are a fundamental determinant of vegetation (through their effect on snow longevity, protection from wind and availability of water), two landforms peculiar to the high country contain specific plant communities. 1) Sub-zero temperature and water have combined over long periods to shatter rock, which has accumulated in streams on slopes or in piles at the base of outcrops. These block streams and boulder fields are common in areas with basaltic or granitic rock. They support a low, closed heathland dominated by *Podocarpus lawrencei*, which is the primary habitat of the Mountain Pygmy Possum (*Burramys parvus*). 2) On some slopes of low gradient, the soil appears to have 'stretched', creating linear depressions of up to 30 cm depth. The cause of these features (called contour trenches by McElroy (1952)) is unclear. However, they fill with water periodically, following snow melt and heavy rain, and contain a distinctive flora, different to the adjoining vegetation only centimetres away.

Geology. The differences in flora and vegetation between different substrata are often subtle and there appear to be few species completely restricted to a single rock type. Geology does influence soil composition, however, thus indirectly determining species distribution in some cases. Limestone-derived soils are less acidic and basalt-derived soils are more fertile than typical alpine humus soils (Rowe 1972). For these reasons, weed diversity and abundance are usually greater in areas underlain by basalt and limestone. In grasslands of basalt areas, the dominant *Poa* species often appear to have more vigorous growth and forbs are less abundant.

Soils. High mountain soils are important in determining the range of species that may grow at any site, and consequently the plant communities that develop. Shallow soils tend to support only shrub-dominated communities. The deeper, better-developed soils are often grass-dominated. The prevention of erosion in high mountain areas is therefore of great importance for the protection of many herb-dominated communities. Significant soil loss may lead to changes from grassland to heathland. The exposure of soil will facilitate this process because shrubs are much more likely to establish on bare patches than herbs (Williams 1992). Peat soils typically support hydrophilic communities dominated by mosses but they do not preclude the growth of species found in the humic soil types. There are many examples of grassland and heathland on humified peat, which has presumably become too dry to support bog communities. Kirkpatrick & Bridle (1999) found that soil nutrients (pH, extractable P, Zn and Mg) were important environmental determinants of broad alpine vegetation formations in Australia (including Tasmania), extractable P being the most significant property of the many variables (including non-edaphic) tested.

Wildfire. Based on growth ring data of Snow Gum in various parts of the NSW and ACT high country (Banks 1986) and of *Podocarpus lawrencei* at Blue Cow (McDougall unpublished data). broadscale fires have occurred in the high subalpine zone on average 2–3 times per century for the past 300 years. The major fires of January 2003 were consistent with that frequency, being the first through most of the study area since 1939. Despite its intensity, the 2003 fire was locally patchy, missing small areas within scorched landscapes and failing to burn the majority of the alpine zone in Kosciuszko National Park. The frequency of wildfire above the treeline is probably less frequent, perhaps once per century. Regeneration in treeless communities following the 2003 fire was rapid and plants of most species had re-appeared by the following

summer. Only the wet communities (especially those dominated by *Sphagnum cristatum*), herbfields dominated by *Celmisia costiniana* and *Podocarpus*-dominated heathland appear to be slow to recover (Walsh & McDougall 2005).

Biotic determinants

Deaths of individuals or patches of plants are common in the treeless plains of the Australian Alps but rarely extensive. So little is known about the pathogens, parasites and herbivores of this area that the occasional death of a plant is ignored. Extensive patch death of *Poa* species in tussock grasslands is sometimes evident, however, and the cause is known and attributable to the larvae of one of two species of native moth (Alpine Case Moth *Lomera caespitosae*, Alpine Grass Grub *Oncopera alpina*) (Fig. 3) (Carr & Turner 1959a). Infestations appear to be sporadic – common and widespread in some years and then extremely rare for many years. Within dead patches, grass tillers are killed but forbs appear to be

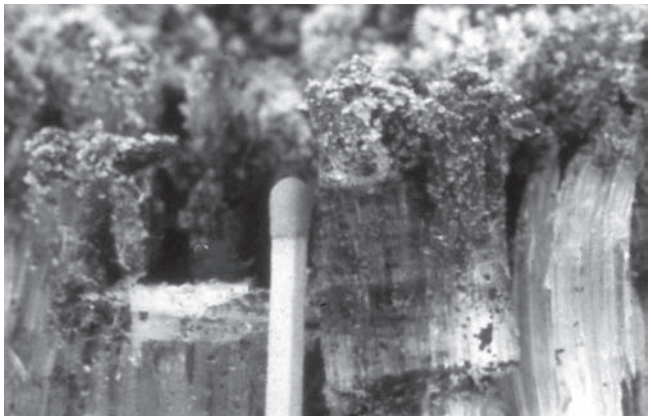

Fig. 2. Needle ice develops in moist, bare soils when the soil surface temperature falls below freezing point. Soil particles are lifted above the needles and are susceptible to erosion once the ice melts. In the example shown, the needles have not melted during the day and have been lifted further by the development of needles beneath.

Fig. 3. Native moths are capable of killing large areas of *Poa* species. The example shown on Mt Twynam (of *Poa fawcettiae*) measured about 1 ha. Forbs seem to be unaffected. The dead mat of grass is stable and will provide protection for the establishment of seedlings, including new *Poa* plants.

unaffected. Minor resprouting of grasses has been observed but the disturbance will usually lead to local changes in plant abundance – the recruitment of grasses and other herbs where a protective cover of dead grass litter persists and the recruitment of shrubs where litter is lost to expose bare ground (Williams 1992).

Macropods are only present in the subalpine part of the study area and even there appear to be uncommon in treeless areas. Wombats are also found in subalpine plains and cause substantial disturbance to plants and soil in the vicinity of their burrows. The effect of native herbivores on the plants and vegetation of treeless vegetation in the Australian Alps is unknown but worthy of investigation. Increases in native herbivore population size, for instance as a result of higher temperatures from global warming, could have a detrimental impact on treeless vegetation, especially where there are also populations of introduced herbivores.

Introduced herbivores undoubtedly have an impact on the flora and vegetation of the treeless plains but the magnitude and consequence of the impact is, in most cases, unknown. The best documented impact of an introduced herbivore comes from long-term monitoring studies of cattle grazing on the Bogong High Plains and Kosciuszko areas (Carr & Turner 1959b, Wimbush & Costin 1979, van Rees 1984, Williams & Ashton 1987, Wahren et al. 1994). Cattle are selective grazers. They prefer inter-tussock herbs (such as *Craspedia* spp., *Celmisia* spp. and *Leptorhynchos squamatus* subsp. *alpinus*) but make up bulk in their diet with tussock grasses (*Poa* spp.). Very little of their diet comprises shrubs and few shrub species (e.g. *Asterolasia trymalioides* and *Grevillea australis*) are apparently palatable. For this reason, cattle spend most of their time in grasslands (including snowpatch communities) (van Rees 1984). Much of their impact in damp areas (such as wetlands and snowpatches) occurs through trampling. Rabbits are rare at the highest altitudes but are apparently slowly moving to higher elevations. They have colonised the Blue Cow ski area (1800 m a.s.l.) in the past decade. Rabbits are known to eat many species and have been found to greatly reduce vegetative cover after fire (Leigh et al. 1987). Hares are a less obvious herbivore – they don't dig burrows and are largely nocturnal – but are surprisingly abundant. Their impact on flora and vegetation has not received the attention it deserves. Pigs, although also rarely seen, leave obvious signs of damage. They dig to detect roots and tubers, and in the process create patches of bare soil – patches of up to 100 m^2 have been observed in Kosciuszko National Park (McDougall & Walsh 2002). Pigs are only present in some subalpine areas of Kosciuszko National Park, the Cobberas and the ACT portions of the study area but could presumably extend their range in the future. They are a significant threat to many plant species and communities. Feral horses are present throughout the study area in variable density. In places where they are common (e.g. the Tantangara area of Kosciuszko National Park and Mt Cobberas area in Victoria), localised trampling damage is easy to find near watering points. Horses are presumably selective grazers. The long-term impact of their grazing in the Australian Alps is undocumented.

Land use and disturbance

For such a small area, the treeless portions of the Australian Alps have been intensively used by people, and the pressures on the plants and vegetation from this use are often obvious.

The degree of use by native peoples prior to European inhabitation is uncertain. The Bogong Moth, which aestivates in the high country, was apparently an important food resource during summer (Flood 1980). The abundant water and numerous plants with tubers and fleshy fruits might have made the area an attractive place for short periods.

Cattle, sheep and horses were brought to the Australian Alps in the mid 19th Century soon after the mountains were first explored by Europeans. Thereafter, the mountains commonly provided feed for stock in times of drought. In the drought of 1902/03 there are thought to have been 100,000 sheep in the Victorian high country alone (Carr & Turner 1959a). Grazing in the high mountains was regulated in the early 20th Century through the allocation of grazing leases. By the mid-20th Century, it was clear that stock were causing considerable damage to plant communities and, more importantly, erosion of soils, which could affect the capacity of the areas to support the dams required for the production of hydro-electricity. Stock grazing was gradually phased out in many parts of the Australian Alps between 1950 and 1970. Small areas of privately-owned treeless country in NSW are still grazed but stock grazing is no longer permitted in Kosciuszko National Park and has not been a feature of the ACT high country. Cattle grazing has recently (mid-2005) been legislated to cease in the Alpine National Park in Victoria, but grazing is still permitted in adjacent areas of State Forest, some of which include treeless subalpine vegetation (e.g the Nunniong Plateau).

Graziers are known to have lit fires in treeless country in late autumn to improve the pick for stock in the following snow-free season (Downes 1961). The frequency and severity of these fires was not documented. Given that conditions at that time of the year would rarely be favourable to the spread of fire it is likely that any fires lit by graziers would have been very localised and cool. If they had been frequent and widespread, obligate seeders such as *Grevillea australis, Epacris gunnii* and *Asterolasia trymaliodes* could not have survived to be as abundant and widespread as they are now. In addition, frequent fires do not show up in the growth ring data of high subalpine Snow Gum (Banks 1986). There is no evidence that aborigines burnt the high country and if macropods were as scarce then as they are now in the higher parts, it is hard to see why they would have used broadscale fire to improve hunting conditions by promoting green pick. It is plausible, however, that some of the fires lit in lower country may have occasionally burnt into alpine areas.

Prospecting for gold at Kiandra (in Kosciuszko National Park) in the 19th Century must have caused great damage to vegetation and soils because large, unvegetated scars from erosion and soil removal are still visible. Gold was discovered there in late 1859 and by February the next year there were 1500 miners living in the treeless Kiandra plains area (Mitchell 1985).

The production of hydro-electricity in the Kosciuszko area and Bogong High Plains in the 1950s required the construction of dams, aqueducts, powerlines and a network of service roads, and caused the destruction or disturbance of thousands of hectares of treeless vegetation. Changes to wetland vegetation may also have occurred through the diversion of water. Many weeds were probably introduced at this time both inadvertently and through the use of exotic species for soil stabilisation. A seed mix of exotic species containing cultivars of *Agrostis capillaris, Avena sativa, Dactylis glomerata, Festuca rubra, Lolium perenne, Poa pratensis, Secale cereale* and *Trifolium repens* was developed specifically to treat disturbed areas (Clothier & Condon 1968).

The high country environment now attracts many visitors both in summer, for the scenery, and in winter, for snow sports. About 100,000 people visit the alpine area of Kosciuszko National Park during the snow-free season (Johnston & Growcock 2005) – many of these walk to Mt Kosciuszko, the highest point in Australia. Most forms of tourism have required the construction of infrastructure, such as walking tracks, accommodation and ski runs. The damage to vegetation and soils on the track from the top of the Thredbo chairlift to Mt Kosciuszko necessitated the construction of a raised metal walkway.

A consequence of a long and varied use of treeless high mountain country by people is the presence of many feral animals (see above) and weeds. The highest parts of the Australian Alps contain relatively few weeds (compared with many plant communities at lower elevations) (Mallen 1986). The high mountain climate is not a barrier to weeds, however. Extremely invasive plants such as *Hieracium* spp. have been discovered at the treeline in Victoria and New South Wales only in the last decade (Morgan 2000), mostly in or near ski villages. Treeless vegetation is likely to face increasing pressure from plant invasions because of global warming and the continued use of non-native plants in some ski resort gardens and in revegetation (McDougall et al. 2005).

Methods

Data collection

Floristic data were obtained from previous surveys of treeless vegetation. Additional quadrats were sampled by us to fill in the spatial gap in data in Kosciuszko National Park and nearby areas. Quadrats containing isolated trees, tree patches (e.g. *Eucalyptus lacrimans*) or mallee eucalypts (e.g. *E. debeuzevillei*) within a treeless landscape were included. The data were collected randomly using a range of quadrat sizes (Table 1). Using a nested quadrat technique McDougall (1978) found that a quadrat size of 8 m^2 was sufficient to capture 95% of species in a diverse open heathland on the Bogong High Plains in the Victorian high country. In all of the surveys, quadrats were placed in what was perceived to be homogeneous vegetation. Any differences in quadrat size should therefore not greatly affect the composition of the resulting quadrats. The Braun-Blanquet cover – abundance scale or slightly modified versions were used in each of the surveys.

Data analysis

Because of taxonomic changes since the surveys of the 1980s, it was necessary to aggregate some taxa prior to analysis: *Agrostis hiemalis* sp. agg. (includes *A. bettyae, A. joyceae, A. propinqua, A. thompsoniae*), *Gentianella*

Table 1. Floristic data used in the classification

Survey	Location	Quadrat dimensions (m)	No. quadrats available	No. quadrats used
Ecology Australia (2003)	NSW ski resorts	5 x 5, 10 x 10[a]	176	102
Gilmour et al. (1987), Helman et al. (1988)[b]	A.C.T.	25 x 20	28	26
McDougall (1982)	Bogong High Plains, Victoria	4 x 5	363	343
This paper	Other areas, NSW	5 x 5	361	329
Walsh et al. (1984)	Other areas, Victoria	4 x 5	464	422
TOTAL			**1392**	**1222**

[a] the larger quadrat size was used in heathy vegetation
[b] full quadrat data from Helman & Gilmour (1985) could not be located and were therefore not used

spp. (except for *G. muelleriana* subsp. *alpestris* and subsp. *willisiana*), *Craspedia* spp. (except those endemic to Kosciuszko National Park and *Craspedia alba*, which was not recorded in quadrats by McDougall (1982)), *Celmisia* spp. (except *C. sericophylla*), *Geranium potentilloides* sens. lat., *Leucopogon* spp. (including only *L. hookeri* and *L. montanus*, which were aggregated by McDougall (1982) because of difficulties with identification when not in flower), *Prasophyllum* spp., *Solenogyne* spp. (includes *S. dominii* and *S. gunnii*), *Stylidium* spp. (includes *S. armeria* and *S. montanum*). Introduced taxa were not used in the classification. Species nomenclature follows Ross & Walsh (2003) and Harden (1991–1995) except where recent taxonomic changes have been published.

A total of 1392 quadrats was analysed using the software package Primer v5. Cover scale values were square-root transformed prior to the calculation of similarities using a Bray Curtis coefficient. The cover values of R, + and 1, each indicating cover values of less than 5% , were amalgamated and assigned a value of 1. The routine CLUSTER was used with the similarity matrix to create a classification of quadrats using the group average cluster mode. Because of the large size of the data set, it was not possible to generate a dendrogram of quadrats. Quadrat clusters were instead sorted by hand using the output of the CLUSTER analysis.

Diagnostic taxa for each community were determined using a G-test of independence, comparing the frequency of a species within a community with its frequency in all quadrats (Sokal & Rohlf 1981). Taxa were listed as diagnostic for significant differences in frequency with $P < 0.01$. Taxa with a frequency of greater than 40% that were not significantly different from their expected frequency are listed in the descriptions below as Other Common Taxa.

Inter-relationships between the identified communities were assessed by running CLUSTER on frequency data for diagnostic species in each community without transformation.

Results

Floristic composition

Based on the quadrat data presented in this paper, previously published lists (Thompson & Gray 1981, Helman & Gilmour 1985, Helman et al. 1988) and our personal observations, 710 native taxa from 82 families have been recorded in the treeless high mountain plains and peaks of the Australian Alps (Appendix 1). The best represented families are Asteraceae (16.3% of the flora), Poaceae (10.6%), Cyperaceae (7.0%), Orchidaceae (4.4%), Fabaceae (4.1%), Apiaceae (3.7%), Ericaceae (3.7%), Scrophulariaceae (3.7%), Myrtaceae (3.4%), Juncaceae (3.0%), Ranunculaceae (3.0%), Rubiaceae (2.5%), and Caryophyllaceae (2.0%).

Of the 710 native taxa recorded, 217 (30.6%) are largely restricted to the treeless vegetation of the Australian Alps (although some extend for a short distance into the surrounding woodland vegetation). A further 101 taxa (14.2%) are restricted to treeless vegetation in the Australian Alps but also occur beyond the Australian mainland – 91 taxa are also found in the Tasmanian high country (Kirkpatrick 1997) and 26 are part of the New Zealand mountain flora (Mark & Adams 1995).

The flora has strong affinities with the high mountain floras of Tasmania, New Zealand and South America. Several of the genera that are common to these floras are more or less restricted to alpine and subalpine environments (e.g. *Aciphylla, Argyrotegium, Celmisia, Chionohebe, Colobanthus, Gentianella, Kelleria, Uncinia*).

One hundred and thirty-one non-native taxa have been recorded in natural vegetation in the study area (Appendix 1). Most of these were recorded rarely or not at all in the quadrat surveys. Only sixteen taxa were recorded in more than 1% of quadrats (*Acetosella vulgaris* 42.9%, *Hypochaeris radicata* 26.5%, *Trifolium repens* 14.9%, *Taraxacum officinale* 8.7%, *Cerastium glomeratum* 7.8%, *Cerastium vulgare* 7.4%, *Poa pratensis* 2.5%, *Aphanes arvensis* 2.4%, *Holcus lanatus* 1.8%, *Anthoxanthum odoratum* 1.4%, *Trifolium dubium* 1.4%, *Vulpia bromoides* 1.3%, *Aira caryophyllea* 1.1%, *Agrostis capillaris* 1.0%, *Myosotis caespitosa* 1.0%).

Significant plant taxa

Thirteen taxa occurring in treeless vegetation are listed in the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) as threatened. Fourteen taxa are listed as threatened under State legislation but not in the EPBC Act: *Carex archeri, C. raleighii, Euphrasia scabra, Prasophyllum bagoensis, P. retroflexum* (*Threatened Species Conservation Act 1995*), *Brachyscome* sp. 3, *Carex cephalotes, Celmisia sericophylla, Deyeuxia affinis, Epilobium willisii, Euphrasia scabra, Juncus antarcticus, Poa saxicola, Utricularia monanthos, Wahlenbergia densifolia* (*Flora and Fauna Guarantee Act 1988*). Under IUCN criteria for the evaluation of threatened status (IUCN 2001), a further 17 taxa may be eligible for listing as threatened nationally. These and listed taxa are described below. The status under the EPBC Act is shown after the Family name; the IUCN status for species that may be eligible is underlined (E = endangered; V = vulnerable).

Argyrotegium nitidulum (Asteraceae; V), like many other alpine species, is rare throughout its range but is not uncommon where it is found. Apart from occasional damage to leaves by an unknown moth (NSW National Parks and Wildlife Service 2000), there appears to be little immediate threat to this species. It has been recorded close to one ski resort but is not currently threatened by development there. Its conservation status possibly should be reviewed.

Bossiaea riparia (Gulf Plain) (Fabaceae; V). The greyish, prostrate, fine-branched form of treeless vegetation appears quite distinct from the taller riparian form found at lower altitudes, and warrants recognition at species level (Jim Ross, National Herbarium of Victoria, pers. comm.). It is largely restricted to the Murrumbidgee River valley between the ACT and Kosciuszko National Park. Although it is locally abundant, most populations are small and on private land. There are a few pre-1900 records of this species for Victoria but it appears now to be extinct in that State.

Bulbine aff. *glauca* (Nungar Plain) (Asphodelaceae; E) has only been recorded at two sites (Nungar Plain and Snowy Plain) and is threatened at both by pig rooting and at one by cattle grazing.

Calotis glandulosa (Asteraceae; V) occurs in Kosciuszko National Park and the Monaro Plains near Cooma. In Kosciuszko National Park it is locally abundant in the Tantangara area and seems to favour disturbed sites.

Calotis pubescens (Asteraceae; E) is only known to occur at Nungar Plain in Kosciuszko National Park (apparently only in Community 31, described below), although there are two old records from other sites, which have not been relocated during recent searches. The extant population is threatened by pig rooting.

Carex paupera (Cyperaceae; V) is endemic in Victoria and known from a few populations on the Dargo High Plains, Bogong High Plains near Mt Jim, and plains near Mt Hotham. Some populations are reasonably extensive, but they occur in areas prone to disturbance. There is some evidence that the species is actually a coloniser of disturbed ground and may be at least partly disturbance-dependent. There is uncertainty about the distinctness of this species from the widespread, variable *C. inversa*.

Deyeuxia affinis (Poaceae; V) is known from only two sites on the Bogong High Plains but is commoner on the Main Range of Kosciuszko National Park. It is no longer subjected to cattle grazing pressures but the small population size would justify its threatened status.

Deyeuxia talariata (Poaceae; V) is largely confined to the Cobberas Mountains and the Nunniong Plateau where known from only 4 populations. It is threatened by disturbance of bogs through the activities of feral horses. Two of the known sites were burnt in the 2003 bushfires.

Dillwynia palustris (Fabaceae; E) is a prostrate pea known from five sites (two in Kosciuszko National Park, two on non-reserve tenures nearby and one in State Forest). The populations in Kosciuszko National Park seem to be small and are threatened by grazing and trampling by pigs and feral horses. Both Kosciuszko National Park populations were burnt in 2003; one had regenerated 12 months later (Walsh & McDougall 2005).

Discaria nitida (Rhamnaceae; V) occurs in about 20 populations, mostly in Kosciuszko National Park. Most populations are at or below the lower treeline. Some Kosciuszko National Park populations are threatened by weeds.

Diuris pedunculata (Orchidaceae; E) has a large range in NSW. It was found recently at Snowy Plain, freehold land on the eastern side of Kosciuszko National Park, and may also have been recorded from the Kiandra area. It may have been overlooked elsewhere in the study area because of its superficial similarity to the more common *D. monticola*.

Eucalyptus lacrimans (Myrtaceae; V) is locally dominant in the Kiandra – Tantangara – Long Plain area and to the east of Adaminaby (and is the dominant of Community 34, described below). The species would probably meet the criteria for listing as Vulnerable as most stands near Adaminaby are on private, grazing land where there is little or no recruitment evident and much death of isolated trees in paddocks. Many stands in Kosciuszko National Park appear to be in poor health and most contain a mix of live and dead trunks with little recruitment. The reasons for the deaths and poor recruitment are worthy of investigation. Some examples were burnt in the 2003 fires.

Euphrasia crassiuscula subsp. *glandulifera* (Scrophulariaceae; V) is confined to a few known populations on the higher parts of the Victorian Alpine National Park (Mt Bogong and Bogong High Plains). All populations are now protected from cattle grazing. Some were extensively burnt in the 2003 fires but recruitment from seed has been recorded since.

Euphrasia eichleri (Scrophulariaceae; V) is confined to a few known populations on the higher parts of the Victorian Alpine National Park (Mt Bogong and Bogong High Plains). All populations are now protected from cattle grazing. It is closely related to *E. alsa*, similarly a localised endemic on the Kosciuszko Main Range. Several populations were burnt in the 2003 fires but new plants have been recorded since.

Euphrasia sp. 3 (Ramshead Range) (Scrophulariaceae; E) is a tiny annual, which appears to be restricted to the Ramshead Range between Charlottes Pass and South Ramshead in Kosciuszko National Park, where it is extremely rare. Whilst there are few apparent threats (feral horse grazing and trampling by horses and tourists), its small population size may make it especially vulnerable to impacts from global warming.

Galium roddii (Rubiaceae; E) is relatively common on the slopes of Cave Creek in Kosciuszko National Park and occurs in smaller populations elsewhere, at Currango and Long Plains. The main population however is threatened by weed competition, especially *Sedum acre*.

Genoplesium turfosum (Orchidaceae; E) is only known from two sites (in northern Kosciuszko NP and in Namadgi National Park). Despite our recent surveys, new populations were not located, although the species is somewhat cryptic.

Kelleria laxa (Thymelaeaceae; V) occurs only in the vicinity of Mt Jim on the Bogong High Plains (Victorian Alpine National Park). About 20 small populations are known in an area of about 2 km^2, varying from a few cm^2 to a few m^2. All populations were subject to summer grazing prior to 2005. The species is also known from New Zealand, but morphological and DNA evidence suggests the Australian plants may constitute a distinct taxon.

Lobelia gelida (syn. *Pratia gelida*; Campanulaceae; V) is confined to a few small populations in Victoria, on Mt Buffalo and near Mt Howitt. At these sites it may be locally abundant in shallow seasonal pools. All populations are now protected from cattle grazing and most are in areas unlikely to be otherwise damaged.

Prasophyllum bagoensis (Orchidaceae; E) This orchid is only known from McPhersons Plain (on freehold land and NSW State Forest lease), where it is threatened by pigs and feral horses.

Prasophyllum niphopedium (Orchidaceae; E) is confined to a few small populations near the Cobberas Mountains in the Alpine National Park and on the nearby Nunniong Plateau. It is subject to grazing and damage by feral horses which are abundant in these areas. *Prasophyllum niphopedium* has been recently segregated from *P. morganii*. The latter species (listed as Vulnerable under the EPBC Act) is now regarded as extinct, being known from subalpine vegetation at Cobungra, Victoria, and last collected in 1933.

Prasophyllum retroflexum (Orchidaceae; V) is rare and restricted to the plains in and around Kiandra but has probably been overlooked because of its similarity to the more common species there (e.g. *P. sphacelatum*), and its short flowering period.

Prasophyllum sp. aff. *canaliculatum* (Orchidaceae; E), is an undescribed orchid that is only known from McPhersons Plain (on freehold land and NSW State Forest lease) (David Jones, CSIRO, pers. comm.) where it is threatened by pigs and feral horses.

Ranunculus anemoneus (Ranunculaceae; V) was apparently close to extinction when the Kosciuszko area was grazed by domestic stock. It is now locally common in a range of communities on the Main Range between Mt Kosciuszko and Mt Jagungal.

Rutidosis leiolepis (Asteraceae; V) is known from only a few sites in the Monaro Plains area south of Canberra and was recorded during the current survey from several grassland/ open heath sites near Kiandra (e.g. Long Plain and Happy Jacks Plain). Feral horses and pigs are abundant in these areas and cause significant local damage to the vegetation containing this daisy.

Rytidosperma pumilum (Poaceae; V), whilst occurring in alpine areas of New Zealand, is known from a single population in Australia, on the Kosciuszko Main Range. The Australian population numbers thousands of plants in an area of only a few ha. In the long term it is indirectly threatened by trampling by bushwalkers (McDougall & Wright 2004) and by loss of habitat through climate change.

Rytidosperma vickeryae (Poaceae; E) occurs in *Sphagnum*-dominated communities of a few subalpine tributaries of the upper Snowy River (e.g. Betts Creek, Perisher Creek) but has been recorded only once beyond that area (Happy Jacks Plain). Some populations may be threatened by future ski development.

Thesium australe (Santalaceae; V) has been recorded from limestone-derived soils near Cave Creek (Kosciuszko National Park) and soils of volcanic origin near the Cobberas mountains in Victoria. Population numbers appear to fluctuate widely from year to year. This species was once a widespread component of grasslands in Queensland, New South Wales, Victoria and Tasmania but is now largely confined to a few highland sites and coastal headlands on the mainland.

Viola improcera (Violaceae; V) has been recorded in the ACT (in the Mt Scabby / Mt Kelly area) and in Victoria on the Nunniong Plateau and Mt Useful. Although not yet recorded in NSW, it probably occurs there, the ACT records being close to the border. In the ACT, this small stoloniferous herb grows in heathland (Helman et al. 1988) and mallee shrubland.

Wahlenbergia densifolia (Campanulaceae; V), in Victoria, is only known from a few subalpine sites (e.g. Cobberas, Nunniong Plateau). Although more widespread in NSW it may be eligible for listing. Three populations were found in the current study in Kosciuszko National Park. Two of these sites (Happy Jacks Plain and Nungar Plain) are frequently damaged by pigs, which preferentially dig in the community containing this species (Community 31, described below). In NSW, this species has also been recorded at Mt Gingera, the Guthega area and the Tinderry Range.

Xerochrysum palustre (Asteraceae; V) is mostly found in lowland and mid-elevation wetlands in Tasmania, Victoria and New South Wales but was recorded during the current study at several sites in the Tantangara – Kiandra area of Kosciuszko National Park.

Two taxa of treeless vegetation (*Actinotus moorei* and *Epilobium willisii*) are now extinct on the mainland but persist in alpine vegetation in Tasmania.

Table 2. Summary of Communities. Distribution: ACT = Australian Capital Territory (and adjacent parts of Kosciuszko NP); BB = Baw Baw – Lake Montain area; BHP = Bogong High Plains; KMR = Kosciuszko Main Range and adjoining subalpine plains; KSUB = other subalpine plains of Kosciuszko National Park and surrounds; VICO = Victorian sites other than BHP and BB (e.g. Mt Buller, Mt Buffalo, Cobberas, Wellington Plains); W = widespread (i.e. throughout most of study area)

Group	Community	Distribution (lineal extent (km))	Habitat	Native taxa/ quadrat	Weeds / quadrat	Altitude (m)	Usual dominants of upper stratum
I – wet heathlands (bogs), wetland margins & valley grassland	1: Baw Baw – Lake Mountain wet heathland	BB (65)	Valley - wet	22.8	0.1	1270 – 1570	*Epacris paludosa*, *Richea continentis*
	2: *Richea continentis – Carpha nivicola – Sphagnum cristatum* wet heathland	W (230)	Valley - wet	17.4	0.1	1320 – 2100	*Baeckea gunniana*, *Richea continentis*
	3: *Baeckea gunniana – Callistemon pityoides - Sphagnum cristatum* wet heathland	W (280)	Valley - wet	25.0	1.3	1160 – 1840	*Baeckea gunniana*, *Epacris paludosa*
	4: *Epacris* moist heathland	BHP, KMR (125)	Valley - moist	19.2	0.3	1650 – 2150	*Epacris glacialis*, *E. gunnii*, *E. petrophila*
	5: Alpine valley grassland	ACT, KSUB (25)	Valley - moist	16.8	0.6	1740 – 2010	*Poa costiniana*
II – damp herbfields, fens & waterways	6: *Lobelia surrepens – Ranunculus millanii* herbfield	W (275)	Valley – wet & dry	12.9	0.6	1090 – 1770	*Lobelia surrepens*, *Ranunculus millanii*
	7: *Hypericum japonicum – Ranunculus pimpinellifolius* herbfield	W (200)	Valley - wet	21.8	4.6	1180 – 1740	*Hypericum japonicum*, *Ranunculus pimpinellifolius*
	8: Fen	W (210)	Valley - wet	13.6	0	1300 – 1920	*Carex gaudichaudiana*
	9: Aquatic	W (270)	Valley - wet			1000 – 1600	Nil
III – gravelly pavement herbfields	10: Short alpine herbfield	BHP, KMR (120)	Valley - wet	17.0	0.0	1600 – 2200	*Caltha introloba*, *Oreobolus pumilio*
	11: *Celmisia sericophylla* herbfield	BHP (25)	Snowpatch - wet	13.0	0.6	1560 – 1820	*Celmisia sericophylla*
IV – snowpatch herbfields	12: *Coprosma niphophila – Colobanthus nivicola* snowpatch feldmark	KMR (7)	Snowpatch - dry	15.0	0.5	2050 – 2200	*Colobanthus nivicola*, *Coprosma niphophila*
	13: *Neopaxia australasica – Ranunculus niphophilus* snowpatch herbfield	KMR (35)	Snowpatch - wet	14.0	0.4	1920 – 2170	*Neopaxia australasica*, *Plantago muelleri*

Group	Community	Distribution (lineal extent (km))	Habitat	Native taxa/ quadrat	Weeds / quadrat	Altitude (m)	Usual dominants of upper stratum
V – subalpine valley & fertile grasslands	14: Subalpine valley grassland	W (220)	Valley - moist	25.9	2.1	1020 – 1680	*Poa costiniana*
	15: Snowy Range Grassland	VICO (90)	Plains	27.7	2.1	1260 – 1760	*Poa costiniana*
	16: Victorian subalpine basalt grassland	VICO (145)	Plains	25.3	4.9	1200 – 1620	*Poa hiemata*
VI – closed alpine grasslands	17: *Poa fawcettiae – Celmisia costiniana* snowpatch grassland	BHP, KMR (115)	Snowpatch	11.4	0.8	1710 – 2160	*Celmisia costiniana*, *Poa fawcettiae*
	18: *Poa fawcettiae - Uncinia sulcata* grassland	KMR (35)	High slopes	11.3	0.1	1970 – 2200	*Poa fawcettiae*, *Uncinia sulcata*
	19: *Chionochloa frigida* grassland	KMR (25)	Sheltered slopes	16.8	0.6	1780 – 2110	*Chionochloa frigida*, *Poa fawcettiae*
VII – high altitude grasslands & open heathlands	20: Short turf snowpatch grassland	BHP (25)	Snowpatch	17.4	2.1	1670 – 1850	*Carex hebes*, *Rytidosperma nudiflorum*
	21: Bogong High Plains *Hovea montana* heathland	BHP (25)	Sheltered slopes	21.4	1.8	1680 – 1840	*Hovea montana*
	22: *Poa fawcettiae – Euphrasia collina* grassland	KMR (40)	Valleys & saddles	20.1	0.9	1740 – 2190	*Poa fawcettiae*
	23: *Grevillea australis – Nematolepis ovatifolia* open heathland	KMR (45)	Slopes	22.8	0.8	1600 – 2030	*Grevillea australis*, *Nematolepis ovatifolia*
	24: Bogong High Plains *Poa costiniana* grassland	BHP (15)	Plains	21.2	2.7	1570 – 1840	*Poa costiniana*
	25: Bogong High Plains *Poa hiemata* grassland	BHP (30)	Plains	20.7	1.6	1380 – 1930	*Poa hiemata*
	26: Bogong High Plains *Grevillea australis – Phebalium squamulosum* open heathland	BHP (35)	Slopes	23.4	1.5	1560 – 1960	*Grevillea australis*
	27: Bogong High Plains *Kunzea muelleri* open heathland	BHP (35)	Slopes	19.9	0.6	1630 – 1900	*Kunzea muelleri*
	28: Snowy Range open heathland	VICO (100)	Plains	23.4	2.2	1340 – 1680	*Hovea montana*
	29: Victorian shale *Hovea montana* heathland	VICO (55)	Slopes	20.2	1.3	1460 – 1740	*Hovea montana*

VIII – subalpine heathland	30: *Poa hiemata – Poa clivicola* grassland	ACT, KSUB (120)	Plains	29.9	2.1	1250 – 1810	*Poa hiemata*, *Poa clivicola*
	31: *Poa hookeri* grassland	KSUB (75)	Plains	27.4	2.4	1200 – 1420	*Poa hookeri*
	32: *Hovea montana - Poa phillipsiana* open heathland	VICO (125)	Plains	21.0	1.2	1160 – 1700	*Poa phillipsiana*
	33: Northern Alps *Hovea montana* open heathland	ACT, KSUB (80)	Slopes	24.0	1.3	1330 – 1800	*Hovea montana*
	34: *Eucalyptus lacrimans* low open woodland	KSUB (35)	Slopes	26.2	2.2	1270 – 1470	*Eucalyptus lacrimans*
	35: *Bossiaea foliosa – Epacris petrophila* heathland	KSUB (10)	Plains	17.8	1.5	1320 – 1360	*Bossiaea foliosa*, *Epacris petrophila*
	36: Broadway *Bossiaea foliosa* closed heathland	KSUB (10)	Slopes	36.6	1.8	1250 – 1350	*Bossiaea foliosa*
	37: Northern Alps Epacris - *Kunzea* open heathland	KSUB (90)	Slopes	25.9	0.7	1250 – 1620	*Epacris gunnii*, *E. petrophila*, *Kunzea muelleri*
IX – limestone grassland	38: *Themeda triandra – Leucochrysum albicans* grassland	KSUB (1)	Slopes	16.2	6.2	1200 – 1220	*Themeda triandra*, *Leucocrysum albicans*
X – short alpine heathlands	39: Kosciuszko alpine *Epacris - Kunzea* open heathland	KMR (40)	Slopes	15.2	0.4	1860 – 2220	*Epacris gunnii*, *Kunzea muelleri*
	40: *Epacris gunnii – Chionohebe pulvinatus* feldmark	KMR (8)	High ridges	14.8	0.5	2010 – 2150	*Epacris gunnii*
	41: Bogong High Plains *Epacris - Kunzea* open heathland	BHP (20)	High ridges	14.3	0.1	1630 – 1880	*Epacris gunnii*
XI – western subalpine open heathland	42: *Epacris celata – Poa clivicola* open heathland	KSUB (1)	Plains	26.0	2.0	1100	*Epacris celata*, *Epacris gunnii*
XII – upper Murrumbidgee dwarf heathland	43: *Bossiaea riparia* dwarf heathland	KSUB (15)	Slopes	24.3	3.5	1220 – 1280	*Bossiaea riparia*
XIII – Baw Baw open heathlands	44: *Pultenaea muelleri* open heathland	BB (15)	Rocky slopes	21.6	2.6	1320 – 1540	*Pultenaea muelleri*
	45: *Epacris petrophila* open heathland	BB (5)	Slopes	21.5	0.3	1310 – 1480	*Epacris petrophila*

Group	Community	Distribution (lineal extent (km))	Habitat	Native taxa/ quadrat	Weeds / quadrat	Altitude (m)	Usual dominants of upper stratum
XIV – high altitude closed heathlands	46: *Nematolepis ovatifolia* – *Prostanthera cuneata* closed heathland	KMR (75)	Slopes	18.0	0.8	1420 – 2040	*Nematolepis ovatifolia, Prostanthera cuneata*
	47: Bogong High Plains *Phebalium squamulosum* – *Bossiaea foliosa* closed heathland	BHP (25)	Slopes	16.5	0.9	1610 – 1830	*Bossiaea foliosa, Prostanthera cuneata*
XV – central Victorian Alps rocky open heathlands	48: *Podolobium alpestre* - *Euryomyrtus ramosissima* open heathland	VICO (30)	Rocky peaks and cliffs	14.6	0.7	1380 – 1800	*Euryomyrtus ramosissima, Podolobium alpestre*
	49: Snowy Range – Mt Buffalo *Kunzea muelleri* heathland	VICO (90)	Rocky slopes	17.4	0.6	1380 – 1740	*Kunzea muelleri*
	50: *Olearia phlogopappa* – *Podolobium alpestre* closed heathland	VICO (160)	Rocky outcrops	18.5	1.3	1660 – 1760	*Podolobium alpestre, Olearia phlogopappa*
XVI – rocky outcrop open heathland	51: *Austrodanthonia alpicola* – *Grevillea australis* open heathland	BHP, KMR (190)	Rocky outcrops – dry	21.2	1.5	1420 – 2180	*Austrodanthonia alpicola, Brachyscome rigidula*
XVII – ACT rocky outcrop mallee shrubland	52: *Eucalyptus debeuzevillei* mallee shrubland	ACT (6)	Rocky slopes	19.8	1.0	1720 – 1810	*Eucalyptus debeuzevillei*
XVIII – boulder heathlands	53: *Podocarpus lawrencei* – *Epacris paludosa* closed heathland	W (180)	Valley - moist	22.2	0.8	1280 – 1950	*Epacris paludosa, Podocarpus lawrencei*
	54: *Podocarpus lawrencei* closed heathland	W (200)	Block stream - dry	8.8	0.5	1400 – 2080	*Podocarpus lawrencei*
XIX – boulder herbaceous communities	55: *Carex appressa* sedgeland	BHP (7)	Block stream - moist	12.5	2.6	1710 – 1800	*Carex appressa*
	56: *Poa helmsii* grassland	BHP (7)	Block stream - dry	12.4	2.0	1730 – 1800	*Poa helmsii*

Plant community descriptions

The Cluster analysis identified 56 communities at the 29.3% similarity level (Table 2). Below this level of similarity, some groups regarded as representing communities of well-defined habitat were combined with quadrats of other habitat. Above this level of similarity, there was a greatly increased number of communities that we felt would be difficult to identify in the field. The 170 quadrats that did not fit within groups at this similarity were not used in the classification. Some perhaps represent under-sampled communities. Others may have been inadvertently sampled across community boundaries. When the frequencies of the diagnostic species in the 56 communities were re-analysed using Primer, 19 Vegetation Classes (in the sense of Keith (2004) were identified at the 20% similarity level (Fig. 4). At a lower similarity level, disparate communities were amalgamated, often because of low species richness (e.g. alpine grasslands of Kosciuszko National Park (Communities 17, 18 and 19) with rocky open heathlands of the central Victorian Alps (Communities 48, 49 and 50)).

In the descriptions of the communities below, the community names were developed using a system of priorities. A vernacular name was used if this was unambiguous. The name 'tall alpine herbfield', used by Costin (1954) for herb-rich communities of dry alpine sites in Kosciuszko National Park, was not used by us because it contained several of our identified communities. Where there was no unambiguous vernacular name, a name was constructed using features that were unique to the community (e.g. usual dominants, location, habitat, diagnostic species) and a structural base name (e.g. heathland, grassland).

In the descriptions below, diagnostic taxa are grouped by life form (shrub or herb) and listed in decreasing order of frequency (with % frequency in parentheses). Other common, but not diagnostic taxa are listed where the frequency is greater than 40%. Significant taxa are those listed and described above. All weeds occurring within a community are listed (with % frequency in parentheses).

The altitudinal range of each community is presented as Lowest – Mean – Highest. Management issues are discussed under the assumption that cattle grazing will no longer be permitted in the Alpine National Park.

Group I – wet heathlands (bogs), wetland margins & valley grassland

Community 1: Baw Baw – Lake Mountain wet heathland

Equivalent communities: Wet alpine heathland, sub-communities 9.1, 9.2, 9.3 (Walsh et al. 1984).

Baw Baw – Lake Mountain wet heathland is restricted to the Baw Baw Plateau and Lake Mountain areas, occurring in broad valley floors and lower slopes of relatively low relief. Permanent water is a feature, either as pools or as slow-flowing streams. Topographically lower sites support dense heath to c. 1 m high, composed mainly of *Richea continentis, R. victoriana, Baeckea gunniana, B. utilis, Epacris paludosa, E. petrophila* in a complex with abundant *Sphagnum cristatum* forming hummocks and hollows associated with a variety of herbs such as *Astelia alpina, Blechnum penna-marina, Brachyscome obovata, Drosera arcturi, Nertera granadensis, Erigeron paludicola, Euphrasia gibbsiae* subsp. *subglabrifolia,* and *Isolepis* spp. This complex is typically surrounded upslope by a drier heath dominated by *Olearia algida, Ozothamnus* sp.1, *Tasmannia vickeriana, Trochocarpa clarkei, Pultenaea muelleri, Leionema phylicifolium* (Lake Mountain only). These mountains are disjunct from the Alps of the main Dividing Range and consequently contain a relatively high percentage of locally endemic or restricted taxa. This community is localised but well protected and under minimal threat. Both plateaux contain areas used for nordic skiing on groomed trails, and some cleared and groomed downhill ski slopes exist on Mt Baw Baw. There is a low level of weed intrusion as a consequence of the latter. Both areas are used for bushwalking and there are local effects associated with this around popular campsites (particularly on the Baw Baw plateau). Grazing has not been permitted at either area since 1975 but a few wild cattle persisted at least until recently near Mt Baw Baw.

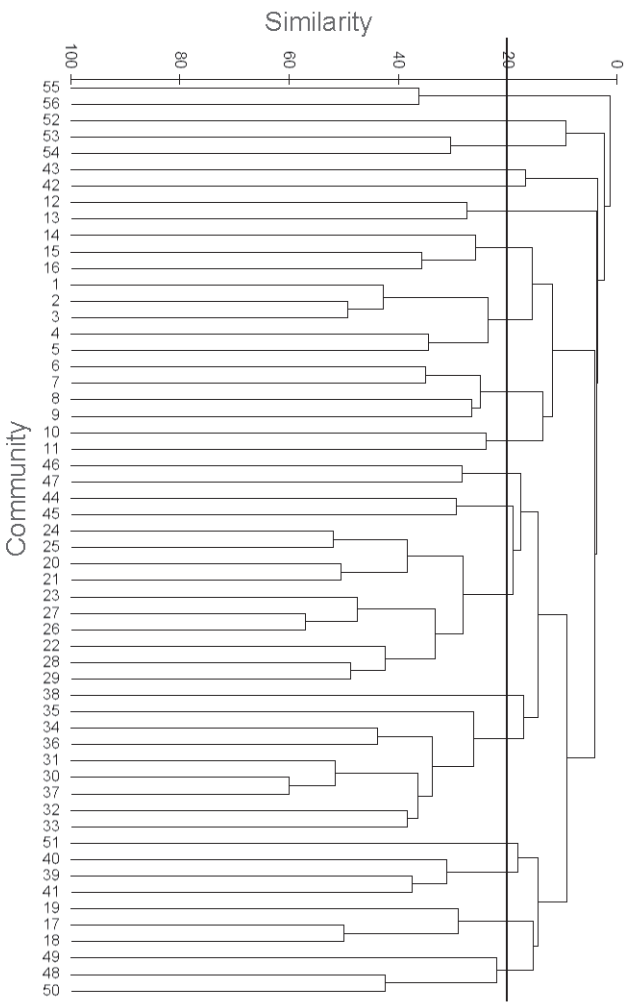

Fig. 4. Dendrogram showing relationships between communities. The 20% line of similarity is shown, at which 20 broad community groups were identified.

No. quadrats 53; Native taxa / quadrat 22.8 ± 0.8; Total native taxa 127; Weeds /quadrat 0.1 ± 0.0; Total weed taxa 3

Altitude: 1270 – 1410 – 1570 m.

Diagnostic Taxa: **Shrubs** *Epacris paludosa* (84), *Richea continentis* (82), *Olearia algida* (80), *Baeckea gunniana* (49), *Callistemon pityoides* (38), *Baeckea utilis* (29), *Epacris petrophila* (27), *Orites lancifolia* (25), *Wittsteinia vacciniacea* (22), *Ozothamnus* sp. 1 (18), *Pultenaea muelleri* (16), *Tasmannia vickeriana* (16), *Coprosma perpusilla* (13), *Trochocarpa clarkei* (9), *Coprosma nitida* (7), *Leptospermum grandifolium* (7); **Herbs** *Astelia alpina* (89), *Gentianella* spp. (82), *Empodisma minus* (75), *Celmisia* spp. (62), *Sphagnum cristatum* (62), *Thelymitra cyanea* (56), *Nertera granadensis* (53), *Euphrasia gibbsiae* subsp. *subglabrifolia* (49), *Oreobolus distichus* (47), *Carpha nivicola* (45), *Isolepis aucklandica* (44), *Lycopodium fastigiatum* (42), *Plantago alpestris* (36), *Blechnum penna-marina* (33), *Gonocarpus micranthus* (33), *Hydrocotyle algida* (33), *Erigeron paludicola* (31), *Epilobium gunnianum* (29), *Brachyscome obovata* (27), *Herpolirion novae-zelandiae* (27), *Ranunculus collinus* (27), *Carex appressa* (25), *Drosera arcturi* (24), *Caltha introloba* (20), *Ranunculus gunnianus* (20), *Juncus sandwithii* (18), *Schoenus calyptratus* (18), *Euchiton collinus* (16), *Huperzia australiana* (16), *Senecio pectinatus* var. *major* (16), *Carex canescens* (13), *Carex jackiana* (13), *Hierochloe redolens* (11), *Isolepis subtilissima* (11), *Lycopodium scariosum* (9), *Montia fontana* (7), *Oxalis magellanica* (7)

Other Common Taxa: *Asperula gunnii* (62)

Significant Taxa: *Actinotus moorei* (one record 1940)

Weeds: *Hypochaeris radicata* (9), *Cerastium vulgare* (2), *Taraxacum officinale* (2)

Community 2*: Richea continentis – Carpha nivicola – Sphagnum cristatum* wet heathland

Equivalent communities: *Epacris paludosa – Sphagnum cymbifolium* alliance & *Carex gaudichaudiana – Sphagnum cymbifolium* alliance (Costin 1954); *Sphagnum – Richea – Astelia* association (McVean 1969); Bog, Unit 7A (McDougall 1982); Wet alpine heathland, subcommunity 9.4 (Walsh et al. 1984); Type 4a (Helman & Gilmour 1985); Group 12 (Helman et al. 1988), Raised and valley bog (Costin et al. 2000).

Community 2 is widespread through the northern Alps and higher subalps, occurring almost continuously along the Dividing Range from the Brindabella Ranges in the ACT, through Kosciuszko National Park in NSW, and in Victoria from The Cobberas, across the Bogong High Plains with outlying examples on the Mt Buffalo plateau. Occurs mainly in broad valleys, but also in seepage zones on slopes of low relief and along margins of smaller watercourses. Free water, either as pools or as slow-flowing streams, may or may not be present. The community is often a low closed heath dominated by *Baeckea gunniana, Epacris paludosa* (and at higher altitudes, *E. glacialis*) and *Richea continentis* with intervening areas dominated by *Sphagnum cristatum* (*S. novo-zelandicum* in pools) and obligately associated herbs (e.g. *Astelia alpina, A. psychrocharis, Baloskion australe, Carex gaudichaudiana, Carpha nivicola, Celmisia* spp. *Diplaspis nivis, Empodisma minus, Erigeron paludicola, Oreobolus distichus, Oschatzia cuneifolia, Poa costiniana*). The distinction between valley bogs and raised bogs made by Costin et al. (2000) is not evident in our classification. Whilst vegetation containing *Sphagnum cristatum* in valleys of the Kosciuszko Main Range may appear different from bogs of hillsides, often having fewer, shorter shrubs, they are inseparable floristically. Some of the valley bogs of Costin et al. (2000) may also fall within Community 5 in cases where only small, isolated patches of *Sphagnum cristatum* are present. Community 2 is widespread and locally abundant but has suffered greatly from grazing, trampling and wildfire in recent times. Grazing ceased through most of Kosciuszko National Park in 1958, and on the northern parts of the Bogong High Plains in 1992 and recovery (indicated by dense *Sphagnum cristatum* cover and less entrenched watercourses) has occurred to varying extents through these areas. Where grazing persisted until 2003 (e.g. parts of the Bogong High Plains, Davies Plain and the Nunniong Plateau), degraded bogs are characterised by a less dense *Sphagnum cristatum* cover and entrenched, more rapidly flowering watercourses. Downhill ski developments occur through much of the range of the community and associated impacts such as clearing and modification of local hydrology are apparent in many of these areas.

No. quadrats 68; Native taxa / quadrat 17.4 ± 0.6; Total native taxa 161; Weeds /quadrat 0.1 ± 0.1; Total weed taxa 4

Altitude: 1320 – 1690 – 2100 m.

Diagnostic Taxa: Shrubs *Richea continentis* (100), *Baeckea gunniana* (82), *Epacris paludosa* (68), *Epacris glacialis* (59); **Herbs** *Empodisma minus* (100), *Sphagnum cristatum* (94), *Poa costiniana* (87), *Celmisia* spp. (*pugioniformis*, sp. aff. *pugioniformis*, *tomentella*) (79), *Carex gaudichaudiana* (75), *Oreobolus distichus* (60), *Astelia alpina* (59), *Carpha nivicola* (53), *Erigeron paludicola* (49), *Diplaspis nivis* (34), *Baloskion australe* (29), *Rytidosperma nivicola* (29), *Aciphylla simplicifolia* (22), *Astelia psychrocharis* (22), *Gentianella muelleriana* (subsp. *muelleriana*, subsp. *alpestris*) (22), *Oschatzia cuneifolia* (22), *Ranunculus gunnianus* (21), *Isolepis aucklandica* (19), *Argyrotegium poliochlorum* (16), *Hydrocotyle algida* (16), *Thelymitra cyanea* (13), *Carex echinata* (6)

Significant Taxa: *Rytidosperma vickeryae*

Weeds: *Acetosella vulgaris* (9), *Festuca rubra* (1), *Holcus lanatus* (1), *Hypochaeris radicata* (1)

Community 3: *Baeckea gunniana – Callistemon pityoides - Sphagnum cristatum* wet heathland

Equivalent communities: *Epacris breviflora – Blindia robusta* alliance (Costin 1954); Wet alpine heathland, subcommunity 9.6 (Walsh et al. 1984); Vegetation Type 4b (Helman & Gilmour 1985); Group 11 (Helman et al. 1988).

Widespread, mostly subalpine, extending from the Brindabella Ranges in the ACT, at scattered localities through Kosciuszko National Park, mostly in the catchments of the Murrumbidgee and Eucumbene Rivers, and in Victoria on the Nunniong Plateau, Dargo High Plains, Baw Baw Plateau, The Cobberas, Mt Buffalo and the Snowy Range south from Mt Howitt, rare on the Bogong High Plains (where generally at low elevations such as Wild Horse Plain). Typically a community of boggy margins of slow-flowing streams, often ± linear and adjacent to *Eucalyptus pauciflora* and/or *E. stellulata* woodlands. Usually at lower elevations than Community 2 but sometimes occurring with and merging into Communities 1 or 2. Examples are usually quite dense heaths and sometimes relatively tall (to c. 1.6 m high), dominated by shrubs such as *Baeckea gunniana, Epacris paludosa, Richea continentis, Callistemon pityoides* and *Epacris breviflora*. Herbs are usually rather scant beneath shrubs, but gaps may be herb-rich with species such as *Oreomyrrhis ciliata, Poa costiniana, Ranunculus pimpinellifolius, Celmisia* spp., *Cotula alpina, Empodisma minus, Gonocarpus micranthus, Hypericum japonicum* and *Juncus falcatus*. *Sphagnum cristatum* is usually present in wetter areas. A relatively rich weed flora is evidence of less exposed environments than Communities 1 and 2, and probably indicative of greater utilisation (in the recent past) by cattle, particularly when seeking water later in the grazing season as surrounding vegetation becomes drier.

No. quadrats 86; Native taxa / quadrat 25.0 ± 0.9; Total native taxa 264; Weeds /quadrat 1.3 ± 0.2; Total weed taxa 21

Altitude: 1160 – 1465 – 1840 m.

Diagnostic Taxa: Shrubs *Baeckea gunniana* (90), *Epacris paludosa* (73), *Richea continentis* (47), *Callistemon pityoides* (40), *Epacris breviflora* (35), *Epacris gunnii* (28), *Pultenaea tenella* (26), *Hakea microcarpa* (23), *Epacris celata* (7), *Pimelea bracteata* (6); **Herbs** *Empodisma minus* (92), *Carex gaudichaudiana* (77), *Asperula gunnii* (71), *Sphagnum cristatum* (70), *Poa costiniana* (65), *Gonocarpus micranthus* (57), *Luzula modesta* (55), *Celmisia* spp. (*pugioniformis*, sp. aff. *pugioniformis*, *tomentella*) (51), *Ranunculus pimpinellifolius* (47), *Baloskion australe* (44), *Oreomyrrhis ciliata* (43), *Epilobium gunnianum* (35), *Oreobolus distichus* (35), *Hypericum japonicum* (31), *Cotula alpina* (30), *Hydrocotyle algida* (29), *Isolepis crassiuscula* (28), *Erigeron paludicola* (27), *Nertera granadensis* (27), *Juncus falcatus* (24), *Myriophyllum pedunculatum* (24), *Caltha introloba* (22), *Comesperma retusum* (19), *Isolepis aucklandica* (19), *Carex appressa* (17), *Wahlenbergia ceracea* (17), *Carex blakei* (16), *Thelymitra cyanea* (16), *Juncus sandwithii* (14), *Brachyscome obovata* (13), *Drosera peltata* (13), *Isolepis subtilissima* (13), *Carex jackiana* (12), *Chiloglottis* spp. (10), *Oreobolus oxycarpus* (10), *Utricularia monanthos* (8), *Veronica serpyllifolia* (8), *Hierochloe redolens* (7), *Coprosma moorei* (6)

Significant Taxa: *Deyeuxia talariata, Dillwynia palustris, Genoplesium turfosum*

Weeds: *Trifolium repens* (26), *Acetosella vulgaris* (16), *Cerastium glomeratum* (14), *Hypochaeris radicata* (14), *Taraxacum officinale* (10), *Cerastium vulgare* (9), *Poa pratensis* (8), *Mimulus moschatus* (6), *Cirsium vulgare* (5), *Prunella vulgaris* (3), *Anthoxanthum odoratum* (2), *Veronica arvensis* (2), *Agrostis capillaris* (1), *Agrostis stolonifera* (1), *Aphanes arvensis* (1), *Bromus hordeaceus* (1), *Conyza bonariensis* (1), *Juncus bufonius* (1), *Phleum pratense* (1), *Trifolium dubium* (1), *Vulpia bromoides* (1)

Community 4: *Epacris* moist heathland

Equivalent communities: *Epacris glacialis* heathland, Unit 7B (McDougall 1982); *Epacris glacialis* heath (Costin et al. 2000).

Many bogs, fens, streams and lakes in the higher parts of the Australian Alps are bordered by a low heathland on mineralised peat soil (Fig. 5). On the Bogong High Plains in Victoria this is invariably dominated by *Epacris glacialis*. On the Main Range of Kosciuszko National Park in NSW the community may be dominated by *Epacris glacialis, E. gunnii* or rarely (mostly at lower elevations) *E. petrophila*. Mat forming plants such as *Stackhousia pulvinaris, Pentachondra pumila, Argyrotegium* spp. and *Oreobolus distichus* are common. Tussock grasses are not abundant although *Poa costiniana* is usually present. Localised trampling damage is evident in examples on the Bogong High Plains, which, up until summer 2004–2005 were accessible to cattle. The community is well-protected and not requiring management action.

No. quadrats 16; Native taxa / quadrat 19.2 ± 1.5; Total native taxa 96; Weeds /quadrat 0.3 ± 0.3; Total weed taxa 4

Altitude: 1650 – 1825 – 2150 m.

Diagnostic Taxa: Shrubs *Pentachondra pumila* (63), *Epacris glacialis* (56), *Pimelea alpina* (56), *Epacris gunnii* (44), *Epacris petrophila* (25); **Herbs** *Poa costiniana* (88), *Celmisia* spp. (*costiniana, pugioniformis, tomentella*) (81), *Empodisma minus* (81), *Oreobolus distichus* (56), *Ranunculus gunnianus* (56), *Stackhousia pulvinaris* (56), *Erigeron nitidus* (50), *Argyrotegium fordianum* (38), *Gentianella muelleriana* subsp. *alpestris* (25), *Argyrotegium poliochlorum* (25), *Ranunculus muelleri* (25), *Rytidosperma nivicola* (25)

Other Common Taxa: *Carex breviculmis* (56), *Craspedia* spp. (*aurantia, maxgrayi*) (56), *Rytidosperma nudiflorum* (50)

Fig. 5. *Epacris glacialis* moist heathland (Community 4) beside Pretty Valley Creek on the Bogong High Plains. There is usually a sharp boundary between this community, which is found on humified peat, and those of dry sites on alpine humus soil (in this case, Community 24 in the background). The creek itself is typical of the habitat of Community 9. However, *Myriophyllum pedunculatum* seems to be the only species of that disparate community to occur here.

Significant Taxa: *Euphrasia* sp. 3

Weeds: *Hypochaeris radicata* (13), *Acetosella vulgaris* (6), *Taraxacum officinale* (6), *Trifolium repens* (6)

Community 5: Alpine valley grassland

Equivalent communities: part of *Poa caespitosa – Danthonia nudiflora* alliance (Costin 1954); Sod tussock grassland (Costin et al. 2000).

This community is similar in appearance, habitat and usual dominant (*Poa costiniana*) to Community 14 yet is distinct floristically, having much lower species diversity and containing many species commonly found in wetland vegetation only at higher elevation. It is restricted to Kosciuszko National Park and is especially common beside low-velocity waterways in the high subalpine zone (e.g. Spencers Creek, Guthrie Creek, upper Snowy River).

No. quadrats 9; Native taxa / quadrat 16.8 ± 0.9; Total native taxa 65; Weeds /quadrat 0.6 ± 0.4; Total weed taxa 5

Altitude: 1740 – 1830 – 2010 m.

Diagnostic Taxa: Shrubs *Epacris glacialis* (56); **Herbs** *Poa costiniana* (100), *Craspedia* spp. (*jamesii*) (89), *Empodisma minus* (89), *Aciphylla simplicifolia* (78), *Carex gaudichaudiana* (67), *Gentianella muelleriana* subsp. *alpestris* (67), *Ranunculus gunnianus* (44), *Deyeuxia carinata* (33), *Ranunculus millanii* (33)

Other Common Taxa: *Asperula gunnii* (78), *Celmisia* spp. (56), *Oreomyrrhis eriopoda* (56), *Microseris* sp. 2 (44)

Weeds: *Acetosella vulgaris* (11), *Agrostis capillaris* (11), *Cerastium vulgare* (11), *Festuca rubra* (11), *Taraxacum officinale* (11)

Group II – Damp herbfields, fens & waterways

Community 6**:** *Lobelia surrepens – Ranunculus millanii* herbfield

Equivalent communities: Pratia depression, Unit 8A & Fen (Bog pool), Unit 8B (McDougall 1982); Damp alpine heathland, subcommunity 10.1 (Walsh et al. 1984); Vegetation Type 9 (Helman & Gilmour 1985).

Lobelia surrepens – Ranunculus millanii herbfield occurs on the Bimberi Range (ACT), northern Kosciuszko National Park and surrounds (e.g. Kiandra, Seventeen Flat, Broadway Plain, McPhersons Plain, Cooleman Plain) and a number of sites of suitable topography in Victoria where locally common (e.g. Bogong High Plains, Mt Buffalo, Dargo High Plains, Snowy Range) but is absent from the Baw Baw Plateau and Lake Mountain. It is a low herbfield that is confined to, and highly characteristic of, seasonally inundated depressions of alpine and high subalpine areas (Fig. 6). There appears to be no convincing explanation for the genesis of these formations. The depressions may be more or less linear and oriented across slopes (i.e. the 'contour trenches' of McElroy (1952)), or they may be nearly circular on almost flat ground. They are underlain by water-retentive soils, often derived from igneous parent material, and filled with water following snow-melt. By early summer they are usually empty of surface water but soils remain moist through the season (sometimes filling again during heavy rains). Representative species include the virtually prostrate species *Lobelia surrepens*, *Ranunculus millanii*, *Gonocarpus micranthus*, *Isolepis montivaga*, *Myriophyllum pedunculatum*, *Stackhousia pulvinaris*, *Lachnagrostis meionectes*. The taller sedge, *Carex gaudichaudiana* is usually present, particularly in deeper sections of the depressions where water tends to persist for longer periods. The very rare species *Lobelia gelida* (Mt Buffalo, Snowy Range) is confined to this community, and *Kelleria laxa* (Bogong High Plains) occurs in this community and adjacent grassland.

No. quadrats 16; Native taxa / quadrat 12.9 ± 1.1; Total native taxa 94; Weeds /quadrat 0.6 ± 0.4; Total weed taxa 10

Altitude: 1090 – 1410 – 1770 m.

Diagnostic Taxa: Herbs *Carex gaudichaudiana* (94), *Ranunculus millanii* (94), *Lobelia surrepens* (88), *Gonocarpus micranthus* (63), *Dichondra repens* (50), *Isolepis montivaga* (44), *Myriophyllum pedunculatum* (38), *Hydrocotyle sibthorpioides* (31), *Lachnagrostis aemula* (19)

Significant Taxa: *Lobelia gelida*, *Kelleria laxa*

Weeds: *Trifolium repens* (15), *Acetosella vulgaris* (10), *Agrostis capillaris* (5), *Agrostis stolonifera* (5), *Cirsium vulgare* (5), *Juncus bufonius* (5), *Poa pratensis* (5), *Rorippa palustris* (5), *Rumex conglomeratus* (5), *Taraxacum officinale* (5)

Community 7: *Hypericum japonicum – Ranunculus pimpinellifolius* herbfield

Equivalent communities: Nil

Fig. 6. Small depression containing *Lobelia surrepens – Ranunculus millanii* herbfield (Community 6) within *Poa costiniana* dominated grassland (Community 24) at head of Cope Creek on the Bogong High Plains.

In Victoria, Community 7 has been recorded from the Dargo High Plains, Nunniong Plateau and plains south of Mt Hotham, with isolated occurrences near Mt Stirling and The Bluff. In New South Wales recorded from Boggy Plain near Tantangara, Long Plain and Bogong Plain near Mt Jagungal but undoubtedly commonly occurring elsewhere within the subalpine area. It occurs in broad valleys or around seepage zones on flat ground anywhere where soils are relatively deep and permanently sodden (but not inundated), often on sites with basaltic parent material (Fig. 7). Forbs such as *Hypericum japonicum, Ranunculus pimpinellifolius, Gonocarpus micranthus* and *Epilobium curtisiae* are the usual dominants and form a dense mat of overlapping leaves. Examples are often small (a few m^2). A relatively high weed percentage (particularly *Acetosella vulgaris*, *Cerastium glomeratum*, *Holcus lanatus*, *Trifolium repens*) is indicative of disturbance and relatively benign growing conditions. Many of the sites (at least in Victoria) are still subject to cattle grazing. Sites in New South Wales may be affected by pigs.

No. quadrats 14; Native taxa / quadrat 21.8 ± 2.0; Total native taxa 108; Weeds /quadrat 4.6 ± 0.7; Total weed taxa 18

Altitude: 1180 – 1435 – 1740 m.

Diagnostic Taxa: Herbs *Carex gaudichaudiana* (93), *Hypericum japonicum* (86), *Ranunculus pimpinellifolius* (86), *Cotula alpina* (71), *Juncus falcatus* (71), *Epilobium curtisiae* (57), *Euchiton collinus* (57), *Gonocarpus micranthus* (57), *Brachyscome scapigera* (50), *Hydrocotyle sibthorpioides* (50), *Oreomyrrhis ciliata* (50), *Veronica serpyllifolia* (43), *Dichondra repens* (36), *Isolepis montivaga* (36), *Isolepis subtilissima* (29), *Schoenus calyptratus* (29), *Carex inversa* (21)

Other Common Taxa: *Luzula modesta* (50)

Significant Taxa: *Epilobium willisii, Wahlenbergia densifolia*

Weeds: *Trifolium repens* (100), *Taraxacum officinale* (50), *Acetosella vulgaris* (43), *Cerastium glomeratum* (43), *Holcus lanatus* (36), *Cerastium vulgare* (29), *Poa pratensis* (29), *Aphanes arvensis* (21), *Hypochaeris radicata* (21), *Prunella vulgaris* (14), *Vulpia bromoides* (14), *Agrostis capillaris* (7), *Medicago* spp. (7), *Myosotis discolor* (7), *Phleum pratense* (7), *Poa annua* (7), *Trifolium dubium* (7), *Veronica peregrina* (7),

Community 8: Fen

Equivalent communities: *Carex gaudichaudiana* alliance (Costin 1954); *Carex – Drepanocladus* association (McVean 1969); Vegetation Type 6a (Helman & Gilmour 1985); Fen (Costin et al. 2000).

Fens are widespread in valleys and low saddles in Kosciuszko National Park (where extending into the alpine zone) and subalpine valleys of the ACT. In Victoria, where less common, they have been recorded from only the Snowy Range, Mt Buffalo, the Bogong High Plains and Nunniong Plateau. The sedge *Carex gaudichaudiana* is ubiquitous within this community and makes it one of the most immediately recognisable of alpine/subalpine vegetation types. Typically, sites are inundated through most, if not all, summer with water depths up to c. 15 cm. Relatively few other species occur within the closed sedgeland, but in some areas *Brachyscome obovata*, *Carex echinata*, *Deschampsia caespitosa*, *Epilobium gunnianum*, *Isolepis crassiuscula*, *Myriophyllum pedunculatum* etc. may be reasonably common. *Sphagnum cristatum* often occupies any ground raised slightly above the bed of the fen. The weed *Myosotis caespitosa*, although not recorded in quadrats, is abundant at a few sites in Kosciuszko National Park (e.g. Boggy Plain, Ogilvies Plain) and may threaten the integrity of this community.

No. quadrats 16; Native taxa / quadrat 13.6 ± 1.9; Total native taxa 87; Weeds /quadrat 0; Total weed taxa 0

Altitude: 1300 – 1700 – 1920 m.

Diagnostic Taxa: Herbs *Carex gaudichaudiana* (100), *Sphagnum cristatum* (81), *Carpha nivicola* (56), *Oreomyrrhis ciliata* (50), *Epilobium gunnianum* (44), *Isolepis crassiuscula* (38), *Myriophyllum pedunculatum* (38), *Brachyscome obovata* (31), *Carex echinata* (31), *Deschampsia caespitosa* (31), *Juncus falcatus* (25)

Other Common Taxa: *Poa costiniana* (63), *Empodisma minus* (50)

Community 9: Aquatic

Equivalent communities: Vegetation Type 6b (Helman & Gilmour 1985).

Occurs in and beside permanent creeks and in deeper pools along intermittent streams (e.g. Nungar Creek and McPhersons Plain in NSW, Sheep Station Ck and Grassy Creek in the ACT, Baw Baw and Nunniong Plateaus and Bogong High Plains in Victoria) but probably more widespread. It includes both true aquatics with fully submerged (e.g. *Myriophyllum alpinum*), floating (*Nymphoides montana*) or emergent foliage (e.g. *Carex gaudichaudiana*), as well as semi-aquatics capable of growing as submergents for extended periods (e.g. *Lilaeopsis polyantha, Neopaxia australasica, Ranunculus pimpinellifolius*). Plant cover is sporadic and sometimes only one or a few species will be present. Some trampling of creek edges by horses and, on Nunniong Plateau, degradation by cattle was observed in the vicinity of this community. It is possible however that some sites formerly supporting this community have been degraded to the extent that they are no longer floristically analogous. The weed *Myosotis caespitosa* is locally abundant at the margins of some examples (e.g. Cooleman Plain in Kosciuszko National Park).

No. quadrats: 1 (this community appears to have been sampled in the ACT by Helman & Gilmour (1985), based on the two-way table in that report, but the full quadrat data were unavailable to us).

Altitude: 1000 – c.1600 m.

Common Taxa: **Herbs** *Brachyscome radicans*, *Carex gaudichaudiana*, *Eleocharis acuta*, *Hydrocotyle sibthorpioides*, *Hydrocotyle tripartita*, *Lilaeopsis polyantha*, *Myriophyllum pedunculatum*, *Neopaxia australasica*, *Nymphoides montana*, *Ranunculus amphitrichus*, *Ranunculus pimpinellifolius*

Weeds: *Juncus articulatus, Myosotis caespitosa, Taraxacum officinale, Trifolium repens*

Fig. 7. An example of Community 7 at Long Plain (Kosciuszko National Park). The forb-dominated vegetation bordering the creek contrasts with the tussock-dominated vegetation (Community 30) in the background.

Group III – gravelly pavement herbfields

Community 10: Short alpine herbfield

Equivalent communities: part of *Plantago muelleri – Montia australasica* alliance (Costin 1954); *Oreobolus pumilio* association (McVean 1969); *Caltha* herbland, Unit 10 (McDougall 1982); Short alpine herbfield (Costin et al. 2000).

Short alpine herbfield is common above 1700 m in Kosciuszko National Park (between Ramshead Range and Mt Jagungal) but individual stands are rarely more than 100 m^2. It is extremely rare in Victoria being confined to a few creeks and snowpatches on the Bogong High Plains. A species-depauperate example of this community occurs on the eastern end of the Baw Baw Plateau. Short alpine herbfield is a sparsely-vegetated, semi-aquatic community of shallow, low-gradient streams (and sometimes shallow lake margins), usually with considerable amounts of exposed rock and coarse gravel (Fig. 8). It is often associated with snowpatches and/or bogs. The small, tough-leaved sedge *Oreobolus pumilio* forms dense low cushions and performs an important function by disrupting water flow which allows more tender herbs (some of very restricted occurrence e.g. *Abrotanella nubigena*, *Deyeuxia affinis*, *Drosera arcturi*, *Parantennaria uniceps*) to take root. *Sphagnum cristatum* (and sometimes *S. novo-zelandicum*) usually occurs at the peripheries. Mat-forming species (*Dichosciadium ranunculaceum, Oreomyrrhis pulvinifica, Plantago glacialis, Plantago muelleri*) may be locally dominant. Some Victorian stands are dominated by *Caltha introloba*. The community appears to be dependent on maintenance of exposed gravelly sites and continuous irrigation. Any disruption to local hydrology may permit the expansion of adjacent communities or incursion of aquatic communities. Because of its frequent proximity to late-melting snow, trampling of this community by sightseers may occur during snowmelt. Although this is rare, we have observed damage to *Oreobolus pumilio* cushions from trampling and it is possible that disruption of rock and gravel by tramping limits opportunities for further establishment by short alpine herbfield species. Whilst monitoring of stands of this community subject to trampling would be worthwhile, the removal of trampling pressure from stands of this very rare community wherever possible would be good management. The relatively high number of species of restricted occurrence in this community makes it a high priority for protection.

No. quadrats 31; Taxa / quadrat 17.0 ± 0.8; Total native taxa 84; Weeds /quadrat 0.0 ± 0.0; Total weed taxa 1

Altitude: 1600 – 1900 – 2200 m.

Diagnostic Taxa: Shrubs *Epacris glacialis* (52); **Herbs** *Oreobolus pumilio* (81), *Caltha introloba* (74), *Carex gaudichaudiana* (74), *Drosera arcturi* (74), *Brachyscome stolonifera* (65), *Poa costiniana* (61), *Rytidosperma nivicola* (61), *Oreomyrrhis pulvinifica* (55), *Diplaspis nivis* (48), *Luzula atrata* (48), *Carpha nivicola* (45), *Schoenus calyptratus* (38), *Myriophyllum pedunculatum* (35), *Oreobolus distichus* (35), *Plantago muelleri* (35), *Deyeuxia affinis* (32), *Carpha alpina* (29), *Parantennaria uniceps* (29), *Plantago glacialis* (29), *Deschampsia caespitosa* (26), *Gentianella muelleriana* subsp. *alpestris* (23), *Isolepis crassiuscula* (23), *Carex hypandra* (19), *Euphrasia collina* subsp. *glacialis* (19), *Craspedia alba* (16), *Dichosciadium ranunculaceum* (13), *Rytidosperma australe* (6)

Significant Taxa: *Deyeuxia affinis*

Weeds: *Agrostis capillaris* (3)

Community 11: Celmisia sericophylla herbfield

Equivalent communities: *Celmisia sericophylla* herbland, Unit 11 (McDougall 1982).

Community 11 occurs in spring-fed drainage lines of steep east to south facing slopes within Community 17, around waterfalls and beside creeks. It is restricted to the area between Mt Hotham and Mt Bogong, where it is most commonly found on slopes of the higher peaks (e.g. Mt Hotham, Mt McKay, Mt Nelse, Spion Kopje and Mt Bogong). A single occurrence of *C. sericophylla* on the Snowy Range (some 60 km distant from the nearest population and unsampled in this study) is in similar habitat and represents a depauperate isolated example. *Celmisia sericophylla* commonly forms dense stands amongst rock in flowing water. *Caltha introloba* may also be abundant but other species tend to be scattered and rare. Other frequent species are generally interlopers from adjacent heaths, grasslands or bogs (e.g. *Acaena novae-zelandiae, Carex gaudichaudiana*, *Isolepis aucklandica, Poa costiniana, Richea continentis*). Many examples of this community were severely burnt during the fires of early 2003 and recovery of these has been patchy. It will be several years before it is known if they regenerate to the original community. If they do not, it is possible that up to 50% of the known area of this very restricted community will have been lost or severely modified by these fires. Some of the few examples of the community near Mt Hotham were damaged by ski slope developments in the 1980s. Generally though, owing to the often steep and rocky terrain in which the community occurs, examples are relatively intact. Localised trampling damage may occur from sightseers visiting the last snow, although the threat is probably small at present. Some patches are within the ski resorts of Falls Creek and Mt Hotham and may face future pressures from skiing development.

No. quadrats 5; Native taxa / quadrat 13.0 ± 2.4; Total native taxa 34; Weeds /quadrat 0.6 ± 0.3; Total weed taxa 2

Altitude: 1560 – 1735 – 1820 m.

Diagnostic Taxa: Shrubs *Richea continentis* (80); **Herbs** *Celmisia sericophylla* (100), *Isolepis aucklandica* (100), *Acaena novae-zelandiae* (80), *Agrostis parviflora* (80), *Carex gaudichaudiana* (80), *Caltha introloba* (60), *Luzula acutifolia* subsp. *acutifolia* (60), *Deyeuxia affinis* (40)

Other Common Taxa: *Poa costiniana* (60)

Significant Taxa: *Deyeuxia affinis*

Weeds: *Acetosella vulgaris* (40), *Hypochaeris radicata* (20)

Group IV – snowpatch herbfields

Community 12: Coprosma niphophila – Colobanthus nivicola snowpatch feldmark

Equivalent communities: *Coprosma pumila – Colobanthus benthamianus* alliance (Costin 1954); *Coprosma pumila* association (McVean 1969); *Coprosma-Colobanthus* Feldmark (Costin et al. 2000).

This community is confined to the Kosciuszko Main Range. It occupies the upper parts of east- to south-facing slopes with the longest lasting snow (Fig. 9). Soils are shallow and largely bare. *Coprosma niphophila* may be locally dominant. Plant cover is sparse and diversity low. Plants have low stature and many have a mat or cushion habit. Snowpatch feldmark is extremely rare, occupying a total area of only a few ha in about 10 stands. There are few immediate threats although a decrease in winter snowfall because of global warming may ultimately allow the invasion of species from adjoining communities. Because of the steep, unstable habitat, people are only likely to walk in this community during snow-melt, and then mostly on Mt Kosciuszko where the walking track skirts the snowpatch. However, this is when the community is probably most vulnerable to trampling. An assessment of the impact of trampling in this community (especially on Mt Kosciuszko) would be useful. If tramping were significant, temporary barriers might be erected during snowmelt.

No. quadrats 6; Native taxa / quadrat 15.0 ± 0.7; Total native taxa 29; Weeds /quadrat 0.5 ± 0.3; Total weed taxa 2

Altitude: 2050 – 2100 – 2200.

Diagnostic Taxa: Shrubs *Coprosma niphophila* (100); **Herbs** *Colobanthus nivicola* (100), *Epilobium tasmanicum* (100), *Neopaxia australasica* (100), *Poa fawcettiae* (100), *Agrostis muelleriana* (83), *Luzula acutifolia* subsp. *nana* (83), *Luzula australasica* subsp. *dura* (83), *Senecio pinnatifolius* var. *alpinus* (83), *Euphrasia collina* subsp. *diversicolor* (67), *Ewartia nubigena* (67), *Ranunculus muelleri* (67), *Carex cephalotes* (50), *Argyrotegium mackayi* (50), *Isolepis montivaga* (50), *Ranunculus anemoneus* (50), *Erigeron setosus* (33)

Significant Taxa: *Ranunculus anemoneus*

Weeds: *Acetosella vulgaris* (33), *Hypochaeris radicata* (17)

Community 13: *Neopaxia australasica – Ranunculus niphophilus* snowpatch herbfield

Equivalent communities: part of *Plantago muelleri – Montia australasica* alliance (Costin 1954); *Plantago muelleri – Conostomum curvirostre* association (McVean 1969).

This is a variable community occurring at the base of high elevation snowpatches (usually adjoining Community 17) (Fig. 10), and copiously irrigated during the extended period of snowmelt. It is apparently confined to Kosciuszko National Park, although there are small areas at the base of the Mt Nelse snowpatch on the Bogong High Plains with floristic affinities. The community is often dominated by *Neopaxia australasica* but *Poa costiniana*, *Carex hypandra, Plantago muelleri* and *Ranunculus niphophilus* may be locally abundant. Trampling of this community by sightseers might occur during snowmelt but we saw no significant damage of this nature during our survey.

No. quadrats 8; Native taxa / quadrat 14.0 ± 1.9; Total native taxa 54; Weeds /quadrat 0.4 ± 0.3; Total weed taxa 2

Altitude: 1920 – 2070 – 2170 m.

Diagnostic Taxa: Herbs *Poa costiniana* (100), *Carex cephalotes* (63), *Neopaxia australasica* (63), *Carex hypandra* (50), *Plantago muelleri* (50), *Polystichum proliferum* (50), *Ranunculus anemoneus* (50), *Ranunculus niphophilus* (50), *Agrostis muelleriana* (38), *Blechnum penna-marina* subsp. *alpina* (38), *Brachyscome nivalis* (38), *Epilobium tasmanicum* (38), *Luzula acutifolia* subsp. *nana* (38), *Oreomyrrhis pulvinifica* (38), *Plantago glacialis* (38), *Cardamine robusta* (25), *Carex canescens* (25)

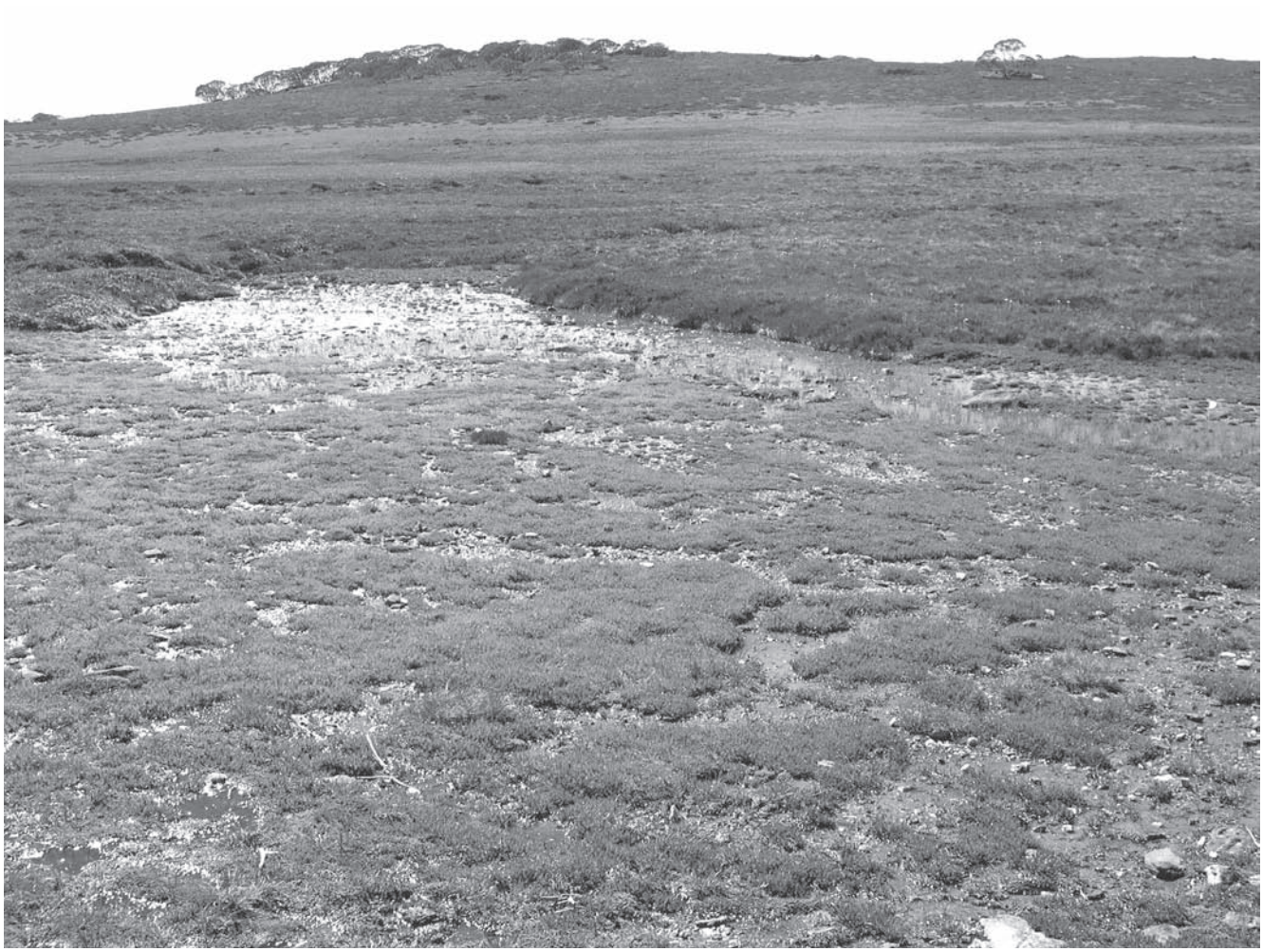

Fig. 8. Short alpine herbfield (Community 10) in Cope Creek, Bogong High Plains. The community occupies wet, gravelly pavements, often at the base of snowpatches. The dominant in the photo is *Oreobolus pumilio*. The low heathland in the background is *Epacris* moist heathland (Community 4).

Significant Taxa: *Ranunculus anemoneus*

Weeds: *Acetosella vulgaris* (25)*, Hypochaeris radicata* (13)

Group V – subalpine valley & fertile grasslands

Community 14: Subalpine valley grassland

Equivalent communities: part of *Poa caespitosa – Danthonia nudiflora* alliance (Costin 1954); Damp alpine heathland, subcommunity 10.3 (Walsh et al. 1984); Group 10 (Helman et al. 1988).

This community is common from Bimberi, Brindabella and Scabby Ranges (ACT) through lower altitude plains within Kosciuszko National Park (Kiandra and Tantangara areas, Mt Selwyn, Tooma/Tumut Divide, Cooleman Plain, Happy Jacks Plain, Currango Plain), but is confined to the more easterly ranges in Victoria (e.g. Mt Wombargo-Cobberas area, Nunniong Plateau, Davies Plain, Dinner Plain). It is a grassland or occasionally open heathland confined to broad valley floors and seepage areas on gentle slopes (Fig. 11). Dominant species vary between localities, but common components include the shrubs *Epacris breviflora*, *E. gunnii*, *Hakea microcarpa* and herbaceous species such as *Austrofestuca hookeriana*, *Baloskion australe*, *Carex gaudichaudiana*, *Empodisma minus*, *Poa costiniana* (the usual dominant) and *Stylidium montanum*. Soils are typically sodden humified peats. Some sites in NSW (Kiandra area) and Victoria (near Mt Wombargo) are subject to excavation by feral pigs, causing these sites to dry and making them vulnerable to weed invasion. Cattle grazing occurred until recently on most sites supporting this community on the Nunniong Plateau and Davies Plain in Victoria. Both these factors are reflected in the relatively high weed diversity.

No. quadrats 70; Native taxa / quadrat 25.9 ± 1.1; Total native taxa 251; Weeds /quadrat 2.1 ± 0.2; Total weed taxa 20

Altitude: 1020 – 1355 – 1680 m.

Diagnostic Taxa: Shrubs *Epacris gunnii* (43), *Epacris breviflora* (40), *Hakea microcarpa* (39), *Baeckea utilis* (20), *Leptospermum myrtifolium* (7), *Leucopogon pilifer* (7); **Herbs** *Poa costiniana* (76), *Empodisma minus* (66), *Baloskion australe* (64), *Luzula modesta* (61), *Carex gaudichaudiana* (59), *Austrofestuca hookeriana* (56), *Gonocarpus micranthus* (51), *Hypericum japonicum* (51), *Oreomyrrhis ciliata* (50), *Craspedia* spp. (*crocata*, *aurantia*) (49), *Stylidium* spp. (46), *Brachyscome scapigera* (39), *Epilobium gunnianum* (37), *Cotula alpina* (36), *Epilobium billardierianum* (34), *Ranunculus pimpinellifolius* (34), *Stellaria angustifolia* (31), *Hydrocotyle algida* (30), *Hypoxis hygrometrica* (30), *Schoenus apogon* (26), *Wahlenbergia ceracea* (26), *Arthropodium milleflorum* (23), *Hydrocotyle sibthorpioides* (23), *Senecio gunnii* (23), *Velleia montana* (23), *Brachyscome obovata* (20), *Ranunculus collinus* (20), *Juncus falcatus* (19), *Poa clivicola*

Fig. 9. The steep east-facing slope between Mt Lee and Northcote Pass (Kosciuszko Main Range) supports Community 12 (the upper, bare, rocky portions) and Community 17 (dominated by *Celmisia costiniana* in the upper portions and *Poa fawcettiae* below).

(19), *Carex blakei* (17), *Austrodanthonia laevis* (16), *Cardamine astoniae* (14), *Dichelachne micrantha* (14), *Isolepis crassiuscula* (14), *Neopaxia australasica* (14), *Plantago varia* (14), *Ranunculus millanii* (14), *Utricularia monanthos* (14), *Agrostis hiemalis sens. lat.* (13), *Carex jackiana* (13), *Comesperma retusum* (13), *Asperula pusilla* (11), *Deyeuxia gunniana* (11), *Euchiton involucratus* (11), *Oreobolus oxycarpus* (11), *Oschatzia cuneifolia* (11), *Poa labillardierei* (11), *Viola fuscoviolacea* (11), *Lachnagrostis aemula* (10), *Ranunculus lappaceus* (10), *Euphrasia caudata* (9), *Deyeuxia innominata* (7), *Juncus brevibracteus* (7), *Juncus phaeanthus* (7),

Other Common Taxa: *Asperula gunnii* (63)

Significant Taxa: *Dillwynia palustris, Xerochrysum palustre*

Weeds: *Trifolium repens* (36), *Hypochaeris radicata* (31), *Taraxacum officinale* (23), *Acetosella vulgaris* (19), *Holcus lanatus* (17), *Anthoxanthum odoratum* (9), *Myosotis caespitosa* (9), *Cerastium vulgare* (7), *Trifolium dubium* (6), *Cerastium glomeratum* (3), *Crepis capillaris* (3), *Achillea millefolium* (1), *Agrostis capillaris* (1), *Centaurium erythraea* (1), *Cirsium vulgare* (1), *Mimulus moschatus* (1), *Prunella vulgaris* (1), *Salix cinerea* (1), *Salix* x *rubens* (1), *Verbascum thapsus* (1)

Community 15: Snowy Range Grassland

Equivalent communities: Alpine grassland, subcommunities 7.1 & 7.2 (Walsh et al. 1984).

This community is characteristic of plains on the Snowy Range between Mt Wellington and Mt Howitt, with isolated occurrences on Mt Stirling, Mt Buffalo and near The Bluff. It is a tussock grassland to open heathland of broad concave plains, usually surrounded by *Eucalyptus pauciflora* woodlands and presumably treeless from the frost hollow effect. Topographically higher examples tend to contain a larger proportion of shrubby species indicating the ecological link of this community between dry heaths (typically dominated by *Hovea montana* and/or *Leucopogon hookeri*) and wet heaths (with *Epacris breviflora*, *E. celata* dominant) or bogs along the valley floor. Dominant grasses are *Poa costiniana*, *Poa fawcettiae*, with sedges *Carex gaudichaudiana* and *Carex breviculmis* and rushes *Empodisma minus* and *Luzula modesta* usually present. A variety of forbs is common (e.g. *Ranunculus* spp., *Brachyscome decipiens*, *Hypericum japonicum*, *Gonocarpus micranthus*). Many sites supporting this community on the southern part of the Snowy Range were severely burnt by wildfire in 1998. Prior to then cattle grazing had occurred through most of the area. Recovery of these sites has proceeded well to the extent that vegetated

Fig. 10. Community 13 (*Neopaxia australasica – Ranunculus niphophilus* snowpatch herbfield) is found at the bases of persistent snowpacks – this example on the east face of Mt Townsend. Plants receive abundant water from snowmelt for most of the growing season.

cover, structure and composition of at least dominant species now approaches that of pre-fire condition. The Mt Buffalo site at Hospice Plain was burnt in the 2003 wildfires and recovery of this nearly pure grassland is proceeding well with most species recorded pre-fire having reappeared by February 2005.

No. quadrats 32; Native taxa / quadrat 27.7 ± 1.0; Total native taxa 136; Weeds /quadrat 2.1 ± 0.3; Total weed taxa 11

Altitude: 1260 – 1525 – 1760 m.

Diagnostic Taxa: Shrubs *Hovea montana* (47), *Pultenaea tenella* (34), *Epacris breviflora* (28); **Herbs** *Ranunculus graniticola* (97), *Asperula gunnii* (88), *Carex breviculmis* (84), *Brachyscome decipiens* (81), *Viola betonicifolia* (78), *Cotula alpina* (72), *Poa fawcettiae* (72), *Microseris* sp. 2 (69), *Scleranthus biflorus* (66), *Empodisma minus* (63), *Luzula modesta* (59), *Carex gaudichaudiana* (56), *Celmisia* spp. (56), *Leptorhynchos squamatus* subsp. *alpinus* (56), *Ajuga australis* (53), *Plantago antarctica* (47), *Brachyscome scapigera* (44), *Ranunculus gunnianus* (44), *Gonocarpus micranthus* (41), *Stackhousia pulvinaris* (38), *Hypericum japonicum* (34), *Prasophyllum* spp. (34), *Trachymene humilis* (34), *Agrostis hiemalis* sens. lat. (31), *Agrostis venusta* (31), *Gentianella muelleriana* subsp. *willisiana* (28), *Schoenus calyptratus* (28), *Luzula flaccida* (25), *Velleia montana* (25), *Caesia alpina* (22), *Argyrotegium mackayi* (22), *Euchiton traversii* (22), *Viola fuscoviolacea* (22), *Ophioglossum lusitanicum* (13)

Other Common Taxa: *Craspedia* spp. (66), *Poa costiniana* (53), *Oreomyrrhis eriopoda* (41), *Pimelea alpina* (41), *Rytidosperma nudiflorum* (41)

Weeds: *Acetosella vulgaris* (50), *Trifolium repens* (44), *Cerastium vulgare* (28), *Hypochaeris radicata* (25), *Taraxacum officinale* (19), *Aphanes arvensis* (16), *Poa pratensis* (9), *Trifolium dubium* (6), *Veronica arvensis* (6), *Achillea millefolium* (3), *Cerastium glomeratum* (1)

Community 16: Victorian subalpine basalt grassland

Equivalent communities: Subalpine grassland, Unit 9 (McDougall 1982); Alpine grassland, subcommunity 7.3 (Walsh et al. 1984).

A grassland usually on soils derived from basalt which imparts to the soil high water retention properties indicated by the presence of a number of species characteristic of bogs and bog margins not usually encountered in grasslands (e.g. *Hypericum japonicum, Carex gaudichaudiana, Epilobium curtisiae, Velleia montana*). Examples of this community may be extensive, occupying many continuous hectares (e.g. Dargo High Plains, Nunniong Plataeu, Bennison High Plains, Dinner Plains). Virtually all sites were grazed by stock prior to cessation of licensed grazing in 2005. Some are on enclaves of private land within the Alpine National Park and will continue to be grazed. The grazing history is probably responsible for the relatively high weed diversity. Local severe trampling damage is evident at Lankeys Plain and there is considerable vehicle-based recreational use around Gow Plain where some of the most extensive stands of the threatened sedge *Carex paupera* occur. The weeds *Viola arvensis* and *Potentilla recta* are largely confined to this community in the Victorian high country, probably escaped from gardens in adjacent freehold land. A program to halt their progress in Victoria is warranted.

No. quadrats 36; Native taxa / quadrat 25.3 ± 1.1; Total native taxa 149; Weeds /quadrat 4.9 ± 0.3; Total weed taxa 21

Altitude: 1200 – 1465 – 1620 m.

Diagnostic Taxa: Herbs *Poa hiemata* (86), *Epilobium billardierianum* (69), *Luzula modesta* (69), *Oreomyrrhis eriopoda* (64), *Hypericum japonicum* (61), *Brachyscome scapigera* (58), *Cotula alpina* (58), *Scleranthus biflorus* (58), *Brachyscome decipiens* (56), *Geranium antrorsum* (53), *Austrodanthonia pilosa* (50), *Carex gaudichaudiana* (50), *Craspedia* spp. (50), *Carex hebes* (44), *Ajuga australis* (42), *Dichondra repens* (42), *Diuris monticola* (42), *Ophioglossum lusitanicum* (42), *Oxalis exilis* (42), *Argyrotegium mackayi* (39), *Ranunculus eichlerianus* (39), *Gonocarpus micranthus* (33), *Prasophyllum* spp. (33), *Acaena ovina* (28), *Carex appressa* (28), *Velleia montana* (28), *Ranunculus lappaceus* (25), *Euchiton collinus* (22), *Plantago antarctica* (22), *Solenogyne* spp. (22), *Asperula scoparia* (17), *Caesia alpina* (17), *Deyeuxia crassiuscula* (17), *Epilobium curtisiae* (17), *Juncus australis* (17), *Plantago varia* (17), *Agrostis australiensis* (14), *Agrostis muelleriana* (14), *Carex inversa* (13), *Agrostis aemula* (11), *Epilobium hirtigerum* (11), *Myosotis australis* (11)

Other Common Taxa: *Carex breviculmis* (69), *Asperula gunnii* (50), *Poa costiniana* (44), *Viola betonicifolia* (42), *Ranunculus graniticola* (40)

Significant Taxa: *Carex paupera, Wahlenbergia densifolia*

Weeds: *Trifolium repens* (97), *Acetosella vulgaris* (69), *Cerastium glomeratum* (44), *Hypochaeris radicata* (42), *Taraxacum officinale* (42), *Aphanes arvensis* (25), *Cerastium vulgare* (25), *Poa pratensis* (22), *Phleum pratense* (14), *Trifolium dubium* (8), *Veronica peregrina* (8), *Viola arvensis* (8), *Vulpia bromoides* (8), *Cirsium vulgare* (6), *Veronica arvensis* (6), *Myosotis discolor* (4), *Agrostis capillaris* (3), *Holcus lanatus* (3), *Lotus corniculatus* (3), *Medicago* spp. (3), *Potentilla recta* (3)

Group VI – closed alpine grasslands

Community 17: *Poa fawcettiae – Celmisia costiniana* snowpatch grassland

Equivalent communities: part of *Celmisia longifolia – Poa caespitosa* alliance (Costin 1954); *Celmisia longifolia* association (McVean 1969); Diuturnal snowpatch, Unit 6 (McDougall 1982).

In New South Wales this community is largely restricted to the Kosciuszko Main Range and a few of the higher peaks elsewhere in Kosciuszko National Park (e.g. Mt Jagungal, Dicky Cooper Bogong). In Victoria, it is confined to the higher parts of the Bogong High Plains (Mt Bogong, Mt Nelse, Spion Kopje), Mt Hotham and Mt Feathertop. This grassland or open-herbfield community is characteristic of sheltered sites that accumulate snow during winter and retain snow often until mid or late summer. Typically sites are steep, often ± concave and of south-easterly aspect (Fig. 9). The growing season is short due to the relatively brief exposure to sun, and the number of species able to flourish in these conditions is relatively low. Plants in this community require adaptations to survive the potentially erosive forces of melting snow on steep slopes and to best utilise the shortened period of insolation – consequently rhizomatous and rosetted perennials dominate (e.g. *Carex hebes*, *C. breviculmis*, *Celmisia costiniana*, *Argyrotegium* spp.). The tough-leaved grasses *Poa fawcettiae* and *Rytidosperma nudiflorum* are particularly abundant. The steepness of these sites, and the volume of water irrigating them during thaw of the snow pack renders them susceptible to soil loss following disruption of the vegetated cover. The evidence of damage from cattle tramping is still obvious in many stands on the Bogong High Plains. Localised, minor trampling damage probably still occurs as a result of people visiting snowpatches in summer as the last snow melts. At this time, the soils are still saturated and vulnerable to trampling.

No. quadrats 28; Native taxa / quadrat 11.4 ± 1.0; Total native taxa 85; Weeds /quadrat 0.8 ± 0.1; Total weed taxa 2

Altitude: 1710 – 1880 – 2160 m.

Diagnostic Taxa: Herbs *Poa fawcettiae* (100), *Carex hebes* (93), *Celmisia costiniana* (75), *Rytidosperma nudiflorum* (57), *Erigeron nitidus* (32), *Argyrotegium mackayi* (32), *Euphrasia collina* subsp. *diversicolor* (21), *Ewartia nubigena* (21)

Other Common Taxa: *Carex breviculmis* (43)

Significant Taxa: *Argyrotegium nitidulum*, *Ranunculus anemoneus*

Weeds: *Acetosella vulgaris* (64), *Hypochaeris radicata* (11)

Community 18: *Poa fawcettiae – Uncinia sulcata* grassland

Equivalent communities: part of *Celmisia longifolia – Poa caespitosa* alliance (Costin 1954); Part of the Tall Alpine Herbfield of Costin et al. (2000).

Community 18 is a dense grassland with low species diversity, which occurs on shallow soil interspersed with large granite tors. It is locally common on mountain tops of the Main Range between Mt Townsend and Mt Twynam, and further north on Mt Jagungal. The community is dominated by *Poa fawcettiae*, which often has a cover close to 100% but species such as *Uncinia sulcata* and *Poa saxicola* may be locally abundant. It is floristically similar to Community 17 and often intergrades with it on the eastern side of ridges and summits. It can be distinguished by its position in the landscape (not occurring under late-lying snowpacks) and less cover of common snowpatch species such as *Carex hebes* and *Rytidosperma nudiflorum*. Small examples of Community 22, often dominated by *Pentachondra pumila*, may occur within Community 18.

No. quadrats 7; Native taxa / quadrat 11.3 ± 1.5; Total native taxa 31; Weeds /quadrat 0.1; Total weed taxa 1

Altitude: 1970 – 2090 – 2200 m.

Diagnostic Taxa: Herbs *Carex hebes* (100), *Poa fawcettiae* (100), *Rytidosperma nudiflorum* (86), *Craspedia costiniana* (71), *Senecio pinnatifolius* var. *alpinus* (71), *Uncinia sulcata* (71), *Poa saxicola* (57)

Other Common Taxa: *Carex breviculmis* (86), *Microseris* sp. 2 (57), *Lycopodium fastigiatum* (43)

Weeds: *Acetosella vulgaris* (14)

Community 19: *Chionochloa frigida* grassland

Equivalent communities: part of *Celmisia longifolia – Poa caespitosa* alliance (Costin 1954); *Danthonia frigida* association (McVean 1969); part of the Tall Alpine Herbfield of Costin et al. (2000).

Community 19 is a grassland with a sparse to dense cover of the tall grass *Chionochloa frigida*. *Poa fawcettiae* may be locally dominant. This community is found on steep slopes with shallow soil at high altitudes on the Main Range of Kosciuszko National Park, from Ramshead Range to Dicky Cooper Bogong. It is especially well-developed on the south- to west-facing slopes of Lake Albina and Carruthers Peak. The community is well protected and under no obvious threat at present. The usual dominant, *Chionochloa frigida*, has apparently expanded its range greatly since the cessation of grazing by domestic animals (Costin et al. 2000).

No. quadrats 12; Native taxa / quadrat 16.8 ± 1.3; Total native taxa 88; Weeds /quadrat 0.6 ± 0.1; Total weed taxa 3

Altitude: 1780 – 1940 – 2110 m.

Diagnostic Taxa: Shrubs *Pimelea alpina* (67); **Herbs** *Chionochloa frigida* (83), *Poa fawcettiae* (83), *Aciphylla glacialis* (58), *Lycopodium fastigiatum* (58), *Carex hebes* (50), *Celmisia costiniana* (50), *Ranunculus anemoneus* (50), *Gonocarpus montanus* (42), *Helichrysum scorpioides* (42), *Polystichum proliferum* (42), *Schizeilema fragoseum* (25)

Other Common Taxa: *Viola betonicifolia* (58), *Carex breviculmis* (50), *Microseris* sp. 2 (42), *Oreomyrrhis eriopoda* (42), *Rytidosperma nudiflorum* (42)

Significant Taxa: *Ranunculus anemoneus*

Weeds: *Acetosella vulgaris* (42), *Hypochaeris radicata* (8), *Taraxacum officinale* (8)

Group VII – high altitude grasslands & open heathlands

Community 20: Short turf snowpatch grassland

Equivalent communities: Short turf snowpatch, Unit 5D (McDougall 1982).

Short turf snowpatch grassland is restricted to the Bogong High Plains, where it occurs on sheltered, east to south-facing slopes where snow usually persists until late spring. Although mostly found below the upper treeline, small patches may be found in alpine areas within Community 17 (e.g. Mt Nelse). Short turf snowpatch grassland is characterised by the scarcity of tussocks grasses and shrubs, the low stature of the dominant herbs present (usually *Carex hebes, Poa hothamensis* and *Rytidosperma nudiflorum*) and a carpet of mosses (mostly *Polytrichum* spp.) in the gaps between the herbs (Fig. 12). *Trachymene humilis* subsp. *brevicaule* and *Argyrotegium* spp. (*A. fordianum*, *A. mackayi, A. nitidulum*) sometimes form large mats within the turf. Most stands are small (usually only a few 100 m^2). Many contain young plants of *Grevillea australis* and *Phebalium squamulosum*, species favoured by the occurrence of bare ground (Wahren et al. 2001). A change from subalpine snowpatch grassland to open heathland (Community 26) seems to be occurring in some cases, probably initiated by past grazing by cattle, which was particularly intense in this community. This transition may also be a consequence of recent elevated temperatures leading to shorter persistence of the snow pack

No. quadrats 13; Native taxa / quadrat 17.4 ± 1.5; Total native taxa 58; Weeds /quadrat 2.1 ± 0.2; Total weed taxa 5

Altitude: 1670 – 1755 – 1850 m.

Fig. 11. Community 14. (Subalpine valley grassland) occupies subalpine valley floors throughout the northern portion of the Australian Alps. It is often dominated by large tussocks of *Poa costiniana* (as in this example at Rocky Plains near Kiandra), although shrubs such as *Epacris breviflora* and *E. gunnii* may be frequent or co-dominant. The example shown was thoroughly burnt in the 2003 fires. Twelve months later (as shown) most species had regenerated and cover of the dominant was approaching pre-fire levels.

Diagnostic Taxa: Shrubs *Olearia frostii* (54), *Pimelea axiflora* subsp. *alpina* (54); **Herbs** *Carex hebes* (100), *Acaena novae–zelandiae* (92), *Poa hothamensis* (92), *Oreomyrrhis eriopoda* (85), *Rytidosperma nudiflorum* (85), *Viola betonicifolia* (85), *Plantago euryphylla* (77), *Scleranthus biflorus* (62), *Argyrotegium fordianum* (46), *Leptinella filicula* (38), *Trachymene humilis* subsp. *brevicaule* (23)

Other Common Taxa: *Celmisia* spp. (69), *Asperula gunnii* (54), *Luzula* spp. (54), *Microseris* sp. 2 (54)

Significant Taxa: *Argyrotegium nitidulum*

Weeds: *Acetosella vulgaris* (100), *Hypochaeris radicata* (77), *Trifolium repens* (16), *Agrostis capillaris* (8), *Cerastium vulgare* (8)

Community 21: Bogong High Plains *Hovea montana* heathland

Equivalent communities: Hovea basaltic heathland, Unit 3B (McDougall 1982).

Low heathland dominated by *Hovea montana* on the Bogong High Plains is common on lee slopes on the basalt country west of Pretty Valley and in the Hotham area. It is also prominent in the vicinity of Mt Fainter, where it has been dissected by numerous cattle tracks. This community is characterised by the dominance of *Hovea montana* and the rarity of the shrubs and tussock grasses of most dry communities elsewhere on the Bogong High Plains. Herb cover is variable, perhaps depending on the cover of *Hovea montana*. The large stands on Mt Fainter, which have been severely damaged by trampling of cattle, occur on lee slopes where snow persists in spring. It seems likely that these and perhaps other examples were once Community 20.

No. quadrats 10; Native taxa / quadrat 21.4 ± 1.5; Total native taxa 63; Weeds /quadrat 1.8 ± 0.3; Total weed taxa 4

Altitude: 1680 – 1755 – 1840 m.

Diagnostic Taxa: Shrubs *Hovea montana* (100), *Melicytus* sp. aff. *dentatus* (50), *Olearia brevipedunculata* (50), *Olearia frostii* (40); **Herbs** *Carex breviculmis* (100), *Viola betonicifolia* (100), *Asperula gunnii* (90), *Poa hothamensis* (90), *Acaena novae–zelandiae* (70), *Brachyscome decipiens* (70), *Oreomyrrhis eriopoda* (70), *Scleranthus biflorus* (70), *Carex hebes* (60), *Ranunculus victoriensis* (60), *Plantago euryphylla* (50), *Poa hiemata* (50), *Brachyscome rigidula* (40), *Asperula pusilla* (30)

Other Common Taxa: *Microseris* sp. 2 (70), *Poa costiniana* (60), *Rytidosperma nudiflorum* (60), *Celmisia* spp. (50), *Leucopogon* spp. (*hookeri, montanus*) (50)

Weeds: *Acetosella vulgaris* (70), *Hypochaeris radicata* (40), *Cerastium glomeratum* (10), *Taraxacum officinale* (10)

Community 22: *Poa fawcettiae – Euphrasia collina* grassland

Equivalent communities: part of *Celmisia longifolia – Poa caespitosa* alliance (Costin 1954); Part of the *Celmisia–Poa* tall alpine herbfield (Costin et al. 2000).

This grassland occurs on sites of low relief with deep soils (e.g. saddles and stream heads) between the Main Range and Mt Jagungal in Kosciuszko National Park. It is generally dominated by *Poa fawcettiae*, although *P. hiemata* and *Pentachondra pumila* may be locally dominant. Species diversity is usually high (compared with other communities at similar elevation). The community is distinguished from other grasslands on the Main Range included in the *Celmisia – Poa* tall alpine herbfield of Costin et al. (2000) by inter-tussock spaces, which contain a large range of herbaceous species. Tall shrubs are rare, although cycles of shrub and grass dominance (as described by Williams (1992) for similar communities on the Bogong High Plains) may be occurring as Community 22 is floristically similar to Community 23 (an open heathland), with which it occurs. Examples of this community occur in ski resorts and may be affected by development. The largest patches can be found in the headwaters of the Snowy River, where they are well protected and not under threat.

No. quadrats 30; Native taxa / quadrat 20.1 ± 0.8; Total native taxa 95; Weeds /quadrat 0.9 ± 0.1; Total weed taxa 4

Altitude: 1740 – 1985 – 2190 m.

Diagnostic Taxa: Shrubs *Pimelea alpina* (60), *Leucopogon montanus* (50), *Pentachondra pumila* (47); **Herbs** *Craspedia* spp. (*aurantia, costiniana, maxgrayi*) (100), *Celmisia* spp. (*costiniana, pugioniformis*) (97), *Carex breviculmis* (90), *Poa fawcettiae* (87), *Rytidosperma nudiflorum* (87), *Oreomyrrhis eriopoda* (70), *Microseris* sp. 2 (67), *Prasophyllum* spp. (67), *Euphrasia collina* subsp. *diversicolor* (63), *Senecio pinnatifolius* var. *alpinus* (63), *Trisetum spicatum* (57), *Viola betonicifolia* (50), *Gentianella muelleriana* subsp. *alpestris* (43), *Aciphylla glacialis* (40), *Erigeron nitidus* (30), *Luzula alpestris* (30), *Poa saxicola* (30), *Argyrotegium fordianum* (27), *Argyrotegium mackayi* (23), *Australopyron velutinum* (20), *Deyeuxia carinata* (17), *Argyrotegium nitidulum* (10)

Significant Taxa: *Argyrotegium nitidulum*

Weeds: *Acetosella vulgaris* (63), *Hypochaeris radicata* (17), *Agrostis capillaris* (3), *Festuca rubra* (3)

Community 23: *Grevillea australis – Nematolepis ovatifolia* open heathland

Equivalent communities: part of Heath Formation (Costin et al. 2000).

This community is scattered and common on the dry slopes of the Main Range between Dead Horse Gap (near Thredbo) and Mt Jagungal. It occurs on less exposed sites with deeper soil profiles than Community 46 but may intergrade with it. Floristically, it appears to be intermediate between Communities 22 and 46. Community 23 is usually dominated by low shrubs of *Grevillea australis* and *Nematolepis ovatifolia* but other shrubs such as *Hovea montana, Kunzea muelleri* and *Oxylobium ellipticum* may be locally abundant. Shrub cover is often sparse but even where it is almost complete the cover and diversity of herbs is high. The ground layer is usually dominated by *Poa hiemata* but *P. fawcettiae* may also be abundant. Some examples are threatened by skiing development and localised trampling by tourists. The community overall is, however, perhaps the most common type of vegetation on the Main Range and is not considered under threat.

No. quadrats 18; Native taxa / quadrat 22.8 ± 1.4; Total native taxa 98; Weeds /quadrat 0.8 ± 0.1; Total weed taxa 2

Altitude: 1600 – 1835 – 2030 m.

Diagnostic Taxa: Shrubs *Grevillea australis* (72), *Pimelea alpina* (67), *Nematolepis ovatifolia* (61), *Oxylobium ellipticum* (33); **Herbs** *Carex breviculmis* (94), *Celmisia* spp. (*costiniana, pugioniformis*) (89), *Craspedia* spp. (*aurantia, jamesii*) (89), *Poa hiemata* (72), *Oreomyrrhis eriopoda* (67), *Rytidosperma nudiflorum* (56), *Aciphylla simplicifolia* (44), *Lycopodium fastigiatum* (39)

Other Common Taxa: *Microseris* sp. 2 (61), *Ranunculus graniticola* (50), *Asperula gunnii* (44), *Scleranthus biflorus* (44)

Significant Taxa: *Argyrotegium nitidulum*

Weeds: *Acetosella vulgaris* (56), *Hypochaeris radicata* (22)

Community 24: Bogong High Plains *Poa costiniana* grassland

Equivalent communities: *Poa costiniana* tussock grassland, Unit 5A (McDougall 1982).

Grassland dominated by *Poa costiniana* is common in areas underlain by basalt on the Bogong High Plains (e.g. Basalt Hill, Mt Jim, Mt Loch) and is occasional on other strata (e.g. on soils overlying gneiss and schist in the upper Cope Creek catchment). The community is characterised by the dominance of *Poa costiniana* and scarcity of other species (especially shrubs), although diversity is relatively high for grasslands at this altitude. Weeds are generally more abundant in this grassland than in others on the Bogong High Plains. Community 24 usually contains shallow depressions (Community 6: *Lobelia surrepens – Ranunculus millanii* herbfield), the pools filling with water during snow melt and after heavy rain (Fig. 6). This community and Community 6 support the only Australian occurrences of *Kelleria laxa*, otherwise confined to New Zealand.

No. quadrats 23; Native taxa / quadrat 21.2 ± 1.2; Total native taxa 92; Weeds /quadrat 2.7 ± 0.3; Total weed taxa 8

Altitude: 1570 – 1730 – 1840 m.

Diagnostic Taxa: Shrubs *Melicytus* sp. aff. *dentatus* (48), *Exocarpos nanus* (26); **Herbs** *Poa costiniana* (100), *Carex breviculmis* (91), *Oreomyrrhis eriopoda* (87), *Microseris* sp. 2 (70), *Rytidosperma nudiflorum* (70), *Acaena novae–zelandiae* (61), *Plantago euryphylla* (57), *Poa hiemata* (57), *Brachyscome decipiens* (52), *Ranunculus victoriensis* (52), *Ajuga australis* (39), *Leptinella filicula* (39), *Colobanthus affinis* (35), *Epilobium billardierianum* (35), *Erigeron nitidus* (35), *Poa hothamensis* (35), *Cardamine lilacina* (30), *Scleranthus singuliflorus* (30), *Veronica serpyllifolia* (30), *Asperula pusilla* (26), *Isolepis montivaga* (26), *Ranunculus muelleri* (26)

Other Common Taxa: *Asperula gunnii* (57), *Viola betonicifolia* (52), *Scleranthus biflorus* (48)

Significant Taxa: *Kelleria laxa*

Weeds: *Acetosella vulgaris* (87), *Trifolium repens* (61), *Taraxacum officinale* (48), *Cerastium glomeratum* (30), *Hypochaeris radicata* (22), *Agrostis stolonifera* (9), *Veronica arvensis* (9), *Cerastium vulgare* (4)

Community 25: Bogong High Plains *Poa hiemata* grassland

Equivalent communities: *Poa hiemata* tussock grassland, Unit 5B & Tussock grassland / mat heathland, Unit 5C (McDougall 1982)

This is one of the most common communities on the Bogong High Plains. It is found from Mt Hotham to Mt Bogong in saddles, low ridges and valley heads with deep soils, mainly originating from metamorphic parent material (Fig. 13). The largest example is on the flat floor of Pretty Valley. Whilst species richness is comparable with Community 24, the abundance of most forbs is much greater in examples of Community 25 and the cover of *Poa* species is less. *Poa hiemata* is the usual dominant. In a few places (e.g. Pretty Valley and Mt Nelse), *Pentachondra pumila* is the dominant and *Poa hiemata* is rare or absent (and replaced as the most abundant grass by *Poa fawcettiae*). Whilst this variant was recognised as distinct by McDougall (1982), quadrats of this nature did not aggregate in the current study. Community 25 often occurs in a mosaic with Community 26 (open heathland). Cyclical changes between these two communities may occur (Williams 1992, McDougall 2003). The area covered by Community 25 declined in the Cope Creek area between 1936 and 1980 (McDougall 2003) and in the Watchbed Creek area between 1961 and 1994 (Bruce et al. 1999).

No. quadrats 77; Native taxa / quadrat 20.7 ± 0.6; Total native taxa 110; Weeds /quadrat 1.6 ± 0.1; Total weed taxa 7

Fig. 12. The short turf snowpatch grassland (Community 20) occurs on lee slopes of low relief on the Bogong High Plains – the example shown (in the background) is on Mt Cope. It is easily distinguished from other grasslands (such as Community 25 in the foreground) by the absence of tussock grass species.

Altitude: 1380 – 1690 – 1930 m.

Diagnostic Taxa: Shrubs *Pimelea alpina* (55), *Asterolasia trymalioides* (43), *Melicytus* sp. aff. *dentatus* (38), *Pentachondra pumila* (17); **Herbs** *Carex breviculmis* (95), *Poa hiemata* (84), *Asperula gunnii* (75), *Rytidosperma nudiflorum* (75), *Oreomyrrhis eriopoda* (74), *Scleranthus biflorus* (73), *Luzula modesta* (71), *Ranunculus victoriensis* (69), *Brachyscome decipiens* (66), *Senecio pinnatifolius* var. *alpinus* (64), *Craspedia* spp. (*coolaminica, jamesii*) (61), *Celmisia* spp. (*costiniana, pugioniformis*) (60), *Plantago euryphylla* (60), *Trisetum spicatum* (56), *Microseris* sp. 2 (53), *Leptorhynchos squamatus* subsp. *alpinus* (47), *Poa fawcettiae* (47), *Ajuga australis* (42), *Cardamine lilacina* (39), *Argyrotegium fordianum* (38), *Carex hebes* (36), *Scleranthus singuliflorus* (30), *Australopyron velutinum* (27), *Leptinella filicula* (27), *Colobanthus affinis* (25), *Prasophyllum* spp. (25), *Erigeron bellidioides* (22), *Erigeron nitidus* (21), *Geranium antrorsum* (21), *Agrostis venusta* (17), *Argyrotegium nitidulum* (8)

Other Common Taxa: *Poa costiniana* (40)

Significant Taxa: *Argyrotegium nitidulum*, *Euphrasia eichleri*

Weeds: *Acetosella vulgaris* (78), *Hypochaeris radicata* (34), *Cerastium glomeratum* (23), *Trifolium repens* (12), *Taraxacum officinale* (10), *Cerastium vulgare* (4), *Agrostis capillaris* (1)

Community 26: Bogong High Plains *Grevillea australis – Phebalium squamulosum* open heathland

Equivalent communities: Heathland/tussock grassland, Unit 3A & Grevillea scree heathland, Unit 3C (McDougall 1982).

This is the most common plant community on the Bogong High Plains, occurring on slopes, plains and some summits (e.g. Mt Bogong, Mt Hotham and Mt Feathertop) generally underlain by metamorphic or sedimentary material but extending into basaltic areas (Fig. 14). The community is dominated by *Grevillea australis* and / or *Phebalium squamulosum* subsp. *alpinum*, although low forms of *Orites lancifolia* are occasionally dominant in the northern part of its range (e.g. Mt Nelse). Grass cover (mostly *Poa hiemata* between shrubs and *P. hothamensis* under shrubs) is usually great and herb diversity is high. Community 26 intergrades with grassland (Community 25) on sites with deep soil profiles and with closed heathland (Community 47) on sites with shallow soil profiles. Cyclic processes of change between these communities probably occur (Williams 1992, McDougall 2003). Although some examples in ski resorts and along walking tracks will sustain damage from trampling or slashing, the community is widespread, well protected and under minimal threat. The significance of trampling will be greatest as the seedlings of *Grevillea australis*, an obligate seeder, attempt to re-establish after the 2003 fires.

No. quadrats 38; Native taxa / quadrat 23.4 ± 0.8; Total native taxa 100; Weeds /quadrat 1.5 ± 0.1; Total weed taxa 3

Altitude: 1560 – 1775 – 1960 m.

Diagnostic Taxa: Shrubs *Grevillea australis* (97), *Leucopogon* spp. (*hookeri, montanus*) (74), *Pimelea axiflora* subsp. *alpina* (53), *Asterolasia trymalioides* (50), *Olearia frostii* (50), *Phebalium squamulosum* subsp. *alpinum* (42), *Melicytus* sp. aff. *dentatus* (39), *Olearia brevipedunculata* (32), *Orites lancifolia* (24), *Exocarpos nanus* (13); **Herbs** *Carex breviculmis* (95), *Celmisia* spp. (89), *Craspedia* spp. (*coolaminica, jamesii*) (84), *Poa hothamensis* (82), *Oreomyrrhis eriopoda* (79), *Trisetum spicatum* (71), *Poa hiemata* (63), *Microseris* sp. 2 (55), *Scleranthus biflorus* (53), *Viola betonicifolia* (53), *Rytidosperma nudiflorum* (47), *Luzula modesta* (45), *Ranunculus victoriensis* (42), *Acaena novae–zelandiae* (39), *Brachyscome rigidula* (39), *Cardamine lilacina* (39), *Helichrysum rutidolepis* (37), *Brachyscome spathulata* (34), *Stellaria pungens* (34), *Scleranthus singuliflorus* (29), *Xerochrysum subundulatum* (26), *Euphrasia crassiuscula* (21), *Gonocarpus montanus* (21), *Goodenia hederacea* (18), *Ranunculus eichlerianus* (18)

Other Common Taxa: *Asperula gunnii* (71), *Leptorhynchos squamatus* subsp. *alpinus* (42)

Significant Taxa: *Euphrasia eichleri*

Weeds: *Acetosella vulgaris* (89), *Hypochaeris radicata* (47), *Cerastium glomeratum* (8)

Community 27: Bogong High Plains *Kunzea muelleri* open heathland

Equivalent communities: *Kunzea* heathland, Unit 4 (McDougall 1982).

This heathland is characterised by the dominance of *Kunzea muelleri*, a layering shrub usually less than 0.5 m tall in this community. It is found throughout the Bogong High Plains, often on sites with shallow soil. Species richness is generally lower than in other open heathlands of similar habitat. *Poa hiemata* is usually the dominant herb although its cover is variable, depending on the extent of *Kunzea muelleri*. In a grazing exclusion plot monitored over some decades (Wahren et al. 1994), *Kunzea* muelleri has spread into an area of Community 26 and become dominant. In the absence of disturbance it is possible that Community 27 expands into other communities. Although *Kunzea muelleri* was found to resprout following the 2003 fires, regeneration has been slow and many plants appear to have been killed. Periodic but rare fire probably limits the extent of this community. *Kunzea muelleri* stems are easily damaged by trampling and the paths of cattle and walkers are readily seen in many stands. Such damage is insubstantial because of the layering nature of the species. Protection from trampling damage will be important however while the species (and community) are recovering from the 2003 fires.

No. quadrats 29; Native taxa / quadrat 19.9 ± 0.6; Total native taxa 84; Weeds /quadrat 0.6 ± 0.1; Total weed taxa 4

Altitude: 1650 – 1790 – 1900 m.

Diagnostic taxa: Shrubs *Kunzea muelleri* (100), *Leucopogon* spp. (*hookeri, montanus*) (90), *Grevillea australis* (86), *Oreomyrrhis eriopoda* (62), *Pimelea alpina* (62), *Asterolasia trymalioides* (41), *Olearia frostii* (38), *Pimelea axiflora* subsp. *alpina* (24), *Podolobium alpestre* (21), *Ozothamnus alpinus* (17); **Herbs** *Asperula gunnii* (97), *Carex breviculmis* (93), *Celmisia* spp. (*costiniana, pugioniformis*) (90), *Craspedia* spp. (*coolaminica, jamesii*) (83), *Poa hiemata* (79), *Luzula modesta* (66), *Oreomyrrhis eriopoda* (62), *Brachyscome spathulata* (48), *Poa hothamensis* (48), *Senecio pinnatifolius* var. *alpinus* (45), *Erigeron nitidus* (41), *Brachyscome nivalis* (34), *Ranunculus victoriensis* (28), *Euphrasia crassiuscula* (17)

Other Common Taxa: *Leptorhynchos squamatus* subsp. *alpinus* (45)

Weeds: *Hypochaeris radicata* (28), *Acetosella vulgaris* (24), *Cerastium glomeratum* (3), *Taraxacum officinale* (3)

Community 28: Snowy Range open heathland

Equivalent communities: Alpine heathland, subcommunities 6.2 & 6.3 (Walsh et al. 1984).

Snowy Range open heathland is a grassy heathland community of sites of generally low relief, typically slopes falling gently to small watercourses. It occurs commonly on the Snowy Range between Mts Wellington and Howitt, but extends to the more isolated Mts Buller and Stirling areas. Soils may be basalt-derived, and, as in similar soils in the high country, of higher apparent fertility and water-holding capacity. Rock outcrops are common - the prostrate shrubs *Euryomyrtus ramosissima*, *Leucopogon fraseri* and *Pimelea alpina*

are often associated with shallow soils overlaying rock. These areas have a history of fairly intensive cattle grazing and the composition and structure may reflect this use (some examples have relatively high weed cover), but grazing has been withdrawn from most sites since 1992, and all sites since 2005. Although this is a locally common community with many examples in good condition, weed control in previously disturbed sites (e.g. old cattle holding yards and watering points) and sites currently used for horse yarding is necessary. Some seriously invasive species, e.g. *Juncus effusus* near watercourses or along tracks, now in manageable numbers, should be eliminated before they become ubiquitous through the range of the community.

No. quadrats 50; Native taxa / quadrat 23.4 ± 0.8; Total native taxa 142; Weeds /quadrat 2.2 ± 0.3; Total weed taxa 15

Altitude: 1340 – 1495 – 1680 m.

Diagnostic Taxa: Shrubs *Hovea montana* (92), *Leucopogon hookeri* (56), *Pimelea alpina* (46), *Euryomyrtus ramosissima* (34), *Bossiaea foliosa* (16), *Leucopogon fraseri* (16), *Bossiaea buxifolia* (4); **Herbs** *Carex breviculmis* (94), *Poa fawcettiae* (92), *Microseris* sp. 2 (84), *Leptorhynchos squamatus* subsp. *alpinus* (80), *Asperula gunnii* (78), *Craspedia* spp. (72), *Ranunculus graniticola* (68), *Viola betonicifolia* (66), *Scleranthus biflorus* (60), *Oreomyrrhis eriopoda* (54), *Trisetum spicatum* (52), *Celmisia* spp. (48), *Austrostipa nivicola* (40), *Rytidosperma nudiflorum* (40), *Stellaria pungens* (38), *Brachyscome scapigera* (36), *Erigeron bellidioides* (36), *Brachyscome spathulata* (30), *Lomandra oreophila* (28), *Euphrasia collina* subsp. *paludosa* (24), *Podolepis jaceoides* (18), *Agrostis hiemalis* sens. lat. (16), *Podolepis robusta* (16), *Luzula alpestris* (14), *Chiloglottis valida* (12), *Euchiton traversii* (10), *Austrodanthonia racemosa* (8), *Eriochilus cucullatus* (8)

Other Common Taxa: *Grevillea australis* (42)

Weeds: *Acetosella vulgaris* (58), *Hypochaeris radicata* (40), *Trifolium repens* (22), *Aphanes arvensis* (20), *Cerastium vulgare* (20), *Cerastium glomeratum* (16), *Aira caryophyllea* (6), *Leucanthemum vulgare* (6), *Poa pratensis* (6), *Holcus lanatus* (4), *Moenchia erecta* (4), *Taraxacum officinale* (4), *Vulpia bromoides* (4), *Trifolium dubium* (2), *Veronica arvensis* (2)

Community 29: Victorian shale *Hovea montana* heathland

Equivalent communities: Alpine heathland, subcommunity 6.1 (Walsh et al. 1984)

Confined to ridges and slopes of the upper catchments of the Macalister, Howqua, Delatite, Wonnangatta and King Rivers, this patchy open to closed heathland is structurally dominated by *Hovea montana*, *Leucopogon hookeri* and *Euryomyrtus ramosissima*, usually with *Poa fawcettiae* in gaps in the shrub canopy. It is established on relatively shallow soils derived from Palaeozoic mudstones and siltstones and usually occurs on moderately sloping sites of mainly northerly aspect. It is often contiguous with *Eucalyptus niphophila* woodlands and/or Community 48. Some sites supporting this community are traversed by the Alpine Walking Track and so receive localised damage, but generally the community is not particularly prone to disturbance. Even before the cessation of grazing across all examples of the community, it was not favoured by stock due to the relatively low proportion of palatable species

No. quadrats 37; Native taxa / quadrat 20.2 ± 0.8; Total native taxa 128; Weeds /quadrat 1.3 ± 0.1; Total weed taxa 5

Altitude: 1460 – 1610 – 1740 m.

Diagnostic Taxa: Shrubs *Hovea montana* (68), *Leucopogon hookeri* (65), *Euryomyrtus ramosissima* (43), *Podolobium alpestre* (35); **Herbs** *Poa fawcettiae* (89), *Carex breviculmis* (86), *Microseris* sp. 2 (78), *Celmisia* spp. (65), *Stellaria pungens* (65), *Brachyscome spathulata* (54), *Trisetum spicatum* (51), *Leptorhynchos squamatus* subsp. *alpinus* (49), *Arthropodium milleflorum* (46), *Stylidium* spp. (46), *Luzula novae–cambriae* (43), *Prasophyllum* spp. (41), *Bulbine bulbosa* (35), *Goodenia hederacea* subsp. *alpestris* (35), *Chrysocephalum semipapposum* (32), *Euphrasia collina* subsp. *paludosa* (32), *Aciphylla glacialis* (30), *Agrostis venusta* (27), *Leucochrysum albicans* subsp. *alpinum* (27), *Brachyscome rigidula* (22), *Rhodanthe anthemoides* (22), *Austrodanthonia eriantha* (16), *Elymus scaber* (16), *Lomandra oreophila* (16), *Galium gaudichaudii* (11)

Other Common Taxa: *Craspedia* spp. (65), *Asperula gunnii* (62)

Weeds: *Hypochaeris radicata* (57), *Acetosella vulgaris* (54), *Aira caryophyllea* (8), *Cerastium glomeratum* (5), *Leucanthemum vulgare* (3)

Group VIII – subalpine grasslands & open heathlands

Community 30: *Poa hiemata – Poa clivicola* grassland

Equivalent communities: Vegetation Type 2 (Helman & Gilmour 1985); Group 16 (Helman et al. 1988); Community 6 (Benson 1994).

This is the most common grassland of the treeless plains in Kosciuszko National Park, occurring from the upper Thredbo Valley in the south to Emu Plain in the west, Cooleman Plain in the north and Snowy Plain in the east (Fig. 7). It also occurs in the ACT at Cheyenne Flat and Bimberi (and probably elsewhere). The community is the dominant of large plains such as Kiandra, Happy Jacks and Long Plains. It is characterised by a dense cover of one, or often several species of *Poa* (mainly *P. clivicola, P. costiniana* or *P. hiemata* but occasionally *P. petrophila* or *P. phillipsiana*) with numerous intertussock spaces containing a large range of herbaceous species. Tall shrubs such as *Hakea microcarpa* and *Cassinia monticola* may be present and at times are abundant enough for the vegetation to be effectively an open heathland. Despite the greater shrub cover, such examples are floristically indistinct from surrounding grasslands. This community has the highest mean native species richness/ quadrat of the grasslands identified. Examples in the Snowy Plain area are on freehold land and grazed by cattle. Pigs are a significant threat to the community in some places (e.g. Nungar and Happy Jacks Plains). Patches of up to 100 m^2 may be overturned by pigs causing the exposure of bare soil, a large reduction in the cover of *Poa* species, and an increase in disturbance tolerant species such as *Geranium antrorsum, Drabastrum alpestre* and *Stellaria multiflora* (McDougall and Walsh 2002).

No. quadrats 50; Native taxa / quadrat 29.9 ± 0.8; Total native taxa 183; Weeds /quadrat 2.1 ± 0.3; Total weed taxa 16

Altitude: 1250 – 1475 – 1810 m.

Diagnostic Taxa: Shrubs *Leucopogon hookeri* (58), *Pimelea linifolia* subsp. *caesia* (46), *Cassinia monticola* (38), *Pimelea biflora* (26), *Oxylobium ellipticum* (18), *Hovea* aff. *heterophylla* (8), *Pultenaea fasciculata* (8), *Pultenaea polifolia* (8); **Herbs** *Ranunculus graniticola* (94), *Carex breviculmis* (92), *Craspedia* spp. (*coolaminica, crocata, jamesii*) (76), *Scleranthus biflorus* (74), *Leptorhynchos squamatus* subsp. *alpinus* (72), *Geranium antrorsum* (68), *Microseris* sp. 2 (60), *Poranthera microphylla* (58), *Aciphylla simplicifolia* (56), *Poa hiemata* (56), *Senecio pinnatifolius* var. *alpinus* (50), *Oreomyrrhis argentea* (48), *Luzula flaccida* (46), *Xerochrysum subundulatum* (44), *Stylidium montanum* (40), *Trisetum spicatum* (40), *Prasophyllum sphacelatum* (38), *Brachyscome decipiens* (38), *Euphrasia collina* subsp. *paludosa* (38), *Poa clivicola* (36), *Australopyron velutinum* (34), *Erigeron bellidioides* (34), *Cardamine lilacina* (30), *Epilobium billardierianum* (30), *Ajuga australis* (28), *Brachyscome scapigera* (28), *Acaena echinata* (26), *Brachyscome aculeata* (22), *Poa phillipsiana* (22),

Rhytidosporum alpinum (22), *Scleranthus fascicularis* (22), *Asperula scoparia* (20), *Diuris monticola* (20), *Podolepis jaceoides* (20), *Rhodanthe anthemoides* (20), *Arthropodium milleflorum* (18), *Festuca asperula* (16), *Plantago antarctica* (16), *Stellaria multiflora* (16), *Linum marginale* (14), *Lobelia pedunculata* (12), *Leptorhynchos elongatus* (10), *Picris angustifolia* subsp. *merxmuelleri* (10), *Senecio* spp. *(lageniformis, longipilus*) (10), *Poa petrophila* (8), *Taraxacum aristum* (6)

Other Common Taxa: *Asperula gunnii* (70), *Poa costiniana* (48), *Celmisia pugioniformis* (46),

Significant Taxa: *Calotis glandulosa, Diuris pedunculata, Galium roddii* (rarely, on rocky outcrops within grassland), *Prasophyllum retroflexum, Rutidosis leiolepis*

Weeds: *Acetosella vulgaris* (72), *Hypochaeris radicata* (38), *Trifolium repens* (26), *Cerastium vulgare* (18), *Taraxacum officinale* (12), *Anthoxanthum odoratum* (8), *Cerastium glomeratum* (6), *Crepis capillaris* (6), *Cirsium vulgare* (4), *Tragopogon dubius* (4), *Aira elegans* (2), *Holcus lanatus* (2), *Trifolium arvense* (2), *Trifolium campestre* (2), *Viola tricolor* (2), *Vulpia bromoides* (2)

Community 31: *Poa hookeri* grassland

Equivalent communities: Nil

Patches of this grassland community are often found within larger stands of Community 30. The two communities are easily distinguished however. Community 31 is dominated by *Poa hookeri,* a much shorter tussock species than those dominant in Community 30. Many prostrate and mat-forming species are present (e.g. *Calotis pubescens, Coprosma nivalis, Dillwynia prostrata, Pimelea biflora, Pultenaea fasciculata, Pultenaea polifolia, Rutidosis leiolepis*). The herbaceous flora between the sparse, short tussocks is diverse. Most examples of this community occur between Long Plain and Nungar Plain in Kosciuszko National Park, with an outlier between Snowy and Botherum Plain. The community is geographically restricted and most patches are small. Pigs are a major threat in the Nungar area. Some examples in the Snowy Plain area are on freehold land and grazed by cattle. Rabbits are also common there and in the adjoining National Park. Pigs seem to overturn plants preferentially in this type of grassland.

No. quadrats 22; Native taxa / quadrat 27.4 ± 1.4; Total native taxa 117; Weeds /quadrat 2.4 ± 0.3; Total weed taxa 15

Altitude: 1200 – 1320 – 1420 m.

Diagnostic Taxa: Shrubs *Leucopogon hookeri* (59), *Pimelea linifolia* subsp. *caesia* (59), *Hovea* aff. *heterophylla* (32), *Pultenaea polifolia* (32), *Pimelea biflora* (23), *Pultenaea fasciculata* (23), *Dillwynia prostrata* (18), *Coprosma nivalis* (14); **Herbs** *Carex breviculmis* (100), *Poa hookeri* (100), *Geranium antrorsum* (91), *Craspedia* spp. (*coolaminica, jamesii*) (86), *Ranunculus graniticola* (82), *Scleranthus biflorus* (82), *Podolepis jaceoides* (73), *Austrodanthonia* spp. (*eriantha, laevis*) (64), *Luzula flaccida* (64), *Microseris* sp. 2 (59), *Rhodanthe anthemoides* (55), *Senecio pinnatifolius* var. *alpinus* (55), *Poa phillipsiana* (50), *Trisetum spicatum* (50), *Brachyscome aculeata* (45), *Plantago euryphylla* (45), *Epilobium billardierianum* (41), *Oreomyrrhis argentea* (41), *Poa clivicola* (41), *Acaena echinata* (36), *Ajuga australis* (36), *Euphrasia collina* subsp. *paludosa* (36), *Poranthera microphylla* (32), *Rutidosis leiolepis* (32), *Diuris monticola* (27), *Poa petrophila* (27), *Drabastrum alpestre* (23), *Euchiton collinus* (23), *Leptorhynchos elongatus* (18), *Senecio longipilus* (18), *Themeda triandra* (18), *Carex incomitata* (14), *Bulbine* aff. *glauca* (9), *Calotis glandulosa* (9)

Other Common Taxa: *Asperula gunnii* (59)

Significant Taxa: *Bulbine* aff. *glauca, Calotis glandulosa*, *Calotis pubescens, Rutidosis leiolepis, Wahlenbergia densifolia*

Weeds: *Hypochaeris radicata* (82), *Acetosella vulgaris* (59), *Cerastium vulgare* (23), *Trifolium repens* (23), *Aira caryophyllea* (9), *Anthoxanthum odoratum* (9), *Crepis capillaris* (9), *Vulpia bromoides* (9), *Cerastium glomeratum* (5), *Dianthus armeria* (5), *Hypericum perforatum* (5), *Myosotis discolor* (5), *Poa pratensis* (5), *Taraxacum officinale* (5), *Tragopogon dubius* (5)

Community 32: *Hovea montana* **–** *Poa phillipsiana* open heathland

Equivalent communities: Alpine heathland, subcommunity 6.4 (Walsh et al. 1984).

This is the commonest grassland/open heathland community on Mt Buffalo where it occurs in broad valleys below the inverted treeline (Fig. 15). It occupies similar topological sites on other mountains (e.g. Davies Plain, Cobberas) and has not yet been recorded above the upper treeline. Soils typically contain less organic matter than other grasslands and are often shallow and/or gravelly. *Poa phillipsiana* generally provides most of the vegetated cover but the robust tussock *Austrostipa nivicola* may be co-dominant. Shrubs such as *Hovea montana* and *Grevillea australis* are often present and suggest an ecotonal position in some sites. A range of robust, conspicuous daisies (e.g. *Craspedia* spp., *Brachyscome spathulata, Podolepis robusta*, *Xerochrysum subundulatum*) make this a visually striking community in peak flowering period. All representatives of this community on Mt Buffalo are well protected and have regenerated well after the 2003 fires, retrieving most, if not all, their pre-fire diversity. Examples on the Nunniong Plateau and the Cobberas mountains are subject to grazing and trampling by cattle and/or feral horses. This has resulted in entrenched paths and extensive latrine areas which are nursery sites for weeds.

No. quadrats 24; Native taxa / quadrat 21.0 ± 0.9; Total native taxa 108; Weeds /quadrat 1.2 ± 0.2; Total weed taxa 4

Altitude: 1160 – 1470 – 1700 m.

Diagnostic Taxa: Shrubs *Hovea montana* (83); **Herbs** *Poa phillipsiana* (100), *Craspedia* spp. (96), *Carex breviculmis* (92), *Scleranthus biflorus* (83), *Austrodanthonia pilosa* (79), *Leptorhynchos squamatus* subsp. *alpinus* (79), *Brachyscome spathulata* (67), *Ranunculus graniticola* (63), *Ajuga australis* (58), *Austrostipa nivicola* (50), *Luzula modesta* (50), *Erigeron bellidioides* (42), *Podolepis robusta* (38), *Xerochrysum subundulatum* (38), *Australopyron velutinum* (25), *Lobelia pedunculata* (17)

Other Common Taxa: *Asperula gunnii* (46), *Microseris* sp. 2 (46), *Pimelea alpina* (42)

Weeds: *Acetosella vulgaris* (58), *Hypochaeris radicata* (33), *Cerastium glomeratum* (21), *Trifolium repens* (13)

Community 33: Northern Alps *Hovea montana* open heathland

Equivalent communities: not clearly identified in previous vegetation descriptions.

Hovea montana (to a height of about 0.5 m) is the usual dominant of this community in an open community interspersed with patches of tussock grasses (commonly *Poa clivicola, P. fawcettiae* or *P. phillipsiana*). One of several shrubs (e.g. *Cassinia monticola, Grevillea australis, Podolobium alpestre*) may occasionally dominate and *Austrostipa nivicola* is abundant at several sites. Community 33 commonly occupies sites with greater soil depth than Community 37 and may occur in mosaic with Community 30. It is found in Kosciuszko National Park (Kiandra, Happy Jacks Plain, Tantangara area) and Namadgi National Park (Mt Bimberi, Mt Murray, Mt Gingera). This community is well protected and not under any obvious threat at present.

Fig. 13. Community 25 covers most of the floor of Pretty Valley on the Bogong High Plains (in a mosaic with *Epacris* moist heathland (Community 4), which is found in moist areas). Large sections of the community here are dominated by *Pentachondra pumila*, a mat-forming shrub. In such cases, tussock grasses may be uncommon but diversity high.

Fig. 14. Open heathland dominated by *Grevillea australis* and *Phebalium squamulosum* var. *alpinum* with large, herb-rich gaps (Community 26), is the most common community on the Bogong High Plains. *Asterolasia trymalioides* (seen here in flower) is occasionally abundant.

No. quadrats 8; Native taxa / quadrat 24.0 ± 0.9; Total native taxa 94; Weeds /quadrat 1.3 ± 0.4; Total weed taxa 4

Altitude: 1330 – 1505 – 1800 m.

Diagnostic Taxa: Shrubs *Hovea montana* (100), *Leucopogon hookeri* (75), *Pimelea linifolia* subsp. *caesia* (63), *Grevillea australis* (50), *Pimelea biflora* (50), *Cassinia monticola* (38); **Herbs** *Carex breviculmis* (100), *Microseris* sp. 2 (100), *Craspedia* spp. (*coolaminica, jamesii*) (88), *Celmisia* spp. (*pugioniformis*) (75), *Ranunculus graniticola* (75), *Aciphylla simplicifolia* (63), *Austrostipa nivicola* (63), *Linum marginale* (50), *Oreomyrrhis argentea* (50), *Poa phillipsiana* (50), *Helichrysum rutidolepis* (38), *Rhodanthe anthemoides* (38)

Other Common Taxa: *Asperula gunnii* (63), *Leptorhynchos squamatus* subsp. *alpinus* (50), *Scleranthus biflorus* (50), *Stellaria pungens* (50), *Stylidium montanum* (50)

Weeds: *Acetosella vulgaris* (50), *Anthoxanthum odoratum* (13), *Hypochaeris radicata* (13), *Vulpia bromoides* (13)

Community 34: *Eucalyptus lacrimans* low open woodland

Equivalent communities: Nil

This open woodland community occurs on isolated knolls and low ridges of frost hollows between Long and Nungar Plains in Kosciuszko National Park (including the Kiandra area and Currango Plain). *Eucalyptus lacrimans* is the structural dominant but it is invariably very sparse. The understorey ranges from grass-dominated (most commonly *Poa phillipsiana*) to shrub-dominated (mostly *Hakea microcarpa*) (Fig. 16). Several species that are uncommon on the treeless plains were recorded in this community (*Daviesia ulicifolia, Dichelachne rara, Grevillea lanigera, Lepidosperma curtisiae, Lomandra longifolia* var. *exilis, Phebalium squamulosum* subsp. *ozothamnoides, Tetratheca bauerifolia*). Woodland dominated by *Eucalyptus lacrimans* occurs in Kosciuszko National Park and the Adaminaby area to the east. The Kosciuszko National Park community appears to be distinct from the Adaminaby community, the understorey of which is dominated by *Themeda triandra* and contains many elements of the Monaro Plains flora. Community 34 is highly localised. Most examples contain dead trees of *Eucalyptus lacrimans* and little or no recruitment of this species. The reason for the possible decline of the dominant species in this community warrants investigation. Some examples of this woodland were burnt in the 2003 fires. Recruitment and survival of *Eucalyptus lacrimans* should be monitored in burnt and unburnt examples to determine if fire plays a role in regeneration.

No. quadrats 5; Native taxa / quadrat 26.2 ± 0.9; Total native taxa 69; Weeds /quadrat 2.2 ± 0.7; Total weed taxa 5

Altitude: 1270 – 1340 – 1470 m.

Diagnostic Taxa: Shrubs *Eucalyptus lacrimans* (100), *Hakea microcarpa* (100), *Pimelea linifolia* subsp. *caesia* (100), *Leucopogon hookeri* (80), *Dillwynia prostrata* (40), *Hovea* aff. *heterophylla* (40), *Olearia myrsinoides* (40); **Herbs** *Carex breviculmis* (100), *Craspedia* spp. (*coolaminica, jamesii*) (100), *Poranthera microphylla* (100), *Trisetum spicatum* (100), *Austrodanthonia laevis* (80), *Poa phillipsiana* (80), *Elymus scaber* (60), *Linum marginale* (40), *Themeda triandra* (40)

Other Common Taxa: *Microseris* sp. 2 (80), *Scleranthus biflorus* (80), *Asperula gunnii* (60), *Ranunculus graniticola* (60)

Weeds: *Hypochaeris radicata* (80), *Acetosella vulgaris* (60), *Cerastium vulgare* (40), *Crepis capillaris* (20), *Tragopogon dubius* (20)

Community 35: *Bossiaea foliosa – Epacris petrophila* heathland

Equivalent communities: Nil

This open to closed heathland is apparently restricted to the Long Plain – Bullocks Hill area of Kosciuszko National Park where locally abundant. The community is characterised by a moderate to dense cover of *Bossiaea foliosa* and / or *Epacris petrophila*. The ground layer is usually sparse and of low diversity. *Poa phillipsiana* and *Poa clivicola* made up most of the ground cover in the examples sampled. In places, especially where dominated by *Bossiaea foliosa*, this community is continuous with understorey vegetation of adjoining snow gum woodland, and is perhaps more characteristic of woodland vegetation than of the vegetation of the plains. Although similar in appearance, the extensive stands of this community dominated by *Epacris petrophila* in Long Plain are floristically distinct from stands dominated by this shrub in the Kiandra valley nearby, which are part of Community 37. Community 35 is abundant where it occurs and appears to be encroaching on grassland vegetation based on a cursory examination of 1970 aerial photography. It is well protected and under little threat at present.

No. quadrats 4; Native taxa / quadrat 17.8 ± 2.8; Total native taxa 43; Weeds /quadrat 1.5 ± 0.5; Total weed taxa 4

Altitude: 1320 – 1340 – 1360 m.

Diagnostic Taxa: Shrubs *Bossiaea foliosa* (75), *Epacris petrophila* (75), *Pimelea linifolia* subsp. *caesia* (75); **Herbs** *Carex breviculmis* (100), *Xerochrysum subundulatum* (100), *Acaena echinata* (75), *Geranium antrorsum* (75), *Poa phillipsiana* (75), *Poa petrophila* (50)

Other Common Taxa: *Celmisia pugioniformis* (50), *Craspedia* spp. (*coolaminica, jamesii*) (75), *Austrodanthonia* spp. (50), *Leptorhynchos squamatus* subsp. *alpinus* (50), *Poa clivicola* (50), *Poranthera microphylla* (50), *Ranunculus graniticola* (50), *Stellaria pungens* (50), *Stylidium montanum* (50)

Weeds: *Acetosella vulgaris* (75), *Cerastium vulgare* (25), *Taraxacum officinale* (25), *Trifolium repens* (25)

Community 36: Broadway *Bossiaea foliosa* closed heathland

Equivalent communities: Nil

This heathland appears to be restricted to the slopes and ridges of the upper Tooma River valley (Toolong, Broadway and Pretty Plains). It is characterised by a dense cover of *Bossiaea foliosa* (to about 1.25 m tall) and, unlike other closed heathlands in the Australian Alps, a very diverse understorey. The mean species richness of this community was the highest recorded. The understorey is dominated by forbs and, although *Poa phillipsiana* was commonly recorded, tussock grasses are not abundant. Almost all of this community was burnt in January 2003. Although not recorded in the quadrats before the fire, *Dichelachne crinita* was common and prominent 12 months after. Community 36 is geographically restricted but the most common community within its range. It has closer affinities with open heath and grassland communities, where *Bossiaea foliosa* is rare or absent than with closed shrub communities where it is abundant. It is possible that this community is an artefact of past grazing management, either through overgrazing (which creates bare spaces that are favourable to shrub germination) or through the frequent burning of grassland to promote new, more palatable growth of grass (which also creates bare ground and would stimulate germination of leguminous seed such as that of *Bossiaea foliosa*). The entire community is well protected across its range. It will be vulnerable to disturbance (from vehicles and feral animals) while it is recovering from the fire.

No. quadrats 5; Native taxa / quadrat 36.6 ± 3.2; Total native taxa 85; Weeds /quadrat 1.8 ± 0.5; Total weed taxa 3

Altitude: 1250 – 1285 – 1350 m.

Diagnostic Taxa: Shrubs *Bossiaea foliosa* (100), *Cassinia monticola* (100), *Hakea microcarpa* (100), *Leucopogon hookeri* (100), *Pimelea*

linifolia subsp. *caesia* (80), *Kunzea muelleri* (60), *Ozothamnus secundiflorus* (40); **Herbs** *Carex breviculmis* (100), *Craspedia* spp. (*coolaminica, jamesii*) (100), *Viola betonicifolia* (100), *Brachyscome aculeata* (80), *Geranium antrorsum* (80), *Leptorhynchos squamatus* subsp. *alpinus* (80), *Poranthera microphylla* (80), *Ranunculus graniticola* (80), *Erigeron bellidioides* (60), *Goodenia hederacea* subsp. *alpestris* (60), *Oreomyrrhis argentea* (60), *Poa phillipsiana* (60), *Podolepis hieracioides* (60), *Senecio gunnii* (60), *Xerochrysum subundulatum* (60), *Austrodanthonia oreophila* (40), *Dichelachne crinita* (40), *Linum marginale* (40), *Lobelia pedunculata* (40)

Other Common Taxa: *Asperula gunnii* (80), *Ajuga australis* (60), *Celmisia pugioniformis* (60), *Grevillea australis* (60), *Hovea montana* (60), *Stellaria pungens* (60), *Stylidium* spp. (*montanum*) (60), *Trisetum spicatum* (60)

Weeds: *Acetosella vulgaris* (100), *Cerastium vulgare* (40), *Hypochaeris radicata* (40)

Community 37: Northern Alps *Epacris* **–** *Kunzea* open heathland

Equivalent communities: Nil

Although *Kunzea muelleri* was present in almost all quadrats sampled in this community and is often the dominant shrub, in many examples it is inconspicuous and the community is then dominated by *Epacris petrophila* (especially in the Kiandra area) or *E. gunnii*. Community 37 appears to be confined to the subalpine plains of Kosciuszko National Park (e.g. Happy Jacks Plain, Toolong Plain, Munyang Creek, Kiandra). Soils are sometimes, but not invariably, shallow. Species richness is high. *Poa clivicola* (and sometimes other *Poa* species) provide most of the ground cover but various inter-tussock species are common. This community appears to be well protected and under little threat at present. Regeneration of the dominants in examples burnt in 2003 has been slow and large areas were still bare two years after the fire. It will be important to minimise disturbance in these areas to facilitate recovery.

No. quadrats 14; Native taxa / quadrat 25.9 ± 1.4; Total native taxa 90; Weeds /quadrat 0.7 ± 0.1; Total weed taxa 4

Altitude: 1250 – 1465 – 1620 m.

Diagnostic Taxa: Shrubs *Kunzea muelleri* (93), *Epacris gunnii* (50), *Pimelea biflora* (50), *Epacris petrophila* (43), *Pultenaea fasciculata* (21); **Herbs** *Carex breviculmis* (100), *Craspedia* spp. (*coolaminica, crocata, jamesii*) (93), *Poranthera microphylla* (86), *Poa clivicola* (79), *Ranunculus graniticola* (79), *Scleranthus biflorus* (79), *Aciphylla simplicifolia* (71), *Geranium antrorsum* (64), *Leptorhynchos squamatus* subsp. *alpinus* (64), *Senecio pinnatifolius* var. *alpinus* (64), *Cardamine lilacina* (57), *Austrodanthonia* spp. (*laevis*) (50), *Erigeron bellidioides* (50), *Oreomyrrhis argentea* (50), *Brachyscome scapigera* (43), *Luzula flaccida* (43), *Xerochrysum subundulatum* (43), *Euphrasia collina* subsp. *paludosa* (36), *Rhytidosporum alpinum* (21)

Other Common Taxa: *Asperula gunnii* (71), *Celmisia pugioniformis* (50), *Brachyscome decipiens* (43), *Brachyscome spathulata* (43), *Grevillea australis* (43), *Microseris* sp. 2 (43)

Weeds: *Acetosella vulgaris* (43), *Cerastium vulgare* (14), *Cirsium vulgare* (7), *Hypochaeris radicata* (7)

Group IX – limestone grassland

Community 38: *Themeda triandra – Leucochrysum albicans* grassland

Equivalent communities: Nil

This grassland community is common on steep slopes in the Blue Waterholes area of Kosciuszko National Park, where it occurs on loose limestone scree and around rocky outcrops. *Themeda triandra* is dominant in most areas, although plant cover is sometimes sparse. There are occasional emergent shrubs of *Cassinia ochracea*, *Grevillea lanigera* and *Hakea microcarpa* but shrub cover is generally low. Slopes in similar habitat at Yarrangobilly Caves about 25 km south of Blue Waterholes support small pockets of this community within a forested landscape. The Cave Creek area has a high diversity of weeds, some of which are locally abundant. *Sedum acre* occupies a niche on rocky sites also occupied by the very restricted *Galium roddii*, which appears to be threatened as a result. Many of the weeds present in Cave Creek are locally dominant in similar habitat at Yarrangobilly Caves (e.g. *Potentilla recta, Rosa rubiginosa, Tragopogon dubius, Verbascum thapsus*). Control of these and other weed species may be required in the future. Control will be difficult however because the steep slopes of Cave Creek are unstable and frequent pedestrian traffic could have a significant impact on plants growing there.

No. quadrats 6; Native taxa / quadrat 16.2 ± 1.5; Total native taxa 32; Weeds /quadrat 6.2 ± 1.2; Total weed taxa 15

Altitude: 1200 – 1220 m.

Diagnostic Taxa: Shrubs *Cassinia ochracea* (83), *Grevillea lanigera* (33), *Hakea microcarpa* (83), *Pimelea linifolia* subsp. *caesia* (83), *Muehlenbeckia axillaris* (33); **Herbs** *Carex breviculmis* (100), *Leucochrysum albicans* subsp. *alpinum* (100), *Poa fawcettiae* (100), *Themeda triandra* (100), *Picris angustifolia* subsp. *merxmuelleri* (83), *Xerochrysum* aff. *viscosum* (83), *Convolvulus angustissimus* subsp. *angustissimus* (67), *Galium roddii* (67), *Linum marginale* (67), *Vittadinia cuneata* (67), *Craspedia coolaminica* (50), *Plantago varia* (50), *Clematis microphylla* var. *leptophylla* (33), *Derwentia perfoliata* (33)

Significant Taxa: *Galium roddii, Thesium australe*

Weeds: *Trifolium dubium* (83), *Hypochaeris radicata* (67), *Rosa rubiginosa* (67), *Sedum acre* (67), *Tragopogon dubius* (67), *Cerastium vulgare* (50), *Crepis capillaris* (50), *Echium vulgare* (33), *Linaria arvensis* (33), *Petrorhagia nanteuilii* (33), *Cerastium glomeratum* (17), *Taraxacum officinale* (17), *Verbascum thapsus* (17), *Verbascum virgatum* (17), *Vulpia bromoides* (17)

Group X – Short alpine heathlands

Community 39: Kosciuszko alpine *Epacris – Kunzea* open heathland

Equivalent communities: *Epacris serpyllifolia – Kunzea muelleri* alliance (Costin 1954); a combination of the *Epacris microphylla* and *Kunzea muelleri* associations (McVean 1969).

Community 39 is a low heathland dominated by *Epacris gunnii, Kunzea muelleri* or occasionally *E. petrophila*, occurring on the upper granite or phyllite slopes and summits of the Kosciuszko Main Range. Sites containing this community are generally rocky with shallow soil. Community 39 has some floristic elements of Community 40 (*Epacris gunnii – Chionohebe pulvinatus* feldmark; e.g. *Leucochrysum albicans* and *Luzula australasica*) but the cushion species are absent. An unusual feature of some Community 39 stands is the presence of *Baeckea gunniana*, a species usually associated with moist sites. It can sometimes be found layering over large granite boulders. The diversity and abundance of herb species is usually low. Rock and bare ground are common. On less exposed sites with deeper soil profiles, Community 39 may grade into Community 23. Some examples (e.g. summit of Mt Kosciuszko) are subject to trampling pressure by tourists. The top stations of some lifts in NSW ski resorts are positioned within this community. The impact of these pressures on the overall community is currently low.

No. quadrats 17; Native taxa / quadrat 15.2 ± 1.0; Total native taxa 69; Weeds /quadrat 0.4 ± 0.0; Total weed taxa 1

Altitude: 1860 – 2005 – 2220 m.

Diagnostic Taxa: Shrubs *Epacris gunnii* (65), *Epacris petrophila* (35), *Kunzea muelleri* (35), *Oxylobium ellipticum* (24); **Herbs** *Celmisia* spp. (*costiniana, pugioniformis*) (88), *Poa fawcettiae* (71), *Ewartia nubigena* (53), *Leucochrysum albicans* subsp. *alpinum* (53), *Lycopodium fastigiatum* (35), *Scleranthus singuliflorus* (29), *Deyeuxia crassiuscula* (24), *Deyeuxia monticola* (24), *Luzula alpestris* (24), *Luzula australasica* subsp. *dura* (24), *Oreomyrrhis brevipes* (24), *Poa saxicola* (18)

Other Common Taxa: *Craspedia* spp. (*aurantia, maxgrayi*) (76), *Carex breviculmis* (53), *Grevillea australis* (47)

Weeds: *Acetosella vulgaris* (35)

Community 40: *Epacris gunnii – Chionohebe pulvinatus* feldmark

Equivalent communities: *Epacris petrophila – Veronica densifolia* alliance (Costin 1954); *Epacris microphylla – Veronica densifolia* association (McVean 1969); *Epacris – Chionohebe* Feldmark (Costin et al. 2000).

This dwarf heathland, referred to as feldmark by Costin et al. (2000), occurs on the Kosciuszko Main Range between Mt Twynam and Rawsons Pass, most commonly on exposed ridgetops and summits. Total plant cover is normally less than 50%, pavements of fractured sedimentary rock being a feature of the habitat. *Epacris gunnii* is the usual dominant. These shrubs are pruned by prevailing winds on the western side but continue to grow on the sheltered eastern side, thus moving slowly across the community (Barrow et al. 1968) (Fig. 17). Some examples, especially in the Mt Twynam area, contain little or no *Epacris gunnii*. Throughout its distribution, the community is characterised by the presence, often in low numbers, of cushion plants and prostrate herbs, some largely restricted to this community (e.g. *Colobanthus pulvinatus, Ranunculus acrophilus, Rytidosperma pumilum, Chionohebe densifolia, Euphrasia collina* subsp. *lapidosa, Kelleria dieffenbachii*). Community 40 may apparently develop on protected slopes and ridges of similar geology when plant and soil cover are lost from other communities (Costin et al. 2000). The walking track along the Main Range passes through several examples. Whilst plant death has occurred on the track surface, the overall effect appears to have been localised. Such walking tracks have created a barrier to the movement of *Epacris gunnii* from windward to leeward (McDougall & Wright 2004) but the impact is barely noticeable. The Main Range Track should ultimately be moved to avoid feldmark communities.

No. quadrats 6; Native taxa / quadrat 14.8 ± 2.2; Total native taxa 36; Weeds /quadrat 0.5 ± 0.3; Total weed taxa 2

Altitude: 2010 – 2100 – 2150 m.

Diagnostic Taxa: Shrubs *Epacris gunnii* (67); **Herbs** *Colobanthus pulvinatus* (100), *Ewartia nubigena* (100), *Luzula australasica* subsp. *dura* (100), *Poa fawcettiae* (100), *Ranunculus acrophilus* (83), *Trisetum spicatum* (83), *Agrostis muelleriana* (67), *Chionohebe densifolia* (67), *Euphrasia collina* subsp. *lapidosa* (67), *Leucochrysum albicans* subsp. *alpinum* (67), *Senecio pectinatus* var. *major* (67), *Kelleria dieffenbachii* (33), *Rytidosperma pumilum* (33)

Other Common Taxa: *Celmisia* spp. (*costiniana, pugioniformis*) (50)

Significant Taxa: *Euphrasia* sp. 3 (Ramshead Range), *Rytidosperma pumilum*

Weeds: *Acetosella vulgaris* (33), *Hypochaeris radicata* (17)

Community 41: Bogong High Plains *Epacris – Kunzea* open heathland

Equivalent communities: *Epacris microphylla* heathland, Unit 14 (McDougall 1982).

This low heathland, which is dominated by *Epacris gunnii*, is structurally and floristically similar to Community 40 of the Kosciuszko Main Range. It is most commonly found on high summits of the Bogong High Plains (e.g. Mt Nelse) but may also occur at lower elevations on sites with skeletal soil. On such sites, *Kunzea muelleri* may be co-dominant. On high altitude exposed sites, there is evidence of the lateral movement of *Epacris gunnii* shrubs across the community, with stems being pruned on the windward side and growing out on the leeward (as in Community 40). Floristic diversity is low and rock cover great. Tussock grasses, although frequent, provide little cover. Because of their occurrence on summits that are popular with tourists, some trampling damage does occur. This has had minimal effect in the past but may be more significant in the coming years as most examples were burnt in 2003. *Epacris gunnii* is an obligate seeder and will take many years to return to its pre-fire abundance in the harsh, exposed habitat of this community.

No. quadrats 8; Native taxa / quadrat 14.3 ± 0.9; Total native taxa 29; Weeds /quadrat 0.1; Total weed taxa 1

Altitude: 1630 – 1825 – 1880 m.

Diagnostic Taxa: Shrubs *Epacris gunnii* (100), *Grevillea australis* (75), *Kunzea muelleri* (75), *Leucopogon* spp. (*hookeri, montanus*) (63); **Herbs** *Carex breviculmis* (100), *Ewartia nubigena* (100), *Poa fawcettiae* (88), *Poa hiemata* (88), *Deyeuxia monticola* (75), *Luzula novae-cambriae* (63), *Agrostis parviflora* (38), *Leucochrysum albicans* subsp. *alpinum* (38)

Other Common Taxa: *Asperula gunnii* (63), *Celmisia* spp. (*costiniana, pugioniformis*) (63), *Luzula modesta* (63), *Oreomyrrhis eriopoda* (63),

Significant Taxa: *Euphrasia crassiuscula* subsp. *glandulifera, Euphrasia eichleri*

Weeds: *Taraxacum officinale* (13)

Group XI – western subalpine open heathland

Community 42: *Epacris celata – Poa clivicola* open heathland

Equivalent communities: Nil

This community is currently recorded only from McPhersons Plain, part of a high plateau on the western side of the Tumut Valley, to the west of Kosciuszko National Park. Other treeless plains on the plateau nearby (Sparks Plain and Tomneys Plain) have not been surveyed so it is possible that it is not restricted to McPhersons Plain. The community comprises very short plants of *Epacris celata* and *E. gunnii*. In stature and abundance, the shrubs are less prominent than the grasses (*Poa clivicola, Poa sieberiana* and *Themeda triandra*), which makes the community look more like a grassland than an open heathland. Community 42 is not closely related to any of the other communities described in this paper. This community appears to be rare and isolated from other treeless vegetation in the Australian Alps. It is not present in a conservation reserve. McPhersons Plain is partly in a State Forest lease and partly freehold. Other plains in the vicinity that might contain the community are freehold land. Some of the community is the subject of a conservation agreement that fosters management of the vegetation for its significant features. Despite this, the community is threatened overall by feral animals, stray domestic stock from neighbouring properties, and future changes in land use.

No. quadrats 3; Native taxa / quadrat 26.0 ± 2.1; Total native taxa 46; Weeds /quadrat 2.0 ± 0.6; Total weed taxa 5

Altitude: c. 1100 m.

Diagnostic Taxa: Shrubs *Epacris celata* (100), *Epacris gunnii* (100); **Herbs** *Brachyscome scapigera* (100), *Cotula alpina* (100), *Deyeuxia gunniana* (100), *Empodisma minus* (100), *Euphrasia collina* subsp. *paludosa* (100), *Stylidium montanum* (100), *Bulbine bulbosa* (67), *Hydrocotyle sibthorpioides* (67), *Lomandra* sp. aff. *oreophila* (67), *Luzula flaccida* (67), *Poa clivicola* (67), *Poa sieberiana* (67), *Themeda triandra* (67)

Other Common Taxa *Asperula gunnii* (67), *Brachyscome decipiens* (67), *Carex breviculmis* (67), *Gonocarpus micranthus* (67), *Hakea microcarpa* (67), *Hypericum japonicum* (67), *Poranthera microphylla* (67)

Significant Taxa: *Dillwynia palustris, Diuris pedunculata, Prasophyllum bagoensis*, *P.* sp. aff. *canaliculatum* (McPhersons Plain)

Weeds: *Hypochaeris radicata* (67), *Trifolium repens* (67), *Cerastium vulgare* (33), *Holcus lanatus* (33), *Poa pratensis* (33)

Group XII – Upper Murrumbidgee dwarf heathland

Community 43: Bossiaea riparia dwarf heathland

Equivalent communities: Nil

Bossiaea riparia dwarf heathland is restricted to the rocky slopes above the upper Murrumbidgee River, and a few of its tributaries (in the vicinity of Currango Plain and Tantangara Dam). The community is characterised by an extensive cover of the shrub *Bossiaea riparia* and much exposed rock. The associated flora is variable and may depend on the amount of soil present and the composition of the surrounding vegetation. Despite its variability, the community has few affinities with other communities. Five species were restricted to it or were very rare in other communities (*Bossiaea riparia, Cryptandra amara, Daviesia mimosoides* subsp. *acris*, *Mirbelia oxylobioides, Patersonia longifolia*). At least one example was burnt in 2003. Regeneration there has been slow. Some examples near Tantangara Dam are very sparsely vegetated and species-poor, perhaps indicating past disturbance. Curiously, aerial photographs taken in 1970 show that some areas now occupied by this community were largely bare at that time. Any attempts to revegetate the remaining bare slopes below Tantangara Dam should be made in the knowledge that the natural community has a sparse plant cover and the community is rare and significant. *Bossiaea riparia* should be the main component of any revegetation plan and seed for the work should be sourced from the immediate area.

No. quadrats 4; Native taxa / quadrat 24.3 ± 3.3; Total native taxa 65; Weeds /quadrat 3.5 ± 1.3; Total weed taxa 10

Altitude: 1220 – 1250 – 1280 m.

Diagnostic Taxa: Shrubs *Bossiaea riparia* (100), *Hakea microcarpa* (100), *Pimelea linifolia* subsp. *caesia* (100), *Cryptandra amara* (75), *Dillwynia prostrata* (50), *Leucopogon fraseri* (50); **Herbs** *Themeda triandra* (100), *Luzula flaccida* (75), *Calotis glandulosa* (50), *Euchiton collinus* (50), *Microlaena stipoides* (50), *Poa clivicola* (50), *Podolepis jaceoides* (50)

Other Common Taxa: *Carex breviculmis* (75), *Microseris* sp. 2 (50), *Rhodanthe anthemoides* (50), *Senecio pinnatifolius* var. *alpinus* (50), *Trisetum spicatum* (50)

Significant Taxa: *Bossiaea riparia, Calotis glandulosa, Rutidosis leiolepis*

Weeds: *Hypochaeris radicata* (75), *Acetosella vulgaris* (50), *Vulpia bromoides* (50), *Agrostis capillaris* (25), *Aira caryophyllea* (25), *Anthoxanthum odoratum* (25), *Aphanes arvensis* (25), *Cerastium glomeratum* (25), *Myosotis discolor* (25), *Trifolium campestre* (25)

Fig. 15. *Hovea montana - Poa phllipsiana* open heathland (Community 32) on Mt Buffalo, Victoria. Shrubs occurring with *H. montana* here are *Olearia algida* and, by rocks, *Grevillea australis*. Flowering *Xerochrysum subundulatum* is apparent.

Group XIII – Baw Baw open heathlands

Community 44: *Pultenaea muelleri* open heathland

Equivalent communities: Baw Baw dry alpine shrubland, subcommunities 5.1 & 5.2 (Walsh et al. 1984).

This community is confined to the Baw Baw Plateau where it is common, usually in rocky areas with some northerly aspect on higher parts of the range between Mts Whitelaw and Erica. A diverse, often dense shrub layer to 1 m high or more is characteristic, usually comprising *Pultenaea muelleri, Olearia phlogopappa, Orites lancifolia* and *Ozothamnus secundiflorus*, and often with other shrubs more characteristic of the adjacent woodlands dominated by *Eucalyptus pauciflora* subsp. *acerina*. A 'halo' of this community is also common on the rim of depressions surrounding Communities 1 and 45. Although somewhat ecotonal, it is floristically well defined. While not entirely confined to the Baw Baw plateau, the shrubs *Tasmannia vickeriana* and *Trochocarpa clarkei* are commoner here than elsewhere in the Alps. A few examples of this community have been modified (slashed and/or cleared) within the Baw Baw ski resort area, but otherwise the community is fully contained within the Baw Baw National Park and is not subject to significant threatening processes.

No. quadrats 17; Native taxa / quadrat 21.6 ± 1.2; Total native taxa 78; Weeds /quadrat 2.6 ± 0.3; Total weed taxa 7

Altitude: 1320 – 1415 – 1540 m.

Diagnostic Taxa: Shrubs *Pultenaea muelleri* (82), *Olearia algida* (65), *Olearia phlogopappa* var. *flavescens* (59), *Orites lancifolia* (53), *Pimelea alpina* (53), *Ozothamnus secundiflorus* (47), *Trochocarpa clarkei* (47), *Ozothamnus* sp. 1 (29), *Leucopogon maccraei* (18), *Olearia megalophylla* (18), *Tasmannia vickeriana* (18), *Leucopogon gelidus* (12); **Herbs** *Carex breviculmis* (100), *Hydrocotyle algida* (88), *Oreomyrrhis eriopoda* (88), *Stylidium* spp. (88), *Viola hederacea* (88), *Celmisia* spp. (82), *Senecio gunnii* (72), *Gonocarpus montanus* (71), *Poa hiemata* (71), *Luzula modesta* (65), *Prasophyllum* spp. (53), *Lycopodium fastigiatum* (47), *Podolepis robusta* (41), *Poranthera microphylla* (35), *Leptinella filicula* (29), *Plantago alpestris* (29), *Scaevola hookeri* (24)

Other Common Taxa: *Asperula gunnii* (76), *Poa fawcettiae* (47), *Rytidosperma nudiflorum* (41), *Scleranthus biflorus* (41)

Weeds: *Hypochaeris radicata* (94), *Acetosella vulgaris* (65), *Cerastium vulgare* (59), *Aira caryophyllea* (18), *Poa pratensis* (18), *Agrostis capillaris* (6), *Trifolium repens* (6)

Community 45: *Epacris petrophila* open heathland

Equivalent communities: Baw Baw damp alpine heathland, subcommunity 8.1 (Walsh et al. 1984).

Largely confined to the Baw Baw plateau with minor occurrences on Lake Mountain, this generally low-growing community is invariably associated with Community 1 (Baw Baw – Lake Mountain wet heathland), but occupying higher sites. The community comprises a number of species of both the wet heathland community below and Community 44 upslope, but often includes *Asterolasia trymalioides*, *Grevillea australis* and *Lobelia pedunculata*, species which generally are not encountered in adjacent communities. The abundance of *Epacris petrophila* here is of interest as it is otherwise a rare species in the Victorian alps, but locally common in parts of Kosciuszko National Park (e.g. Communities 4, 35, 37, 39) where it occurs at considerably higher altitudes.

No. quadrats 8; Native taxa / quadrat 21.5 ± 1.7; Total native taxa 60; Weeds /quadrat 0.3 ± 0.0; Total weed taxa 1

Altitude: 1310 – 1380 – 1480 m.

Diagnostic Taxa: Shrubs *Asterolasia trymalioides* (100), *Epacris petrophila* (100), *Grevillea australis* (100), *Pimelea alpina* (88), *Olearia algida* (63), *Orites lancifolia* (63), *Ozothamnus* sp. 1 (63), *Trochocarpa clarkei* (38), *Exocarpos nanus* (33); **Herbs** *Asperula gunnii* (100), *Empodisma minus* (100), *Poa hiemata* (100), *Podolepis robusta* (88), *Celmisia* spp. (75), *Lobelia pedunculata* (63), *Gentianella* spp. (50), *Xerochrysum subundulatum* (50), *Rhytidosporum procumbens* (25)

Other Common Taxa: *Carex breviculmis* (75), *Luzula modesta* (50), *Oreomyrrhis eriopoda* (50)

Weeds: *Cerastium vulgare* (25)

Group XIV – high altitude closed heathlands

Community 46: *Nematolepis ovatifolia – Prostanthera cuneata* closed heathland

Equivalent communities: part of *Oxylobium ellipticum – Podocarpus alpinus* alliance (Costin 1954); *Phebalium ovatifolium* association (McVean 1969).

A tall, closed heathland (to about 1.5 m in height) dominated by one or more of *Nematolepis ovatifolia, Orites lancifolia,* and *Prostanthera cuneata* occurs close to the treeline and on isolated rocky outcrops between Mt Kosciuszko and Mt Jagungal, with outliers in the upper Tumut River valley and Kiandra. The understorey is often sparse, although any gaps in the canopy are commonly more diverse and dominated by tussock grass species (mostly *Poa fawcettiae* and *P. hiemata*). This community may be distinguished from Community 23 by its taller stature, closed structure, greater shrub diversity and lesser understorey diversity. Community 46 is also commonly found closer to the treeline. This community is common and under little threat, although small areas are subject to clearing applications for skiing development. The northern outliers have special significance: that in the upper Tumut Valley contains the northern-most population of *Nematolepis ovatifolia* and that at Kiandra contains the northern-most population of *Phebalium squamulosum* subsp. *alpinum*. Much of the community was burnt in 2003 but regeneration seems to have occurred of most species (Walsh & McDougall 2005).

Fig. 16. Community 34 is a very open woodland dominated by *Eucalyptus lacrimans*. The understorey may be open heathland (as shown here on Long Plain) or grassland. This community is found on isolated knolls within subalpine plains or spurs extending from the Snow Gum woodland above.

No. quadrats 21; Native taxa / quadrat 18.0 ± 1.5; Total native taxa 107; Weeds /quadrat 0.8 ± 0.1; Total weed taxa 4

Altitude: 1420 – 1850 – 2040 m.

Diagnostic Taxa: Shrubs *Nematolepis ovatifolia* (81), *Olearia brevipedunculata* (76), *Prostanthera cuneata* (76), *Grevillea australis* (57), *Melicytus* sp. aff. *dentatus* (57), *Pimelea alpina* (48), *Orites lancifolia* (33), *Oxylobium ellipticum* (24), *Ozothamnus secundiflorus* (19), *Pimelea ligustrina* (19); **Herbs** *Viola betonicifolia* (62), *Poa hiemata* (57), *Poa fawcettiae* (48), *Erigeron nitidus* (43), *Euphrasia collina* subsp. *diversicolor* (24), *Helichrysum scorpioides* (19), *Poa ensiformis* (19)

Other Common Taxa: *Asperula gunnii* (52), *Carex breviculmis* (52), *Craspedia* spp. (*aurantia, jamesii*) (48)

Weeds: *Acetosella vulgaris* (67), *Cirsium vulgare* (5), *Festuca rubra* (5), *Hypochaeris radicata* (5)

Community 47: Bogong High Plains *Phebalium squamulosum – Bossiaea foliosa* closed heathland

Equivalent communities: *Phebalium-Bossiaea* heathland, Unit 2 (McDougall 1982).

Community 47 occurs throughout the Bogong High Plains on sites with shallow soil, often near the treeline or on lower rocky summits and ridges (Fig. 18). It may be dominated by *Prostanthera cuneata*, *Bossiaea foliosa* or *Orites lancifolia* (or any combination of these species). Tall shrubs such as *Phebalium squamulosum* subsp. *alpinum, Olearia phlogopappa* var. *flavescens* and *Ozothamnus alpinus* are occasional components. *Melicytus* sp. aff. *dentatus* and *Hovea montana* are commonly found beneath the upper shrub canopy with a sparse cover of herbs, of which *Poa hothamensis* is generally the most abundant. Shrub cover is often close to 100% whereas understorey cover may be minimal. The shrub canopy is usually 1 to 1.5 m in height. The community is common and widespread within a small geographic range. It is often the subject of slashing for ski slope maintenance in the resorts of Falls Creek and Mt Hotham.

No. quadrats 35; Native taxa / quadrat 16.5 ± 0.8; Total native taxa 73; Weeds /quadrat 0.9 ± 0.1; Total weed taxa 3

Altitude: 1610 – 1730 – 1830 m.

Diagnostic Taxa: Shrubs *Melicytus* sp. aff. *dentatus* (71), *Phebalium squamulosum* subsp. *alpinum* (71), *Hovea montana* (60), *Prostanthera cuneata* (51), *Bossiaea foliosa* (49), *Orites lancifolia* (49), *Grevillea australis* (46), *Olearia phlogopappa* var. *flavescens* (40), *Olearia frostii* (37), *Ozothamnus alpinus* (14); **Herbs** *Poa hothamensis* (94),

Fig. 17. An aerial view of Community 40 (*Epacris gunnii – Chionohebe pulvinatus* feldmark) at Northcote Pass on the Kosciuszko Main Range showing the mosaic of *Epacris gunnii* and rocky pavement. The walking track bisecting the community here is interrupting the slow movement of shrubs across the ridge.

Asperula gunnii (83), *Viola betonicifolia* (83), *Acaena novae-zelandiae* (57), *Leptinella filicula* (46), *Carex hebes* (43), *Helichrysum rutidolepis* (26), *Lagenophora stipitata* (17)

Other Common Taxa: *Carex breviculmis* (71), *Celmisia* spp. (46)

Weeds: *Acetosella vulgaris* (80), *Hypochaeris radicata* (9), *Cerastium glomeratum* (6)

Group XV – Central Victorian Alps rocky open heathlands

Community 48: *Podolobium alpestre* **-** *Euryomyrtus ramosissima* open heathland

Equivalent communities: Low alpine shrubland, subcommunity 2.2; Sparse rocky alpine heathland, subcommunity 3.1 (Walsh et al. 1984).

This is a structurally and ecologically distinctive community confined to exposed rocky peaks and associated clifflines of moderately high altitude in an area bounded approximately by Mt Cobbler, The Viking, Mt Howitt and Mt McDonald in Victoria. The substrate is derived from Palaeozoic sediments and is sometimes shaly. Soils are shallow, often confined to crevices in the rock, and runoff is high. Species in this community must be drought-tolerant to survive the extreme exposure over summer. The community is a sparse heathland with any or all of a mix of shrubs to c. 1 m high with the cliff-specialist graminoids *Poa fawcettiae*, *Austrodanthonia alpicola* and *Luzula novae-cambriae*. *Joycea pallida*, usually a tussock of lower altitudes is a surprising occasional component of this community. Some sites supporting this community are prone to trampling by hikers and sightseers, particularly on accessible summits like Mt Buller, and to erosion on slopes where the Alpine Walking Track passes through the community. Levels of visitation are generally not so high as to cause anything but localised damage.

No. quadrats 22; Native taxa / quadrat 14.6 ± 0.7; Total native taxa 86; Weeds /quadrat 0.7 ± 0.2; Total weed taxa 4

Altitude: 1380 – 1525 – 1800 m.

Diagnostic Taxa: Shrubs *Podolobium alpestre* (68), *Euryomyrtus ramosissima* (59), *Acacia siculiformis* (45), *Kunzea muelleri* (41), *Phebalium squamulosum* subsp. *alpinum* (32), *Crowea exalata* (32), *Micrantheum hexandrum* (32), *Westringia senifolia* (32), *Acacia alpina* (14), *Daviesia ulicifolia* (14), *Grevillea victoriae* subsp. *victoriae* (14); **Herbs** *Poa fawcettiae* (95), *Leucochrysum albicans* subsp. *alpinum* (59), *Bulbine bulbosa* (50), *Luzula novae-cambriae* (50), *Brachyscome spathulata* (45), *Austrodanthonia eriantha* (32), *Austrodanthonia alpicola* (27), *Joycea pallida* (18), *Lomandra oreophila* (18)

Other Common Taxa: *Carex breviculmis* (73), *Microseris* sp. 2 (41)

Weeds: *Hypochaeris radicata* (36), *Acetosella vulgaris* (27), *Aira caryophyllea* (5), *Spergularia media* (5)

Community 49: Snowy Range – Mt Buffalo *Kunzea muelleri* heathland

Equivalent communities: *Kunzea ericifolia* heathland, subcommunities 4.1, 4.2 & 4.3 (Walsh et al. 1984).

A low heathland of relatively dry, rocky sites of gentle gradient on the Snowy Range, Mt Speculation, Mt Buller, The Bluff and Mt Buffalo in Victoria (Fig. 19). The root-suckering shrub *Kunzea muelleri* is ubiquitous in this community, usually with a high cover which results in a relatively low species diversity. The shrub *Micrantheum hexandrum* is relatively uncommon throughout the Alps (often commoner beside streams below the treeline), but is frequent through the range of this community and helps to distinguish it from other, higher-altitude *Kunzea muelleri* heathlands of the Bogong High Plains and Kosciuszko areas. The tussock grasses, *Poa fawcettiae* and *Austrostipa nivicola* are common components and indicative of its dry environment. The tangled, shrubby nature of this community generally does not invite traverse by cattle or people so damage is usually slight and localised, and is reflected by the low weed abundance. Recovery of *Kunzea muelleri* after the 2003 fires on Mt Buffalo has been slow, by both seed and root sucker. It would appear that this shrub is relatively slow growing and that extensive areas are probably very old. Traffic across recovering areas of this community should be discouraged until establishment is well underway.

No. quadrats 17; Native taxa / quadrat 17.4 ± 1.3; Total native taxa 87; Weeds /quadrat 0.6 ± 0.1; Total weed taxa 2

Altitude: 1380 – 1545 – 1740 m.

Diagnostic Taxa: Shrubs *Kunzea muelleri* (100), *Hovea montana* (65), *Pimelea alpina* (59), *Euryomyrtus ramosissima* (29), *Micrantheum hexandrum* (24); **Herbs** *Carex breviculmis* (94), *Poa fawcettiae* (82), *Brachyscome spathulata* (71), *Austrostipa nivicola* (53), *Chiloglottis valida* (24), *Rhytidosporum procumbens* (24)

Other Common Taxa: *Asperula gunnii* (71), *Microseris* sp. 2 (53), *Grevillea australis* (47), *Leptorhynchos squamatus* subsp. *alpinus* (47), *Celmisia* spp. (41), *Craspedia* spp. (41), *Leucopogon* spp. (41), *Prasophyllum* spp. (41)

Weeds: *Hypochaeris radicata* (47), *Acetosella vulgaris* (12)

Community 50: *Olearia phlogopappa – Podolobium alpestre* closed heathland

Equivalent communities: Low alpine shrubland, subcommunity 2.1 (Walsh et al. 1984).

Community 50 is generally a dense shrubby community of rock outcrops, rocky slopes and gullies, resembling in many respects *Podocarpus lawrencei* heathland (Community 54), but lacking the dominant of that community. It has been recorded mainly from the Crosscut Saw between Mts Howitt and Cobbler, the high ridge between Mt Howitt and The Bluff and on Mt Buller with an outlier on Mt Cobberas 1. The rocks are mainly sedimentary, but igneous on Mt Buffalo and Mt Cobberas. The low diversity and near absence of herbaceous species is indicative of the rocky substrate permitting few footholds for shallow-rooted species. Most dominant species in this community are obligate seed regenerators, as evidenced by the response to the fires of January 2003. This suggests that, to some extent, the distribution and abundance of this community may be linked to past fire history. Elevated rocky sites like this are subject to lightning strikes, and small local fires may result. Because of their exposure, slope and preponderance of obligate seed regenerators (which are generally slower to recover than resprouters), areas of this community recovering from the 2003 fires are prone to loss of the small amount of soil present in heavy rainfall events. There is little that is practicable to protect these sites, but where possible, access to foot traffic should be restricted.

No. quadrats 6; Native taxa / quadrat 18.5 ± 2.8; Total native taxa 58; Weeds /quadrat 1.3 ± 0.2; Total weed taxa 3

Altitude: 1660 – 1695 – 1760 m.

Diagnostic Taxa: Shrubs *Olearia phlogopappa* var. *flavescens* (100), *Podolobium alpestre* (83), *Pimelea axiflora* subsp. *alpina* (67), *Tasmannia xerophila* (67); **Herbs** *Stellaria pungens* (83), *Polystichum proliferum* (50), *Wahlenbergia gloriosa* (33)

Other Common Taxa: *Acaena novae-zelandiae* (50), *Asperula gunnii* (50), *Hovea montana* (50), *Leucopogon hookeri* (50), *Oreomyrrhis eriopoda* (50), *Poa fawcettiae* (50), *Trisetum spicatum* (50)

Weeds: *Acetosella vulgaris* (83), *Hypochaeris radicata* (50), *Epilobium ciliatum* (17)

Fig. 18. Closed heathland dominated by *Prostanthera cuneata*, *Orites lancifolia* and *Phebalium squamulosum* var. *alpinum* in Rocky Valley on the Bogong High Plains (Community 47). This community is generally found on the upper slopes of subalpine valleys and may extend into adjoining Snow Gum woodland.

Fig. 19. Snowy Range – Mount Buffalo *Kunzea muelleri* heathland (Community 49) on Mt Buffalo. Shrubs associated with *K. muelleri* here include *Acacia alpina*, *Boronia algida*, *Grevillea australis* and *Micrantheum hexandrum*.

Group XVI – rocky outcrop open heathland

Community 51: *Austrodanthonia alpicola – Grevillea australis* open heathland

Equivalent communities: *Brachycome nivalis – Danthonia alpicola* alliance (Costin 1954); *Poa hothamensis* (rocky) grassland, Unit 13 (McDougall 1982); *Brachyscome-Austrodanthonia* tall alpine herbfield (Costin et al. 2000).

Community 51 occurs on cliffs and other rocky outcrops from Mt Buller to the Bogong High Plains in Victoria and from the Main Range to Kiandra in New South Wales. Although described in the past as a grassland dominated by *Austrodanthonia alpicola*, this community often has a significant component of shrubs (mostly *Grevillea australis, Leucopogon montanus* or *Podocarpus lawrencei*). Plant cover in general is minimal. Despite the occurrence of local endemics (e.g. *Poa hothamensis* and *Euphrasia crassiuscula* on the Bogong High Plains), this community spans geographic areas, perhaps because of the large number of character species that are commonly found throughout its range (e.g. *Austrodanthonia alpicola, Brachyscome nivalis, Brachyscome rigidula, Crassula sieberiana, Deyeuxia monticola, Luzula novae-cambriae*) but rarely in other communities. Examples on the cliffs above Blue Lake in Kosciuszko National Park are possibly threatened by rock climbing. Examples elsewhere may be damaged by tourists climbing rocky outcrops for better views but the overall threat to the community from these activities is currently low.

No. quadrats 32; Native taxa / quadrat 21.2 ± 0.9; Total native taxa 132; Weeds /quadrat 1.5 ± 0.1; Total weed taxa 4

Altitude: 1420 – 1790 – 2180 m.

Diagnostic Taxa: Shrubs *Grevillea australis* (59), *Leucopogon* spp. (*hookeri, montanum*) (59), *Pimelea axiflora* subsp. *alpina* (31), *Podocarpus lawrencei* (22); **Herbs** *Poa hothamensis* (72), *Austrodanthonia alpicola* (50), *Brachyscome rigidula* (50), *Crassula sieberiana* (50), *Trisetum spicatum* (50), *Luzula novae-cambriae* (47), *Brachyscome nivalis* (41), *Epilobium billardierianum* (41), *Polystichum proliferum* (31), *Aciphylla glacialis* (28), *Leucochrysum albicans* subsp. *alpinum* (28), *Deyeuxia monticola* (25), *Ewartia nubigena* (22), *Scleranthus singuliflorus* (22), *Euphrasia crassiuscula* (19), *Geranium potentilloides* (19), *Scleranthus diander* (19), *Chrysocephalum semipapposum* (16), *Wahlenbergia gloriosa* (9), *Austrodanthonia oreophila* (6)

Other Common Taxa: *Carex breviculmis* (78), *Craspedia* spp. (*aurantia, jamesii*) (56), *Celmisia* spp. (*costiniana, pugioniformis*) (50), *Viola betonicifolia* (41)

Significant Taxa: *Euphrasia crassiuscula* subsp. *glandulifera*

Weeds: *Acetosella vulgaris* (63), *Hypochaeris radicata* (41), *Taraxacum officinale* (16), *Spergularia rubra* (3)

Group XVII – ACT rocky outcrop mallee shrubland

Community 52: *Eucalyptus debeuzevillei* mallee shrubland

Equivalent communities: Group 15 (Helman et al. 1988).

This community is a shrubland with scattered mallee *Eucalyptus debeuzevillei*. It is restricted to the rocky upper slopes of peaks such as Mt Scabby and Mt Kelly on the ACT / NSW border. The community is characterised by its high diversity of shrub species, three of which (*Epacris robusta*, *Phebalium squamulosum* subsp. *ozothamnoides* and *Leptospermum namadgiensis*) are not known from other treeless communities, and low diversity of herbs.

No. quadrats 4; Native taxa / quadrat 19.8 ± 3.6; Total native taxa 51; Weeds /quadrat 1.0 ± 0.0; Total weed taxa 3

Altitude: 1720 – 1780 – 1810 m.

Diagnostic Taxa: Shrubs *Eucalyptus debeuzevillei* (100), *Oxylobium ellipticum* (100), *Podolobium alpestre* (100), *Epacris robusta* (75), *Phebalium squamulosum* subsp. *ozothamnoides* (75), *Kunzea muelleri* (50), *Leptospermum namadgiensis* (50), *Podocarpus lawrencei* (50), *Westringia lucida* (50); **Herbs** *Viola improcera* (100), *Caladenia alpina* (50), *Derwentia perfoliata* (50), *Helichrysum scorpioides* (50)

Other Common Taxa: *Luzula* spp. (75), *Asterolasia trymalioides* (50), *Leucopogon hookeri* (50), *Pimelea linifolia* subsp. *caesia* (50), *Poa phillipsiana* (50), *Senecio pinnatifolius* var. *alpinus* (50), *Stellaria pungens* (50)

Significant Taxa: *Viola improcera*

Weeds: *Acetosella vulgaris* (50), *Hypochaeris radicata* (50), *Taraxacum officinale* (25)

Group XVIII – boulder heathlands

Community 53: *Podocarpus lawrencei – Epacris paludosa* closed heathland

Equivalent communities: *Baeckea gunniana – Richea continentis* association (McVean 1969)

Community 53 is a closed heathland that straddles many small creeks in Kosciuszko National Park, often where water flows amongst large boulders (e.g. Guthrie Creek, Hedley Tarn, Mt Selwyn), and is occasionally found at the edge of large waterways (e.g. Tooma River). In the classification, only one quadrat from Victoria (Lankeys Plain) was included but the community has probably been undersampled there as examples are often narrow and intergrade imperceptibly with other communities. The community is dominated by tall shrubs, commonly *Podocarpus lawrencei*, *Epacris paludosa, Tasmannia xerophila* and *Baeckea utilis*. Herbs are generally sparse under the dense shrub canopy. This community does not appear to be under threat at present, although examples are found in ski resorts.

No. quadrats 13; Native taxa / quadrat 22.2 ± 2.4; Total native taxa 102; Weeds /quadrat 0.8 ± 0.5; Total weed taxa 6

Altitude: 1280 – 1680 – 1950 m.

Diagnostic Taxa: Shrubs *Podocarpus lawrencei* (92), *Epacris paludosa* (75), *Tasmannia xerophila* (75), *Baeckea utilis* (67), *Olearia phlogopappa* var. *flavescens* (58), *Pimelea bracteata* (58), *Oxylobium ellipticum* (42), *Ozothamnus secundiflorus* (33), *Leucopogon maccraei* (17); **Herbs** *Acaena novae-zelandiae* (92), *Blechnum penna-marina* (92), *Viola betonicifolia* (83), *Epilobium gunnianum* (50), *Geranium potentilloides* (42), *Gonocarpus montanus* (42), *Helichrysum rutidolepis* (33), *Polystichum proliferum* (33), *Chionochloa frigida* (25), *Dianella tasmanica* (25), *Huperzia australiana* (25)

Other Common Taxa: *Poa hiemata* (50), *Asperula gunnii* (42), *Empodisma minus* (42), *Richea continentis* (42)

Weeds: *Acetosella vulgaris* (38), *Cerastium glomeratum* (8), *Cirsium vulgare* (8), *Festuca rubra* (8), *Hypochaeris radicata* (8), *Taraxacum officinale* (8)

Community 54: *Podocarpus lawrencei* closed heathland

Equivalent communities: part of *Oxylobium ellipticum – Podocarpus alpinus* alliance (Costin 1954); *Podocarpus lawrencei* association (McVean 1969); *Podocarpus* heathland, Unit 1 (McDougall 1982); *Podocarpus* heathland, subcommunity 1.1 (Walsh et al. 1984).

Closed heathland dominated by *Podocarpus lawrencei* occurs in areas of minimal soil development and abundant large rocks (Fig. 20). The community is found in Victoria (on the Bogong High Plains, Mt Hotham area, Mt Howitt, Mt Buffalo, Cobberas and Crosscut Saw) and New South Wales (between Mt Kosciuszko and Mt Jagungal with an outlier in the Happy Jacks Plain area) but apparently not in the ACT. Examples have been recorded on metamorphic rock, where the dominant species, *Podocarpus lawrencei*, layers over large rock slabs, on granite boulder streams and outcrops, and on basalt scree. Species richness is commonly low and in sites with large rocks and no exposed soil there were often only one or two species per quadrat. After the 2003 fires, the diversity of many *Podocarpus lawrencei* heathlands increased. *Pelargonium helmsii*, a species rarely recorded prior to 2003, was found to be common in many burnt *Podocarpus lawrencei* heathlands in Kosciuszko National Park. A population of *Senecio velleioides*, normally a species of wet forest, was located in this community two years after the fire, at 1880 m a.s.l. on Blue Cow Mountain, the first record in treeless vegetation in the Australian Alps. *Podocarpus lawrencei* heathland is highly restricted and the primary habitat for the Mountain Pygmy Possum, an endangered mammal. Surveys of regeneration following the 2003 fires suggest that recovery of many stands will be slow and patchy, and some may not recover at all in the short term. Basal regeneration has been observed in some populations in the ACT and Cobberas (Carey et al. 2003, Tolsma et al. 2004) but none had been observed in populations in Kosciuszko National Park three years after the fires (McDougall and Broome unpublished data). Resprouting of partially burnt stems did occur throughout its range but it tended to be rare and much of the regeneration subsequently died. Seedlings were observed in the summer following the fire but these have been rare or patchy at some sites. At Mt Blue Cow, for instance, very few seedlings could be found in the summit area. Further downslope, seed germination did occur in the three snow-free seasons following the fire and seedlings were locally abundant. Supplementary planting of *Podocarpus lawrencei* may be necessary in the summit area of Mt Blue Cow if the community is to persist there with its structural dominant. This task will be very difficult because there is little soil in which to plant.

No. quadrats 24; Native taxa / quadrat 8.8 ± 1.2; Total native taxa 65; Weeds /quadrat 0.5 ± 0.3; Total weed taxa 6

Altitude: 1400 – 1745 – 2080 m.

Diagnostic Taxa: Shrubs *Podocarpus lawrencei* (100), *Pimelea ligustrina* (63), *Olearia phlogopappa* var. *flavescens* (46), *Tasmannia xerophila* (46), *Orites lancifolia* (38), *Nematolepis ovatifolia* (17); **Herbs** *Polystichum proliferum* (50), *Uncinia flaccida* (17)

Weeds: *Acetosella vulgaris* (29), *Arenaria serpyllifolia* (4), *Cerastium vulgare* (4), *Hypochaeris radicata* (4), *Taraxacum officinale* (4), *Trifolium repens* (4)

Group XIX – boulder herbaceous communities

Community 55: *Carex appressa* sedgeland

Equivalent communities: Part of *Carex appressa* sedgeland, Unit 12 (McDougall 1982).

Carex appressa sedgeland occupies basalt block streams on the Bogong High Plains. Whilst this is also the habitat for Communities 54 and 56, Community 55 is found in block streams that are partly or largely covered with soil and where the habitat is moist. Species diversity is low and weeds are relatively common. Communities dominated by *Carex appressa* may also be found below the treeline in the Australian Alps. These appear to be floristically distinct and are not included in Community 55. Most or all examples of this community were burnt in the January 2003 fires. The long-term effects of the fires are currently unknown but in general, *Carex* species regenerate rapidly after fire due to their deep, fire-protected, rhizomes.

No. quadrats 3; Native taxa / quadrat 12.7 ± 1.5; Total native taxa 19; Weeds /quadrat 2.3 ± 0.3; Total weed taxa 5

Altitude: 1710 – 1735 – 1780 m.

Diagnostic Taxa: Herbs *Carex appressa* (100), *Blechnum penna-marina* (67), *Hydrocotyle sibthorpioides* (67), *Alchemilla* sp. (33)

Other Common Taxa: *Acaena novae-zelandiae* (67), *Epacris paludosa* (67), *Hypericum japonicum* (67), *Oreomyrrhis ciliata* (67), *Poa costiniana* (67), *Ranunculus victoriensis* (67)

Weeds: *Trifolium repens* (67), *Cerastium vulgare* (33), *Lotus corniculatus* (33), *Mimulus moschatus* (33), *Taraxacum officinale* (33)

Community 56: *Poa helmsii* grassland

Equivalent communities: Part of *Carex appressa* sedgeland, Unit 12 (McDougall 1982)

Poa helmsii grassland occupies rocky slopes of basalt areas on the western edge of the Bogong High Plains. Examples tend to be linear, possibly indicating that they inhabit soil-filled block streams. Sites are much drier than those of Community 55, which occurs in similar habitat. *Poa helmsii* is the dominant species of this species-poor community, although *Carex appressa* (the dominant of Community 55) is also present. Weeds are relatively common. Most or all examples of this community were burnt in the January 2003 fires. The effects of the fires are unknown, but generally, *Poa* species are rapid post-fire colonisers with plants either resprouting from protected shoots or establishing from seedlings.

No. quadrats 5; Native taxa / quadrat 12.4 ± 1.3; Total native taxa 24; Weeds /quadrat 2.0 ± 0.4; Total weed taxa 3.

Altitude: 1730 – 1755 – 1800 m.

Diagnostic Taxa: Herbs *Acaena novae-zelandiae* (100), *Carex appressa* (100), *Poa helmsii* (100), *Melicytus* sp. aff. *dentatus* (80), *Asperula pusilla* (40)

Other Common Taxa: *Poa costiniana* (60), *Stellaria pungens* (60), *Viola betonicifolia* (60)

Weeds: *Acetosella vulgaris* (100), *Taraxacum officinale* (60), *Trifolium repens* (40)

Significant Plant Communities

Whilst all plant communities of the treeless area in the Australian Alps are of high conservation significance, some communities are of especial significance because of their small extent or the high degree of threat operating on them. The following communities have either already been identified as threatened under environmental legislation or might be considered so using criteria similar to those used by the IUCN for individual species.

Peat-based wetlands.

The Montane Peatlands endangered ecological community listed under the NSW *Threatened Species Conservation Act 1995* (TSC Act) incorporates Communities 2, 3 and 8. Community 6 will probably be part of the listing when it

is present within Community 2. Across their range in NSW, peat communities have been greatly reduced in extent by grazing, peat mining, fire and changes to hydrological systems (Whinam & Chilcott 2002). The Alpine Bog Community listed under the Victorian *Flora and Fauna Guarantee Act 1988* (FFG Act) includes Communities 1, 2, 3 and 4. The chief threatening process for peat communities in the Australian Alps is physical damage by trampling leading to loss of cover and alteration of local hydrology which leads to channelling of waterflow through the bog. This alteration of drainage patterns within and immediately outside the bog reduces its water-holding capacity, which in turn accelerates the degradation process. Damaged bogs are often identified by deeply channelled streams. Pristine bogs typically have little or no free running water. Although most alpine areas in the Australian Alps are now protected from grazing, human foot traffic remains a significant damaging process in many areas. Some bogs remain unprotected from cattle grazing on the Nunniong Plateau, and trampling by feral horses is an increasing threat in the Nunniong-Cobberas areas in Victoria, and the Tantangara and upper Thredbo valley areas in NSW. Significant areas of bog have been lost through the creation of lakes or dams for hydroelectricity production.

Snowpatches.

The Alpine Snowpatch Community, which is listed under the Victorian FFG Act, includes Communities 17 and 20. Throughout the Australian Alps, these communities are extremely rare and highly susceptible to damage (in the past by cattle and presently by human foot traffic) and the consequent risk of erosion and/or incursion into the low grass/forb sward by shrubs. Because of their dependence on late-lying snowpacks, these communities are amongst the most likely to be affected by elevated temperatures due to the greenhouse effect. A future National listing of snowpatch

Fig. 20. *Podocarpus lawrencei* closed heathland (Community 54) is found in areas with a deep profile of fragmented rock (usually basalt or granite) and minimal soil. In some examples (especially on sites of low relief), rocks may be small (a few cm in diameter). More commonly, rocks are large boulders (to several m in diameter in granitic areas) or slabs (especially in metamorphic areas). Species diversity is low and *Podocarpus lawrencei* is the dominant in all examples. An outlier of the community near Happy Jacks Plain is shown – the edges were burnt in the 2003 fire. The rock type here is basalt.

communities might include Communities 12, 13, 17 and 20. It might also include Community 11 (*Celmisia sericophylla* herbfield), most examples of which are narrow strips within snowpatch vegetation.

Short alpine herbfield.

The *Caltha introloba* Herbland Community, which is listed under the Victorian FFG Act, is referable to Community 10 (short alpine herbfield) above. In Victoria it is regarded as threatened because of its extreme rarity, its susceptibility to change in local hydrology and to damage by trampling. It is known by a very few examples on the Bogong High Plains. Although more common in the Kosciuszko area between the Ramshead Range and Mt Jagungal, short alpine herbfield has a very small area of occupancy and is threatened by changes in hydrology, which may result from global climate change.

Fens.

Under the Victorian FFG Act definition, fens include both Community 6 and 8. In the Victorian Alps, permanent standing water is less common than it is in New South Wales. There are no natural lakes above the treeline and the largest pools are less than c. 0.5 ha, and usually under 100m^2 in extent. The main threat to fens in Victoria has been identified as physical disturbance, primarily by cattle. Since cattle will be excluded from the Alpine National Park, there will remain only a few fens on the Nunniong Plateau likely to be accessed by stock. Nonetheless, increasing feral horse and sambar deer numbers remain a threat to the community, and any of the processes that impinge on the hydrology of bogs (which are usually part of the same alpine wetland complex) are also likely to have impacts on fens. In NSW, fens are included in the Montane Peatlands endangered ecological community under the TSC Act.

Epacris gunnii – Chionohebe pulvinatus *Feldmark*.

Although this community tends to develop on any eroded surface of suitable geology on the Kosciuszko Main Range, its overall extent is very small. It is threatened in places by trampling by bushwalkers, although this is minor at present (McDougall & Wright 2003). The community may face a much greater threat if predicted less severe climatic conditions allow the invasion of species from adjoining communities.

Podocarpus *closed heathland*.

This community is the primary habitat of the endangered Mountain Pygmy Possum (*Burramys parvus*). It occupies a very small area within the Australian Alps. Many examples were burnt in the fires of 2003. Regeneration of the dominant *Podocarpus lawrencei* has been variable but it will clearly take decades until the new cohort reaches reproductive maturity. Until that time, burnt patches are especially vulnerable to further fires and any other process that hinders the development of the dominant.

Epacris celata – Poa clivicola *open heathland*.

Community 42 has only been recorded on McPhersons Plain, west of Kosciuszko National Park. Although it probably also occurs on neighbouring treeless areas (Tomneys and Sparkes Plains), none is in a conservation reserve. Parts of McPhersons Plain are in State Forest lease, the remainder is freehold land. The State Forest lease is currently managed by the lessee for the protection of the significant species and vegetation of the Plain but there is no long-term security for these important values. The community supports two listed threatened species (*Diuris pedunculata* and *Prasophyllum bagoensis*) and several undescribed orchids that are probably of restricted distribution (David Jones, CSIRO, pers. comm.).

Themeda triandra – Leucochrysum albicans *grassland*.

This grassland is extremely localised, being restricted to areas of limestone in Kosciuszko National Park, principally Cave Creek (with minor occurrences at Yarrangobilly). It is especially vulnerable to weed invasion. The examples at Yarrangobilly were dominated by weeds following the 2003 fires and it is not clear if the native species will again attain dominance. The Cave Creek examples have less cover of weeds (even where they were burnt) but the diversity of weeds is great in the Cave Creek area and there is potential for further degradation of floristic values through weed spread. *Potentilla recta* and *Sedum acre* are significant threats.

Bossiaea riparia *dwarf heathland*.

Community 43 has a very small area of occupancy. Although there are few immediate threats to the community (small areas have been damaged by off-road vehicles), the main areas currently containing Community 43 at Gulf Plain were largely bare in 1970 (judging from aerial photos taken at that time). The reasons for the lack of vegetative cover are unknown but the community has clearly undergone major natural regeneration in recent times.

Poa hookeri *grassland*.

Grassland dominated by *Poa hookeri* (Community 31) is reasonably common in a few places in Kosciuszko National Park (e.g. Nungar Plain, Happy Jacks Plain). This grassland contains a large number of significant species but is under great threat. It appears to be a favoured food source for pigs and large patches of this community have been turned over in the last decade. It is not clear if damaged areas regenerate to Community 31 or to 30, the latter of which is the more common in Plains where Community 31 occurs.

Discussion

Although the treeless vegetation of the Australian Alps occupies a very small area (c. 160,000 ha), it has exceptional diversity – comprising 710 native plant taxa and 56 communities. Even at single locations there may be great

diversity. On the Kosciuszko Main Range, for instance, an area of 10,000 ha, 212 native taxa (Costin et al. 2000) and 18 plant communities (this study) have been recorded. McDougall & Walsh (2002) recorded almost 200 native taxa on one subalpine plain in Kosciuszko National Park (Nungar Plain).

The communities identified above are largely in accord with previous classifications; 46 of the communities have an analog. Ten new communities were identified, however, all in the subalpine portion of Kosciuszko National Park, where there had been very little floristic survey previously. Further survey of communities with a low sample size and great variation between quadrats (i.e. Communities 9, 33, 34, 35, 42, 43 and 52) is warranted to determine if these are variants of others or if there are additional unidentified communities within them.

The treeless areas have been intensively utilised since European settlement, initially as summer pastures but more recently as water catchments for electricity production and as tourist attractions both in winter and summer. The impact of that use is still obvious as slowly revegetating scars (e.g. the old steps from Rawsons Pass to Mt Kosciuszko), widespread infrastructure (e.g. roads, tracks, fences, ski lifts and powerlines) and the presence of exotic species, many of which were deliberately introduced. The treeless communities of the Australian Alps have demonstrated remarkable resilience from the effects of their many uses as they have following the fires of January 2003. It is not possible to foretell, however, how much greater pressure the communities can sustain.

Treeless plant communities have undergone considerable change over the past 70 years and are likely to be under increasing pressure in the future with predicted changes to mountain climate. Current models of global warming predict elevation of mean temperatures in south-eastern Australia and, most probably, the normal winter snowline. Changes in the abundance of alpine plant communities because of global warming have been predicted (Pickering & Armstrong 2003). There is certainly likely to be a contraction of treeless areas, since tree establishment is controlled by low temperature in the growing season (Harwood 1980, Slatyer 1989). The expansion of tree islands last Century is noticeable on aerial photographs of the Bogong High Plains and Kosciuszko National Park (McDougall 2003, unpublished data) but it is impossible to irrefutably attribute this spread to global warming. If there are significant reductions in rainfall and snowfall associated with global warming, some wetland and snowpatch communities may also contract. A major shift from grassland to heathland during the 20th Century was noted on the Bogong High Plains in areas grazed by cattle (McDougall 2003, Bruce et al. 1999) and in Kosciuszko National Park after 1970 in areas no longer grazed by domestic stock (McDougall unpublished data). The shift is therefore independent of grazing regime. Similar changes in arctic vegetation have been attributed to the effects of global warming (Sturm et al. 2001) and the global contraction of glaciers attest to the potency of this phenomenon. The broadscale extinction of alpine plant species because of global warming seems less likely in the short-term because very few species have such a narrow ecological and altitudinal tolerance, but it can be expected in the medium to long-term.

One consequence of increased mean temperatures may be the invasion of the alpine zone by weeds. Few weed species have successfully established and persisted in the alpine zone. Costin et al. (2000) noted 48 species as having been recorded on the Kosciuszko Main Range but only 14 of these had persisted. There is a significant inverse correlation between altitude and the number of weed species recorded in treeless vegetation in the Australian Alps (McDougall et al. 2005). Whilst this probably indicates that the mountain climate acts as a sieve of weeds, 43% of weed species recorded in treeless vegetation occur in the 400 m altitude band below the alpine zone. A small increase in mean temperature could facilitate the upward invasion of many new weed species.

Pressures from tourist activities on treeless vegetation may be managed but they will continue, such is the popularity of the high mountain environment. The task of land managers is to minimise or eliminate other pressures. Introduced herbivores having a demonstrable impact (e.g. pigs, rabbits and feral horses) should be eradicated where possible. Their spread and impact has increased noticeably in recent years and there is no reason to suggest these will not continue at an accelerated rate. The impact of hares should be assessed and control measures initiated if they are having a detrimental impact. The planting of non-indigenous plant species should not be permitted in the subalpine or alpine zone and consideration should be given to removing exotic species already planted in some ski resort gardens. Many species have escaped from ski resort gardens (McDougall & Appleby 2000) and, although some escapes have been successfully controlled (e.g. around Mt Buffalo Chalet), their management seems an unnecessary cost. In addition, the continual introduction of new species into gardens will invite a further suite of escapes, most of which have been selected for their capacity to grow in cold conditions.

Sound management of treeless vegetation in the Australian Alps has been based on long-term monitoring and research. With the rapid changes occurring in the vegetation from fire, climate change, and recovery from grazing, and the exceptional significance of the vegetation and flora, it is critical that the research programs set up with foresight by early mountain ecologists be continued and expanded to chart the rapid changes that are clearly occurring in the vegetation, and to react to them accordingly.

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Appendix 1. Vascular plants of treeless vegetation in the Australian Alps

The list was compiled from quadrats sampled and used in the current study, our incidental observations, the lists of Thompson & Gray (1981), Helman & Gilmour (1985) (vegetation groups 1, 3, 4, 5 & 6) and Helman et al. (1988) (vegetation groups 8, 10, & 12).

[1]Distribution: a = on the Australian mainland restricted to treeless vegetation in the Australian Alps (but may extend for a short distance into adjoining snow gum woodland), 1 = occurring in alpine vegetation in Tasmania (Kirkpatrick 1997), 2 = occurring in alpine vegetation in New Zealand (Mark & Adams 1995), 3 = occurring in other locations outside Australia; b = commonly occurring in treeless vegetation of the Australian Alps but present elsewhere (at lower elevation and / or beyond the Australian Alps); c = occurring rarely in treeless vegetation of the Australian Alps and more common in vegetation elsewhere. * = non-native species (listed only if recorded from natural vegetation).

Taxon	% quadrats	% communities	Distribution[1]
FERNS & FERN ALLIES			
Adiantaceae			
Cheilanthes austrotenuifolia			c
Cheilanthes distans			c
Pellaea falcata			c
Aspleniaceae			
Asplenium flabellifolium	0.8	11	b
Asplenium trichomanes subsp. *quadrivalens*			c
Pleurosorus rutifolius			c
Athyriaceae			
Cystopteris tasmanica			a[12]
Blechnaceae			
Blechnum fluviatale	0.2	2	c
Blechnum penna-marina subsp. *alpina*	4.1	31	b
Blechnum vulcanicum			a
Dennstaedtiaceae			
Pteridium esculentum			c
Dryopteridaceae			
Polystichum proliferum	5.1	35	b
Gleicheniaceae			
Gleichenia dicarpa			c
Grammitidaceae			
Grammitis poeppigiana			a[12]
Hymenophyllaceae			
Hymenophyllum peltatum			a
Isoetaceae			
Isoetes muelleri			c
Lycopodiaceae			
Huperzia australiana	1.4	9	a
Lycopodium fastigiatum	8.3	39	b
Lycopodium scariosum	0.6	6	a[12]
Ophioglossaceae			
Botrychium australe			b
Botrychium lunaria			a[1]
Ophioglossum lusitanicum subsp. *coriaceum*	2.1	13	b
Osmundaceae			
Todea barbara			c
CONIFERS			
Pinaceae			
**Pinus contorta*			
Podocarpaceae			
Podocarpus lawrencei	4.6	20	b
MONOCOTYLEDONS			
Amaryllidaceae			
**Narcissus pseudonarcissus*			
Anthericaceae			
Arthropodium milleflorum	5.2	31	b
Arthropodium minus	0.3	2	c
Arthropodium strictum			c
Caesia alpina	4.0	28	a
Thysanotus tuberosus subsp. *tuberosus*			c
Asphodelaceae			
Bulbine bulbosa	3.8	17	b
Bulbine aff. *glauca* (Nungar Plain)	0.2	4	a
Asteliaceae			
Astelia alpina var. *novae-hollandiae*	9.6	19	a
Astelia psychrocharis	1.7	9	a
Colchicaceae			
Burchardia umbellata			c
Wurmbea dioica	0.1	2	c
Cyperaceae			
Baumea acuta			c
Baumea gunnii	0.4	4	c
Carex alsophila	0.1	2	c
Carex appressa	6.0	33	b
Carex archeri			a[1]
Carex blakei	3.0	13	a
Carex breviculmis	56.2	87	b
**Carex buxbaumii*			
Carex canescens	1.6	15	a[13]
Carex capillacea	1.0	13	a[1]
Carex cephalotes	0.7	6	a[12]
Carex chlorantha	0.7	7	b
Carex echinata	1.1	11	a[23]

Carex fascicularis	0.1	2	c
Carex gaudichaudiana	26.3	48	b
Carex hebes	18.7	72	a
Carex hypandra	0.8	4	a[1]
Carex incomitata	0.4	4	c
Carex inversa	0.8	7	c
Carex iynx	0.1	2	c
Carex jackiana	4.1	30	a[3]
**Carex ovalis*			
Carex paupera	0.1	2	a
Carex raleighii	0.2	4	a[1]
Carex tereticaulis			c
Carpha alpina	1.1	7	a[123]
Carpha nivicola	8.3	20	a
Eleocharis acuta	0.2	2	c
Eleocharis gracilis	0.5	6	c
Eleocharis pusilla			c
Eleocharis sphacelata	0.1	2	c
Gahnia subaequiglumis			c
Isolepis alpina			a[1]
Isolepis aucklandica	5.4	15	b
Isolepis crassiuscula	5.3	19	b
Isolepis fluitans	0.5	7	c
Isolepis gaudichaudiana	0.1	2	a
Isolepis habra	0.5	6	b
Isolepis inundata			c
Isolepis montivaga	3.6	30	a[1]
Isolepis subtilissima	2.3	13	b
Lepidosperma curtisiae			c
Lepidosperma laterale	0.4	9	c
Oreobolus distichus	11.2	30	b
Oreobolus oxycarpus subsp. *oxycarpus*	2.1	9	a
Oreobolus pumilio subsp. *pumilio*	2.9	13	a[1]
Schoenus apogon	2.1	9	c
Schoenus calyptratus	5.7	37	a[1]
Uncinia compacta	0.2	2	a[1]
Uncinia flaccida	1.1	15	a[1]
Uncinia sinclairii			a[2]
Uncinia sulcata	0.4	4	a
Hypoxidaceae			
Hypoxis hygrometrica var. *hygrometrica*	2.1	7	b
Hypoxis hygrometrica var. *splendida*			a
Iridaceae			
Patersonia longifolia	0.1	2	c
Juncaeae			
Juncus alexandri subsp. *alexandri*	0.1	2	c
Juncus antarcticus	0.5	6	a[12]
**Juncus articulatus*	0.1	2	
Juncus australis	1.1	9	b
Juncus brevibracteus	0.9	9	a
Juncus bufonius	0.6	7	c
**Juncus bulbosus*			
**Juncus effusus*			
**Juncus ensifolius*			
Juncus falcatus	4.5	15	b
Juncus homalocaulis			c
Juncus phaeanthus	0.4	2	a
Juncus sandwithii	2.5	13	a[1]
Juncus sarophorus	0.2	2	c
Juncus subsecundus			c
**Juncus tenuis*			
Juncus thompsonianus	0.1	2	a
Juncus vaginatus			c
Luzula acutifolia subsp. *acutifolia*	0.7	7	a[1]
Luzula acutifolia subsp. *nana*	1.1	11	a
Luzula alpestris	4.1	35	a
Luzula atrata	2.0	11	a[1]
Luzula australasica subsp. *dura*	1.7	13	a
Luzula meridonalis var. *flaccida*	6.3	26	b
Luzula modesta	28.3	59	b
Luzula novae-cambriae	7.5	50	a[1]
Orchidaceae			
Caladenia alpina	1.4	20	b
Caladenia fitzgeraldii	0.2	2	c
Chiloglottis turfosa			a
Chiloglottis valida	1.6	11	b
Dipodium punctatum			c
Diuris monticola	4.6	20	a
Diuris pedunculata			c
Eriochilus cucullatus	0.9	11	c
Genoplesium turfosum			a
Microtis unifolia	0.1	2	c
Prasophyllum alpestre [a]	5.1	48	a[1]
Prasophyllum bagoensis			a
Prasophyllum sp. aff. *canaliculatum* (McPhersons Plain)			a
Prasophyllum candidum [a]			a
Prasophyllum montanum			a
Prasophyllum morganii			a
Prasophyllum niphopedium			a
Prasophyllum retroflexum [a]			a
Prasophyllum sphacelatum [a]	1.4	15	a
Prasophyllum tadgellianum [a]	1.2	15	a[1]
Pterostylis alpina			c
Pterostylis cycnocephala	0.2	6	c
Pterostylis dubia	0.1	2	c
Pterostylis furcata			c

Pterostylis monticola			c
Pterostylis mutica			c
Spiranthes australis subsp. *australis*	0.1	2	c
Thelymitra aristata			c
Thelymitra cyanea	4.9	11	a
Thelymitra ixioides var. *ixioides*			c
Thelymitra megcalyptra			c
Poaceae			
Agrostis australiensis	1.1	9	a
Agrostis bettyae [b]	0.1	2	c
**Agrostis capillaris*	1.0	22	
Agrostis joyceae [b]			a
Agrostis muelleriana	3.5	31	a[12]
Agrostis parviflora	3.0	35	a[1]
Agrostis propinqua [b]			b
**Agrostis stolonifera*	0.3	6	
Agrostis thompsoniae [b]			a
Agrostis venusta	7.5	48	b
**Aira caryophyllea*	1.1	13	
**Aira elegantissima*	0.1	2	
**Aira praecox*			
**Alopecurus pratensis*			
**Anthoxanthum odoratum*	1.4	13	
**Apera interrupta*			
**Arrhenatherum elatius*			
Australopyron velutinum	6.5	44	a[1]
Austrodanthonia alpicola	3.0	17	a
Austrodanthonia eriantha	2.0	19	b
Austrodanthonia laevis	2.9	22	b
Austrodanthonia linkii var. *fulva*			c
Austrodanthonia longifolia			c
Austrodanthonia monticola	0.2	2	c
Austrodanthonia oreophila	0.5	7	a
Austrodanthonia penicillata	0.5	9	b
Austrodanthonia pilosa	5.4	24	b
Austrodanthonia racemosa var. *racemosa*	1.1	11	b
Austrofestuca eriopoda			c
Austrofestuca hookeriana	3.8	9	b
Austrostipa nivicola	5.3	26	a
**Bromus carthaticus*			
**Bromus diandrus*			
**Bromus hordeaceus*	0.1	2	
**Bromus madritensis*			
**Bromus molliformis*			
Chionochloa frigida	1.4	11	a
**Cynosurus cristatus*			
**Dactylis glomerata*			
Deschampsia caespitosa	1.5	11	b
Deyeuxia affinis	1.5	11	a
Deyeuxia brachyathera	1.6	26	a[1]
Deyeuxia carinata	1.2	15	a[1]
Deyeuxia contracta			c
Deyeuxia crassiuscula	4.2	41	a
Deyeuxia gunniana	1.0	6	b
Deyeuxia innominata	0.7	7	a[1]
Deyeuxia monticola var. *monticola*	5.1	44	b
Deyeuxia quadriseta	0.5	7	c
Deyeuxia scaberula			c
Deyeuxia talariata	0.1	2	b
Dichelachne crinita	0.6	9	c
Dichelachne micrantha	1.4	7	c
Dichelachne rara	0.1	2	c
Echinopogon ovatus			c
Elymus scaber sens. lat.	4.0	28	b
Eragrostis brownii			c
**Festuca arundinacea*			
Festuca asperula	0.9	6	b
Festuca muelleri	1.1	17	a
**Festuca rubra*	0.4	9	
Hierochloe redolens	2.0	20	b
Hierochloe submutica	0.3	7	a
**Holcus lanatus*	1.8	15	
**Hordeum glaucum*			
Joycea pallida	0.7	7	c
Koeleria macrantha			c
Lachnagrostis aemula	1.6	13	b
Lachnagrostis avenacea	0.2	4	c
Lachnagrostis meionectes	0.5	7	a
**Lolium perenne*			
Microlaena stipoides var. *stipoides*	0.5	9	c
**Phleum pratense*	0.6	6	
**Poa annua*	0.1	2	
Poa clivicola	7.0	33	a[1]
Poa costiniana	40.4	70	a[1]
Poa ensiformis	0.3	2	c
Poa fawcettiae	30.8	74	a[1]
Poa helmsii	1.1	11	b
Poa hiemata	30.3	70	a[1]
Poa hookeri	2.4	7	b
Poa hothamensis var. *hothamensis*	13.7	33	a
Poa labillardierei var. *acris*			a[1]
Poa labillardierei var. *labillardieri*	1.6	13	b
Poa petrophila	1.7	13	b
Poa phillipsiana	6.9	37	a
**Poa pratensis*	2.5	17	
Poa saxicola	2.6	26	a[1]
Poa sieberiana var. *cyanophylla*	0.2	2	c
Poa sieberiana var. *hirtella*			c

Poa sieberiana var. *sieberiana*	0.5	6	c
Rytidosperma australe	0.2	2	a[12]
Rytidosperma nivicolum	4.7	24	a[1]
Rytidosperma nudiflorum	23.4	70	a[1]
Rytidosperma pumilum	0.2	2	a[2]
Rytidosperma vickeryae	0.2	2	a
Tetrarrhena turfosa			c
Themeda triandra (*T. australis*)	2.3	17	c
Trisetum spicatum subsp. *australiense*	23.9	69	b
**Vulpia bromoides*	1.3	17	
**Vulpia myuros*			
Phormiaceae			
Dianella admixta			c
Dianella sp. aff. *tasmanica*	0.7	9	b
Herpolirion novae-zelandiae	2.0	17	a[12]
Thelionema caespitosum			c
Potamogetonaceae			
Potamogeton cheesemanii			c
Restionaceae			
Baloskion australe	10.9	30	b
Empodisma minus	32.0	59	b
Xanthorrhoeaceae			
Lomandra longifolia var. *exilis*			c
Lomandra sp. aff. *oreophila* (McPherson's Plain NSW)	0.2	2	
Lomandra oreophila	2.5	13	a
DICOTYLEDONS			
Alseuosmiaceae			
Wittsteinia vacciniacea	1.0	2	c
Apiaceae			
Aciphylla glacialis	7.4	46	a
Aciphylla simplicifolia	10.2	41	a
Actinotus bellidioides			a
Actinotus moorei			a[1]
Daucus glochidiatus	0.2	4	c
Dichosciadium ranunculaceum var. *ranunculaceum*	0.3	2	a
Diplaspis nivis	4.0	13	a
Eryngium vesiculosum			c
Gingidia algens	0.2	2	a
Gingidia harveyana	0.2	6	a
Hydrocotyle algida	8.2	30	a
Hydrocotyle sibthorpioides	4.9	31	b
Hydrocotyle tripartita	1.1	7	b
Lilaeopsis polyantha	0.5	6	b
Oreomyrrhis argentea	4.2	15	a[1]
Oreomyrrhis brevipes	0.6	6	a
Oreomyrrhis ciliata	10.5	41	a[1]
Oreomyrrhis eriopoda	30.7	76	b
Oreomyrris pulvinifica	1.7	6	a
Oschatzia cuneifolia	2.5	13	a
Platysace lanceolata			c
Schizeilema fragoseum	0.5	7	a
Trachymene anisocarpa			c
Trachymene humilis subsp. *brevicaule*	2.2	19	a[1]
Trachymene humilis subsp. *humilis*	0.1	2	c
Araliaceae			
Polyscias sambucifolia			c
Asteraceae			
Abrotanella nivigena			a[3]
**Achillea millefolium*	0.2	4	
Argyrotegium fordianum	7.8	41	a[1]
Argyrotegium mackayi	6.6	41	a[1]
Argyrotegium nitidulum	1.6	13	a[2]
Argyrotegium poliochlorum	1.6	13	a[1]
Brachyscome aculeata	2.9	19	b
Brachyscome decipiens	19.0	48	b
Brachyscome graminea	0.2	2	b
Brachyscome nivalis	5.1	30	a
Brachyscome obovata	4.2	17	a
Brachyscome radicans	0.6	7	a[1]
Brachyscome rigidula	4.9	28	b
Brachyscome scapigera	12.0	37	b
Brachyscome spathulata subsp. *spathulata*	15.9	61	b
Brachyscome stolonifera	2.5	9	a
Brachyscome tadgellii			
Brachyscome sp. 1 (*sensu* Ross & Walsh 2003)	0.2	4	a
Brachyscome sp. 2 (*sensu* Ross & Walsh 2003)			a
Brachyscome sp. 3 (*sensu* Ross & Walsh 2003)	0.5	4	a
Calotis glandulosa	0.3	4	b
Calotis pubescens	0.1	2	a
Calotis scabiosifolia var. *integrifolia*	0.1	2	b
Cassinia aculeata			c
Cassinia longifolia			c
Cassinia monticola	3.8	22	a
Cassinia ochracea	0.1	2	a
Celmisia costiniana[c]	5.6	31	a
Celmisia latifolia[c]			a
Celmisia pugioniformis[c]	9.5	33	b
Celmisia sericophylla	0.6	4	a
Celmisia tomentella[c]	1.3	15	b
Celmisia sp. aff. *pugioiformis* (supalpine wetlands)[c]	0.3	4	b
Centipeda cunninghamii			c
Centipeda minima			c
Chrysocephalum apiculatum	0.3	4	c

Chrysocephalum semipapposum	2.2	13	b
**Cirsium arvense*			
**Cirsium vulgare*	1.0	13	
**Chondrilla juncea*			
**Conyza bonariensis*			
Cotula alpina	10.5	33	a[1]
Craspedia adenophora (sp. B *sensu* Costin et al. 2000)	0.7	13	a
Craspedia alba	0.5	4	a
Craspedia aurantia[d]	5.0	35	a
Craspedia canens			c
Craspedia coolaminica[d]	5.4	20	a[1]
Craspedia costiniana	2.6	19	a
Craspedia crocata[d]	2.2	19	a
Craspedia jamesii[d]	9.2	39	a
Craspedia lamicola	1.1	15	a
Craspedia leucantha			a
Craspedia maxgrayii	3.3	20	a
Craspedia paludicola			c
**Crepis capillaris*	0.9	9	
Cymbonotus preissianus	0.5	7	b
Erigeron bellidioides	11.8	59	b
Erigeron conyzoides			a
Erigeron nitidus	10.3	46	a
Erigeron paludicola	6.7	17	a
Erigeron setosus	0.6	6	a
Erigeron tasmanicus			a[1]
Euchiton collinus	4.9	22	b
Euchiton gymnocephalus			c
Euchiton involucratus	0.8	4	b
Euchiton traversii	1.3	11	a[12]
Euchiton umbricola	0.1	2	b
Ewartia nubigena	4.8	26	a
Helichrysum adenophorum var. *waddelliae*			b
Helichrysum leucopsideum	0.1	2	b
Helichrysum rutidolepis	5.4	37	b
Helichrysum scorpioides	2.0	24	b
**Hieracium aurantiacum*			
**Hieracium praealtum*			
**Hypochaeris glabra*			
**Hypochaeris radicata*	26.5	81	
**Lactuca serriola*			
Lagenophora montana			a
Lagenophora stipitata[e]	3.3	33	b
Leptinella filicula	7.9	39	b
Leptorhynchos elongatus	0.7	4	b
Leptorhynchos squamatus subsp. *alpinus*	23.9	52	a
**Leucanthemum maximum*			
**Leucanthemum vulgare*	0.3	4	
Leucochrysum albicans subsp. *alpinum*	5.3	28	a
Leucochrysum albicans var. *albicans*	0.1	2	b
Leucochrysum albicans var. *buffaloensis*			a
Microseris sp. 2 (*sensu* Ross & Walsh 2003)	33.1	70	a
Olearia algida	9.1	39	a[1]
Olearia brevipedunculata	7.3	33	a
Olearia erubescens	0.4	6	c
Olearia floribunda	0.2	2	c
Olearia frostii	5.6	17	a
Olearia megalophylla	0.2	2	c
Olearia myrsinoides	0.2	4	b
Olearia phlogopappa var. *flavescens*	6.7	35	a
Olearia ramulosa var. *stricta*	0.2	6	c
Olearia rhizomatica			a
Ozothamnus alpinus	1.8	15	a
Ozothamnus sp. 1 (*sensu* Ross & Walsh 2003)	5.4	44	a
Ozothamnus rogersianus			b
Ozothamnus secundiflorus	2.5	19	b
Ozothamnus stirlingii			c
Ozothamnus thyrsoides			c
Parantennaria uniceps	0.8	4	a
Picris angustifolia subsp. *merxmuelleri*	1.2	13	b
Picris aff. *angustifolia* (Nungar Plain)	0.1	2	a
Podolepis hieracioides	0.5	7	b
Podolepis jaceoides	3.2	11	b
Podolepis robusta	5.5	41	a
Podolepis sp. aff. *robusta* (*sensu* Ross & Walsh 2003)	0.7	7	a
Rhodanthe anthemoides	5.3	30	b
Rutidosis leiolepis	0.9	6	b
Senecio extensus	0.7	9	a[1]
Senecio glabrescens			c
Senecio gunnii	8.2	57	b
Senecio lageniformis	0.4	4	a
Senecio linearifolius	0.7	11	c
Senecio longipilus	0.8	7	b
Senecio pectinatus var. *major*	3.3	31	a
Senecio pinnatifolius var. *alpinus*	19.4	67	a[1]
Senecio velleioides			c
Solenogyne dominii	0.4	4	c
Solenogyne gunnii	1.1	15	b
**Sonchus asper*			
**Sonchus oleraceus*			
**Tanacetum parthenium*			
Taraxacum aristum	0.5	6	b
**Taraxacum officinale sens. lat.*	8.7	50	
**Tragopogon dubius*	0.7	7	

**Tragopogon porrifolius*			
Vittadinia cuneata	0.3	2	c
Xerochrysum palustre	0.2	4	b
Xerochrysum subundulatum	9.0	37	b
Xerochrysum aff. *viscosa* (Cave Creek)	0.4	2	a
Boraginaceae			
Cynoglossum suaveolens			c
**Echium vulgare*	0.2	2	
Myosotis australis	0.4	4	b
**Myosotis caespitosa*	1.0	4	
**Myosotis discolor*	0.3	7	
Myosotis sp. (*sensu* Costin et al. 2000)			a
Brassicaceae			
Barbarea grayi	0.1	2	a
**Barbarea verna*			
**Capsella bursa-pastoris*			
Cardamine astoniae	1.5	7	a[1]
Cardamine lilacina	10.5	56	b
Cardamine papillata	0.2	2	b
Cardamine paucijuga			c
Cardamine robusta	0.2	4	a
Drabastrum alpestre	0.9	9	b
**Erophila verna* subsp. *verna*	0.1	2	
**Hirschfeldia incana*			
**Lepidium campestre*			
**Rorippa palustris*			
Callitrichaceae			
Callitriche palustris	0.1	2	b
**Callitriche stagnalis*	0.1	2	
Campanulaceae			
Lobelia gelida	0.1	2	a
Lobelia pedunculata	2.5	24	b
Lobelia surrepens	3.9	30	a[1]
Wahlenbergia ceracea	4.7	31	b
Wahlenbergia densifolia	0.3	6	a
Wahlenbergia gloriosa	1.4	20	b
Wahlenbergia gracilis	0.2	4	c
Wahlenbergia graniticola			c
Wahlenbergia multicaulis	0.1	2	c
Wahlenbergia stricta	0.4	4	c
Caryophyllaceae			
**Arenaria leptoclados*			
**Arenaria serpyllifolia*	0.1	2	
**Cerastium glomeratum*	7.8	37	
**Cerastium vulgare*	7.4	43	
Colobanthus affinis	4.2	26	a[123]
Colobanthus curtisiae	0.1	2	a
Colobanthus nivicola	0.7	4	a
Colobanthus pulvinatus	0.7	4	a[1]
**Dianthus armeria*	0.1	2	
**Gypsophila tubulosa*			
**Moenchia erecta*			
Sagina namadgi			b
**Sagina procumbens*			
Scleranthus biflorus	29.6	70	b
Scleranthus brockiei			a[12]
Scleranthus diander	0.6	4	b
Scleranthus fascicularis	1.4	7	a
Scleranthus singuliflorus	6.4	30	a[3]
**Spergularia media*	0.1	2	
**Spergularia rubra*	0.1	2	
Stellaria angustifolia	2.9	11	b
Stellaria flaccida	0.1	2	c
Stellaria multiflora	2.2	24	b
Stellaria pungens	13.7	56	b
Chenopodiaceae			
**Chenopodium album*			
Chenopodium erosum			c
Clusiaceae			
Hypericum gramineum	0.7	7	b
Hypericum japonicum	11.6	37	b
**Hypericum perforatum*	0.2	4	
Convolvulaceae			
Convolvulus angustissimus subsp. *angustissimus*	0.3	2	c
Dichondra repens	3.0	17	b
Crassulaceae			
Crassula helmsii			c
Crassula peduncularis	0.2	4	b
Crassula sieberiana	2.0	13	b
**Sedum acre*	0.3	2	
Dilleniaceae			
Hibbertia obtusifolia			c
Hibbertia pedunculata	0.3	4	c
Hibertia serpyllifolia			c
Droseraceae			
Drosera arcturi	3.8	11	a[12]
Drosera peltata subsp. *auriculata*			c
Drosera peltata subsp. *peltata*	1.4	7	b
Ericaceae			
Acrotriche divaricata			c
Brachyloma daphnoides	0.2	2	c
Epacris breviflora	6.0	17	a
Epacris celata	1.3	11	a
Epacris glacialis	6.7	19	a
Epacris gunnii	14.8	61	b
Epacris microphylla var. *rhombifolia*			a
Epacris paludosa	15.4	26	b
Epacris petrophila	4.7	22	a[1]

Epacris robusta	0.2	2	c
Gaultheria appressa	0.1	2	b
Leucopogon attenuatus			c
Leucopogon fraseri	1.6	15	b
Leucopogon gelidus	0.6	9	b
Leucopogon hookeri [f]			a[1]
Leucopogon maccraei	0.6	7	b
Leucopogon microphyllus var. *pilibundus*			c
Leucopogon montanus [f]			a[1]
Leucopogon pilifer	0.5	4	c
Monotoca oreophila			b
Monotoca rotundifolia			c
Monotoca scoparia	0.1	2	c
Pentachondra pumila	5.0	22	a[12]
Richea continentis	16.1	31	a
Richea victoriana			b
Trochocarpa clarkei	1.6	11	a
Euphorbiaceae			
Bertya findlayi			b
Micrantheum hexandrum	1.1	7	b
Poranthera microphylla [g]	8.4	43	c
Poranthera oreophila [g]			a
Fabaceae			
Almaleea capitata	0.1	2	a
Bossiaea buxifolia	0.2	2	c
Bossiaea foliosa	6.1	39	b
Bossiaea obcordata			c
Bossiaea riparia	0.3	2	a
**Cytisus scoparius* subsp. *scoparius*			
Daviesia mimosoides subsp. *acris*	0.1	2	b
Daviesia ulicifolia	0.8	13	b
Desmodium varians			c
Dillwynia palustris	0.3	6	a
Dillwynia prostrata	0.7	6	a
Dillwynia sericea			c
Glycine clandestina			c
Gompholobium huegelii			c
Hovea asperifolia subsp. *asperifolia*			
Hovea montana	21.1	54	a[1]
Hovea pannosa			c
Hovea aff. *heterophylla* (Long Plain)	1.1	7	a
Indigofera australis			c
**Lotus angustissimus*			
**Lotus corniculatus*			
**Lotus uliginosus*			
**Melilotus albus*			
Mirbelia oxylobioides	0.1	2	c
Oxylobium ellipticum	4.3	33	b
Podolobium alpestre	6.7	35	b
Pultenaea capitellata			a
Pultenaea fasciculata	1.3	13	a[1]
Pultenaea muelleri var. *muelleri*	2.0	6	b
Pultenaea polifolia	1.1	7	b
Pultenaea subspicata	0.7	7	b
Pultenaea tenella	4.1	13	a
Sphaerolobium vimineum			c
Swainsona monticola	0.6	4	a
**Trifolium ambiguum*			
**Trifolium arvense*	0.1	2	
**Trifolium campestre*	0.2	4	
**Trifolium dubium*	1.4	13	
**Trifolium hybridum*			
**Trifolium pratense*			
**Trifolium repens*	14.9	41	
**Vicia sativa*			
Fagaceae			
Nothofagus cunninghamii	0.1	2	c
Gentianaceae			
**Centaurium erythraea*	0.1	2	
Gentianella bawbawensis [h]			a
Gentianella cunninghamii subsp. *cunninghamii*			a
Gentianella cunninghamii subsp. *major*			a
Gentianella muelleriana subsp. *alpestris* [h]	2.7	19	a
Gentianella muelleriana subsp. *muelleriana* [h]	3.1	24	a
Gentianella muelleriana subsp. *jingerensis*	0.1	2	a
Gentianella muelleriana subsp. *willisiana* [h]			a
Geraniaceae			
Geranium antrorsum	11.9	44	a
**Geranium molle*			
Geranium neglectum	0.2	2	c
Geranium obtusisepalum			a
Geranium potentilloides var. *abditum* [i]			a
Geranium potentilloides var. *potentilloides* [i]	4.0	43	b
Geranium retrorsum	0.1	2	c
Geranium sessiliflorum subsp. *brevicaule*	0.3	7	a[1]
Geranium solanderi	0.5	9	b
Geranium sp. 7 (*sensu* Ross & Walsh 2003)	0.2	4	a
Pelargonium australe	0.1	2	b
Pelargonium helmsii	0.1	2	a
Goodeniaceae			
Goodenia hederacea subsp. *alpestris*	4.9	31	a
Scaevola hookeri	1.0	11	b

Velleia montana	5.4	26	a[1]
Velleia paradoxa			b
Haloragaceae			
Gonocarpus humilis	0.2	4	c
Gonocarpus micranthus subsp. *micranthus*	14.7	33	b
Gonocarpus montanus	8.0	54	b
Gonocarpus tetragynus	0.1	2	c
Haloragis heterophylla	0.1	2	c
Myriophyllum alpinum	0.3	7	a
Myriophyllum pedunculatum subsp. *pedunculatum*	5.8	24	b
Myriophyllum variifolium	0.3	6	c
Lamiaceae			
Ajuga australis sens. lat.	13.0	44	b
Mentha laxiflora			c
**Mentha spicata*			
Prostanthera cuneata	7.0	43	a
Prostanthera lasianthos			c
Prostanthera phylicifolia			c
**Prunella vulgaris*	0.7	6	
**Salvia verbenaca*			
Scutellaria humilis			c
Westringia lucida	0.4	6	a
Westringia senifolia	0.6	4	a
Lauraceae			
Cassytha pubescens			c
Lentibulariaceae			
Utricularia dichotoma			c
Utricularia monanthos	2.0	11	a[12]
Linaceae			
Linum marginale	2.7	19	b
Loganiaceae			
Logania albiflora			c
Mitrasacme serpyllifolia	0.2	2	b
Schizacme montana var *montana*	0.6	9	a
Malaceae			
**Cotoneaster horizontalis*			
**Malus domestica*			
Malvaceae			
**Malva nicaeensis*			
Menyanthaceae			
Nymphoides montana			b
Mimosaceae			
Acacia alpina	1.2	11	a
Acacia dealbata subsp. *subalpina*			c
Acacia gunnii			c
Acacia melanoxylon			c
Acacia obliquinervia			c
Acacia siculiformis	1.0	6	c
Myrtaceae			
Baeckea gunniana	17.2	39	a[1]
Baeckea latifolia			a
Baeckea utilis	3.1	11	b
Callistemon pallidus			c
Callistemon pityoides	5.2	9	b
Calytrix tetragona		c	
Eucalyptus debeuzevillei	0.2	4	b
Eucalyptus kybeanensis			c
Eucalyptus lacrimans	0.4	2	b
Eucalyptus niphophila	0.6	11	b
Eucalyptus pauciflora			c
Eucalyptus stellulata	0.2	4	b
Euryomyrtus denticulata			c
Euryomyrtus ramosissima subsp. *ramosissima*	4.2	11	b
Kunzea ericoides sens. lat.			c
Kunzea muelleri	10.1	43	a
Kunzea parvifolia	0.2	2	c
Leptospermum brevipes			c
Leptospermum grandifolium	0.7	9	c
Leptospermum jingera			a
Leptospermum lanigerum			c
Leptospermum micromyrtus	0.1	2	b
Leptospermum myrtifolium	0.7	7	a
Leptospermum namadgiensis	0.2	2	a
Onagraceae			
Epilobium billardierianum subsp. *cinereum*	12.8	54	b
Epilobium billardierianum subsp. *hydrophilum*			b
Epilobium brunnescens subsp. *beaugleholei*			a
**Epilobium ciliatum*	0.2	4	
Epilobium curtisiae	2.0	11	a[1]
Epilobium gunnianum	9.9	39	b
Epilobium hirtigerum	0.3	2	c
Epilobium sarmentaceum	0.7	9	a[1]
Epilobium tasmanicum	1.1	11	a[12]
Epilobium willisii			a[1]
Oxalidaceae			
Oxalis exilis	2.2	17	b
Oxalis magellanica	0.4	4	b
Pittosporaceae			
Billardiera macrantha			c
Rhytidosporum alpinum	1.6	9	a[1]
Rhytidosporum inconspicuum			a
Rhytidosporum procumbens	0.9	9	c
Plantaginaceae			
Plantago alpestris	2.8	17	a
Plantago antarctica	4.0	26	a[1]
Plantago euryphylla	15.0	56	a
Plantago glacialis	1.1	6	a

Plantago hispida			c
**Plantago major*			
Plantago muelleri	1.3	6	a
Plantago varia	2.1	13	c
Polemoniaceae			
**Collomia grandiflora*			
**Navarettia squarrosa*			
Polygalaceae			
Comesperma ericinum			c
Comesperma retusum	2.0	4	b
Comesperma volubile			c
Polygala japonica			c
Polygonaceae			
**Acetosella vulgaris*	42.9	83	
**Fallopia japonica*			
Muehlenbeckia axillaris	0.2	4	a[12]
**Polygonum arenastrum*			
**Polygonum aviculare*			
Rumex brownii	0.2	6	b
**Rumex conglomeratus*	0.1	2	
**Rumex crispus*			
**Rumex obtusifolius*			
Portulacaceae			
Montia fontana subsp. *amporitana*			a
Montia fontana subsp. *fontana*	0.3	2	a
Neopaxia australasica	4.7	33	b
Primulaceae			
**Anagallis arvensis*			
Proteaceae			
Banksia marginata			c
Grevillea australis	26.6	67	a[1]
Grevillea diminuta			a
Grevillea lanigera	0.7	9	b
Grevillea victoriae subsp. *nivalis*			b
Grevillea victoriae subsp. *victoriae*	0.2	6	a
Hakea lissosperma	0.1	2	a
Hakea microcarpa	8.7	33	b
Orites lancifolia	7.3	28	a
Persoonia chamaepeuce	0.7	11	b
Persoonia subvelutina			c
Ranunculaceae			
**Aquilegia vulgaris*			
Caltha introloba	5.6	19	a
Clematis microphylla var *leptophylla*	0.2	2	c
Ranunculus acrophilus	0.5	4	a
Ranunculus amphitrichus	0.9	9	b
Ranunculus anemoneus	1.9	17	a
Ranunculus clivicola	0.2	2	a
Ranunculus collinus	3.0	11	a[1]
Ranunculus diminutus	0.1	2	b
Ranunculus dissectifolius	0.7	9	a
Ranunculus eichleranus	3.2	19	a
Ranunculus graniticola	21.8	56	a
Ranunculus gunnianus	5.6	33	a[1]
Ranunculus lappaceus	1.3	7	b
Ranunculus millanii	2.4	17	a
Ranunculus muelleri	2.8	26	a
**Ranunculus muricatus*	0.1	2	
Ranunculus niphophilus	0.7	7	a
Ranunculus papulentus			c
Ranunculus pimpinellifolius	7.4	13	a[1]
Ranunculus pumilio var. *pumilio*			c
**Ranunculus repens*			
Ranunculus scapiger			c
Ranunculus victoriensis	9.3	22	a
Rhamnaceae			
Cryptandra amara	0.3	4	c
Discaria nitida			a
Discaria pubescens	0.1	2	b
Rosaceae			
Acaena agnipila	0.2	2	c
Acaena echinata	2.7	19	b
Acaena novae-zelandiae			c
Acaena ovina	1.6	13	b
Acaena sp. (*sensu* Costin et al. 2000)	20.4	74	a
Alchemilla sp. 1 (*sensu* Ross & Walsh)	0.1	6	a
**Aphanes arvensis*	2.4	11	
Aphanes australiana	0.2	2	c
**Aphanes inexpectatus*			
**Crataegus monogyna*			
Geum urbanum var. *strictum*	0.4	6	a
**Potentilla recta*	0.1	2	
**Rosa rubiginosa*	0.3	2	
**Rubus anglocandicans*			
**Rubus leucostachys*			
Rubus parvifolius	0.4	7	b
Rubiaceae			
Asperula conferta	0.6	11	b
Asperula euryphylla	0.2	2	c
Asperula gunnii	53.0	81	b
Asperula pusilla	3.0	28	a[1]
Asperula scoparia	2.4	17	b
Coprosma hirtella	0.2	6	c
Coprosma moorei	0.7	6	a[1]
Coprosma niphophila	0.6	4	a[2]
Coprosma nitida	0.7	9	a[1]
Coprosma nivalis	1.2	15	a
Coprosma perpusilla subsp. *perpusilla*	0.6	2	a[1]

Coprosma pumila			a[12]
Galium ciliare			c
Galium gaudichaudii	0.5	6	c
Galium migrans			c
Galium propinquum			c
Galium roddii	0.4	4	a
Nertera sp. (*sensu* Costin et al. 2000)	5.3	17	a
Rutaceae			
Asterolasia trymalioides	9.6	35	a
Boronia algida	0.2	4	b
Crowea exalata subsp. *exalata*	0.7	6	c
Leionema phylicifolium	2.0	20	c
Leionema lamprophyllum			c
Nematolepis ovatifolia	3.6	19	a
Nematolepis squamulosa subsp. *alpinum*	6.7	33	a
Nematolepis squamulosa subsp. *ozothamnoides*	0.2	4	c
Salicaceae			
**Salix cinerea*	0.1	2	
**Salix* x *rubens*	0.1	2	
Santalaceae			
Choretrum pauciflorum			c
Exocarpus cupressiformis			c
Exocarpus nanus	3.2	26	b
Thesium australe			b
Sapindaceae			
Dodonaea viscosa			c
Scrophulariaceae			
Chionohebe densifolia	0.4	4	a[2]
Derwentia derwentiana subsp. *derwentiana*	0.4	9	a
Derwentia derwentiana subsp. *maideniana*			a
Derwentia nivea	0.1	2	a
Derwentia perfoliata	0.6	9	b
Euphrasia alsa	0.1	2	a
Euphrasia caudata	0.6	4	a
Euphrasia collina subsp. *diversicolor*	5.8	31	a
Euphrasia collina subsp. *glacialis*	0.7	7	a
Euphrasia collina subsp. *lapidosa*	0.4	4	a
Euphrasia collina subsp. *paludosa*	8.5	44	b
Euphrasia collina subsp. 1 (*sensu* Ross & Wlash 2000)			a
Euphrasia crassiuscula subsp. *crassiuscula*	1.6	9	a
Euphrasia crassiuscula subsp. *eglandulosa*			a
Euphrasia crassiuscula subsp. *glandulifera*			a
Euphrasia eichleri			a
Euphrasia gibbsiae subsp. *subglabrifolia*	2.3	4	a
Euphrasia lasianthera			a
Euphrasia scabra sens. lat.			c
Euphrasia sp. 3 (Ramshead Range *sensu* Briggs & Leigh 1996)			a
Glossostigma cleistanthum			c
Gratiola nana	0.6	9	a[1]
Limosella australis	0.2	4	b
**Linaria arvensis*	0.2	2	
**Mimulus moschatus*	0.6	6	
**Parentucellia latifolia*			
**Verbascum thapsus*	0.2	4	
**Verbascum virgatum*	0.1	2	
**Veronica arvensis*	0.8	11	
Veronica calycina			c
Veronica gracilis	1.9	17	b
Veronica serpyllifolia sens. lat.	2.8	19	b
Stackhousiaceae			
Stackhousia monogyna	0.4	9	b
Stackhousia pulvinaris	4.7	28	a[1]
Stackhousia viminea			c
Stylidiaceae			
Stylidium armeria[j]			
Stylidium montanum[j]	16.3	69	a
Thymelaeaceae			
Kelleria dieffenbachii	0.6	6	a[12]
Kelleria laxa			a[2]
Pimelea alpina	23.4	56	a
Pimelea axiflora subsp. *alpina*	9.2	35	a
Pimelea biflora	3.3	22	a
Pimelea bracteata	1.0	4	a
Pimelea linifolia subsp. *caesia*	5.6	22	a
Pimelea ligustrina subsp. *ciliata*	2.3	15	a
Pimelea microcephala	0.2	4	
Pimelea pauciflora	0.3	4	b
Tremandraceae			
Tetratheca bauerifolia	0.2	4	c
Tetratheca procumbens			a
Urticaceae			
Urtica incisa			c
**Urtica urens*			

Violaceae			
Melicytus sp. aff. *dentatus* (Snowfields variant *sensu* Ross & Walsh 2000)	15.4	63	a
**Viola arvensis*	0.3	4	
Viola betonicifolia subsp. *betonicifolia*	28.2	70	b
Viola fuscoviolacea	2.9	17	a
Viola hederacea	2.9	15	b
Viola improcera	0.2	2	a
**Viola odorata*			
Winteraceae			
Tasmannia lanceolata			c
Tasmannia xerophila subsp. *xerophila*	2.9	20	b
Tasmannia vickeriana	1.1	6	a

[a] The frequencies of these *Prasophyllum* spp. are probably underestimated. Unidentified *Prasophyllum* species occurred in 11% of quadrats and 76% of communities.

[b]These species were recorded in early surveys as *Agrostis hiemalis* (in 3% of quadrats and 15% of communities).

[c]The frequencies of these *Celmisia* spp. are probably underestimated. Unidentified *Celmisia* species occurred in 32% of quadrats and 48% of communities. The name *Celmisia pulchella* has been suggested for a diminutive species known from wet heathland communities in Kosciuszko National Park, wetlands along the NSW coastal escarpment and Central Tablelands.

[d]The frequencies of these *Craspedia* spp. are probably underestimated. Unidentified *Craspedia* species occurred in 29% of quadrats and 63% of communities.

[e]Some records of *Lagenophora stipitata* are probably referable to *L. montana,* which was not widely recognised at the time of the earlier surveys.

[f]The frequencies of these *Leucopogon* spp. are probably underestimated; *L. hookeri* and *L. montanus* were grouped in the survey of McDougall (1982) because of difficulties with identification when not in flower.

[g]Most records of *Poranthera microphylla* are probably referable to *P. oreophila*, a recently described species.

[h]The frequencies of these *Gentianella* spp. are probably underestimated. Unidentified *Gentianella* species occurred in 8% of quadrats and 26% of communities.

[i]No distinction was made between the varieties of *Geranium potentilloides* in the early surveys. The data shown for var. *potentilloides* will contain some records of var. *abditum*.

[j]The data shown for *Stylidium montanum* will contain some records of *S. armeria* (especially on the Bogong High Plains where *S. armeria* is the more common species in shrublands), both of which were included in *S. graminifolium* at the time of the early surveys.