THE VEGETATION AND HIGHER PLANT FLORA OF THE CRADLE MOUNTAIN–PENCIL PINE AREA, NORTHERN TASMANIA

by J.B. Kirkpatrick and J. Balmer

(with four tables, six text-figures, three plates and an appendix)

The Cradle Mountain–Pencil Pine area, northern Tasmania, has a highly varied vegetation and a rich and highly Tasmanian endemic flora. The distributions of the synusiae and floristic plant communities in the region are strongly influenced by geology, the altitudinal environmental gradient, drainage conditions and fire history.
Key Words: Tasmania, synusiae, plant communities.

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INTRODUCTION

The Cradle Mountain–Pencil Pine area has become the focus of development of the recreational/tourism resource of the Western Tasmanian World Heritage Area, with the construction of a major road link, a dramatic expansion in accommodation outside the park and the erection of an innovative visitor centre at its entrance. The flora and vegetation form one of the major attractions of the area. Although statewide studies have indicated the plant community composition of the area (Kirkpatrick 1983, 1986; Jarman *et al.* 1984, 1988a; Kirkpatrick *et al.* 1988; Whinam *et al.* 1989), their listings are based on limited sampling. There has been no general description of the vegetation and flora of the area since the pioneering study of Sutton (1928). In response to the need for a contemporary inventory of the biological resources of the area we have undertaken a quadrat-based study of community ecology, have mapped the distribution of synusiae and have listed all higher plant species that have been collected from, or observed in, the Cradle Mountain–Lake St Clair National Park.

THE STUDY AREA

The study area corresponds to that part of the Cradle Mountain–Lake St Clair National Park represented on the 1:25 000 TASMAP topographic sheets "Cradle" and "Pencil Pine". It also includes the Pencil Pine Development Zone which lies directly to the north of the park (fig. 1).

The area has one of the coldest and wettest climates in Australia (table 1) in a landscape that has been heavily modified by glacial processes, and is lithologically varied (fig. 1). Peat formation has occurred at the higher altitudes on all substrates and at lower altitudes where drainage is poor or the soils are siliceous. Three major fires occurred in this area in the early years of this century or the late years of last century. Plates 1 and 2 provide striking evidence of the two more recent events, which burned the area between Barn Bluff and Cradle Mountain and the slopes below Hansons Peak. An older fire burned from the northwest over Hounslow Heath (fig. 2), and there are signs of many much older fires in the landscape. The lowland grasslands and sedgelands were burned at relatively frequent intervals from at least first European occupancy to the 1960's. Stem ages, from Jarman *et al.* (1988b) suggest that there were fires in 1916, 1935, 1941 and 1954. A fire, possibly caused by lightning strike, burned part of the east of the study area in the last two to three decades (fig. 2).

FLORISTICS OF THE RESERVE

One of the first Australian species lists that indicated ecological occurrence was produced for the Cradle area by Sutton (1928). His plant census of the Cradle area recognised 287 plant taxa. Of these names, 101 are no longer used to represent Tasmanian taxa; a further 11 species are never likely to have occurred within the Cradle area (eg. *Milligania longifolia*, *Epacris myrtifolia*) and still others refer to taxa which have been merged with or split from others since the census (eg. *Persoonia gunnii*, *Epilobium billardierianum*). As a consequence, the value of Sutton's plant census has very much diminished. A current (although incomplete)

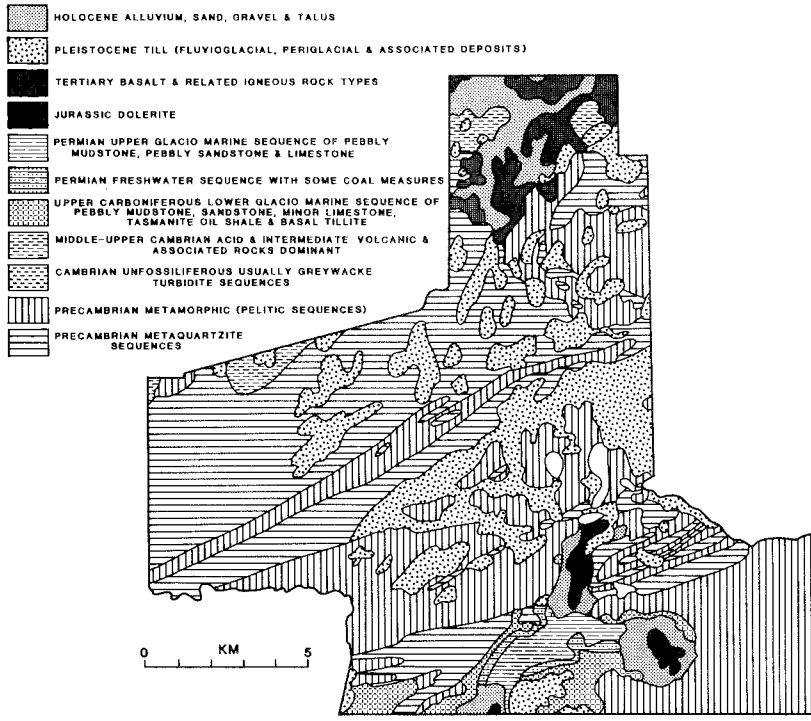


FIG. 1 — Lithology map of Cradle Mt–Pencil Pine area.

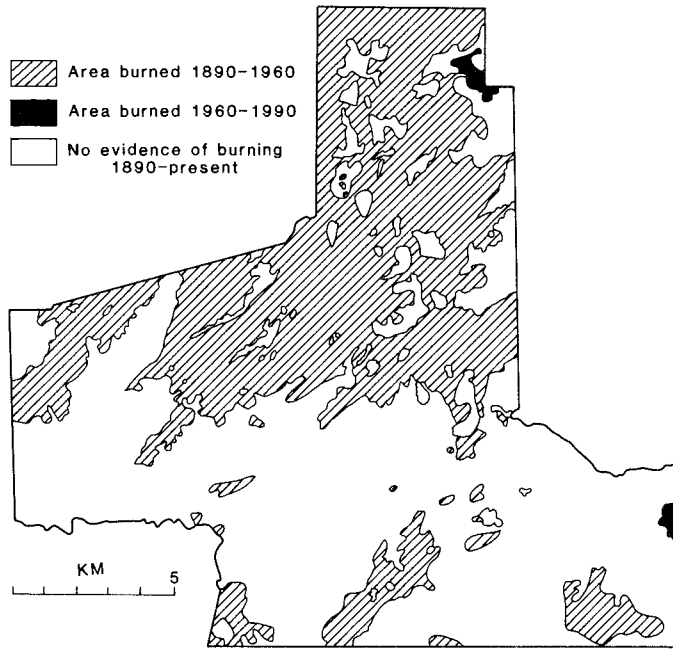


FIG. 2 — Fire history map of the Cradle Mt–Pencil Pine area.

list of vascular plant taxa known to occur within the Cradle Mountain–Lake St Clair National Park is appended. Notes regarding the occurrence of species within the Cradle area are included.

Nearly one-third of Tasmania's vascular flora is located within the Cradle Mountain National Park. More than 450 native higher plant taxa from 79 families have been recorded. The families represented by the greatest number of native taxa are Asteraceae (58), Epacridaceae (39), Poaceae (36), Cyperaceae (31) and Myrtaceae (20). Only eight species of conifer and 34 ferns are recorded from the reserve. There are likely to be many more native monocotyledons than the 116 listed, since taxonomic keys are still not readily available. At least 164 of the native taxa within the reserve are endemic to Tasmania.

The lower plant flora is probably as diverse, if not more so, than the higher plant flora within the reserve. Unfortunately records and collections of the lower plant flora by specialist taxonomists are at preliminary stages. Nevertheless, substantial information on some of these groups now exists for some areas (Dr G. Kantvilas & Dr S.J. Jarman, pers. comm., Parks, Wildlife and Heritage files).

Exotic species are not a major problem for park management, although at least 22 exotic weed species occur within the park. A number of others are historically planted garden species (e.g. a Californian redwood planted near the Waldheim chalet — Ziegeler, pers. comm.). All seem to be restricted to the roadsides with the exception of *Poa annua* and *Cerastium glomeratum* which are also found close to huts and where sewage effluent has been dispersed.

The reserve is probably most important for its alpine flora, containing nearly 38 700 ha of the state's alpine and subalpine vegetation. It also contains a range of other vegetation types (Kirkpatrick & Dickinson 1984) including buttongrass moorlands (17 600 ha), wet scrub (3800 ha) eucalypt forests (26 400 ha including 8000 ha of old growth tall forest — Davies 1988) and cool temperate rainforests (39 400 ha). Specht *et al.* (1974) have listed the alliances occurring within the reserve and more recent systematic community studies have further sampled and described these communities (Jarman *et al.* 1984, 1988a, Kirkpatrick *et al.* 1988, Whinam *et al.* 1989)

The alpine areas contain an interesting mixture of eastern and western elements of the Tasmanian alpine flora (Kirkpatrick 1982, 1989). The central alpine province occupies a majority of the alpine area of the park. The other vegetation types are similarly dominated by what is an essentially central Tasmanian flora (in particular the *Sphagnum* peatlands, buttongrass moorlands and grassy communities). The reserve is located in the transition zone between the drier more fertile eastern part of the state and the wet infertile region to the west. In consequence, it is an area where a number of species reach the extreme in their distribution and many overlap. For example *Eucalyptus amygdalina* is largely replaced here by *E. nitida* and hybrid populations of these two species result in the vicinity of Lake St Clair. Similarly, in parts of the Cradle area *E. nitida* intergrades with *E. coccifera* over the altitudinal gradient (Shaw *et al.* 1984).

THE PLANT COMMUNITIES

Methods

All structural and floristic elements of the vegetation (synusiae) perceptible or interpretable from 1:25 000 coloured aerial photographs were mapped after ground truthing and aerial reconnaissance. Fire boundaries were

TABLE 1

Climatic data for Cradle Valley
(Lat. 41°38' Long. 145° 57'. Elevation 914 m)

	J	F	M	A	M	J	J	A	S	O	N	D	Yr
Mean daily max. temp. (°C)	17.2	17.6	14.7	11.2	7.5	5.1	4.6	5.2	6.6	9.8	12.0	14.0	10.5
Mean daily min. temp. (°C)	6.3	7.8	5.9	4.3	1.5	0.1	0.1	0.0	0.3	1.6	3.0	4.0	2.9
Mean rainfall (mm)	147	135	154	228	280	275	320	307	275	251	219	183	2744
Rain days	16	14	18	20	21	21	24	23	22	21	19	18	237
Mean days snow seen	1	0	1	3	5	5	9	10	8	7	3	2	
Mean days frost seen	2	1	3	5	13	19	20	19	17	15	8	4	

From Gutteridge *et al.* 1984: 36.

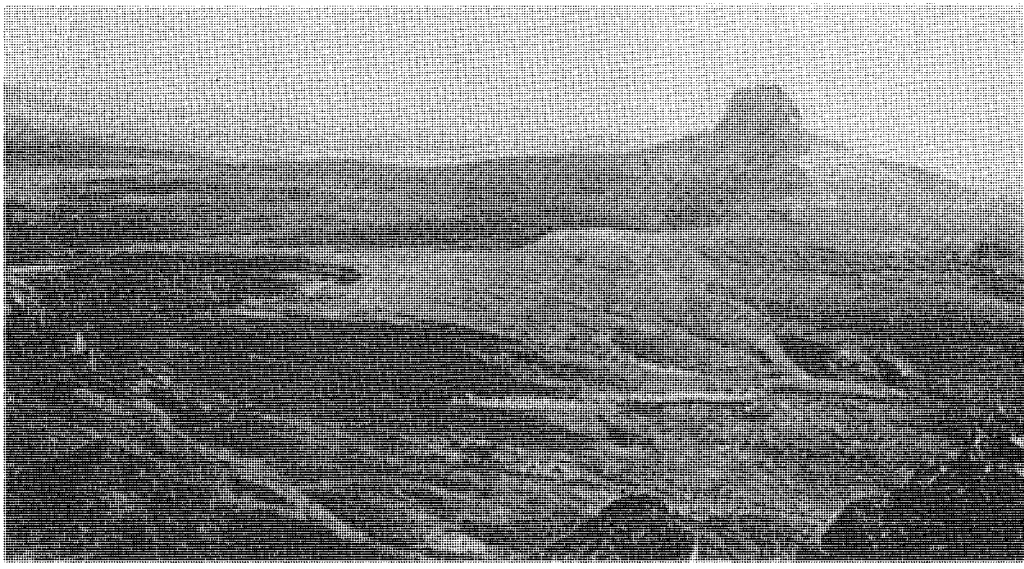


PLATE 1
Photograph taken in the 1920's of Barn Bluff, showing fire-killed vegetation.

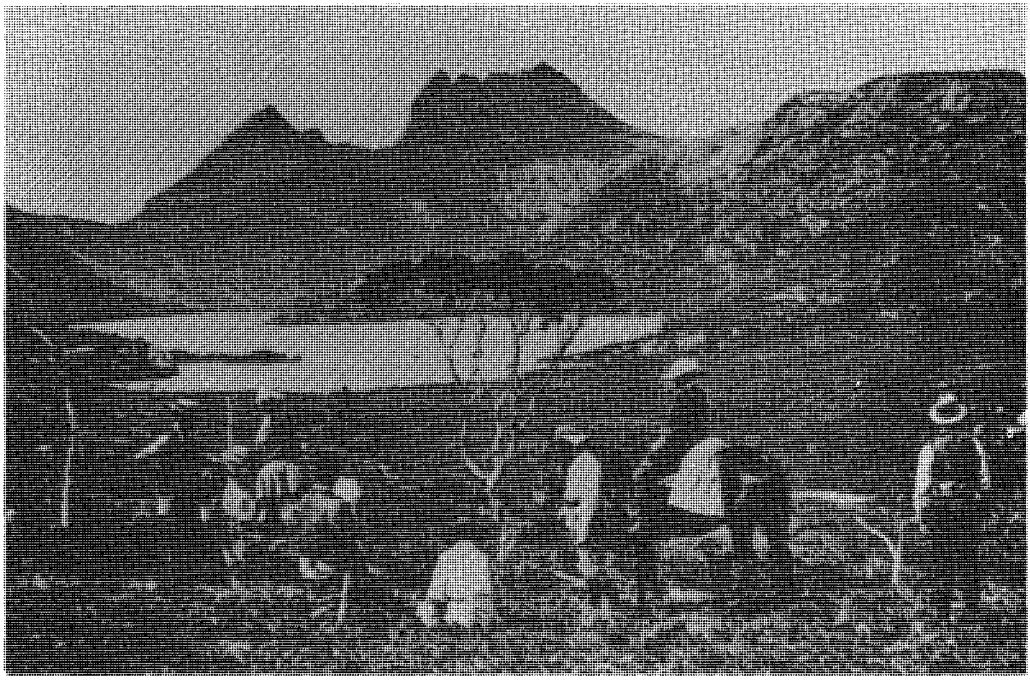


PLATE 2
Photograph taken from Cradle Valley in the 1920's, showing fire-killed vegetation on the south side of Lake Dove.

identified from these photographs, historical photographs and ground observations.

During March 1989, floristic presence and environmental data were collected from c. 40 10 × 10 m quadrats located subjectively without preconceived bias (Mueller-Dombois & Ellenberg 1974) throughout the major environments of the study area. These data were supplemented by quadrats from the studies of Kirkpatrick (1986), Kirkpatrick & Duncan (1987) and Cullen & Kirkpatrick (1988) and by data from the files of the Department of Parks, Wildlife and Heritage. In all 141 quadrats were included in the analysis. Data on geology (five classes: 1 = basalt, 2 = dolerite and alluvium, 3 = fine grained sedimentary rocks, 4 = glacial deposits, 5 = coarse grained sedimentary rocks), slope (three classes: 1 = flat, 2 = gentle slopes, 3 = moderate and steep slopes), aspect (five classes: 1 = northwest, 2 = west and north, 3 = southwest and northeast, 4 = east and south, 5 = southeast), altitude and species dominance were available for most quadrats. A fire susceptibility index was derived for the classificatory groups by attributing double the sum of the total percentage frequency of those taxa in table 2 known to be killed by fire and to lack any short-term mechanism for regeneration, and adding it to the sum of the percentage frequency scores of those species known to regenerate poorly after fire (Kirkpatrick 1984a). Other species scored zero. This sum was then divided by the number of taxa in the group that had percentage frequency values greater than 50 to give the final index.

The polythetic divisive programme TWINSPAN (Hill 1979) was used to aid the definition of floristic communities. Detrended correspondence analysis (Hill & Gauch 1980) was used to ordinate the percentage frequency data for the TWINSPAN groups. For every split in the classificatory dendrogram, tests were made for significant environmental differences between the relevant two groups. Chi-squared was used for class data and the Student's t-test was used for parametrically distributed continuous data. Mean index and other environmental values were regressed against the first two axes of the ordination, and the residuals from the significant regression lines were tested against the remaining variables.

Species nomenclature follows Buchanan *et al.* (1989). Structural terminology follows Kirkpatrick (1983) for alpine vegetation, Gibson & Kirkpatrick (1985a) for bolster heath, Jarman *et al.* (1984, 1988a) for rainforest and buttongrass moorland respectively, Kirkpatrick *et al.* (1988) for grassy vegetation and Specht (1981) for other vegetation.

RESULTS AND DISCUSSION

The species, life-form composition and environmental attributes of the 13 floristic groups selected from the TWINSPAN analysis are shown in tables 2 and 3 respectively (see pp. 138–140). The floristic groups partly overlap mapped synusiae. Their attributes and ecology and those of the synusiae are discussed below under four broad headings.

Alpine Vegetation

On dolerite and the argillaceous sedimentary rocks there is a sharp treeline at approximately 1200 m wherever drainage is good. On the skeletal soils of the siliceous sedimentary rocks the change in stature from tree to shrub is gradational, as on the West Coast Range (Kirkpatrick 1977). Alpine vegetation extends downslope to approximately 1100 m, where there is a sharp boundary with *Melaleuca squamea* heath or *Gymnoschoenus sphaerocephalus* sedgeland, this boundary being most frequently evident on the siliceous rocks. Similar sharp boundaries have been noted elsewhere in Tasmania (Kirkpatrick & Brown 1987).

There are four strong floristic groups within the alpine quadrat data set. They can be broadly characterised as alpine herbfield (group 3), bolster heath (group 12), heath on quartzite (group 11) and heath on dolerite (group 10). All of these units vary structurally and transgress the notional climatic treeline.

The most localised group (group 3, table 2) is mapped as alpine herbfield (fig. 3) and is associated with deep mineral soils formed on the erosion products of siltstones, usually below persistent snow patches. As described for a similar snow patch on Mt Field West (Gibson & Kirkpatrick 1985b), the silt forms convex mounds covered by a closely-cropped herb-rich lawn. Wallaby and wombat scats are present in abundance. The most frequent and abundant species in these lawns are *Poa gunnii*, *Erythranthera australis*, *Hydrocotyle sibthorpioides* and *Gnaphalium collinum*. *Helichrysum backhousii* is the most common shrub found in these lawns, which usually grade into fjaeldmark upslope and abut on to deciduous or coniferous heath downslope and across slope. The alpine herbfield and grassland of snow patches and associated deposits is maintained in a tight sward by wallaby and wombat grazing. Shrub and tree seedlings are present but do not escape into adulthood.

In the more poorly-drained parts of the alpine zone three types of bolster heath are found, over-ridden to varying degrees by the dwarf pines *Diselma archeri* and *Microcachrys tetragona*. These are largely mapped as part of the coniferous heath and alpine heath

Ac coniferous heath,on dolerite(d),on quartzitic conglomerate(q)
Ag al pine grassland
As al pine heath on dolerite(d),on quartzitic conglomerate(q)
Fj fjaeldmark
Ro rock or block stream
Sb string bog
Sf snow patch fjaeldmark

Ec *Eucalyptus coccifera* woodland /open forest
Ed *Eucalyptus delegatensis* open forest / tall open forest
Eg *Eucalyptus gunnii* woodland / open forest
En *Eucalyptus nitida* open scrub / open forest
Es *Eucalyptus subcrenulata* open forest

B heathy sedgeland
G *Poa* grassland
H herbfield
L *Leptospermum / Melaleuca* scrub / forest
S *Sphagnum* bog
Tm *Milligania* tall alpine herbfield
Tg *Restio / Empodisma / Gleichenia / Astelia*, tall alpine herbfield

D deciduous heath / scrub / forest
K *Athrotaxis selaginoides* forest
P *Athrotaxis cupressoides* woodland / forest
Rf evergreen closed forest

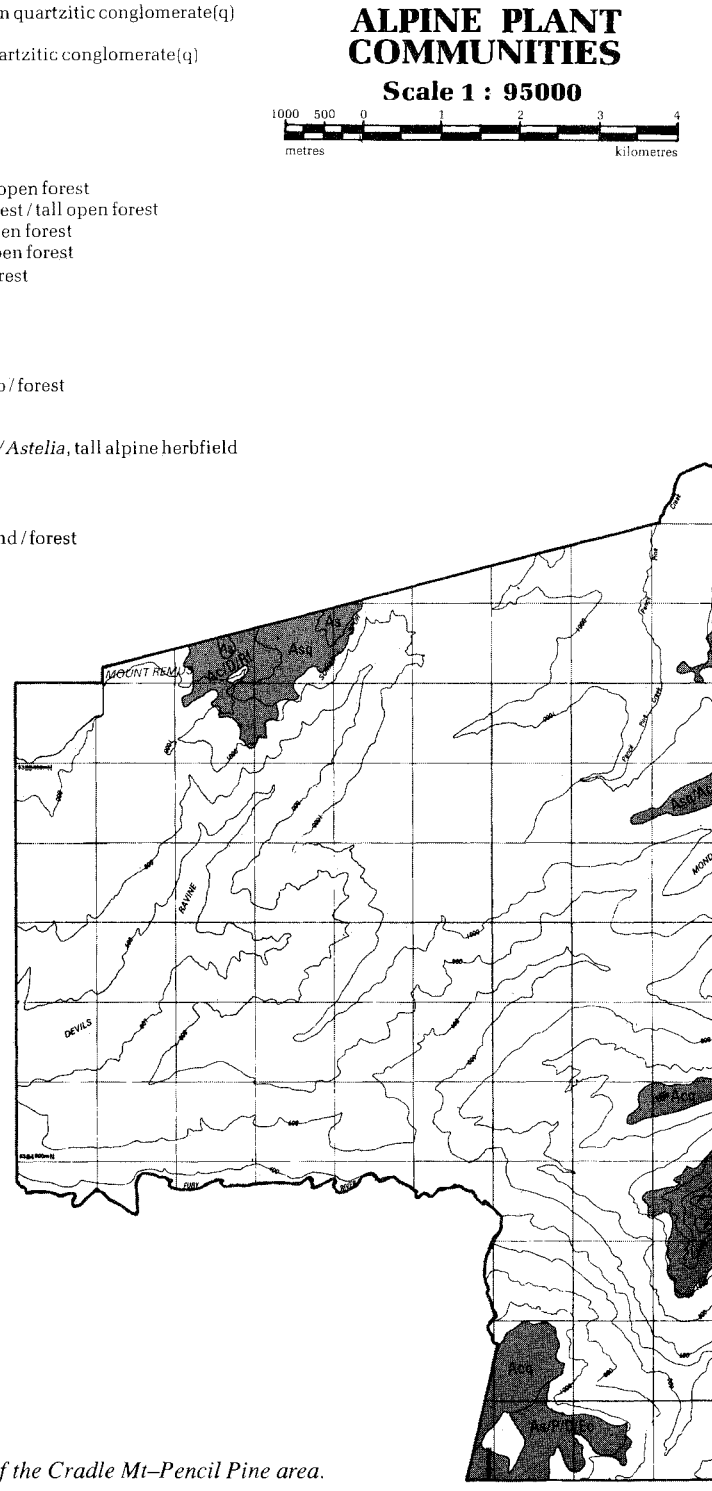
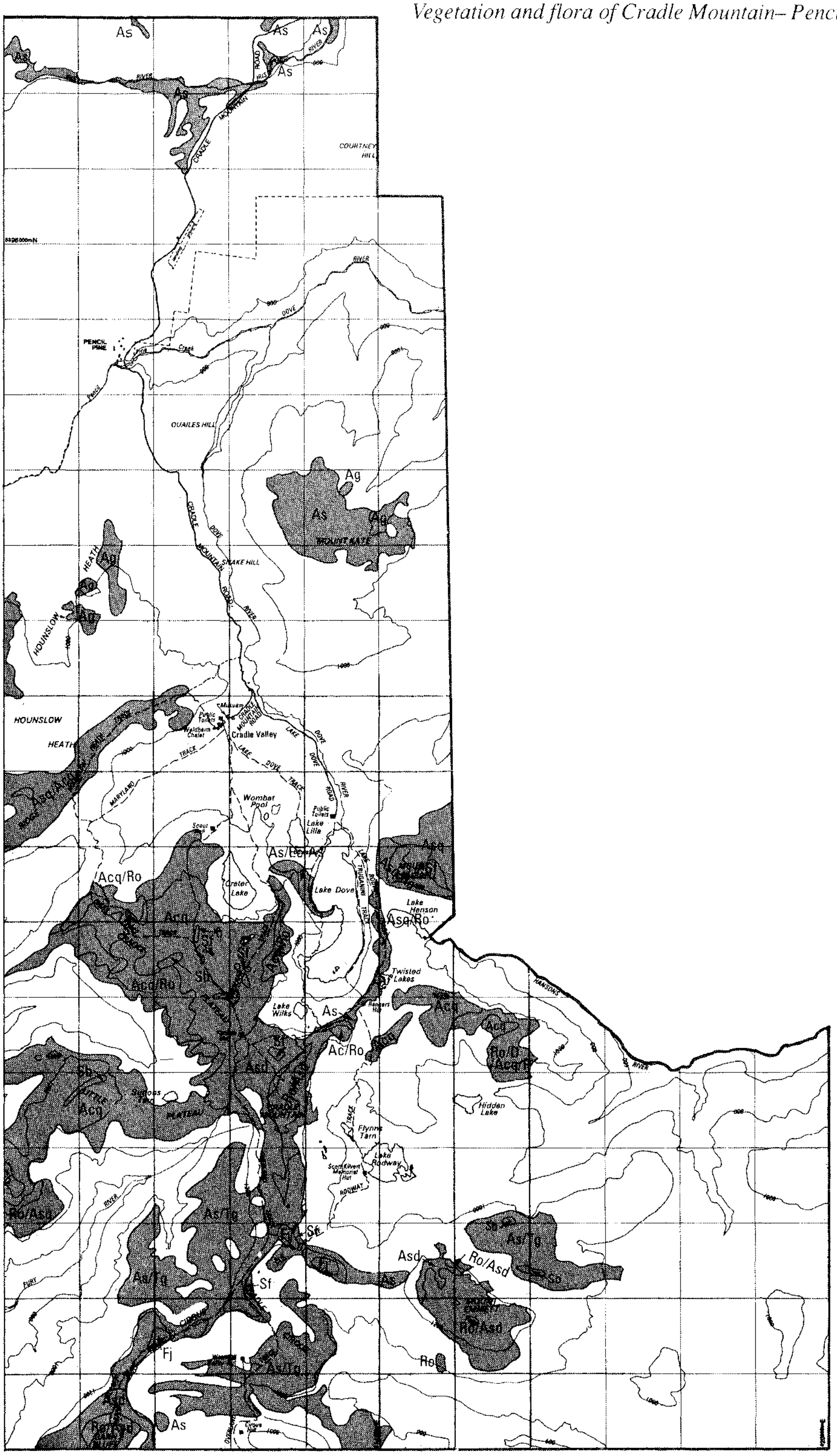


FIG. 3 — Alpine vegetation map of the Cradle Mt–Pencil Pine area.



As
Ag
Acq/Ro
Acq
Sf
Sh
Ac/Ro
Asd
Asq/Ro
Ro/D
As/Tg
Ro/Asd
Asd
Sb
Fj
Ro
PENCIL PINE
QUAILES HILL
SNAKE HILL
COURTNEY HILL
HOUNSLOW HEATH
Cradle Valley
Wombat Pool
Lake Lilla
Crater Lake
Lake Dove
Lake Henson
Twisted Lakes
Lake Wilks
Hidden Lake
Flynns Tarn
Lake Rodway
DOVE RIVER
CRADLE MOUNTAIN ROAD
LAKE DOVE TRACK
RIVER

complexes. Near and on Barn Bluff *Phyllachne colensoi* high mountain cushion heath, paradoxically absent from Cradle Mountain, occurs on constantly wet slopes. The flush area below the one large snow patch on the dolerite peak of Cradle Mountain supports a mosaic cushion heath consisting of a mixture of *Abrotanella forsteroides*, *Dracophyllum minimum*, *Donatia novae-zelandiae* and *Pterygopappus lawrencei*. On the siliceous plateaus the former species is absent from the mosaics and *Donatia novae-zelandiae* cushion heath is common. This latter type predominates on the poorly-drained parts of the more argillaceous sedimentary rocks. The floristic group that subsumes the bolster heath communities (12) has *Epacris serpyllifolia*, *Pentachondra pumila* and *Empodisma minus* as its most constant species.

The snow patches on quartzitic conglomerate have been mapped (fig. 3). Their vegetation differs markedly from that of the snow patches on siltstone and dolerite in that the sparse vegetation cover is evenly spread rather than patchy, and consists of a subset of the species of the adjacent bolster heath rather than having distinctive markers like *Erythranthera australis* and *Gaultheria depressa*. Thus, the fjaeldmark vegetation of the snow patches on siliceous rocks falls into group 12, while that of the argillaceous snow patches falls into group 3.

Floristic group 11 corresponds largely with coniferous heath and alpine heath on quartzitic conglomerate, but also includes the most wind-exposed stands of *Nothofagus gunnii*, where it forms a prostrate heath plant. *Microcachrys tetragona* is the most frequent dominant in this floristic community, the other highly frequent species being *Cyathodes dealbata*, *Ehrharta tasmanica*, *Pentachondra pumila*, *Richea sprengelioides* and *Exocarpos humifusus*.

The final alpine floristic group (10) is found on both dolerite and the more finely-grained sedimentary rocks. It is thus found in coniferous and alpine heath on these substrates. The major dominant of the coniferous heath is *Podocarpus lawrencei*, while *Orites revoluta* and *Richea sprengelioides* dominate much of the alpine heath. This floristic group also subsumes most of the mapping unit labelled fjaeldmark and *Milligania densiflora* tall alpine herbfield. The fjaeldmark is closely similar to that described for Dome Hill (Kirkpatrick & Whinam 1988) and Pyramid Mountain (Kirkpatrick 1984b), with stone steps turning into stone stripes with increasing steepness of slope, and with the features being best developed in the direction facing the prevailing winds. The *Milligania* herbfield is found below the dolerite columns of the major peaks where colluvium is constantly flushed with moisture. The most constant species of the floristic group are *Podocarpus lawrencei*, *Tasmannia lanceolata*, *Orites revoluta* and *Richea sprengelioides* while the species most characteristic of the group are *P. lawrencei*, *Cyathodes straminea* and *Pimelea sericea*.

The fires that burned parts of the alpine environment at the turn of the century have left substantial areas of alpine heath, much of it dominated by *Richea scoparia*, in which gymnosperms are infrequent or absent, contrasting markedly with their ubiquity elsewhere in the alpine zone. However, in the area burned earlier on the Hounslow Heath gymnosperms, especially *Microcachrys tetragona* and *Podocarpus lawrencei*, are more common.

Treeless Low Altitude Vegetation

The mapping units included in this general category are heathy sedgeland, *Poa* grassland, herbfield, *Gleichenia* tall alpine herbfield and *Sphagnum* bog (fig. 4). The mapping units seem less well-matched with the floristic groups than the alpine units because of the higher degree of local floristic heterogeneity.

Heathy sedgeland is the most widespread of these units. It is found on peaty soils of low nutrient status up to approximately 1100 m a.s.l. Pure buttongrass, layered eastern moor, common highland sedgey and highland dry sedgey communities are common within the mapped area, the former two communities being concentrated at lower latitudes and on apparently less fertile soils than the latter two. *Gymnoschoenus* sedgelands are most highly concentrated in floristic communities 9 and 13, although they also occur in communities 5 and 8. The most frequent species in community 9 are *Hibbertia procumbens*, *Ehrharta tasmanica*, *Mitrasacme montana*, *Lepidosperma filiforme*, *Lepyrodia tasmanica* and *Empodisma minus*. This community occurs on highly siliceous rocks or deposits at relatively low altitude. On the steeper slopes that it occupies, *Gymnoschoenus* sedgeland eventually becomes overtopped by *Leptospermum nitidum* or *Melaleuca squamea* in the prolonged absence of fire, becoming physiognomically a heath then a scrub (mapped as *Leptospermum* ± *Melaleuca* scrub). The scrub community is poorly-represented in the quadrat data, the one quadrat falling in group 13.

Gleichenia alpina tall alpine herbfield occurs in situations that are better drained and more fertile than those occupied by sedgeland, but less so than those occupied by tussock grassland. *Gleichena* constitutes almost all the cover in the ground stratum. A sparse emergent layer of *Richea pandanifolia* characterises some areas of this vegetation type, which is concentrated in floristic group 13.

Poa tussock grassland occupies the most fertile and well-drained of the lowland treeless land, usually on

deep, finely-textured, mineral, rock-free soils. Four of the grassy communities recognised by Kirkpatrick *et al.* (1988) occur within the study area. *Poa labillardieri-Trachymene humilis* tussock grassland is found on the more fertile soils of the northern part of the study area, particularly those formed on basalt. *Poa labillardieri-Veronica gracilis* tussock grassland is the commonest grassland community within the park. *Poa labillardieri-Oreobolus distichus* tussock grassland occurs adjacent to badly drained ground, and *Poa-Scirpus* tussock grassland occurs on silty, high-altitude sites subject to flushing. This latter community falls largely within the floristic group 3 of the present study and has been discussed under alpine herbland. The first community corresponds largely with our floristic group 1, while the other two fall within floristic group 2. The most frequent taxa in this latter group are *Poa labillardieri*, *Agrostis* spp., *Microseris lanceolata*, *Hydrocotyle sibthorpioides*, *Danthonia* spp., *Luzula* spp. and *Oreomyrrhis ciliata*. Floristic group 1 is extremely rich in frequent species. These include the shrubs *Bellendena montana*, *Epacris gunnii* and *Olearia algida*, the grasses *Deyeuxia quadriseta*, *Dichelachne rara*, *Elymus scabrum* and *Poa*, and the herbs *Geranium sessiliflorum*, *Hypericum japonicum*, *Leptorhynchos squamatus*, *Velleia montana*, *Scleranthus biflorus*, *Helichrysum rutidolepis*, *Ranunculus* spp., *Gonocarpus serpyllifolius*, *Acaena novae-zelandiae*, *Rubus gunnianus* and *Hydrocotyle sibthorpioides*.

In the parts of the study area where stock have grazed after fire there has been little or no regeneration of tree species, although the intertussock flora is in a richer state than in the few grasslands within the National Park. These grasslands were burned and grazed in the past, but have been free of fire and introduced stock grazing for several decades. The rich flowering evident in plate 3 can no longer be found.

In the north of the study area, complex patterns of fluvial deposition and erosion have created considerable variation in drainage, inundation and nutrient conditions. Consequently heath, herbland, *Sphagnum* bog, tussock grassland and sedgeland occur in close juxtaposition. The herbland occurs on highly fertile flushes below rainforest and is dominated by a mat of *Gunnera cordifolia*. The heath is extremely herb-rich and is dominated by various combinations of *Richea acerosa*, *Epacris gunnii* and *Richea gunnii*. This latter species extends as a dominant to *Sphagnum* bogs. Many of the large bogs in the study area also support stands of *Athrotaxis cupressoides*. Four of the *Sphagnum* bog communities of Whinam *et al.* (1989) are found in the study area. These are subalpine coniferous mire, buttongrass-*Sphagnum* bog, *Richea-Sphagnum* bog and rainforest-*Sphagnum* mire.

Communities Dominated by *Eucalypts*

Eucalyptus delegatensis, *E. nitida*, *E. coccifera*, *E. gunnii* and *E. subcrenulata* are each found emergent over a variety of understorey types within the study area (fig. 5, pp.130–131). *Eucalyptus delegatensis* can be found with the widest variety of understorey, which includes tussock grasses, *Gleichenia*, scleromorphic shrubs, broad-leaved shrubs and rainforest. *E. delegatensis* is confined to well-drained sites on relatively fertile soils. It attains 1000 m on north-facing slopes. As well-drained soils become poorer in nutrients, *E. nitida* displaces *E. delegatensis*. The understorey to *E. nitida* grades from scleromorphic shrubs to rainforest. On the well-drained sites receiving the least summer heat that are occupied by eucalypts, *E. coccifera* replaces the previous two species. Whereas neither *E. delegatensis* nor *E. nitida* are strongly associated with any of our floristic communities, *E. coccifera* is the major dominant of two. Community 4 occurs on more fertile sites than community 8. This difference is reflected in the most frequent species, which for 4 are *Poa gunnii*, *P. labillardieri*, *Cyathodes parvifolia*, *Eucalyptus coccifera*, *Lycopodium fastigiatum*, *Coprosma nitida*, *Tasmannia lanceolata*, *Oxalis magellanica* and *Geranium potentilloides*, whereas for community 8 they are *Epacris serpyllifolia*, *Boronia citriodora*, *E. coccifera*, *Empodisma minus* and *Bauera rubioides*. *Eucalyptus gunnii* and *E. subcrenulata* occur on more poorly-drained ground than the three species discussed above, with *E. gunnii* occurring on more fertile sites than the latter species. Both species can be found emergent from rainforest, scleromorphic shrubs, *Gleichenia* herbfield or sedgeland. Only *E. gunnii* can be found with an understorey of tussock grassland or *Sphagnum* bog. Whereas *E. subcrenulata* occurs sporadically in several floristic communities, *E. gunnii* is concentrated in community 5. The most frequent species in this community are *E. gunnii*, *Empodisma minus*, *Lycopodium fastigiatum*, *Hydrocotyle sibthorpioides* and *Ehrharta tasmanica*.

Rainforest

Four rainforest synusiae have been mapped. The most general category is simply denoted as rainforest. This almost totally consists of forest dominated by *Nothofagus cunninghamii*, although *Phyllocladus asplenifolius* and other evergreen angiosperm trees are often subordinate in the canopy. The deciduous tree, *Nothofagus gunnii*, and the gymnosperms, *Athrotaxis selaginoides* and *A. cupressoides* are also distinguished on the map (fig. 6, pp.132–133). The following communities of Jarman *et al.* (1984) have been

B heathy sedgeland
G *Poa* grassland
H herbfield
L *Leptospermum / Melaleuca* scrub / forest
S *Sphagnum* bog
Tm *Milligania* tall alpine herbfield
Tg *Restio / Empodisma / Gleichenia / Astelia*, tall alpine herbfield

D deciduous heath / scrub / forest
K *Athrotaxis selaginoides* forest
P *Athrotaxis cupressoides* woodland / forest
Rf evergreen closed forest

Ac coniferous heath,on dolerite(d),on quartzitic conglomerate(q)
Ag alpine grassland
As alpine heath on dolerite(d),on quartzitic conglomerate(q)
Fj fjaeldmark
Ro rock or block stream

Ec *Eucalyptus coccifera* woodland /open forest
Ed *Eucalyptus delegatensis* open forest / tall open forest
Eg *Eucalyptus gunnii* woodland / open forest
En *Eucalyptus nitida* open scrub / open forest
Es *Eucalyptus subcrenulata* open forest

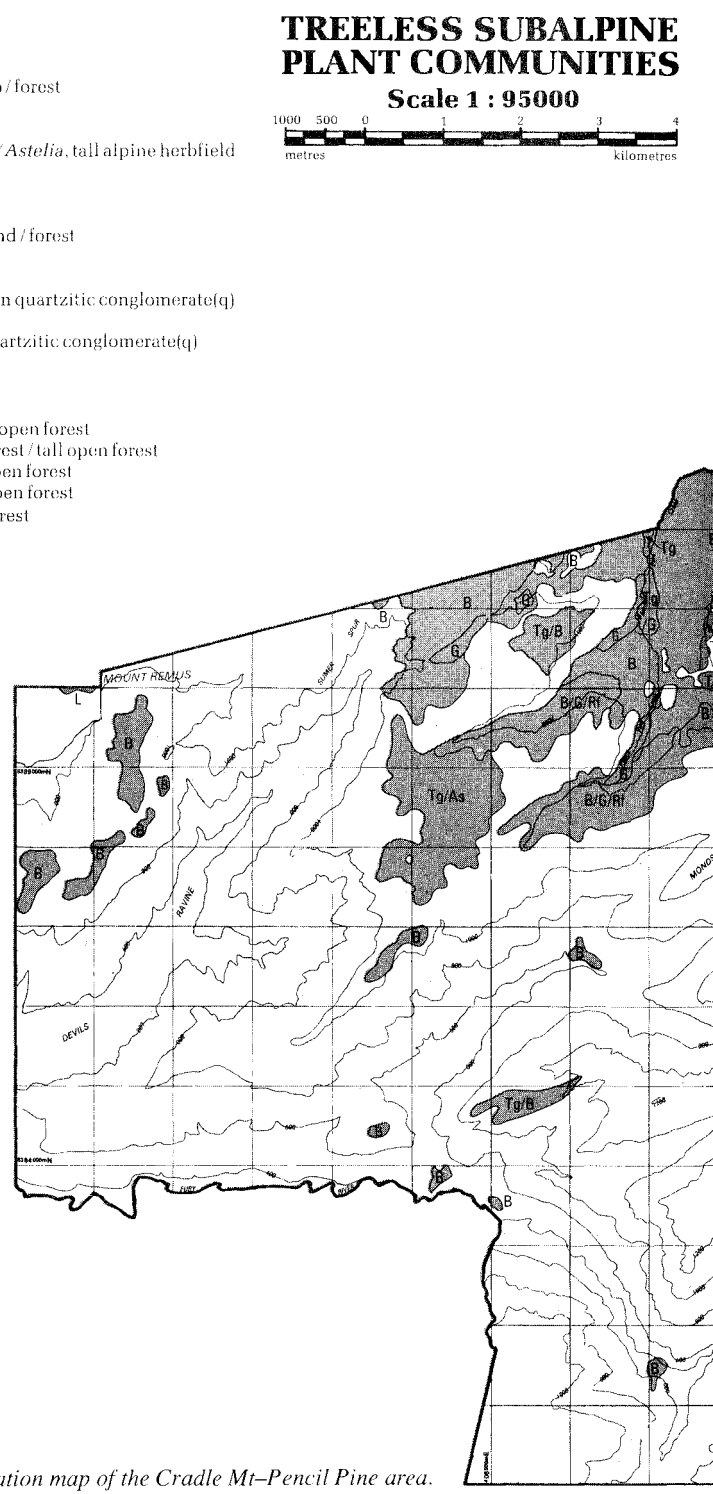
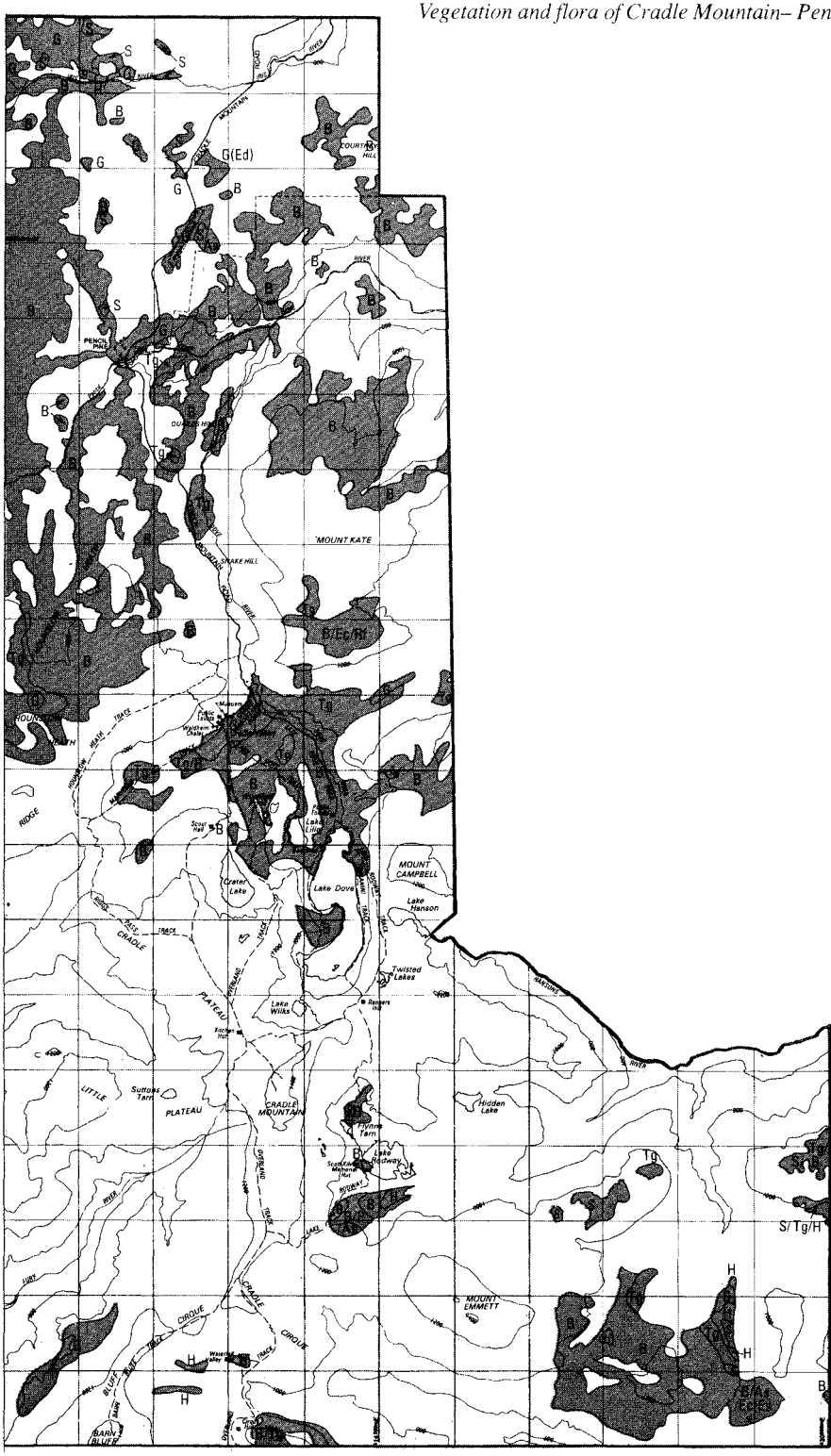


FIG. 4 —Treeless subalpine vegetation map of the Cradle Mt–Pencil Pine area.


MOUNT KATE
B/Ec/H
Tg
MOUNT CAMPBELL
Lake Dove
Lake Hanson
Crater Lake
Twisted Lakes
Lake Wilks
Hidden Lake
Lake Rodway
CRADLE MOUNTAIN
PLATEAU
Suttons Tarn
MOUNT EMMETT
S/Tg/H
B/As/Ec
CIRQUE
BARN BLUFF
G(Ed)

Ec *Eucalyptus coccifera* woodland /open forest
Ed *Eucalyptus delegatensis* open forest / tall open forest
Eg *Eucalyptus gunnii* woodland / open forest
En *Eucalyptus nitida* open scrub / open forest
Es *Eucalyptus subcrenulata* open forest

B heathy sedgeland
G *Poa* grassland
H herbfield
L *Leptospermum / Melaleuca* scrub / forest
S *Sphagnum* bog
Tm *Milligania* tall alpine herbfield
Tg *Restio / Empodisma / Gleichenia / Astelia*, tall alpine herbfield

D deciduous heath / scrub / forest
K *Athrotaxis selaginoides* forest
P *Athrotaxis cupressoides* woodland / forest
Rf evergreen closed forest

Ac coniferous heath,on dolerite(d),on quartzitic conglomerate(q)
Ag alpine grassland
As alpine heath on dolerite(d),on quartzitic conglomerate (q)
Fj fjaeldmark
Ro rock or block stream

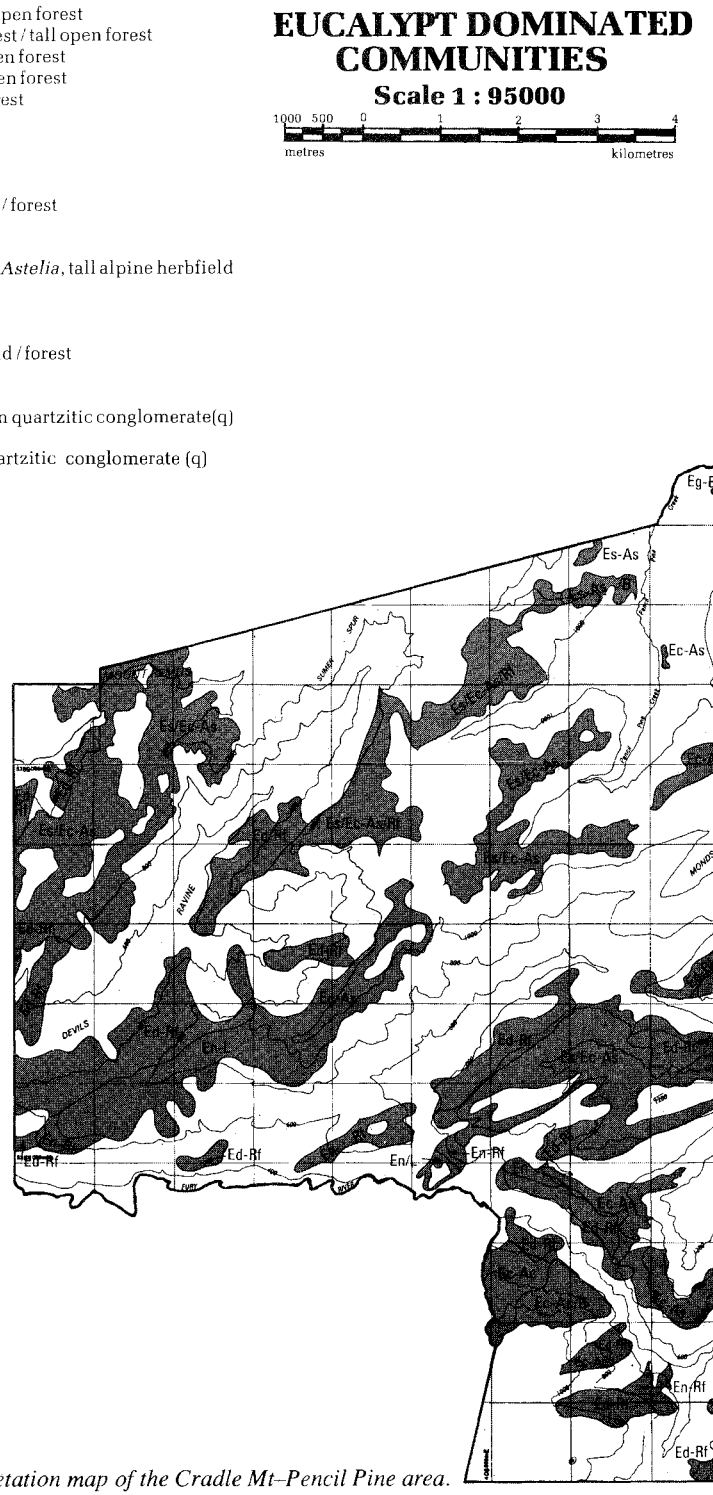
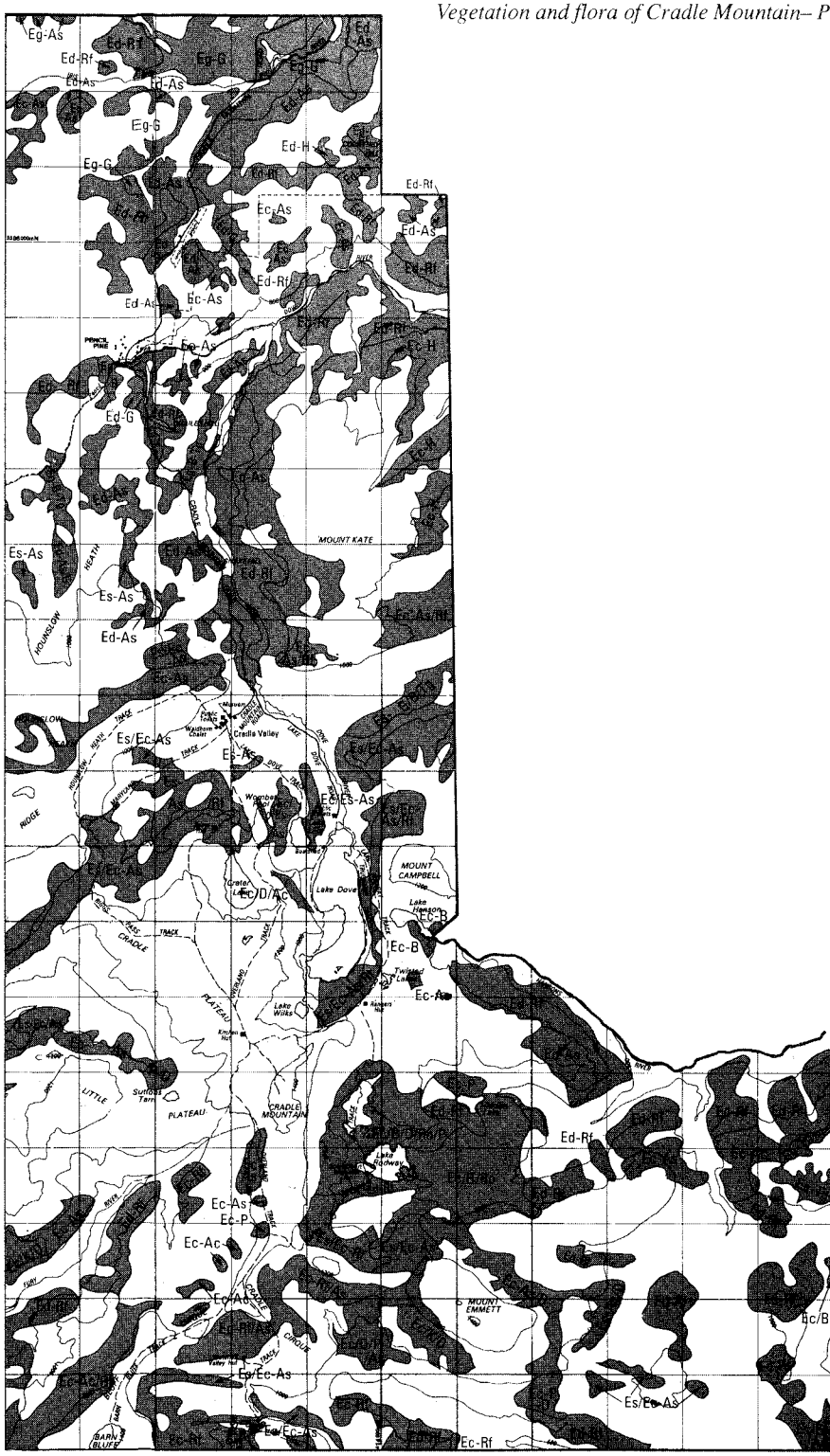


FIG. 5 — Eucalypt-dominated vegetation map of the Cradle Mt–Pencil Pine area.


Eg-As
Ed-Rf
Ed-As
Eg-G
Ed-H
Ec-As
Ec-H
Ed-G
MOUNT KATE
Es-As
Ed-As
Ec-As/Rf
Es/Ec-As
Cradle Valley
Ec/D/Ac
MOUNT CAMPBELL
Lake Dove
Ec-B
Lake Wilks
Ec-P
Ec-Ac
MOUNT EMMETT
Ec/B
Es/Ec-As
Ec-Rf
CRADLE MOUNTAIN
PLATEAU
HEATH
RIDGE
CIRQUE
BARN BLUFF

D deciduous heath / scrub / forest
K *Athrotaxis selaginoides* forest
P *Athrotaxis cupressoides* woodland / forest
Rf evergreen closed forest

Ac coniferous heath, on dolerite(d), on quartzitic conglomerate(q)
Ag alpine grassland
As alpine heath on dolerite(d), on quartzitic conglomerate(g)
Fj fjaeldmark
Ro rock or block stream

Ec *Eucalyptus coccifera* woodland / open forest
Ed *Eucalyptus delegatensis* open forest / tall open forest
Eg *Eucalyptus gunnii* woodland / open forest
En *Eucalyptus nitida* open scrub / open forest
Es *Eucalyptus subcrenulata* open forest

B heathy sedgeland
G *Poa* grassland
H herbfield
L *Leptospermum / Melaleuca* scrub / forest
S *Sphagnum* bog
Tm *Milligania* tall alpine herbfield
Tg *Restio / Empodisma / Gleichenia / Astelia*, tall alpine herbfield

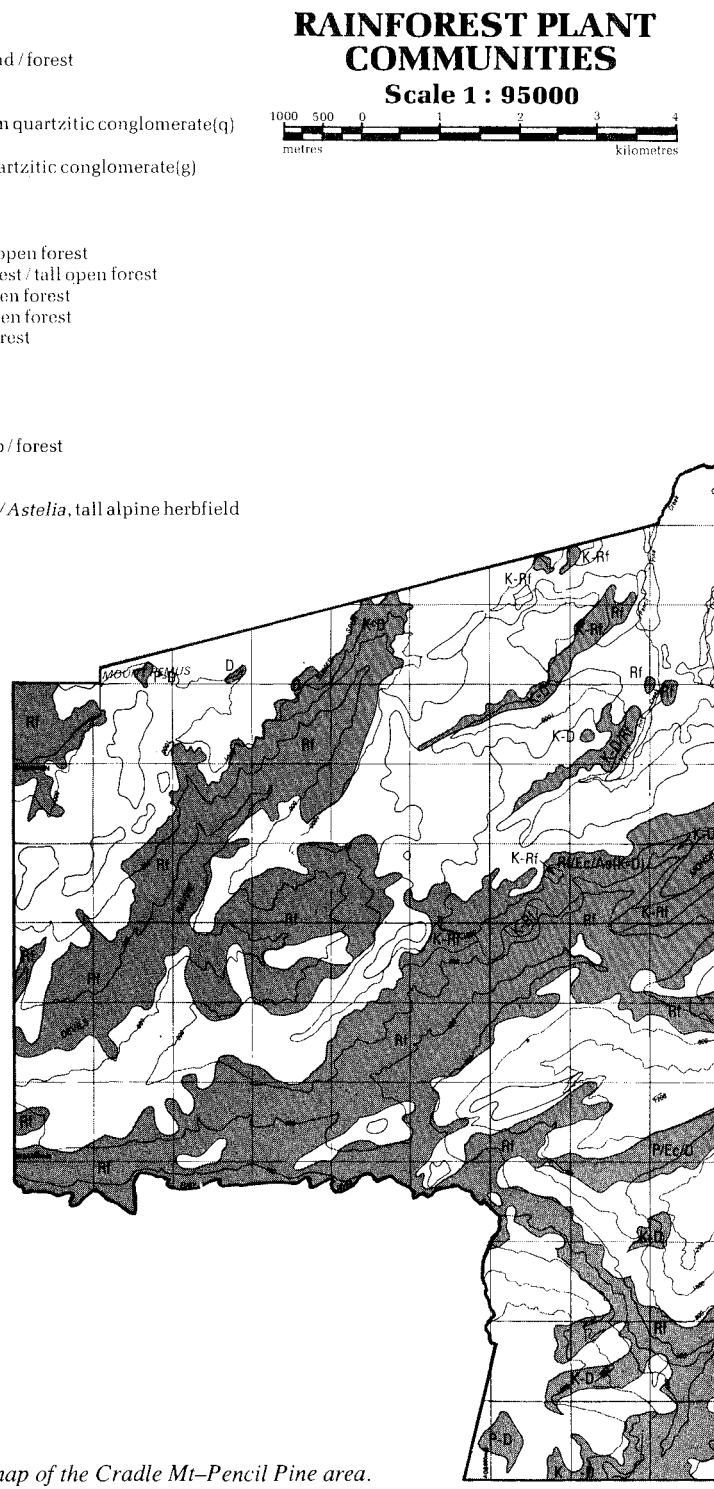
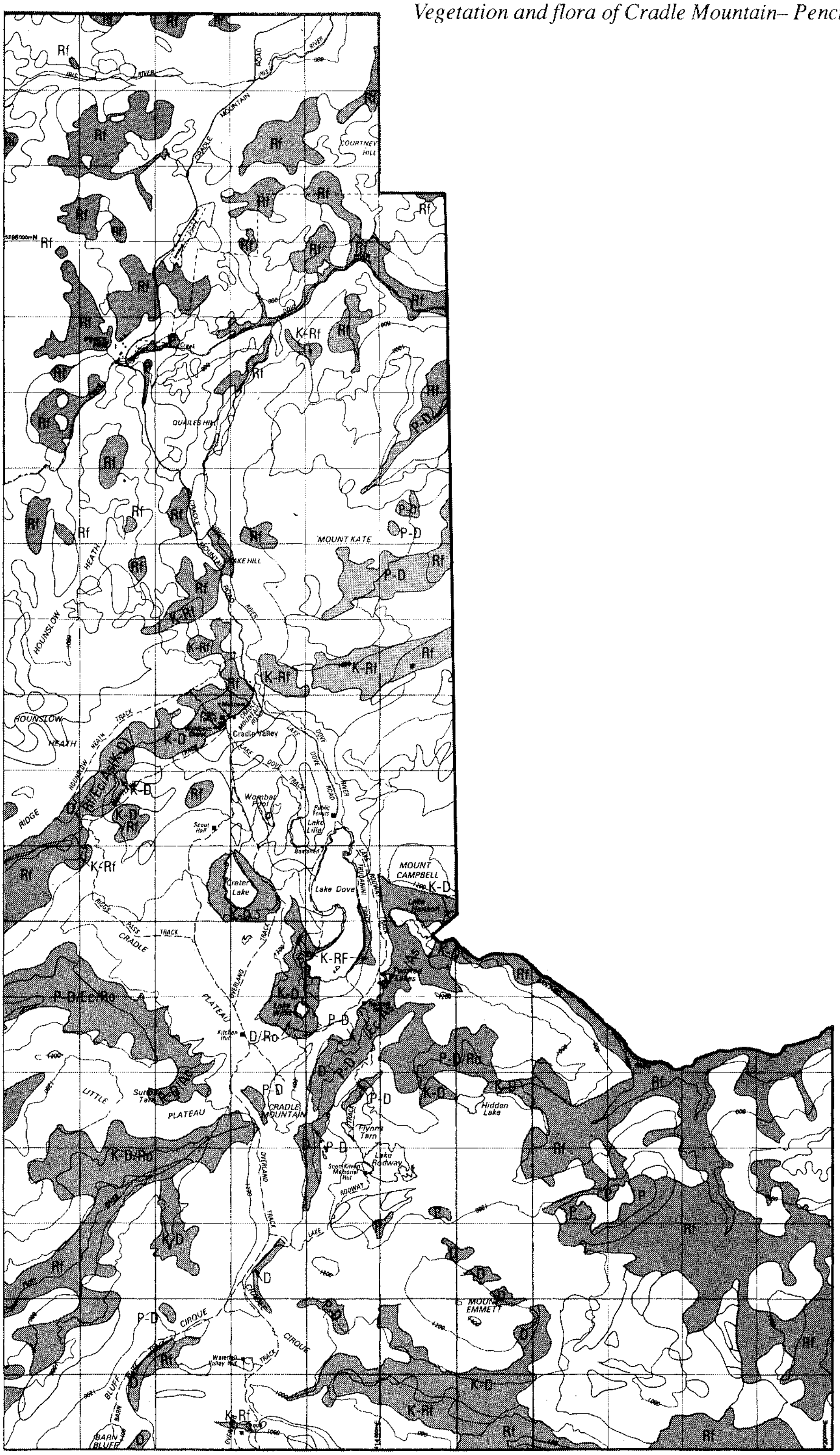


FIG. 6 — Rainforest vegetation map of the Cradle Mt–Pencil Pine area.



COURTNEY HILL
QUAILES HILL
MOUNT KATE
SNAKE HILL
HOUNSLOW HEATH
HOUNSLOW HEATH TRACK
Cradle Valley
Wombat Pool
Scout Hut
Lake Lilla
Crater Lake
Lake Dove
MOUNT CAMPBELL
RIDGE PASS TRACK
CRADLE PLATEAU
OVERLAND TRACK
Kitchen Hut
LITTLE PLATEAU
CRADLE MOUNTAIN
Hidden Lake
Flynns Tarn
Lake Rodway
MOUNT EMMETT
CIRQUE
Waterfall Valley Hut
BARN BLUFF
Rf
K-Rf
K-D
P-D
D/Ro
P-D/Ro
K-D/Ro
P-D/Ec/Ro
K-RF

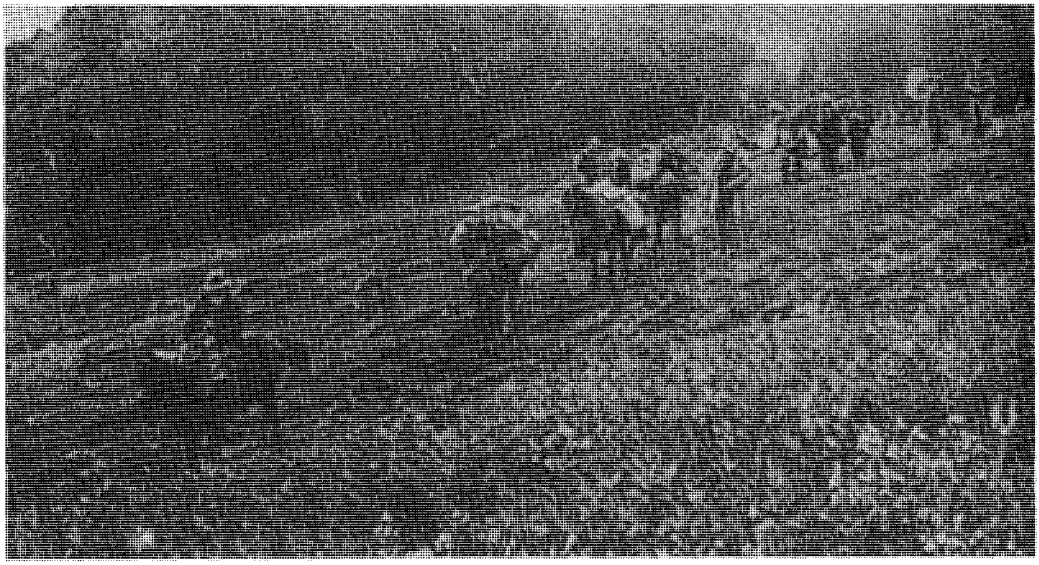


PLATE 3
Photograph taken in Cradle Valley in the 1920's, showing a prolific display of wildflowers in the grassland vegetation.

observed in the study area: callidendrous 1A and 2A; thamnic 1C, 4C, 5B and 5C; implicate 2A; open montane 1, 2 and 3.

The floristic classification of the Cradle–Pencil Pine data set placed the rainforest *sensu lato* in three groups. Group 6 largely consisted of the quadrats in rainforest dominated by *Athrotaxis selaginoides*. The other most frequent species in these forests were *Trochocarpa gunnii*, *Richea pandanifolia*, *Trochocarpa cunninghamii* and *Phyllocladus aspleniifolius*. Group 7 has high concentrations of *Nothofagus cunninghamii*, *Phyllocladus aspleniifolius* and *Athrotaxis cupressoides*. The highest concentration of *Nothofagus gunnii* in a forest community is in group 8 where it is most often subordinate to *Eucalyptus coccifera*.

Environmental Relationships

The initial division in the classificatory analysis placed most of the sites on quartzitic conglomerate in the negative group and most of the sites on alluvium and basalt in the positive group (fig. 2). The quadrats in the group on infertile ground split into those of high-altitude and low-altitude sites with further significant environmental splits being on substrate, slope, altitude and fire history. The quadrats in the positive initial group split into further groups on slope and altitude.

The first axis of the ordination had an eigen value of 0.603 and was most closely correlated with the fire susceptibility index ($r = 0.713$, $df = 12$, $P < 0.01$). The residuals from this regression were not significantly correlated with any of the measured environmental factors. The second axis of the ordination had an eigen value of 0.277 and was most closely correlated with altitude ($r = 0.866$, $df = 12$, $P < 0.001$). The residuals from this regression line were significantly correlated with slope ($r = 0.610$, $df = 12$, $P < 0.05$). In the cases of both axes, variability in the correlated attributes was close to parallel with the axes.

The results of the above analyses are consistent with a model of floristic variation in the vegetation of the area that is based on the causal roles of summer heat, waterlogging, soil nutrient status and fire regimes.

The upper altitudinal limit of trees within the Cradle area, and elsewhere in the state (Kirkpatrick 1982), correlates best with the mean temperature of the warmest month. Summer heat is greater on north than on south-facing slopes, making the upper limit of trees vary appropriately. The sharp boundary between treeless vegetation dominated by alpine species and treeless vegetation dominated by *Gymnoschoenus sphaerocephalus* occurs below the limit of trees but, like the treeline, varies in altitude with aspect (Kirkpatrick & Brown 1987), suggesting that summer warmth may be

critical in its determination. *Eucalyptus delegatensis* forest fits the same pattern. We suggest that the altitudinal floristic gradient indicated in the ordination analysis is largely a response to a decline in summer warmth with altitude, although it may also be influenced by variation in exposure to strong winds.

In the area above the treeline there is a strong relationship between slope and vegetation type, with cushion plants dominating the gentler situations and upright shrubs dominating on steeper slopes. This correlation seems best explained by moisture relationships as cushion plants can be dominant on quite steep slopes where seepage is constant.

Within the altitudinal zone potentially occupied by trees there are large treeless areas. The ratio of treeless to treed vegetation increases with decreasing slope at any one altitude, indicating that waterlogged conditions may be critical in inhibiting tree growth and establishment. Even if tree growth is not totally prevented by waterlogging, a slowing of growth rates would make individuals prone to being set back to ground level by fire, in the case of eucalypts, or lead to an open, and therefore more inflammable forest, in the case of rainforest trees. On poor soils below 1100 m heathy sedgeland occupies most of the treeless area. It forms an amorphous peat with low porosity which probably exacerbates drainage problems for trees.

Heaths rich in herbs and grasses, herblands and tussock grasslands occupy the more fertile treeless areas, some of which are clearly well-drained and most of which are sufficiently well-drained to support tree growth. On some sites, particularly the alluvial flats in the north of the study area, the absence of trees may relate to occasional severe frosts and the resistance of the surviving understorey sward to re-invasion (Slatyer 1989). Here, the topographic situation of the inverted treeline supports this hypothesis. The grasslands of Cradle Valley are likely to have an alternative origin. They occupy a well-drained and relatively productive slope and have a jagged and topographically varied boundary with adjacent rainforest. This boundary may have resulted from a single fire that killed rainforest on the lower slopes and then was reinforced by repeated fires within the regenerating vegetation. Alternatively, fires may have spread from frost-induced treeless vegetation at the base of the slope, merely extending, rather than creating, the grassland.

There is little doubt that fire has played a major role in the causation of vegetation patterning in the Cradle area. Fire sensitive species, such as *Athrotaxis selaginoides*, *A. cupressoides*, *Nothofagus gunnii* and *Diselma archeri* (Kirkpatrick & Dickinson 1984, Brown 1988) often have jagged edges to their distributions that do not correspond with underlying environmental gradients, and size and age class analysis of stands reveals recolonisation from the margins of old burns. At the other extreme of fire frequency, comparison of grasslands and heathy sedgelands on similar sites with different times elapsed since fire suggests, that, over at least a part of their distributions, they require occasional fire for their maintenance. The pattern of juxtaposition of various lowland vegetation types fits closely with that which would be expected from the dynamic model of Jackson (1968).The ordination, like that of Kirkpatrick (1984a) in a similar environment, reflects the major phytosociological gradient from frequently burned to unburned sites.

The environmental gradient from argillaceous to siliceous rocks is associated with a floristic shift from relatively soft herbs and grasses to hard-leaved shrubs and graminoids and with some shift in forest, treeless lowland and alpine dominants on otherwise similar sites.

Fertility, summer heat and soil drainage interactively contribute to the potential growth rates for individual species. This integral response to the complex of environmental conditions is reflected most clearly in the structural/floristic gradient in the long, unburned rainforest.

On the best sites for tree growth, *Nothofagus cunninghamii* tends to form almost monospecific stands of callidendrous rainforest. As growth rates slow *Athrotaxis* species become dominant with progressively more complex and species rich understoreys. On the poorest sites for tree species growth, *Nothofagus gunnii* dominates a deciduous scrub. Within the *Athrotaxis* forest there is little doubt that *A. cupressoides* occupies more frost-prone sites than *A. selaginoides* (Cullen & Kirkpatrick 1988).

Conservation Management

Table 4 (pp. 140–141) summarises the management and conservation attributes of the synusiae mapped in figures 3 to 6. Our present knowledge of the ecology and conservation status of these synusiae suggests that a policy of total fire exclusion is appropriate for the preservation of the rainforest and alpine communities, and that management should be directed towards minimising the chances of fire entering these communities. The no campfire policy presently in force will aid this end, but the opening of the new link road to the northwest of Cradle Mountain will present a major ignition danger, both in itself as an attractor of arsonists and in the danger of escapes from the preventative burning it may encourage. We suggest that police or other Government patrols be placed on the susceptible sections of this road on dangerous days. In the long term, the survival of much of the area of

eucalypt forest and lowland treeless communities may depend on a very occasional conflagration. These do not need to be encouraged. There is no convincing evidence of any totally fire-dependent species in the study area. Even the eucalypts will regenerate without fire in glacially-scraped country or on sharp ridges after tree fall.

The impact of trampling on the native vegetation has been much mitigated recently by track reconstruction, after a disastrous start (Calais & Kirkpatrick 1986). The construction of toilets has also mitigated the severe damage to alpine and subalpine root systems caused by the digging of holes for the deposition of faeces and paper. This latter activity is not appropriate in alpine vegetation where surface deposition is less environmentally damaging and no deposition is optimal.

The invasion of exotic species in the National Park is very much dependent on nutrient enrichment, which is only a problem around huts. In these locations *Poa annua* and *Cerastium glomeratum* are the major invaders. Exotics, if ever present, have not survived in the Cradle Valley grassland.

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TABLE 2
The percentage frequency of species by TWINSPAN group*

Group	LF†	1	2	3	4	5	6	7	8	9	10	11	12	13
No. of quadrats		5	15	11	10	8	8	20	14	3	15	9	15	8
Melaleuca squamea	S	–	–	–	–	–	–	–	14	–	7	–	–	63
Sprengelia incarnata	S	–	–	–	–	–	–	–	21	33	–	–	40	50
Lycopodium laterale	Fcz	–	–	–	–	–	–	–	14	–	–	–	7	50
Erigeron stellatus	Hrz	20	–	9	10	38	–	–	14	33	–	33	40	62
Carpha alpina	Mtz	–	27	18	–	–	–	–	14	–	–	22	80	63
Astelia alpina	Mtz	–	7	36	–	13	13	25	14	33	27	33	67	50
Baeckea gunniana	S	–	–	–	–	13	–	25	29	33	–	33	53	38
Drosera arcturi	Hra	–	–	–	–	–	–	–	–	–	7	–	53	13
Oreobolus pumilio	Mm	–	–	9	–	–	–	5	25	–	–	11	53	13
Gentianella diemensis	Hra	–	20	–	–	–	–	–	7	–	20	47	60	–
Mitrasacme montana	Hm	–	–	9	–	–	–	–	7	100	–	11	47	75
Restio complanatus	Mz	–	–	–	–	–	–	–	25	67	–	–	13	50
Pultenaea species	S	20	7	–	–	25	–	15	43	67	–	–	7	50
Gymnoschoenus sphaerocephalus	Mtz	–	–	–	–	25	–	5	21	100	–	–	–	50
Boronia citriodora	S	–	–	–	–	–	–	15	86	33	40	33	53	63
Epacris serpyllifolia	S	–	–	9	–	–	–	15	71	–	27	36	80	15
Microcachrys tetragona	Sgp	–	–	–	–	–	–	–	7	–	13	67	53	–
Nothofagus gunnii	Td	–	–	36	–	–	25	–	57	–	7	56	–	–
Exocarpos humifusus	Sp	–	–	–	–	–	–	–	50	–	40	67	20	–
Orites revoluta	S	–	–	36	–	–	–	45	43	–	87	44	20	13
Podocarpus lawrencii	Sgp	–	–	18	–	–	–	15	14	–	80	33	7	–
Cyathodes straminea	S	–	–	9	–	–	–	15	7	–	60	33	–	13
Orites acicularis	S	–	7	27	–	–	–	15	14	–	60	11	13	38
Lepyrodia tasmanica	Mz	–	–	–	–	–	–	–	–	67	–	–	–	38
Stylidium graminifolium	Hr	–	–	–	–	25	–	10	43	67	7	–	7	25
Hibbertia procumbens	Sp	–	–	–	–	25	–	20	14	100	–	–	–	–
Pentachondra pumila	Sp	–	–	–	–	13	–	20	36	67	47	100	53	13
Richea sprengelioides	S	–	–	–	–	–	–	20	57	–	67	100	53	–
Cyathodes petiolaris	S	–	–	–	–	–	–	–	50	–	14	22	–	13
Monotoca submutica	S	–	–	–	–	38	13	25	57	33	7	11	7	13
Persoonia gunnii	S	–	–	–	–	–	25	5	50	–	–	–	–	–
Oxylobium ellipticum	S	–	–	–	–	13	–	10	64	–	–	11	–	–
Nothofagus cunninghamii	T	–	13	–	30	25	88	75	57	–	–	22	–	–
Phyllocladus aspleniifolius	Tg	–	–	–	–	–	88	55	14	–	–	–	–	–
Trochocarpa gunnii	S	–	–	–	–	–	88	50	7	–	–	–	–	–
Athrotaxis selaginoides	Tg	–	–	–	–	–	88	–	36	–	–	11	–	–
Trochocarpa cunninghamii	Sp	–	–	–	–	–	88	–	36	–	7	44	–	–
Bauera rubioides	Sp	–	–	–	–	–	50	20	93	67	–	–	–	50
Diplarrena latifolia	Mtz	20	13	–	–	13	–	30	50	67	13	22	27	50
Eucalyptus coccifera	T	–	13	–	70	–	–	50	79	–	7	–	7	25
Poa species	Pt	40	67	82	80	63	–	45	29	67	80	33	53	63
Celmisia asteliifolia	Hr	–	27	18	–	13	–	15	36	–	33	67	40	13
Cyathodes dealbata	Sp	–	–	18	–	–	–	10	–	–	7	67	47	–
Empodisma minus	Mz	20	60	27	40	88	13	60	64	100	–	56	87	75
Ehrharta species	P	40	33	9	70	88	–	65	36	100	27	67	67	100
Uncinia species	M	–	40	73	40	13	–	60	21	–	27	56	20	25
Richea scoparia	S	–	7	64	–	–	50	55	36	–	40	56	47	13
Gonocarpus species	Sp	100	53	27	60	100	7	30	14	33	60	–	7	–
Cyathodes parvifolia	S	20	13	–	100	50	38	75	57	33	7	–	–	–
Lepidosperma filiforme	Mtz	–	33	–	–	50	–	20	57	100	–	–	–	13

Group	LF†	1	2	3	4	5	6	7	8	9	10	11	12	13
No. of quadrats		5	15	11	10	8	8	20	14	3	15	9	15	8
Gleichenia alpina	Fz	20	20	–	20	50	–	20	–	33	–	11	33	75
Coprosma nitida	S	20	13	18	70	63	13	40	21	–	67	11	–	–
Tasmannia lanceolata	S	40	–	45	80	63	–	55	43	–	73	22	–	–
Restio australis	Mz	20	47	–	10	50	–	15	—	67	–	–	–	50
Bellendena montana	S	80	27	55	30	13	–	10	7	–	53	22	7	13
Viola species	Hrs	60	60	–	10	50	–	10	–	67	–	–	–	–
Hydrocotyle species	Hcs	100	93	91	60	75	–	15	–	33	–	–	–	13
Lissanthe montana	S	60	27	73	–	50	–	25	–	33	40	11	–	–
Lycopodium fastigiatum	Fcz	40	20	55	80	75	–	40	14	33	40	22	27	–
Oxalis magellanica	Hrz	–	40	73	70	50	–	40	–	–	–	–	7	–
Geranium species	Hrs	80	53	45	70	50	–	–	–	–	–	–	–	–
Epacris gunnii	S	80	–	–	10	63	–	15	–	–	7	–	13	13
Rubus gunnianus	Hrc	100	53	36	–	63	–	45	–	33	27	–	20	25
Eucalyptus gunnii	T	40	7	–	60	75	20	–	–	–	–	–	–	–
Olearia erubescens	S	40	20	–	–	50	13	20	–	33	–	–	–	–
Lagenifera stipitata	Hr	20	27	45	20	63	–	35	–	3	20	–	–	–
Bossiaea cordigera	Sp	–	–	–	–	63	–	15	–	–	–	–	–	–
Libbertia pulchella	Mz	–	–	–	60	13	–	20	–	–	–	–	–	–
Blechnum penna-marina	Fz	20	27	55	50	37	–	25	–	–	–	–	7	–
Leptospermum rupestre	S	20	27	55	50	38	–	40	7	33	13	–	27	25
Cotula reptans & *Oreomyrrhis ciliata*	Hc	40	80	82	60	38	–	10	–	–	7	–	–	–
Acaena species	Hc	80	67	55	60	25	–	15	–	–	7	–	–	–
Plantago species	Hr	100	67	91	20	25	–	–	–	–	40	–	13	–
Gnaphalium species	Hrs	60	60	91	10	25	–	–	–	33	7	–	–	–
Ranunculus species	Hr	100	73	55	20	13	–	–	–	–	–	–	–	–
Agrostis species	P	80	93	64	40	25	–	5	–	–	13	–	–	–
Helichrysum backhousii	S	–	–	73	–	–	–	15	–	–	40	44	27	13
Diplaspis species	Hr	20	–	64	–	–	–	5	–	–	7	–	13	–
Deyeuxia species	P	100	73	36	10	38	–	20	14	–	33	–	7	13
Danthonia species	P	100	100	45	10	–	–	15	7	–	7	–	47	13
Helichrysum scorpioides	Hz	80	60	9	–	37	–	10	–	–	7	–	–	–
Carex species	Mt	20	73	9	30	38	–	5	–	–	7	–	7	25
Oreobolus distichus	Mm	60	20	27	–	13	–	5	–	–	–	–	20	25
Cotula alpina	Hc	100	33	37	–	25	–	10	–	33	–	–	–	–
Leptorhynchos squamatus	Hr	80	–	18	–	25	–	–	–	–	27	–	–	–
Helichrysum acuminatum	Hr	60	33	–	–	13	–	–	–	–	20	–	–	–
Veronica species	Hz	60	27	–	–	37	–	–	–	33	–	–	–	–
Asperula species	Hc	60	27	9	–	–	–	10	–	–	7	–	–	–
Craspedia glauca	Hr	60	47	9	–	–	–	–	–	–	–	–	–	–
Dichelachne rara	P	80	7	–	–	25	–	–	–	–	–	–	–	–
Elymus scabrum	Pt	60	7	–	–	–	–	–	–	–	–	–	–	–
Scleranthus biflorus	Hm	80	13	–	–	–	–	–	–	–	–	–	–	–
Velleia montana	Hr	80	–	–	–	–	–	–	–	–	–	–	–	–
Olearia algida	S	80	–	–	–	–	–	–	–	–	–	–	–	–
Conifer species‡	g	–	–	36	–	–	100	75	64	–	87	78	60	13
Bolster shrub species#	m	–	–	–	–	–	–	–	–	–	–	–	47	–

* Species that occur in less than 50% of the quadrats for all groups have been excluded.

† LF (life forms): F = fern, H = forb, M = gramminoid, P = grass, S = shrub, T = tree; a = annual/geophyte, c = creeping, d = deciduous, g = coniferous species, m = mat/cushion, p = prostrate, r = rosette, s = stoleniferous, t = tussock, z = rhizomatous.

‡ Percentage of quadrats in each group with any conifer species present.

\# Percentage of quadrats in each group with any shrubs with a bolster form present.

TABLE 3
Life form composition and environmental attributes of TWINSPAN groups*

Group	1	2	3	4	5	6	7	8	9	10	11	12	13
Number of taxa†	28	17	18	17	22	7	9	16	16	10	11	14	18
Trees	–	–	–	12	5	43	33	19	–	–	9	–	–
deciduous	–	–	–	–	–	–	–	6	–	–	9	–	–
Shrubs	18	6	28	29	36	57	44	63	25	90	55	43	28
prostrate shrubs	4	6	–	6	9	29	–	13	19	20	36	14	6
Woody plants	18	6	28	41	41	100	77	82	25	90	64	43	28
Forbs	61	59	44	29	27	–	–	–	19	–	9	14	11
rosette forbs	36	35	28	12	23	–	–	–	13	–	9	14	6
creeping/stoloniferous forbs	29	41	22	24	18	–	–	–	6	–	–	–	–
annuals	–	–	–	–	–	–	–	–	–	–	–	14	–
Graminoids	4	12	6	6	14	–	22	19	44	–	18	29	39
Tussock	–	6	–	–	5	–	–	13	19	–	–	14	22
Grasses	18	24	11	12	9	–	11	–	13	10	9	14	11
tussock grasses	4	6	6	6	5	–	–	–	6	10	9	7	6
Ferns	–	–	11	12	9	–	–	–	–	–	–	–	11
Non-woody plants	82	94	72	59	59	–	33	18	75	10	36	57	72
mat forming herbs	10	–	–	–	–	–	–	–	6	–	–	7	6
rhizomatous herbs	7	12	17	24	28	–	14	19	38	–	9	21	45
Mean altitude (m)	826	999	1142	851	837	967	962	1049	837	1233	1196	1195	925
(st. dev.)	24	126	111	16	13	6	136	70	75	49	54	46	82
Fire score	0	6	21	2	2	59	28	30	0	24	34	19	6
Mean slope score	1.0	1.3	1.7	2.1	1.4	2.0	1.7	2.4	2.0	2.3	1.5	1.3	1.4
Mean aspect score	2.2	3.0	2.9	2.7	2.1	3.0	2.7	3.0	3.3	2.3	2.7	2.9	2.9
Mean geology score	3.8	3.5	3.7	4.2	2.4	4.0	3.8	4.8	4.7	3.5	4.7	4.4	3.9

* Life forms of the taxa occurring in less than 50% of the quadrats for the group were excluded. The indices used for fire, slope, aspect and geology are defined in the text (under "Methods").
† Number of taxa occurring in 50% or more of the quadrats for each group.

TABLE 4 notes

Fire Response Classes
1 Permanent or semi-permanent (500+ yr) elimination of dominant species
2 Long-term (100+ yr) change in dominant species
3 Short-term (100 yr) restoral of dominance, but not fire requiring
4 Eliminated if fire frequency is ever less than 400 yr
5 Requires frequent fire (1 in 100 yr)

Usage response classes
1 Highly susceptible to trampling (no more than 500 people per annum per place) and not resilient, camping likely to create long-term damage
2 Highly susceptible to trampling, but resilient, camping possible without severe and prolonged damage
3 Generally resistent to and resilient from trampling

Community rarity classes (global)
1 Extremely rare synusia (10 km^2 *in toto*)
2 Rare synusia (10–200 km^2 *in toto*)
3 Common synusia (200 km^2 *in toto*)

Reservation classes (global)
Percentage of 1800 AD area of type in secure reserves
1 1%
2 1–5%
3 5–25%
4 25–100%

Species rarity classes
1 Rare or threatened species common
2 Rare or threatened species uncommon or absent

TABLE 4
Attributes of Perceptible Synusiae

	Fire response					Usage response			Community rarity			Reservation status				Species rarity	
	1	2	3	4	5	1	2	3	1	2	3	1	2	3	4	1	2
Alpine communities																	
Ac coniferous heath	x	–	–	–	–	x	–	–	–	x	–	–	–	–	x	x	–
Ag alpine grassland	–	–	x	–	–	x	–	–	x	–	–	–	–	–	x	x	–
Ah short alpine herbfield	–	–	x	–	–	x	–	–	x	–	–	–	–	–	x	x	–
As alpine heath	–	–	x	–	–	x	–	–	–	x	–	–	–	–	x	–	x
Fj fjaeldmark	x	–	–	–	–	x	–	–	–	x	–	–	–	–	x	x	–
Treeless subalpine communities																	
B heathy sedgeland	–	–	–	–	x	–	x	–	–	–	x	–	–	–	x	–	x
G *Poa* grassland	–	–	x	–	–	–	x	–	–	x	–	–	–	x	–	x	–
H herbfield	–	–	x	–	–	–	x	–	x	–	–	–	–	x	–	x	–
Tm *Milligania* tall alpine herbfield	–	–	x	–	–	x	–	–	x	–	–	–	–	–	x	x	–
S *Sphagnum* bog	–	x	–	–	–	–	x	–	–	x	–	–	–	–	x	–	x
Tg *Gleichenia/Restio/Empodisma/ Astelia* tall alpine herbfield	–	–	–	x	x	–	x	–	–	x	–	–	–	–	x	–	x
L *Leptospermum±Melaleuca* scrub	–	–	–	x	–	–	x	–	–	–	x	–	–	–	x	–	x
Eucalypt communities																	
Ec *Eucalyptus coccifera* woodland/open forest	–	–	x	x	–	–	–	x	–	–	x	–	–	–	x	–	x
Ed *Eucalyptus delegatensis* open forest	–	–	–	x	–	–	–	x	–	–	x	–	–	x	–	–	x
Eg *Eucalyptus gunnii* woodland/open forest	–	–	x	x	–	–	x	–	–	x	–	–	–	–	x	–	x
En *Eucalyptus nitida* open forest	–	–	–	x	–	–	–	x	–	–	x	–	–	–	x	–	x
Es *Eucalyptus subcrenulata* woodland/open forest	–	–	–	x	–	–	x	–	–	x	–	–	–	–	x	–	x
Rainforest communities																	
K *Athrotaxis selaginoides* forest	x	–	–	–	–	–	x	–	–	–	x	–	–	–	x	–	x
P *Athrotaxis cupressoides* woodland/forest	x	–	–	–	–	x	–	–	–	x	–	–	–	–	x	x	–
Rf evergreen closed forest	x	x	–	–	–	–	x	x	–	–	x	–	–	–	x	–	x
D deciduous heath/scrub/forest	x	–	–	–	–	x	–	–	–	–	x	–	–	–	x	–	x
Miscellaneous																	
Ro Rock or block stream																	
(a) quartzitic	–	–	x	–	–	–	–	x	–	x	–	–	–	–	x	–	x
(d) on dolerite	–	–	x	–	–	–	–	x	–	x	–	–	–	–	x	x	–

APPENDIX
Cradle Mountain Lake St Clair National Park 1989 Plant Census

E = endemic to Tasmania, I = introduced to Tasmania, C = occurring on the CRADLE sheet, R = rare in Tasmania. P = occurring on the PENCIL PINE sheet.

	Distribution/ status
DICOTYLEDONS	
APIACEAE (UMBELLIFERAE)	
Aciphylla procumbens (F.Muell.) Benth.	E C
Actinotus bellidioides (Hook.f.) Benth.	C
Actinotus moorei Rodway	E C P
Actinotus suffocata (Hook.f.) Rodway	C
Centella cordifolia (Hook.f.) Nannf.	
Dichosciadium ranunculaceum (F.Muell. ex Hook.) Domin	E C P
Diplaspis cordifolia Hook.f	E C
Diplaspis hydrocotyle Hook.f.	C P
Hydrocotyle hirta R.Br. ex A.Rich.	
Hydrocotyle muscosa R.Br. ex A.Rich.	
Hydrocotyle pterocarpa F.Muell.	P
Hydrocotyle sibthorpioides Lamk.	C P
Lilaeopsis polyantha (Gand.) H.Eichler	
Oreomyrrhis argentea (Hook.f.) Hook.f.	C R
Oreomyrrhis ciliata Hook.f.	C P
Oreomyrrhis eriopoda (DC.) Hook.f.	
Oreomyrrhis sessiliflora Hook.f.	E C
ASTERACEAE (COMPOSITAE)	
Abrotanella forsteroides (Hook.f.) Benth.	E C
Abrotanella scapigera (F.Muell.) Benth.	E C P
Bellis perennis L.	I C P
Brachyscome angustifolia A.Cunn.ex DC. var. *angustifolia*	
Brachyscome decipiens Hook.f.	
Brachyscome spathulata Gaud. ssp. *glabra* (DC.) Stace	E C P
Brachyscome tenuiscapa Hook.f.	
Celmisia asteliifolia Hook.f.	C P
Celmisia saxifraga (Benth.) W.M.Curtis	E C
Cirsium vulgare (Savi) Ten.	I C P
Cotula alpina (Hook.f.) Hook.f.	C P
Cotula filicula (Hook.f.) Benth.	
Cotula reptans (Benth.) Benth.	C P
Craspedia alpina Backh. ex Hook.f.	
Craspedia glauca (Labill.) Sprengel var. *gracilis* Hook.f.	C P
Erigeron pappocromus Labill.	P
Erigeron stellatus (Hook.f.) W.M.Curtis	E C P
Ewartia catipes (DC.) P.Beauv.	E C
Ewartia meredithiae (F.Muell.) P.Beauv.	E C
Ewartia planchonii (Hook.f.) P.Beauv.	E C
Gnaphalium collinum Labill.	C P
Gnaphalium fordianum M.Gray	R
Gnaphalium supinum L.	
Gnaphalium traversii Hook.f.	
Gnaphalium umbricola J.H.Willis	C
Helichrysum acuminatum DC.	C P
Helichrysum backhousii (Hook.f.) F.Muell. ex Benth. var. *backhousii*	E C P
var. *oreophilum* W.M.Curtis	E
Helichrysum expansifolium (P.Morris & J.H.Willis) N.Burb.	E C
Helichrysum hookeri (Sonder) Druce	C
Helichrysum ledifolium (DC.) Benth.	E C
Helichrysum milliganii Hook.f.	E C P
Helichrysum pumilum Hook.f.	
var. *pumilum*	E C P
var. *spathulatum* A.M.Buchanan	E C
Helichrysum rosmarinifolium (Labill.) Benth.	
Helichrysum rutidolepis DC.	C P
Helichrysum scorpioides Labill.	C P
Helipterum albicans (A.Cunn.) DC.	
var. *incanum* (Hook.) Paul G.Wilson	E P R
Hypochoeris glabra L.	I P
Hypochoeris radicata L.	I C
Lagenifera stipitata (Labill.) Druce	C P
Leptorhynchos squamatus (Labill.) Less.	P
Leontodon taraxacoides (Vill.) Merat	I C
Microseris lanceolata (Walp.) Schultz-Bip.	C P
Olearia algida Wakef.	P
Olearia erubescens (DC.) Dippel	C P
Olearia ledifolia (DC.) Benth.	E C P
Olearia myrsinoides (Labill.) F.Muell. ex Benth.	
Olearia obcordata (Hook.f.) Benth.	E C P
Olearia persoonioides (DC.) Benth.	E C P
Olearia phlogopappa (Labill.) DC.	C P
Olearia pinifolia (Hook.f.) Benth.	E C P
Olearia stellulata (Labill.) DC.	
Olearia tasmanica (Hook.f.) W.M.Curtis	E C
Podolepis jaceoides (Sims) Voss	C P
Pterygopappus lawrencii Hook.f.	E C
Senecio gunnii (Hook.f.) Belcher	
Senecio jacobea L.	I P
Senecio lautus Forst.f. ex Willd.	
Senecio leptocarpus DC.	C P
Senecio minimus Poiret	
Senecio pectinatus DC.	

var. *ochroleuca* F.Muell.	E	C	P	
var. *pectinatus*		C	P	
Sonchus oleraceus L.	I		P	
Taraxacum officinale Weber	I		P	
BRASSICACEAE (CRUCIFERAE)				
Cardamine gunnii Hewson		C		
Cardamine paucijuga Turcz.		C		
Cheesemania radicata (Hook.f.) O.E.Shultz	E	C		R
CALLITRICHACEAE				
Callitriche brachycarpa Hegelm.				
CAMPANULACEAE				
Pratia surrepens (Hook.f.) F.E.Wimmer			P	
Wahlenbergia ceracea Loth.			P	
Wahlenbergia saxicola A.DC.	E	C	P	
CARYOPHYLLACEAE				
Cerastium fontanum Baumg.	I		P	
Cerastium glomeratum Thuill.	I		P	
Colobanthus apetalus (Labill.) Druce		C	P	
Sagina procumbens L.	I	C	P	
Scleranthus biflorus (Forst. & Forst.f.) Hook.f.		C	P	
Scleranthus brockiei P.A.Williamson				
CASUARINACEAE				
Allocasuarina monilifera (L.Johnson) L.Johnson		C		
Allocasuarina zephrea L.Johnson	E	C		
CLUSIACEAE (GUTTIFERAE)				
Hypericum gramineum Forst.f.			P	
Hypericum japonicum Thunb.		C	P	
CUNONIACEAE				
Anodopetalum biglandulosum A.Cunn. ex Hook.f.	E	C		
Bauera rubioides Andrews		C		
DILLENIACEAE				
Hibbertia procumbens (Labill.) DC.		C	P	
Hibbertia serpyllifolia R.Br. ex DC.				
DONATIACEAE				
Donatia novae-zelandiae Hook.f.		C		
DROSERACEAE				
Drosera arcturi Hook.		C		
Drosera binata Labill.		C		
Drosera peltata Thunb.			P	
Drosera pygmaea DC.		C		
ELAEOCARPACEAE				
Aristotelia peduncularis (Labill.) Hook.f.	E	C	P	
EPACRIDACEAE				
Archeria comberi Melville	E	C		
Archeria eriocarpa Hook.f.	E	C	P	
Archeria hirtella (Hook.f.) Hook.f.	E	C		
Archeria serpyllifolia Hook.f.	E	C		
Cyathodes dealbata R.Br.	E	C	P	
Cyathodes glauca Labill.	E			
Cyathodes juniperina (Forst.) Druce		C	P	
Cyathodes parvifolia R.Br.	E	C	P	
Cyathodes petiolaris (DC.) Druce	E	C		
Cyathodes straminea R.Br.	E	C	P	
Dracophyllum minimum F.Muell.	E	C		
Epacris gunnii Hook.f.	E	C	P	
Epacris impressa Labill.		C	P	
Epacris lanuginosa Labill.		C	P	
Epacris serpyllifolia R.Br.		C	P	
Leucopogon collinus (Labill.) R.Br.		C	P	
Leucopogon sp. aff. *collinus*	E	C	P	
Leucopogon milliganii (F.Muell.) Rodway	E	C	P	
Lissanthe montana R.Br.		C	P	
Monotoca empetrifolia R.Br.	E			
Monotoca glauca (Labill.) Druce	E	C		
Monotoca sp. aff. *linifolia*	E	C	P	
Monotoca submutica (Benth.) Jarman	E	C	P	
var. *autumnalis* Jarman	E			
var. *submutica*	E			
Pentachondra pumila (Forst. & Forst.f.) R.Br.		C	P	
Prionotes cerinthoides (Labill.) R.Br.	E	C		
Richea acerosa (Lindley) F.Muell.	E	C	P	
Richea curtisiae A.M.Gray	E	C	P	
Richea gunnii Hook.f.	E	C	P	
Richea pandanifolia Hook.f.	E	C	P	
Richea procera (F.Muell.) F.Muell.	E			
Richea scoparia Hook.f.	E	C	P	
Richea sprengelioides (R.Br.) F.Muell.	E	C	P	
Sprengelia incarnata Smith var. *incarnata*		C	P	
var. *montana* R.Br.	E			
Trochocarpa cunninghamii (DC.) W.M.Curtis	E	C	P	
Trochocarpa gunnii (Hook.f.) Benth.	E	C	P	
Trochocarpa thymifolia (R.Br.) Sprengel	E	C		
ERICACEAE				
Gaultheria depressa Hook.f.		C		R
Gaultheria hispida R.Br.	E	C	P	
Pernettya tasmanica Hook.f.	E	C		
ESCALLONIACEAE				
Anopterus glandulosus Labill.	E			
Tetracarpaea tasmanica Hook.f.	E	C	P	

EUCRYPHIACEAE
Eucryphia lucida (Labill.) Baill. E C

FABACEAE (LEGUMINOSAE)
Acacia dealbata Link
Acacia mucronata Willd. ex Wendl.f. C
Bossiaea cordigera Benth. ex Hook.f. C P
Bossiaea riparia A.Cunn. ex Benth.
Oxylobium ellipticum (Labill.) R.Br. C P
Pultenaea dentata Labill. C P
Pultenaea juniperina Labill. C P
Pultenaea subumbellata Hook. C P
Trifolium repens L. I C P

FAGACEAE
Nothofagus cunninghamii (Hook.) Oersted C P
Nothofagus gunnii (Hook.f.) Oersted E C P

GENTIANACEAE
Gentianella diemensis (Griseb.) J.H.Willis C P

GERANIACEAE
Geranium potentilloides L'Herit. ex DC. C P
Geranium sessiliflorum Cav.
ssp. *brevicaule* (Hook.) Carolin P

GOODENIACEAE
Scaevola hookeri (Vriese) F.Muell. ex Hook.f. C
Velleia montana Hook.f. C P

GUNNERACEAE
Gunnera cordifolia Hook.f. E C P

HALORAGACEAE
Gonocarpus micranthus Thunb.
ssp. *micranthus* C P
Gonocarpus montanus (Hook.f.) Orch. C P
Gonocarpus serpyllifolius Hook.f. C P
Gonocarpus teucrioides DC. P
Myriophyllum aquaticum (Vell.) Verdc.
Myriophyllum pedunculatum Hook.f. P

LAMIACEAE (LABIATAE)
Ajuga australis P
Prunella vulgaris L. C P

LENTIBULARIACEAE
Utricularia dichotoma Labill. C
Utricularia monanthos Hook.f.

LOGANIACEAE
Mitrasacme archeri Hook.f. E C
Mitrasacme montana Hook.f. ex Benth. C P
Mitrasacme pilosa Labill.
Mitrasacme serpyllifolia R.Br.

MENYANTHACEAE
Liparophyllum gunnii Hook.f. C
Nymphoides exigua (F.Muell.) Kuntze E
Villarsia reniformis R.Br.

MONIMIACEAE
Atherosperma moschatum Labill. C P

MYRTACEAE
Baeckea gunniana Schauer C P
Baeckea leptocaulis Hook.f. E
Callistemon viridiflorus (Sims) Sweet E
Eucalyptus amygdalina Labill. E
Eucalyptus archeri Maiden & Blakely E C P
Eucalyptus coccifera Hook.f. E C P
Eucalyptus dalrympleana Maiden
ssp. *dalrympleana* P
Eucalyptus delegatensis R.Baker
ssp. *tasmaniensis* Boland C P
Eucalyptus gunnii Hook.f. E C P
Eucalyptus nitida Hook.f. E C P
Eucalyptus pauciflora Sieber ex Sprengel
ssp. *pauciflora*
Eucalyptus rodwayi R.Baker & H.G.Smith E
Eucalyptus subcrenulata Maiden & Blakely E C P
Eucalyptus vernicosa Hook.f. E C P
Leptospermum glaucescens .Schauer C
Leptospermum lanigerum (Aiton) Smith C P
Leptospermum nitidum Hook.f. C
Leptospermum rupestre Hook.f. E C P
Leptospermum scoparium Forst. & Forst.f.
var. *scoparium* C P
Melaleuca squamea Labill. C P

ONAGRACEAE
Epilobium billardieranum Ser. ex DC.
ssp. *cinereum* (A.Rich.) Raven & Engelhorn P
Epilobium ciliatum Raf.
ssp. *ciliatum* I C
Epilobium curtisiae Raven
Epilobium fugitivum Raven & Engelhorn E
Epilobium gunnianum Hausskn. C
Epilobium sarmentaceum Hausskn. C
Epilobium tasmanicum Hausskn.

OXALIDACEAE
Oxalis corniculata L.
ssp. *corniculata* C P
Oxalis magellanica Forst.f. C P

PITTOSPORACEAE
- *Billardiera longiflora* Labill. C P
- *Pittosporum bicolor* Hook. C P

PLANTAGINACEAE
- *Plantago coronopus* L. I C
- *Plantago daltonii* Decne. E C P
- *Plantago glabrata* Hook.f. E C P
- *Plantago glacialis* B.Briggs, Carolin & Pulley R
- *Plantago gunnii* Hook.f. E C
- *Plantago lanceolata* L. I P
- *Plantago major* L. I C P
- *Plantago paradoxa* Hook.f. E C P
- *Plantago tasmanica* Hook.f.
  - var. *archeri* (Hook.f.) W.M.Curtis E
  - var. *tasmanica* C P

POLYGONACEAE
- *Comespermum retusum* Labill.
- *Muehlenbeckia axillaris* (Hook.f.) Walp. C P
- *Rumex acetosella* L. I C P
- *Rumex obtusifolius* L. I P

PORTULACACEAE
- *Montia australasica* (Hook.f.) Pax & Hoffm. C

PRIMULACEAE
- *Anagallis arvensis* L. P

PROTEACEAE
- *Agastachys odorata* R.Br. E
- *Banksia marginata* Cav. C P
- *Bellendena montana* R.Br. E C P
- *Cenarrhenes nitida* Labill. E C
- *Grevillea australis* R.Br. P
- *Hakea epiglottis* Labill. E
- *Hakea lissosperma* R.Br. C
- *Hakea microcarpa* R.Br. E
- *Lomatia polymorpha* R.Br. E P
- *Lomatia tinctoria* R.Br. E
- *Orites acicularis* R.Br. E C P
- *Orites diversifolia* R.Br. E
- *Orites revoluta* R.Br. E C P
- *Persoonia gunnii* Hook.f. E C
- *Persoonia juniperina* Labill.
- *Persoonia muelleri* (P.Parm.) Orch. E P
- *Telopea truncata* (Labill.) R.Br. E C P

RANUNCULACEAE
- *Anemone crassifolia* Hook. E C P
- *Caltha phylloptera* A.W.Hill E C R
- *Clematis aristata* R.Br. ex DC.
- *Clematis vitalba* L. C
- *Ranunculus collicolus* Menadue
- *Ranunculus collinus* R.Br. ex DC.
- *Ranunculus decurvus* (Hook.f.) Melville E C
- *Ranunculus glabrifolius* Hook. P
- *Ranunculus nanus* Hook. E
- *Ranunculus pascuinus* (Hook.f.) Melville E
- *Ranunculus triplodontus* Melville E C P

RHAMNACEAE
- *Cryptandra alpina* Hook.f. E
- *Pomaderris apetala* Labill.

ROSACEAE
- *Acaena montana* Hook.f. E C P
- *Acaena novae-zelandiae* Kirk C P
- *Aphanes arvensis* L. I C
- *Rubus gunnianus* Hook. E C P

RUBIACEAE
- *Asperula gunnii* Hook.f. C P
- *Coprosma hitella* Labill. P
- *Coprosma moorei* F.Muell. ex Rodway C P R
- *Coprosma nitida* Hook.f. C P
- *Coprosma perpusilla* Colenso
- *Coprosma pumila* Hook.f. C P
- *Coprosma quadrifida* (Labill.) Robinson
- *Galium australe* DC. C
- *Nertera depressa* Banks & Soland. ex Gaertner C

RUTACEAE
- *Boronia citriodora* Gunn ex Hook.f. C P
- *Boronia parviflora* Smith C
- *Boronia pilosa* Labill.
- *Boronia rhomboidea* Hook. C P
- *Phebalium montanum* Hook. E
- *Phebalium oldfieldii* (F.Muell.) F.Muell. ex Benth. E C
- *Phebalium squameum* (Labill.) Engl. E C P

SANTALACEAE
- *Exocarpos humifusus* R.Br. E C P
- *Exocarpos nana* Hook.f. R
- *Leptomeria glomerata* F.Muell. E C

SCROPHULARIACEAE
- *Euphrasia collina* R.Br.
  - ssp. *diemenica* (Sprengel) W.R.Barker E C P
- *Euphrasia gibbsiae* Du Rietz E C
  - ssp. *discolor* W.R.Barker E
  - ssp. *gibbsiae* E
  - ssp. *microdonta* W.R.Barker E
- *Euphrasia hookeri* Wettst.
- *Euphrasia striata* R.Br. E C
- *Glossostigma elatinoides* (Benth.) Benth. ex Hook.f.

Ourisia integrifolia R.Br.	E	C	P	
Veronica calycina R.Br.		C	P	
Veronica gracilis R.Br.	I	C	P	
Veronica nivea Lindley		C		
Veronica serpyllifolia L.		P		
STYLIDIACEAE				
Forstera bellidifolia Hook.f.	E			
Phyllachne colensoi (Hook.f.) Bergg.		C		R
Stylidium graminifolium Swartz		C	P	
THYMELAEACEAE				
Drapetes tasmanicus Hook.f.		C	P	
Pimelea drupacea Labill.		C	P	
Pimelea lindleyana Meissner	E		P	
Pimelea sericea R.Br.	E	C	P	
TREMANDRACEAE				
Tetratheca procumbens Gunn ex Hook.f.	E		P	
URTICACEAE				
Australina pusilla (desf. ex Puiret) Cavdich				
Urtica incisa Poiret				
VIOLACEAE				
Viola betonicifolia Smith		C	P	
Viola hederacea Labill.		C	P	
WINTERACEAE				
Tasmannia lanceolata (Poiret) A.C.Smith		C	P	

MONOCOTYLEDONS

CENTROLEPIDACEAE				
Centrolepis monogyna (Hook.f.) Benth.	E	C	P	
Centrolepis muscoides (Hook.f.) Hieron.	E	C		
Gaimardia fitzgeraldii F.Muell. & Rodway	E	C		
Gaimardia setacea Hook.f.				
CYPERACEAE				
Carex sp. aff. *appressa*	E	C	P	
Carex appressa R.Br.		C	P	
Carex cephalotes F.Muell.				R
Carex gaudichaudiana Kunth		C	P	
Carex hypandra F.Muell. ex Benth.		C		
Carpha alpina R.Br.		C	P	
Carpha curvata W.M.Curtis	E			
Carpha rodwayi W.M.Curtis	E			
Eleocharis gracilis R.Br.				
Gahnia grandis (Labill.) S.T.Blake		C	P	
Gymnoschoenus sphaerocephalus (R.Br.) Hook.f.		C	P	
Isolepis aucklandica Hook.f.		C	P	
Isolepis crassiuscula Hook.f.		C	P	
Isolepis fluitans (L.) R.Br.		C		
Lepidosperma filiforme Labill.		C	P	
Lepidosperma inops F.Muell.			P	
Lepidosperma laterale R.Br.				
Lepidosperma lineare R.Br.				
var. *inops* F.Muell. ex Rodway	E			
var. *lineare*				
Oreobolus acutifolius S.T.Blake	E	C	P	
Oreobolus distichus F.Muell.		C	P	
Oreobolus oligocephalus W.M.Curtis	E	C		
Oreobolus pumilio R.Br.		C	P	
Schoenus apogon Roemer & Schultes			P	
Schoenus calyptratus Kuk.		C	P	
Schoenus fluitans Hook.f.				
Schoenus maschalinus Roemer & Schultes				
Schoenus tenuissimus Benth.				
Uncinia compacta R.Br.		C	P	
Uncinia tenella R.Br.		C	P	
Uncinia riparia R.Br.				
HYDATELLACEAE				
Hydatella filamentosa (Rodway) W.M.Curtis	E	C		
HYPOXIDACEAE				
Campynema lineare Labill.	E	C	P	
IRIDACEAE				
Diplarrena latifolia Benth.	E	C	P	
Diplarrena moraea Labill.				
Isophysis tasmanica (Hook.) T.Moore	E	C	P	
Libertia pulchella Sprengel		C	P	
Patersonia fragilis (Labill.) Ashers. & Graebner				
JUNCACEAE				
Juncus antarcticus Hook.f.		C		
Juncus falcatus E.Meyer				R
Juncus pauciflorus R.Br.				
Juncus planifolius R.Br.				
Juncus sandwithii Lourteig		C		
Luzula atrata Edgar				
Luzula australasica Steudel	E			
Luzula flaccida (Buchenau) Edgar				
Luzula modesta Buchenau				
Luzula novae-cambriae Gandoger				
LILIACEAE				
Astelia alpina R.Br.				
var. *alpina*		C	P	
Blandfordia punicea (Labill.) Sweet	E	C		
Dianella revoluta R.Br.				
Dianella tasmanica Hook.f.			P	
Drymophila cyanocarpa R.Br.		C	P	
Herpolirion novae-zelandiae Hook.f.		C	P	

Milligania densiflora Hook.f. E C P
Milligania lindoniana Rodway ex W.M.Curtis E C
Milligania stylosa (F.Muell. ex Hook.f.) F.Muell. ex Benth. E
Wurmbea uniflora (R.Br.) T.Macfarlane E

ORCHIDACEAE
Acianthus viridis Hook.f. C
Caladenia lyallii Hook.f.
Corybas diemenicus (Lindley) Reichb.f. C
Eriochilus cucullatus (Labill.) Reichb.f.
Prasophyllum alpinum R.Br.
Pterostylis falcata R.Rogers

POACEAE (GRAMINEAE)
Agrostis avenacea J.Gmelin I
Agrostis billardieri R.Br.
Agrostis gigantea Roth
Agrostis aff *hiemalis* (Walt.) Britton et al.
Agrostis parviflora R.Br. C P
Agrostis rudis Roemer & Schultes P
Agrostis venusta Trin.
Amphibromus archeri (Hook.f.) P.Morris
Amphibromus recurvatus Swallen
Australopyrum pectinatum (Labill.) A.Löve C P
Dactylis glomerata L. I P
Danthonia fortunae-hibernae Renvoize E C P
Danthonia gracilis Hook.f. C P
Danthonia nudiflora P.Morris C P
Danthonia pauciflora R.Br. E C
Deyeuxia accedens Vick. E
Deyeuxia brachyathera (Stapf) Vick. R
Deyeuxia carinata Vick. C
Deyeuxia monticola (Roemer & Schultes) Vick. C P
Deyeuxia quadriseta (Labill.) Benth. C P
Dichelachne rara (R.Br.) Vick. P
Ehrharta distichophylla Labill.
Ehrharta stipoides Labill. C
Ehrharta tasmanica (Hook.f.) Willemse var. *subalpina* (F.Muell. ex Benth.) Willemse E C P
var. *tasmanica* C P
Elymus scabrus (Labill.) A.Löve P
Erythranthera australis (petrie) Zotov C
Hierochloe fraseri Hook.f. ex Rodway C P
Hierochloe redolens (Vahl) Roemer & Schultes C
Holcus lanatus L. I C P
Pentapogon quadrifidus (Labill.) Baillon C P
Poa annua L. I C P
Poa gunnii Vick. E C P
Poa labillardieri Steudel var. *acris* Vick. E C P
var. *labillardieri* C P
Poa pratensis L.
Poa saxicola R.Br. C P
Poa sieberiana Sprengel C P
Stipa rudis Sprengel ssp. *australis* J.Everett & S.Jacobs
Trisetum spicatum (L.) Richter ssp. *australiense* Hulten

PATAMOGETONACEAE
Potamogeton tricarinatus F.Muell. & A.Benn. ex A.Benn.

RESTIONACEAE
Calorophus elongatus Labill. E
Empodisma minus (Hook.f.) L.Johnson & Cutler C P
Leptocarpus tenax (Labill.) R.Br.
Lepyrodia tasmanica Hook.f. C P
Restio australis R.Br. C P
Restio complanatus R.Br. C P
Restio monocephalus R.Br. E
Restio tetraphyllus Labill.

XYRIDACEAE
Xyris marginata Rendle E
Xyris muelleri Malme E
Xyris operculata Labill.

GYMNOSPERMS

CUPRESSACEAE
Diselma archeri Hook.f. E C P

PHYLLOCLADACEAE
Phyllocladus aspleniifolius (Labill.) Hook.f. E C P

PODOCARPACEAE
Microcachrys tetragona (Hook.) Hook.f. E C P
Microstrobos niphophilus Garden & L.Johnson E C
Podocarpus lawrencei Hook.f. C P

TAXODIACEAE
Athrotaxis cupressoides D.Don. E C P
Athrotaxis laxifolia Hook. E C P
Athrotaxis selaginoides D.Don. E C

PTERIDOPHYTES

ASPIDIACEAE
Polystichum proliferum (R.Br.) C.Presl C P

ASPLENIACEAE
Asplenium terrestre Brownsey

BLECHNACEAE
Blechnum chambersii Tind.
Blechnum fluviatile (R.Br.) E.J.Löwe ex Salom
Blechnum nudum (Labill.) Mett. ex Luerss.
Blechnum penna-marina (Poiret.) Kuhn C P
Blechnum vulcanicum (Blume) Kuhn
Blechnum wattsii Tind. C P

DAVILLIACEAE
Rumohra adiantiformis (Forst.f.) Ching

DENNSTAEDTIACEAE
Histiopteris incisa (Thunb.) J.Smith. C P
Hypolepis rugosula (Labill.) J.Smith P
Pteridium esculentum (Forst.f.) Cockayne

DICKSONIACEAE
Dicksonia antarctica Labill. P

GLEICHENIACEAE
Gleichenia alpina R.Br. C P
Gleichenia dicarpa R.Br.
Sticherus lobatus Wakef.

GRAMMITIDACEAE

Ctenopteris heterophylla (Labill.) Tind.
Grammitis billardieri Willd. C P
Grammitis magellanica Desv.
ssp. *nothofagetii* Parris C
Grammitis meridionalis Parris P
Grammitis poeppigiana (Mett.) Pichi-Serm. R

HYMENOPHYLLACEAE
Apteropteris applanata A.M.Gray &
R.G.Williams E C P
Hymenophyllum australe Willd. P
Hymenophyllum cupressiforme Labill. P
Hymenophyllum flabellatum Labill.
Hymenophyllum peltatum (Poiret.) Desv. C P
Hymenophyllum rarum R.Br. C P

ISOETACEAE
Isoetes gunnii A.Braun E C

LINDSAEACEAE
Lindsaea linearis Swartz C

LYCOPODIACEAE
Lycopodium australianum Herter C
Lycopodium fastigiatum R.Br. C P
Lycopodium laterale R.Br. C
Lycopodium scariosum Forst.f. P

POLYPODIACEAE
Microsorium diversifolium (Willd.) Copel. P

Species Found Outside the National Park Within the Pencil Pine Planning Area

DICOTYLEDONS

APIACEAE (UMBELLIFERAE)
Trachymene humilis (Hook.f.) Benth.

ASTERACEAE (COMPOSITAE)
Cassinia aculeata (Labill.) R.Br.

EPACRIDACEAE
Leucopogon hookeri Sonder
Leucopogon stuartii F.Muell ex Sonder

RANUNCULACEAE
Ranunculus lappaceus Smith
Ranunculus scapigerus Hook.

STACKHOUSIACEAE
Stackhousia pulvinaris F.Muell. R

THYMELAEACEAE
Pimelea ligustrina Labill. R
ssp. *ligustrina*

MONOCOTYLEDONS

CYPERACEAE
Carex breviculmis R.Br.
Carex inversa R.Br

JUNCACEAE
Juncus aff. *astreptus*

ORCHIDACEAE
Diuris pedunculata R.Br.

POACEAE (GRAMINEAE)
Danthonia penicillata (Labill.) R.Br.
Poa tenera F.Muell. ex Hook.f.

PTERIDOPHYTES

OPHIOGLOSSACEAE
Botrychium lunaria (L.) Swart