Floristics and vegetation patterns of Coolah Tops, New South Wales

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Binns, D.L. (State Forests of NSW PO Box J19 Coffs Harbour Jetty, NSW, Australia 2450) 1997. Floristics and vegetation patterns of Coolah Tops, New South Wales. Cunninghamia *5(1): 233–274.*The vascular vegetation of Coolah Tops, a relatively isolated basalt plateau (latitude 31°41' to 31°15' S, longitude 149°58' to 150°15'E), is described from fifty randomly located plots distributed throughout the range of vegetation types and physical environments and representing the range of forest management histories. This area was formerly State Forest but is now included mostly within Coolah Tops National Park. Floristic data are analysed using classification and ordination. The floristic composition, structure and environment of twenty-two floristic communities are described. The vegetation is predominantly grassy open forest with *Eucalyptus laevopinea*, *Eucalyptus nobilis*, *Eucalyptus pauciflora* and *Eucalyptus dalrympleana* subsp. *heptantha* as the most common canopy dominants. A list of 316 native and thirty-seven naturalised taxa is presented, with frequency of occurrence in broad floristic groups. The vascular flora is of relatively low diversity and only four species are regarded as being of conservation significance, although a further two nationally significant species may occur in the area. Altitude and past grazing history (which is correlated with altitude) have the most influence on vegetation patterns, with topography and past logging history contributing least.

Introduction

Coolah Tops is an elevated and relatively isolated basalt plateau, up to 1250 m altitude and mostly exceeding 1000 m, bounded approximately by latitude 31°41' to 31°15'S and longitude 149°58' to 150°15'E. It forms a south-westerly extension of the New South Wales Northern Tablelands (Anderson 1961), at the junction of the Warrumbungle and Liverpool Ranges, north-east of Coolah. It is bounded by flat to undulating, predominantly cleared grazing lands to the south and west, but partially forested ranges extend to the north and east. The study area (Fig. 1) is the former Warung and Bundella State Forests, a contiguous area of about 13 000 ha which, except for small areas held as Crown Lease, are now included in Coolah Tops National Park. The area has been used for rough grazing since early this century and for commercial timber harvesting since at least 1941 (Forestry Commission of NSW 1982), although there is evidence of some logging, ringbarking and partial clearing being carried out prior to this by local landholders.

Although there is broad-scale regional information on vegetation available, there appear to have been no vegetation studies of Coolah Tops published, and no floristic data from the area are listed in recent reviews (Bryant & Benson 1981, Keith 1988, Benson & Melrose 1993). At a regional level, McRae & Cooper (1985) describe the vegetation of the Merriwa area, their study area being immediately adjacent and to the south of Coolah Tops. However, the habitats have little in common, with only minor overlap along the southern foothills of Liverpool Range. Fisher (1985) has described the rainforests of Liverpool Range, but these all occur further east (the most westerly at 150°30'E) and, for dominants at least, have little in common with the most mesic vegetation at Coolah Tops. Benson and Andrew (1990) report on the flora and fauna of the former Ben Halls Gap State Forest (now Ben Halls Gap National Park) on the eastern end of the Liverpool Range, which is also on basalt at a similar altitude (up to 1370 m) and supports some similar floristic assemblages. A floristic list for Coolah Tops has been previously compiled and is included in the Management Plan (Forestry Commission of NSW 1982). However, the source for these records is unknown and locality details are not given. It is uncertain whether all records are strictly from the previous State Forests, or whether some may be from adjacent private property. Specimens in the National Herbarium of New South Wales indicate that there have been periodic collections from the area, especially in the vicinity of Norfolk Falls, in the former Norfolk Falls Flora Reserve.

This paper describes the terrestrial vascular flora of the area, particularly the vegetation types and distribution, habitat and abundance of plant species, identifies vascular plant species and communities of conservation significance and assesses the influence of past management and other environmental factors on floristic patterns. The survey data which forms the basis of this paper was originally collected for State Forests of New South Wales as part of an Environmental Impact Statement for a proposal to continue logging in the area.

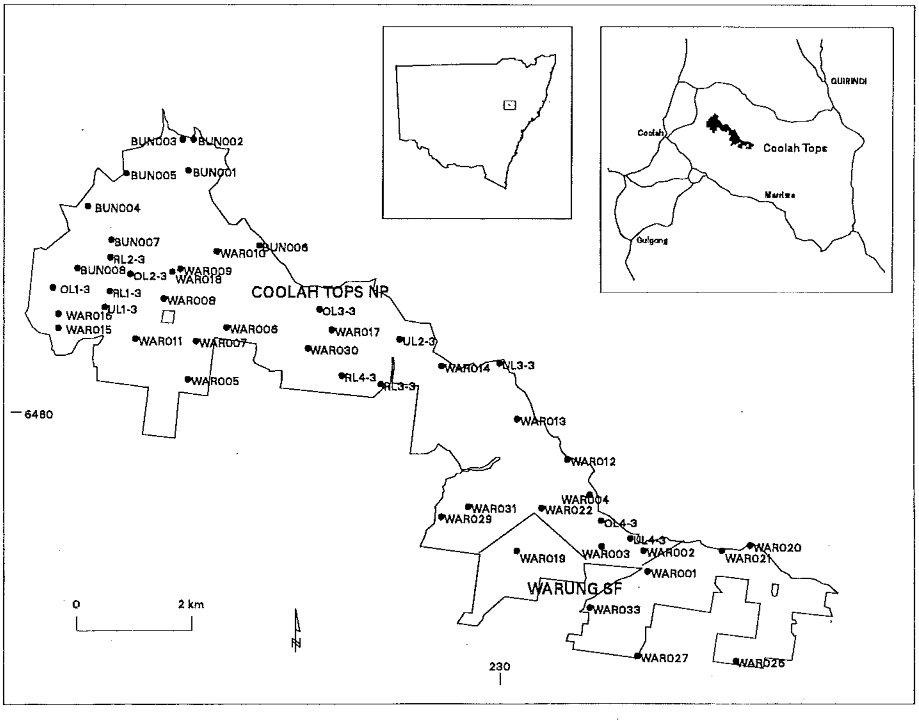

Fig. 1. Location of Coolah Tops study area and flora survey plots (•).

Methods

Sampling strategy and plot location

Floristic data were derived from non-permanent plots established within the study area to sample the full range of Forest Types (Forestry Commission of New South Wales 1989) mapped in the area, and to sample the range of physical habitats and management histories. Particular attention was also given to sampling or at least inspecting unusual or restricted habitats (e.g. rock outcrops, swamps, riparian habitats). Plots in more extensive types were randomly selected but constrained to be within 500 m of road access or in areas which could be sampled en route to those in restricted or unusual habitat types. Plots in restricted or unusual types were not constrained by proximity to roads. This strategy was designed to ensure efficient sampling of the full range of types and habitats while reducing unproductive travelling time as far as possible.

In the field, plots were positioned as far as possible within a relatively homogeneous patch of vegetation. The standard size was a 50 m × 20 m (0.1 ha) rectangle, although some habitats required a variation in shape to ensure homogeneity within one plot e.g. longer and narrower plots, up to 100 m × 10 m, were used for riparian vegetation.

A total of fifty plots, including those on fauna survey transects, was surveyed during the present survey. Approximate locations of all survey plots are shown in Fig. 1. The majority (thirty-nine plots) were surveyed during 23 February–1 March 1993, with additional plots surveyed in September 1993 and May 1994. Plot locations and survey dates are listed in Appendix 2. Table 1 shows the distribution of plots among combinations of two major environmental factors, altitude and degree of topographic exposure, to assess the extent to which the sampling strategy based primarily on mapped forest types has covered the range of environmental variation. Lithology is not included as a factor since the area is uniformly on basalt. The plots are well distributed across the range of these environmental factors, but the lowest altitude class is relatively over-sampled (these are potentially of most conservation significance due to past clearing) and the 800–1000 m class relatively undersampled (these are the steeper slopes, least likely to be affected by forest management activities planned at the time of the survey).

Floristic and structural data

All vascular plant species which could be distinguished within a plot were recorded and a cover-abundance code estimated for each species within each vertical stratum, and for all strata combined. Codes are based on projected canopy cover, as follows: 1 = < 5%, few individuals; 2 = < 5%, any number of individuals; 3 = 6–25%; 4 = 26–50%; 5 = 51–75%; 6 = > 75%. Taxonomy and nomenclature follow the National Herbarium of NSW. This is mostly as published in Harden (1990–1993), except where more recent revisions have been published. Voucher specimens of many species were collected from the area and are retained at the State Forests Research Division herbarium at West Pennant Hills. In a few cases, where difficulties were encountered in identification, specimens were referred to specialists at the National Herbarium of

Table 1. Distribution of flora survey plots among combinations of altitude and degree of topographic exposure.

The latter is categorised as: EXP=exposed (ridge crests and northerly aspects); MOD=moderate (flat areas and easterly and westerly slopes); SHL=sheltered (riparian and southerly slopes). Exp. no. is the number of plots which would be allocated to that combination if approximately 50 plots were distributed evenly across all combinations.

Altitude (m)	Degree of top. exp	Area (ha)	No. Plots	Exp. no. plots
600–800	EXP	111	1	1
	MOD	326	3	1
	SHL	142	2	1
800–1000	EXP	533	1	2
	MOD	1154	1	5
	SHL	924	5	4
1000–1200	EXP	2040	5	8
	MOD	4355	18	17
	SHL	2861	13	11
>1200	all	227	1	1

NSW for determination. For all trees with stem diameter at breast height (1.3 m) greater than 10 cm, the number of stems of each species was recorded by 10 cm diameter classes, up to 50 cm. Diameter was measured for all stems over 50 cm. These data were used to calculate an estimate of basal area by tree species for each plot. All stumps were similarly recorded and the data used to give a measure of logging intensity within the plot. Slope, altitude, aspect, topographic position, drainage, percentage cover and particle size of surface rock and cover of outcropping bedrock were recorded. An assessment was made of previous disturbance by logging, fire and grazing, on the basis of any available visual evidence. An estimate of intensity and time since disturbance was recorded.

Field work was carried out mostly in late summer. Some ephemeral species may have been overlooked, and spring flowering geophytes, including Orchidaceae, would have been generally overlooked. Although these may be a significant component of the total flora, they normally form a minor component of forest vegetation in NSW and their omission is not expected to affect the community analysis. Some species, especially monocotyledons, may have been overlooked due to absence of active growth or vegetative similarity to common species. No attempt was made to sample soil-stored seed. No detailed survey of naturalised species along roads (i.e. within 5 m of the road pavement) was undertaken, but such species were noted if they were common, or also occurred in nearby forest. The total number of naturalised species is likely to be understated as a result, but the survey reflects the relative importance of the naturalised component in the vegetation generally and the likely future invasion potential.

Data analysis

Floristic data were classified into vegetation communities by grouping floristically similar plots using a numerical hierarchical agglomerative classification process, using the Bray-Curtis association measure and a flexible UPGMA sorting strategy with beta = 0.0 (FUSE module of the PATN package, Belbin 1994). A beta value of zero was chosen to yield a 'space-conserving' fusion strategy which does not exaggerate floristic differences between groups. Communities were defined at dissimilarity levels of 0.6 and 0.8, which provide a reasonable reflection of what are perceived as plant communities in the field.

The analysis of a full floristic data set, including all strata, implicitly assumes that the overstorey and the various understorey strata respond similarly to environmental factors, and at similar spatial and temporal scales. In fact, this is unlikely to be the case. For example, at the extreme, canopy trees respond to environmental factors at a much broader scale than herbs in the lowest understorey stratum and the latter are much more likely to reflect recent disturbance events (such as fire) to which canopy species are relatively insensitive. Thus an analysis of all strata combined may obscure spatial patterns relating to these variations in responses. However, it is difficult to define limits which realistically and consistently allow separate analyses of strata across a range of vegetation types, and any defined limits are essentially arbitrary. In practice, an analysis of all species combined tends to be dominated by the influence of lower strata species, which usually contribute more than the canopy species to the overall floristic characterisation of a plot. To allow consideration of these interactions, three separate analyses were performed and compared: 1. Basal area of all stems >10 cm diameter was used to define overstorey communities; 2. Total cover of all species was used for a full floristic analysis; 3. Cover of understorey species (i.e. excluding canopy species which were defined as those with stem diameter > 10 cm) was used for an understorey analysis. As only cover-abundance codes were recorded for understorey floristic data, these were converted to percentages for analyses 2 and 3, as the mid-point of the cover class for cover > 5 per cent and using 1 per cent and 3 per cent for codes 1 and 2 respectively.

For examination of logging impact and the influence of other environmental factors on plant community floristic composition, the full data matrix was reduced by including in the analysis only the twenty-nine plots which were either previously logged or potentially able to be logged under current precriptions. This also excluded floristically disparate plots in habitats not subject to logging, such as swamps, riparian habitats and steep, rocky habitats. Also, species which occurred in two or fewer such plots were omitted, leaving a matrix of cover codes for 29 sites × 95 species for analysis. Cover codes, rather than mid-point percentages as used for classification, were used to give greater relative weight to the influence of less common species.

A constrained ordination method, Canonical Correspondence Analysis (Ter Brack 1986, 1987) was used for analysis of relationships between floristic composition and environmental factors. This method maximally correlates the arrangement of species and sites along ordination axes, subject to the constraint that the axes are linear combinations of the explanatory variables. Ter Braak (1986) fully describes the underlying assumptions and strengths of this method. The main assumption is that individual species response models are all similar and all of unimodal, Gaussian form. Although it is doubtful whether this assumption is reasonable for all species, CCA has been shown to be robust to moderate violations of assumptions (Palmer 1993). It also has the advantage that the results are unaffected by correlations among environmental variables. In interpreting the ordination diagram, environmental variables are represented by arrows, the length representing the strength of correlation between the environmental variable and the ordination axes, and the direction representing the direction of maximum change of the variable. Species and sites may be then ordered along vectors for environmental variables to indicate floristic trends. Analyses were performed using programs written in Splus (Statistical Science, Inc. version 3.0 1991).

Results

Floristics

A total of 297 native vascular plant taxa and thirty-three naturalised taxa was recorded during the field survey, including 316 from survey plots. Appendix 1 lists these species by family, with their frequency of occurrence by broad floristic group (described below) and logging category. Appendix 1 also includes additional species (nineteen native and four naturalised) previously recorded in the area in the forest Management Plan (Forestry Commission of NSW 1982). While some of these are infrequent or localised species which were overlooked during the present survey, it is curious that

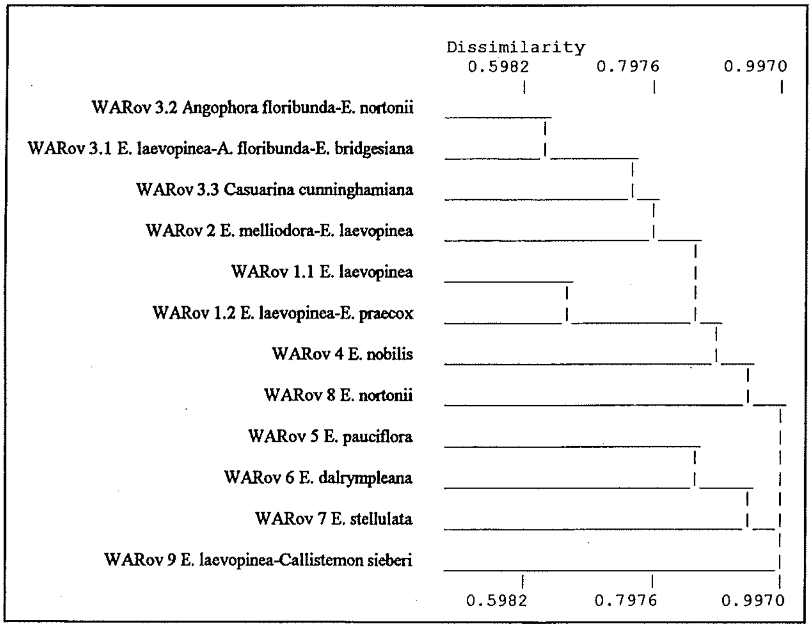

Fig. 2. Dendrogram from floristic classification of overstorey basal areas, truncated at the 0.6 dissimilarity level.

Table 2. Summary of distribution of plots among understorey and floristic communities

Floristic community	**Understorey community** 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	TOT
1																			1	1
2.1																1				1
2.2															1					1
2.3														2						2
2.4													1							1
2.5													1							1
3.1																		1		1
3.2												8								8
3.3						3														3
3.4						1														1
3.5											3									3
3.6										8										8
3.7						2														2
3.8					1	2				1							1			5
4.1						1		2												3
4.2									2											2
4.3							1													1
4.4				1																1
4.5					1															1
4.6			1																	1
5.1		1																		1
5.2	2																			2
TOTAL	**2**	**1**	**1**	**1**	**2**	**9**	**1**	**2**	**2**	**9**	**3**	**8**	**2**	**2**	**1**	**1**	**1**	**1**	**1**	**50**

several naturalised exotics were listed as common. Although there are no details for the previous records, these species are most likely to be restricted to highly disturbed habitats adjacent to pasture in private property.

Some specimens could not be confidently determined to species level because of lack of fertile material and vegetative similarity among species, or because of uncertain taxonomic limits within groups. Such difficulties were experienced with the following species or groups: *Geranium potentilloides / G. solanderi / G. homeanum / G. retrorsum*; *Cymbonotus* (all flowering material was *C. preissianus*, but *C. lawsonianus* may have been represented in non-fertile specimens); *Danthonia pilosa / D. racemosa; Gonocarpus humilis* (vegetative material could include *G. tetragynus*); *Hibbertia obtusifolia* (many specimens had characteristics of *H. linearis* and could be regarded as intermediates between these two species); *Poa sieberiana / P. labillardieri; Senecio diaschides / Senecio* species E. *Leptospermum polygalifolium* subsp. *montanum* and *L. gregarium* appeared to intergrade to a considerable extent and some specimens could not be unequivocally assigned to either.

A feature of the survey area is its general uniformity of vegetation structure and floristics, reflected in relatively low overall floristic richness. For example, the floristic richness (316 species in fifty plots) may be compared with that of the predominantly grassy forests of the Mount Royal Management Area, a more coastal area of slightly smaller extent at similar latitude, for which about 395 vascular plant species were recorded from an equivalent number of plots (Shields, York and Binns 1992). This relatively depauperate flora is perhaps surprising considering that the geographical position of the area might lead to an expectation that the flora would be a mixture of both tablelands and western slopes floristic elements. However, because the area is at the extreme western margin of the tablelands, many of the common tablelands species are absent. This is particularly notable among the eucalypts, with some otherwise widespread and abundant northern tablelands species such as *Eucalyptus campanulata* and *Eucalyptus obliqua* apparently absent, and only nine eucalypt species overall. Relatively little of the total recorded diversity is contributed by the steep slopes along the boundary which have a western slopes influence, the plateau grassy forests contributing a total of 216 species to plot data. This is perhaps partly due to increased sampling emphasis on commercial plateau forests and relatively less effort on steeper slopes.

Overstorey and understorey classification

Twelve forest overstorey classes were defined, in nine groups, from classification of tree basal area data. The relationships among these classes is shown by the dendrogram (Fig. 2) and their composition is briefly discussed below in the descriptions of floristic communities.

Nineteen communities in six groups were derived from classification of floristic survey data excluding eucalypts (understorey data), at dissimilarity levels of 0.6 and 0.8 respectively (Fig. 3). The relationship with the full floristic classification (summarised in Table 2) shows that most understorey communities are uniquely correlated with floristic communities, or have only one 'misclassified' plot. The major discrepancy is understorey community 6 which occurs across a range of floristic communities. Understorey community 6 is most strongly characterised by relative abundance of the prostrate herb *Acaena novae-zelandiae*. Its distribution across several floristic communities is due to its association with several distinct overstorey communities and the relatively strong influence of the canopy component over otherwise minor differences in overall floristic composition of these plots. Due to the close correlation between the two classifications, the understorey classification is not further described, and any discrepancies between the two classifications are discussed in the floristic community descriptions below.

Table 3. Summary of distribution of plots among overstorey and floristic communities

	Floristic community																						
		RIPARIAN					PLATEAU GRASSY								DRY SLOPES								
	1	2.1	2.2	2.3	2.4	2.5	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.8	4.1	4.2	4.3	4.4	4.5	4.6	5.1	5.2	TOT
Overstorey Community																							
1.1 *E. laevopinea*							1	2	1		3	6		5		1							19
1.2 *E. laevopinea–E. praecox*													2										2
2 *E. melliodora–E. laevopinea*															3		1						4
3.1 *E. laevopinea–Ang. floribunda–E. bridgesiana*		1		1												1							3
3.2 *Angophora floribunda E. nortonii*																				1			1
3.3 *C. cunninghamii*			1																				1
4 *E. nobilis*	1			1				1				1											4
5 *E. pauciflora*								5	1	1		1											8
6 *E. dalrympleana* ssp. *heptantha*					1																1		2
7 *E. stellulata*									1														1
8 *E. nortonii*																		1	1				2
9 *E. laevopinea–C. sieberi*						1																	1
Non-forest																						2	2
TOTAL	1	1	1	2	1	1	1	8	3	1	3	8	2	5	3	2	1	1	1	1	1	2	50

Descriptions of floristic communities

Twenty-two floristic communities in five groups were defined, at the 0.6 and 0.8 levels of dissimilarity, from the classification of all species combined (Fig. 4). Table 3 summarises the relationship between floristic communities and understorey communities, and Table 4 summarises the distribution of floristic communities among overstorey communities. The floristic communities are briefly described below (R denotes floristic richness as number of species per plot, or median floristic richness where there are three or more plots), with comments on the relationships with overstorey communities (summarised in Table 3) and where appropriate, with understorey classes (Table 2).

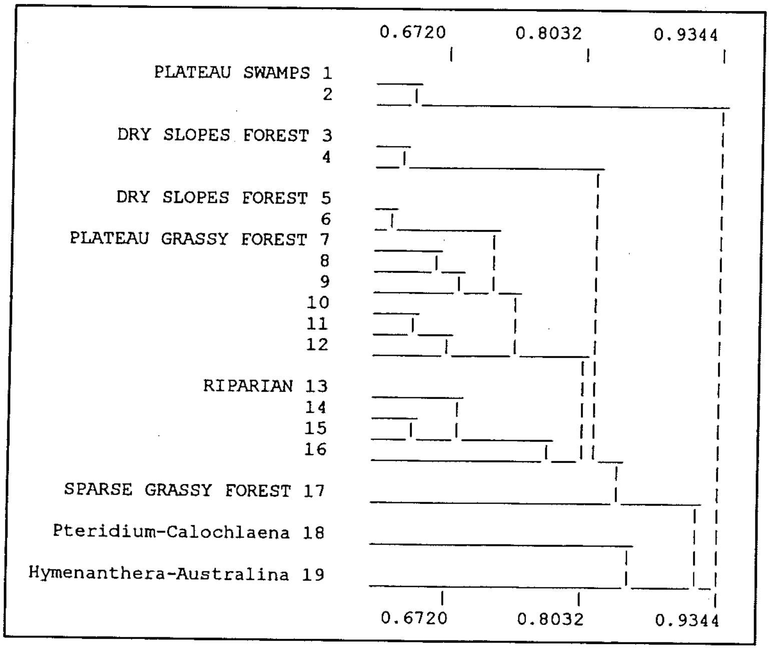

Fig. 3. Dendrogram from floristic classification of cover of understorey species, truncated at the 0.6 dissimilarity level.

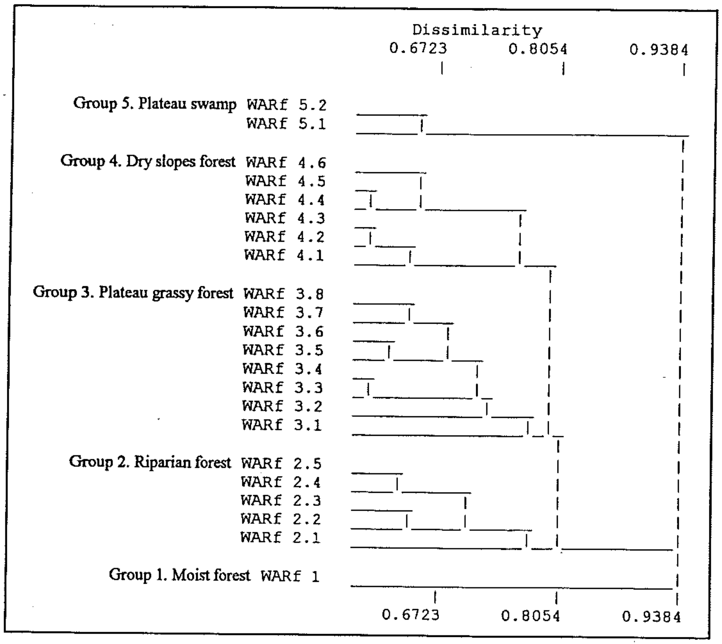

Fig. 4. Dendrogram from floristic classification of cover of all species, truncated at the 0.6 dissimilarity level.

Floristic group 1. Moist forest

1.1 *Hymenanthera dentata–Australina pusilla*
Plot WAR020; R=23

A dense, low forest of *Hymenanthera dentata, Lomatia arborescens* and *Acacia melanoxylon* to 6 m tall, with scattered taller *Eucalyptus nobilis* and *Acacia melanoxylon* (overstorey class 4), sampled only on one steep, rocky scree slope below a cliff in the far east of the area. The moderately dense ground cover is composed mainly of *Australina pusilla, Polystichum proliferum, Smilax australis* and *Urtica incisa.* Remarkably, this steep, stony area along with much of the surrounding area on less extreme slopes, was extensively ringbarked about fifty years previously. This past disturbance has undoubtedly had some effect on present understorey composition, although broadly similar understorey occurs on apparently undisturbed lower slopes and along creeks in deeply incised parts of Jemmys Creek. Scattered emergent individuals of *Casuarina cunninghamiana* occur along the creek in this latter area. Moist forest is of limited distribution in the Coolah Tops area, confined to sheltered lower slopes in less accessible areas.

Floristic group 2. Riparian forest

2.1 *Pittosporum undulatum–Doodia aspera*
Plot WAR003; R=67

Open forest sampled only as a narrow riparian strip along a branch of Jemmys Creek at low altitude, comprising a mosaic of small tree and shrub thickets up to 12 m tall (especially *Angophora floribunda, Pittosporum undulatum, Acacia melanoxylon* and *Rapanea howittiana*) mixed with patches of dense herbaceous ground cover. The most abundant ground cover species are the ferns *Doodia aspera, Adiantum aethiopicum Calochlaena dubia* and *Hypolepis glandulifera*, herbs *Australina pusilla* and *Hydrocotyle laxiflora* and twiner *Desmodium varians*. This floristic community represents the moister end of the gradient for overstorey community 3.1, dominated by *Eucalyptus bridgesiana* and *Eucalyptus laevopinea*. A more extensive area of floristically similar vegetation, but with a denser small tree stratum, occurs on sheltered slopes in the headwaters of Branch Creek.

2.2 *Casuarina cunninghamii–Hydrocotyle peduncularis*
Plot WAR028; R=77

Open forest clearly dominated by *Casuarina cunninghamiana* (overstorey class 3.3) with occasional *Eucalyptus laevopinea* and *Eucalyptus nobilis*, especially near the edge of the stand, and a subcanopy of *Angophora floribunda*. Understorey is mainly a mosaic of a dense, low ground cover dominated by the herb *Hydrocotyle peduncularis*, interspersed with taller patches of the fern *Hypolepis glandulifera*. This community is floristically similar to WARf 2.1, but is along a larger, more open creek and has a higher proportion of species characteristic of aquatic and swampy habitats. In the survey area *Casuarina cunninghamiana* occurs fairly commonly as scattered trees along larger creeks below about 900 m altitude, but seldom forms distinct stands. The sample plot is representative of a narrow (up to 20 m wide) riparian strip extending for several hundred metres along one section of Cattle Creek, but no other similar stands were observed along other creeks nearby. Judging from remaining remnants, this community was previously widespread in surrounding private property.

2.3 *Acacia melanoxylon–Acaena novae-zelandiae*
Plots WAR017, WAR030; R=63-94

Open forest or woodland up to 28 m tall with a mixed shrubby and herbaceous understorey. The overstorey is variously dominated by *Eucalyptus nobilis* (overstorey class 4) or *Eucalyptus laevopinea* and *Angophora floribunda* (class 3.1). Main small trees and shrubs (up to 3 m tall) are *Acacia melanoxylon, Coprosma quadrifida* and *Lomatia arborescens*. The mostly dense ground cover is diverse, common species being *Acaena nova-zelandiae, Dichondra repens, Hydrocotyle peduncularis* and *Hypolepis glandulifera. Geranium retrorsum* and the vine *Smilax australis* may be locally common. This is the characteristic riparian vegetation along larger streams draining the slopes at moderate to high altitudes. Along more deeply dissected creeks at slightly lower altitudes (750–900 m), lower slopes support dense, tall shrub understorey clearly dominated by *Hymenanthera dentata*, with the thorny vine *Smilax australis* also abundant. Narrow riparian strips in these areas support scattered emergent eucalypts, *Angophora floribunda* and *Casuarina cunninghamiana* over an uneven low canopy including a number of rainforest elements such as *Rapanea howittiana, Pittosporum undulatum* and *Marsdenia rostrata*.

2.4 *Eucalyptus dalrympleana* ssp. *heptantha–Hydrocotyle peduncularis*
Plot WAR011; R=86

Woodland of *Eucalyptus dalrympleana* ssp. *heptantha* and *Eucalyptus stellulata* (overstorey class 6) with diverse understorey, occurring as narrow riparian strips along small, rocky creeks on the plateau. Shrub thickets dominated by *Leptospermum gregarium* are interspersed with patches of dense low ground cover variously dominated by *Acaena novae-zelandiae, Blechnum minus, Hydrocotyle peduncularis* or the exotic *Trifolium repens*. Aquatic species such as *Myriophyllum variifolium* and *Potamogeton tricarinatus* are locally abundant in larger pools in the creek. Overstorey community 6 is restricted to riparian sites along small creeks on the plateau and around swamp margins. It grades into community 5 (*Eucalyptus pauciflora*) upslope.

2.5 *Callistemon sieberi–Hydrocotyle peduncularis*
Plot BUN005; R=59

Woodland up to 25 m tall of scattered *Eucalyptus laevopinea* with a subcanopy to 12 m of individuals and small stands of *Callistemon sieberi*. Isolated shrubs of *Callistemon sieberi* and *Notelaea microcarpa* are interspersed with patches of herbaceous ground cover and extensive areas of bare rock and open water. The most common ground cover species are *Gratiola peruviana* and *Hydrocotyle peduncularis. Polystichum fallax* is locally abundant on steep, stony creek banks. This riparian community is similar to 2.4, but occurs where the proportion of outcropping rock is higher. It is the only habitat in the area for the rare epilithic fern *Asplenium trichomanes* subsp. *quadrivalens*. The combination of tree species (overstorey community 9) was recorded only along Rocky

Creek near the north-western boundary of the forest, but broadly similar vegetation is typical of riparian zones of rocky creek beds on the plateau.

Floristic group 3. Plateau grassy forest

3.1 *Eucalyptus laevopinea–Pteridium esculentum*
Plot UL4.2; R=20

An area of several hectares in the former Jemmys Creek Flora Reserve, dominated by *Eucalyptus laevopinea* (overstorey community 1.1), with a very dense ground cover dominated by the ferns *Pteridium esculentum* and *Calochlaena dubia.* Because of the very dense structure of these ferns, floristic diversity is unusually low. Other patches locally dominated by these ferns occur scattered throughout the open forests of the plateau, but the total extent is not large.

3.2 *Acacia dealbata–Poa sieberiana*
Plots OL3.3, RL3.3, RL4.3, UL2.3, UL3.3, WAR004, WAR013, WAR014; R=29-49, median=43.5

Open forest or woodland, 25–35 m tall (median 30 m), which is very widespread on the plateau, occurring in a wide range of habitats but mostly avoiding steep slopes, creeks and areas of impeded drainage. The overstorey is mostly community 5, usually clearly dominated by *Eucalyptus pauciflora*, with *Eucalyptus nobilis* as a frequent but less common associate. *Eucalyptus stellulata* is often present as occasional subcanopy trees, and is sometimes locally common. Occasionally the overstorey is community 1.1, *Eucalyptus laevopinea*. There is a sparse to moderately dense shrub stratum 1–4 m tall dominated by *Acacia dealbata* and a mostly dense grassy ground cover clearly dominated by *Poa sieberiana*. Other species are far less prominent, and include *Asperula conferta*, *Hydrocotyle laxiflora*, *Arthropodium* species B and *Glycine clandestina*. This is the single most widespread community associated with *Eucalyptus pauciflora* forests at the higher altitudes (1120–1200 m, median 1160 m). The other, similar very widespread plateau floristic community, 3.6, is mostly associated with *Eucalyptus laevopinea* (overstorey community 1.1) and occurs at slightly lower altitudes.

3.3 *Acaena novae-zelandiae–Danthonia racemosa*
Plots WAR007, WAR008, WAR009; R=49-53

Fairly widespread in open forest on the plateau in the western half of the area, but not sampled elsewhere. Although there are many species in common with the widespread grassy understorey communities (3.2 and 3.6), this community is characterised by the relative lack of *Poa* spp. and dominance of the low herb *Acaena novae-zelandiae* and tufted grass *Danthonia racemosa*. It is associated with a range of plateau overstorey communities (Table 3). In plot WAR007, *Eucalyptus laevopinea* is co-dominant with *Eucalyptus bridgesiana* around the margin of a swampy depression. Although covering several hectares at the sample site, no stands of similar overstorey composition were observed elsewhere in the survey area, *Eucalyptus bridgesiana* mostly occurring with *Eucalyptus melliodora* on slopes at lower altitudes.

3.4 *Aceana novae-zelandiae*
Plot WAR006; R=51

This community is very similar to 3.3 and occurs in similar habitats. It differs primarily in the absence of *Danthonia racemosa*.

3.5 *Eucalyptus laevopinea–Hydrocotyle laxiflora-Pteridium esculentum*
Plots OL4.3, WAR019, WAR022; R=41–46

Open forest of *Eucalyptus laevopinea* (overstorey community 1.1) with a mixed herbaceous ground cover and virtually non-existent shrub stratum. Apart from *Hydrocotyle laxiflora*, frequent and common ground cover species include the fern *Pteridium esculentum*, thorny vine *Smilax australis*, twiner *Desmodium varians*, herb *Dichondra repens* and tussock grass *Poa labillardieri*.

3.6 *Poa labillardieri-Pteridium esculentum*
Plots OL2.3, RL2.3, UL1.3, WAR010, WAR021, BUN006, BUN007, BUN008; R=36–45, median=41

Grassy open forest or occasionally woodland 22-45 m tall (median height 28 m) with few shrubs and a usually dense ground cover clearly dominated by *Poa labillardieri*. *Pteridium esculentum* is also usually common and may locally form dense thickets. Other common species are *Hydrocotyle laxiflora*, *Acaena novae-zelandiae*, *Wahlenbergia stricta*, *Microlaena stipoides*, *Dichondra repens*, *Gnaphalium gymnocephalum*, *Danthonia* spp., *Viola betonicifolia*, *Desmodium varians*, *Dichelachne* spp. and *Glycine clandestina*. This is one of the most widespread floristic communities on the plateau and occurs at slightly lower altitudes (1050–1140 m, median 1110 m) than the other main plateau floristic community, 3.2. It is usually associated with overstorey community 1.1, where *Eucalyptus laevopinea* is usually clearly and often solely dominant. *Eucalyptus nobilis* is the most frequent associate and may be locally dominant (overstorey community 4). At the 0.1 ha scale used for sample plots, most stands are dominated by one or other of these two overstorey species and stands in which the two species are co-dominant are rare. At a broader scale, *Eucalyptus nobilis* occurs scattered through many of the extensive stands of *Eucalyptus laevopinea*.

3.7 *Eucalyptus praecox–Acaena novae-zelandiae*
Plots WAR002, WAR031; R=47–63

This community is floristically similar to WARf 3.6, but with *Poa labillardieri* a minor component and *Acaena novae-zelandiae* relatively more common. It differs structurally in generally having sparser ground cover. It is of fairly restricted extent, occurring locally and sporadically on upper slopes, mainly around the south-eastern edge of the plateau. *Eucalyptus praecox* and *Eucalyptus laevopinea* are co-dominant in the overstorey (overstorey community 1.2).

3.8 *Eucalyptus laevopinea–Viola betonicifolia*
Plots BUN003, OL1.3, RL1.3, WAR012, WAR016; R=18–62, median=34

Open forest with mostly sparse ground cover and no shrub stratum, characterised by relative lack of grasses in the understorey. No single understorey species is clearly dominant. Frequent species include *Viola betonicifolia*, *Hydrocotyle laxiflora* and

Gnaphalium gymnocephalum. Overall floristically similar to other plateau communities, but it appears to be mainly associated with dense regrowth stands of mainly *Eucalyptus laevopinea* (overstorey community 1.1) where overstorey competition suppresses understorey development. This floristic community includes four understorey communities, and is predominantly characterised by the dense canopy cover of *Eucalyptus laevopinea* which, in the classification analysis, has tended to mask the contribution from the understorey species which have mostly low cover. Plots WAR012, WAR016 and RL1.3 belong to two of the most widespread understorey communities, charaterised respectively by relative abundance of *Acaena novae-zelandiae* (WAR012, WAR016) and *Microlaena stipoides* (RL1.3). Plot OL1.3 is one of two plots in understorey community 5, which has a relatively higher cover of *Danthonia racemosa* than other similar open forest communities. Plot BUN003 is uniquely understorey community 17. This plot has a virtually non-existent understorey with no dominant species. Even though the understorey species are shared with other grassy forest communities, it is classified separately by the understorey classification because of the very low overall cover.

Floristic group 4. Dry slopes forest and woodland

4.1 *Eucalyptus melliodora–Microlaena stipoides*
Plots WAR026, WAR027, WAR032; R=55–67, median=62

Woodland to open forest 20–25 m tall of *Eucalyptus melliodora* and *Eucalyptus laevopinea* (overstorey community 2). These two overstorey species are usually co-dominant, although *Eucalyptus melliodora* may be locally more abundant and plot WAR032 samples a small area where this species is locally solely dominant and *Eucalyptus laevopinea* is absent. *Eucalyptus bridgesiana* occurs as occasional individuals and is locally common in patches, especially at lower altitudes (e.g. plot WAR026), and overstorey community 2 intergrades extensively with 3.1 (*Eucalyptus laevopinea–Eucalyptus bridgesiana*). Although not recorded during the present survey, *Eucalyptus moluccana* is reported from the steeper slopes (Forestry Commission of NSW 1982) and may be associated with this floristic community, although the presence of this species requires confirmation. There is typically a subcanopy of *Angophora floribunda* or *Allocasuarina torulosa*, or commonly both species. The understorey comprises a scattered to moderately dense shrub stratum to 2 m tall, main shrub species being *Olearia elliptica*, *Cassinia quinquefaria* and *Bursaria spinosa*. The ground stratum is of mixed composition with no clear dominants, but common species include the grasses *Microlaena stipoides* and *Echinopogon ovatus*, the herbs *Acaena novae-zelandiae* and *Dichondra repens* and the twiner *Desmodium varians*. This community is extensive over slopes below the plateau, especially lower slopes on deeper soils in the eastern part of the survey area, mainly below 800 m altitude but extending to the plateau at about 1000 m in a few places. It shares many species with plateau communities, although the relative abundances differ considerably, and includes two understorey communities (Table 2). Plots WAR026 and WAR027 belong to understorey community 8, which has *Microlaena stipoides* and *Echinopogon ovatus* as the most common constituents. WAR032 has more in common with grassy plateau communities and belongs to the widespread understorey community 6, in which *Acaena novae–zelandiae* is relatively more common.

4.2 *Eucalyptus melliodora–Cassinia quinquefaria*
Plots WAR029, WAR033; R=54–62

Open forest of *Eucalyptus laevopinea, Eucalyptus bridgesiana* and *Eucalyptus melliodora* in varying proportions (overstorey communities 1.1 and 3.1), with a moderate to very dense shrub understorey 1–3 m tall and sparse ground cover. *Cassinia quinquefaria* is the dominant shrub species, but *Olearia elliptica* is usually present and may be locally dominant. Common ground cover and low shrub species include *Danthonia racemosa, Glycine clandestina* and *Swainsonia galegifolia*. This community is very widespread on the steep and usually rocky slopes of the southern and eastern escarpments of the area (below 800 m altitude) and could be regarded as the characteristic community of those habitats.

4.3 *Allocasuarina torulosa–Olearia elliptica*
Plot WAR001; R=65

Open forest characterised by a subcanopy of *Allocasuarina torulosa* and a sparse to dense shrub stratum of *Olearia elliptica* 1–2 m tall. This community is very similar to 4.2 and represents areas of local dominance of *Olearia elliptica*.

4.4 *Eucalyptus nortonii–Bothriochloa macra*
Plot WAR015; R=65

This community was recorded only as a small, heavily browsed area at low altitude on a dry slope in Norfolk Island Creek valley, at the western boundary of the forest adjacent to cleared grazing land. The overstorey is a low open forest or woodland of *Eucalyptus nortonii* (overstorey community 8). This overstorey community is of restricted extent in the area, occurring mostly below and sometimes immediately above the cliff line on the northern and western boundary. It is much more extensive in adjacent private property. Plot WAR015 is representative of a small area mapped as Forest Type 103. The understorey is unusual in that *Bothriochloa macra,* absent from plateau forests, is the single most abundant grass species. This native grass is apparently tolerant of heavy grazing and at the time of survey, formed a low turf at this site.

4.5 *Eucalyptus nortonii–Cassinia quinquefaria*
Plot BUN004; R=40

Low woodland of *Eucalyptus nortonii* with a dense shub stratum of *Cassinia quinquefaria*. Ground cover sparse, but of similar composition to that of grassy plateau forests. This community is restricted to slopes in the north-west of the area.

4.6 *Cassinia quinquefaria–Bothriochloa macra*
Plot BUN002; R=56

This is a mosaic of shrub thickets up to 4 m tall with low turf and bare rock, and scattered emergents of *Eucalyptus nortonii* and *Angophora floribunda* up to 15 m tall (overstorey community 3.2). Shrub layer mainly *Cassinia quinquefaria, Acacia neriifolia* and *Olearia elliptica*. The low, heavily browsed turf is dominated by *Danthonia laevis* and *Bothriochloa macra*. This plot is representative of several small patches on the plateau along the cliff top on the northern boundary of the study area. The skeletal soil over extensive rock slabs prevents establishment of denser tree growth.

Table 4. Plant species of conservation significance at Coolah Tops

Species	**Significance**	**Distribution and habitat at Coolah Tops**
Asplenium trichomanes subsp. *quadrivalens*	Local and sporadic in NSW, but cosmopolitan in temperate regions.	Small populations epilithic in sheltered microsites near waterfalls.
Discaria pubescens	Nationally rare, 3RCa, but widespread in NSW	Widespread in plateau grassy forest, but uncommon and sporadic and often more abundant near creeks. Largest single stand about 30 mature plants.
Macrozamia concinna (D.L. Jones ined.)	Nationally rare with restricted distribution, mainly occurring in the Nundle area	Scattered on rocky slopes in dry slopes forest in the far east of the area.
Teucrium species D	Restricted distribution, otherwise only in Tamworth district.	A single small population of less than 30 plants, on a steep, rocky slope near the western boundary of the study area.

Floristic group 5. Plateau swamp

5.1 *Leptospermum polygalifolium–Hydrocotyle peduncularis*
Plot WAR018; R=34

A mosaic of shrub thickets of *Leptospermum polygalifolium* with dense low herbfield dominated by *Hydrocotyle peduncularis*, and scattered emergents of *Eucalyptus dalrympleana* ssp. *heptantha*. This is a variant of 5.2 with similar composition of herbaceous vegetation but with the shrub stratum dominated by *Leptospermum polygalifolium* rather than *Leptospermum gregarium*.

5.2 *Leptospermum gregarium–Hydrocotyle peduncularis*
Plots BUN001, WAR005; R=22-34

This is typically a mosaic of very dense shrub thickets up to 3 m tall interspersed with dense low herbfields and turf, at a scale of tens of square metres to tenths of a hectare. The dominant shrub species are *Leptospermum gregarium* and *Hakea microcarpa*. Abundant ground cover herbs are *Eleocharis dietrichiana, Myriophyllum pedunculatum, Gonocarpus micranthus, Haloragis heterophylla, Hydrocotyle peduncularis, Isotoma fluviatilis* subsp. *borealis, Cyperus sphaeroideus, Hypericum japonicum* and *Schoenus apogon*. In most areas there are only isolated emergent eucalypts (mostly *Eucalyptus dalrympleana* subsp. *heptantha* or *Eucalyptus stellulata*), but a higher tree density occurs on hummocks and around swamp margins (overstorey community 6). This is the characteristic community of impeded drainage depressions in headwaters of minor creeks on the plateau. These areas suffer regular localised soil disturbance from activities of feral pigs, reflected in the occurrence of several exotic species such as *Juncus bufonius*. Where disturbance by pigs or cattle grazing is intensive, weeds such as *Trifolium repens* may become locally dominant. The very extensive swamp along

Norfolk Creek has a high proportion of naturalised species, but is otherwise similar to other swamp areas, and was not sampled.

Species of conservation significance

Only four of the species recorded during the survey are considered to be of conservation significance (Table 4). Only one of these (*Discaria pubescens*) is listed as nationally rare or threatened, coded 3RCa by Briggs and Leigh (1995). It is a very widespread but sporadic shrub which is considered adequately reserved, occurring in at least ten National Parks or Nature Reserves outside Coolah Tops. A further species, *Macrozamia concinna* (D.L. Jones ined.) is considered of national significance but has not been assigned a conservation code (D.L. Jones, pers. comm.). *Teucrium* species D has a restricted distribution, mainly in the Tamworth area, and also could be considered of national significance.

In addition to survey results, a search for records of rare plants was made of the January 1994 version of the ROTAP database (NSW National Parks and Wildlife Service) for the rectangle bounded by 31°41'–31°53' and 149°55'–150°17'E, which includes Coolah Tops and surrounding plains. This database contained only one record from Coolah Tops, of *Callistemon shiressii* from Norfolk Falls. This is almost certainly the result of misidentification of *Callistemon sieberi*, as it is not supported by a specimen and *C. shiressii* is otherwise known only from a restricted area between Colo River and Howes Valley in central coastal NSW, growing on sandstone. Two additional species are recorded in this database from private property on the plains from within the defined rectangle, but not from Coolah Tops. *Bothriochloa biloba* (3V) is represented by two records and may occur in grassy woodland at the base of the slopes. *Thesium australe* (3VCi+) is represented by a single record from near Blackville, in the valley to the north of Coolah Tops. Griffith (1992) lists an additional record from Cassilis. This species is almost invariably associated with grassy understorey dominated by *Themeda australis*. No community of this type was recorded during the survey and there is only a low probability that *Thesium australe* would occur in the Coolah Tops area.

Floristic patterns in relation to logging, grazing and environmental factors

The two-dimensional ordination from CCA (Fig. 5), is plotted with ellipses representing twice the standard deviation around centroids for logged and unlogged plots, and arrows representing several environmental variables as described above under methods. The ellipses are plotted as a guide only, as the data are not multivariate normal and the shape of the ellipse will be exaggerated by outliers. The relatively longer arrows for grazing history and altitude suggests that these variables contribute to floristic variation to a greater extent than does logging history. Overstorey type, logging history and degree of topographic exposure contribute to a lesser extent, and the latter two are correlated to some extent, so that floristic variation in relation to logging history may also, or alternatively, be related to topographic exposure. When floristic data are ordered along the logging history vector, species which tend to be most strongly associated with unlogged plots are *Pterostylis coccina*, *Leucopogon lanceolatus, Dianella longifolia, Hypericum gramineum* and *Gonocarpus humilis*. Species which are associated with the logged end of the floristic gradient, especially recently logged plots, include *Urtica incisa, Pteridium esculentum, Echinopogon ovatus, Stellaria pungens, Stipa rudis* subsp. *nervosa* and *Cynoglossum australe*, and the naturalised alien herbs *Sonchus oleraceus, Conyza albida* and *Taraxacum officionale*.

Logged plots have a floristic richness which is very similar to but slightly lower than unlogged plots, overall. Median richness for unlogged plots which sample areas potentially able to be logged (n=14) is 44 species per 0.1 ha plot. For recently (<10 yrs) logged plots (n=6) it is 41 and for older (20–40 yrs) logged plots (n=9) it is 42 species per plot. There were no statistically significant differences among these results ($p > 0.5$, Kruskal-Wallis Test). A total of 127 species was recorded from logged plots and 145 from unlogged but loggable plots. 102 species were recorded in both logged and unlogged but loggable plots. A total of forty-three species was recorded from unlogged plots which could potentially be logged, but not from logged plots.

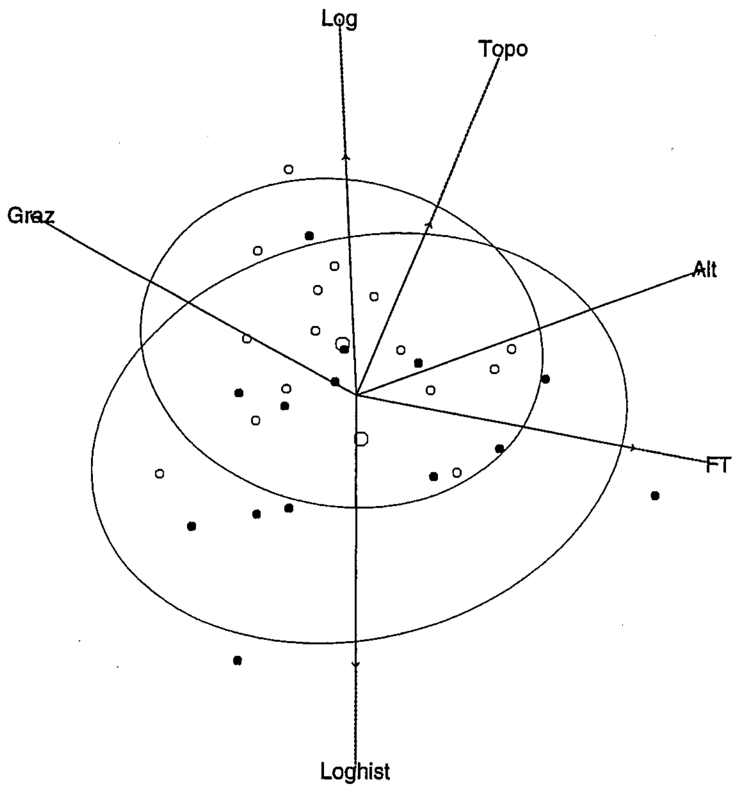

Fig. 5. CCA ordination of logged and loggable plots with logging category superimposed. Filled symbols represent logged plots and open symbols represent unlogged plots. Ellipses are twice standard deviation from the centroid for each logging group. Environmental variables are displayed as arrows: Log = time since logging (recent to unlogged), Loghist = logged (1) or unlogged (0), Topo = topographic position (exposed to sheltered), Alt = altitude (low to high), Graz = grazing (0 ungrazed, 1 grazed), FT = overstorey community group number.

Although it is not possible to accurately assess grazing history in the field on an individual plot basis, State Forests' management records (R. Irvine, District Forester, Dubbo, pers. comm.) indicate that the central area of the forest has been subject to a far lower intensity of grazing by domestic stock than elsewhere. The CCA ordination diagram with ellipses of twice standard deviation plotted around centroids for each grazing category (Fig. 6) shows a strong tendency for separation of lightly grazed from more heavily grazed plots, with relatively little overlap. Ordering of species along the grazing category vector suggests that species which are associated with less heavily grazed plots include the shrubs *Acacia dealbata* and *Lomatia arborescens*, twiners *Glycine clandestina* and *Hardenbergia violacea*, abundant tussock grass *Poa sieberiana*, forb *Gonocarpus humilis* and orchid *Pterostylis coccina*. Species which occur in more heavily grazed plots include forbs *Acaena novae-zelandiae*, *Gnaphalium gymnocephalum* and *Urtica incisa*, grasses *Danthonia laevis*, *Microlaena stipoides*, *Stipa rudis* and *Echinopogon ovatus* and graminoid *Lomandra filiformis*. However, the CCA plot also suggests a strong negative interaction between grazing and altitude, and this is supported by the negative correlation between these two factors (Spearman rank correlation

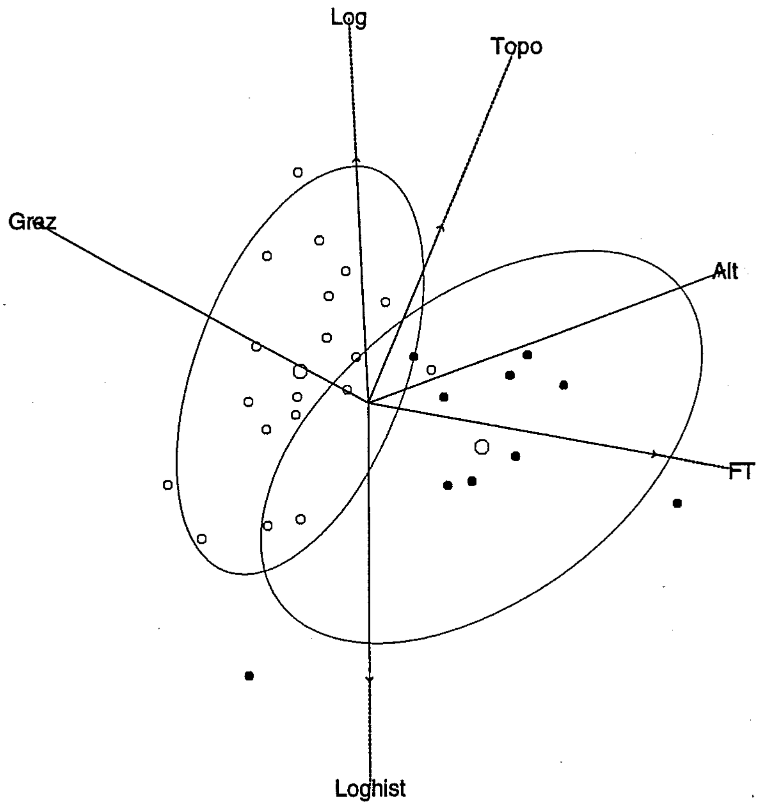

Fig. 6. CCA ordination of logged and loggable plots with grazing history superimposed. Filled symbols represent 'ungrazed' plots and open symbols represent grazed plots. Ellipses are twice standard deviation from the centroid for each grazing group. Environmental variables are displayed as arrows and defined as described for Fig. 5.

co-efficient = -0.61, p=0.0005). The more heavily grazed areas are those at slightly lower altitudes on the plateau. Thus, it is possible that the fairly strong floristic gradient apparently associated with grazing history may actually be an altitudinal gradient.

Discussion

Floristics and conservation of communities

Considered in isolation, the vegetation of the area is remarkably uniform, of low floristic diversity, supports very few significant vascular plant species and appears to have low intrinsic botanical conservation value. However, considered in a broader context, the area does have several important features of conservation and botanical significance. Geographically, the area represents a westerly extension of the northern tablelands intruding into the western slopes and forms a substantial part of an isolated basaltic plateau in a generally lower-altitude and largely cleared landscape. The combination of a discrete geographical unit within an otherwise largely cleared landscape gives the area an inherent general conservation significance, recognised in the forest Management Plan (Forestry Commission of NSW 1982). Botanically, the area clearly has strong floristic similarities to the northern tablelands to the north-east, but also has several unusual features. The extensive and structurally very well-developed *Eucalyptus pauciflora* forests, including the tallest recorded individuals of this species, are well-recognised (Forestry Commission of NSW 1982). The very extensive occurrence of both *Eucalyptus laevopinea* and *Eucalyptus nobilis*, the latter probably at its western limit of distribution, is also of significance. The other important feature is the absence of several eucalypts which are widespread and abundant elsewhere on the northern tablelands in similar habitats, notably *Eucalyptus campanulata* and *Eucalyptus obliqua*.

The assessments of Benson (1989) and Hager and Benson (1994) are used as an indication of conservation status of overstorey communities. Due to recent substantial increases in the National Park estate, especially in coastal and tablelands areas, some communities occurring in former State Forests would now be assessed as less threatened, although the status of communities which occur predominantly on private lands will not have changed significantly. The most extensive overstorey community in the area, 1.1 *Eucalyptus laevopinea*, is regarded as inadequately reserved generally, and poorly reserved in the southern part of the northern tablelands. Stands in which *Eucalyptus nobilis* is clearly dominant (overstorey community 4) are not recognised as a separate community, but are probably related to the poorly reserved Hager and Benson EF373 *Eucalyptus laevopinea–Eucalyptus nobilis*. Stands in which *Eucalyptus laevopinea* is co-dominant with *Eucalyptus praecox* (overstorey community 1.2) do not have a clear Benson equivalent, but could perhaps be regarded as a geographical variant of the related *Eucalyptus mannifera* ssp. *elliptica*, assessed as vulnerable. In any case, these stands are potentially of conservation significance.

Communities containing *Eucalyptus pauciflora*, *Eucalyptus stellulata* and/or *Eucalyptus dalrympleana* as dominants are assessed in the earlier of the two reports (Benson 1989) as not threatened, but inadequately reserved. Particular note is made of the inadequacy of reservation of *Eucalyptus pauciflora* at Coolah Tops. For the southern zone of the northern tablelands, Hager and Benson assess the equivalent associations as being adequately conserved, with at least ten and probably 25 per cent of the total area reserved (probably largely a result of extensive areas included in Barrington Tops NP).

The overstorey communities dominated by, or containing, species of boxes (2, 3.1, 3.2 and 8) have no clear Benson equivalent and must be regarded as being of significance. Communities 2 and 3.1 are most similar to the *Eucalyptus melliodora-Eucalyptus bridgesiana* association, which is assessed as poorly reserved and vulnerable. Communities 3.2 and 8, containing *Eucalyptus nortonii*, appear to have no equivalent association. In the study area, these communities occur mainly at lower altitudes adjacent to private property, much of the latter having been cleared. They are probably representative of some of the area now cleared (especially the steeper slopes), and could reasonably be regarded as remnants of previously relatively widespread communities in the surrounding foothills. However, there may have been substantial differences in understorey composition between the occurrences on Crown Land and those which previously existed in the surrounding private property. The Crown Land boundary invariably coincides with abrupt transitions in slope, with the steeper, rocky slopes with dense shrub understorey of *Cassinia quinquefaria* and *Olearia elliptica* in Crown tenure contrasting with the gentler slopes of adjacent private property. The understorey in the private property is mostly heavily grazed, dominated by exotics and difficult to relate to what would have been present prior to settlement. McRae & Cooper (1985) describe remnants on the nearby basalt plains (to the immediate south of the present survey area) as being woodlands of *Eucalyptus albens–Eucalyptus moluccana*, *Eucalyptus melliodora* and *Brachychiton populneus*. *Eucalyptus melliodora* is scattered at lower altitudes in the study area, but is a canopy dominant only in very limited areas close to the boundary with private property. Although *Eucalyptus moluccana* is recorded for the area in the management plan (Forestry Commission of NSW 1982), the original source of the record is unknown and this species was not recorded during recent survey.

Impact of past logging

Although both logged and unlogged stands were sampled, it was difficult to assess past logging impact, mainly because there are no detailed pre-logging data available, and substantial differences may exist between previously logged and unlogged areas irrespective of logging history. Present differences in vegetation may be related more to site factors other than logging history. However, survey data do provide an indication of possible logging impact in the context of spatial variability in vegetation of unlogged sites. As shown by the ordination diagram of Fig. 5, there does appear to be a weak impact of logging on floristic composition. It is possible that the observed pattern is related to site factors other than logging. For example, logging may have tended to occur in particular vegetation types, for productivity or other reasons, resulting in the observed apparent effect being an artefact of the distribution of logging treatment. Stands dominated by *Eucalyptus laevopinea* were more likely to have been previously logged than those dominated by *Eucalyptus pauciflora*, due to the higher commercial value of the former species. Degree of topographic exposure appears to be the variable most strongly correlated with logging (Fig. 5). Thus, the observed pattern of floristic composition in relation to logging may partly be due to topographic variation, with past logging avoiding more sheltered sites.

Examination of correlations between ordination scores and abundance of individual species gives some indication of which species potentially contribute most to observed differences in composition, but unfortunately provides only weak evidence of logging impact in terms of individual species, because logging categories are not clearly separated on the ordination diagram, and correlations with an individual species are more likely to be due to chance than those with a suite of species. It is also not possible to evaluate logging impact on the large proportion of species which occurred at low frequency in survey plots. More intensive survey would partly assist, but for most species, detailed and specifically-directed monitoring studies would be required to satisfactorily examine this issue. Using data from this survey, only five of the species which occurred at frequency ≥5 were significantly more frequent in unlogged plots. These were the native herbs *Dichelachne crinita, Hypericum gramineum, Pterostylis coccina* and *Picris angustifolia*, and the tree *Eucalyptus pauciflora*. The latter is most likely due to less likelihood of logging in forests containing this species, which is of low commercial value. *Hypericum gramineum* and *Pterostylis coccina* were also indicated as associated with unlogged plots by the ordination results. Species recorded more frequently in logged plots were *Cynoglossum australe, Echinopogon ovatus, Eucalyptus laevopinea* and *Pteridium esculentum*. As mentioned above, in the case of *Eucalyptus laevopinea* this is because forests containing that species are favoured for logging. The remaining three species are also indicated as favouring logged plots from the ordination results.

Following logging disturbance, vegetation may be expected to undergo successional change to some extent, at least in the most heavily affected patches. Ordination patterns suggest that this occurs to only a limited extent, probably because the majority of species present are either resilient to logging damage or quickly recolonize immediately after logging. For example, the most abundant understorey species in grassy forests, *Poa sieberiana* and *Poa labillardieri*, appear resilient to physical damage and recover quickly unless tussocks are completely uprooted. Unless there is severe soil disturbance, the species which were previously present quickly recover. The patchy nature of post-logging disturbance, whereby a substantial or major proportion of any 0.1 ha plot remains relatively undisturbed, results in any successional changes being confined to relatively small patches in the general logged area and contributes to overall lack of clear evidence of successional trends. Any changes which do occur are most pronounced in a few highly disturbed patches along roadsides, on snig tracks and on log dumps. Observations suggest that notable colonizing species are the naturalised herb *Conyza albida* and the native herbs *Cynoglossum australe, Pteridium esculentum* and *Acaena novae-zelandiae*. These species are all present in unlogged and older logged plots, but at reduced abundance. *C. albida* and *C. australe* probably colonize patches of disturbed soil from seed, while *P. esculentum* and *A. novae-zelandiae* proliferate vegetatively from rhizomes in areas where they previously existed. These species become less abundant over time, the naturalised species in particular decreasing to pre-logging levels within 10 years, while the native species tend to be more persistent.

Grazing and feral animals

The study area was extensively grazed by domestic cattle and sheep, at least immediately prior to recent dedication as a National Park. Grazing obviously has the potential to alter floristic composition by reducing the abundance of, or eliminating, preferred forage species. The extent to which this has occurred in the study area, if at all, is unknown. Low intensity grazing impact in forests is generally poorly known. Grazing may have a greater impact on floristic composition than does logging, and this warrants further investigation. However, it cannot be unequivocally stated that the observed relatively strong differences between the floristic composition of grazed and 'ungrazed' plots is due to grazing impact, since the plots are not interspersed and it is equally likely that floristic differences may actually be due to an altitudinal gradient, or interactions between altitude and grazing history. Due to the correlation between them, it is not possible to distinguish the effects of these factors from the data. For some species, there appears to be no logical reason, based on the little that is known of their ecology, for the observed differences to be due to grazing history, and altitude is the more likely explanation. Notable examples are *Poa sieberiana* in 'ungrazed' plots, and the soft grasses *Microlaena stipoides*, *Echinopogon ovatus* and *Danthonia laevis* associated with grazed plots when they might be expected to be preferentially browsed and be disadvantaged by higher grazing pressure. Other differences are perhaps more readily explained in terms of grazing history, notably the less palatable *Lomandra filiformis* favouring grazed plots, and the seasonal geophyte *Pterostylis coccina* being associated with 'ungrazed' plots.

Considerable soil disturbance caused by the foraging activities of feral pigs was observed during the survey, mainly in swampy heath and sedgelands. As this activity is concentrated in certain habitats, it is a potential threat to populations of species which are intolerant of such regular disturbance. Several herds of feral goats were observed during survey. Their activities are concentrated in rocky areas near cliffs. Much of the vegetation in these areas was heavily browsed at the time of survey, but whether goats or native wallaroos (also abundant) were mostly responsible was not clear. In any case, goats must be considered a potential threat to species which are restricted to rocky sites.

Weeds

Weed species (naturalised exotics) form a relatively small proportion (about 10 per cent) of the overall flora of the area. Most occur infrequently and are a minor component of the vegetation generally, although some species are very widespread. *Cirsium vulgare* and *Hypochoeris radicata* each occur in over thirty plots (over 60 per cent of the sample). These species often occur in relatively undisturbed forests. Their abundance in the study area may have been increased by both grazing and logging, although survey data suggest that neither species is more frequently associated with either logged or more heavily grazed plots. Weeds which do increase in abundance following logging decrease to pre-logging levels within 10 years. Although widespread, weeds are not sufficiently abundant at present to seriously threaten the integrity of native vegetation in the area in the short term. Clover, *Trifolium repens*, is locally common in previously heavily-grazed areas near swamps and may constitute a threat to herb communities in local areas. Several species of declared noxious weeds, such as *Hypericum perforatum* and *Chondrilla juncea*, while currently rare or infrequent, have the potential to increase in abundance and possibly pose a flora conservation threat. Blackberry, *Rubus ulmifolius/R. discolor* complex, is infrequent but locally common, particularly in riparian sites near private property boundaries. Local infestations have been previously controlled using herbicides, but it may pose a future threat to flora conservation in the absence of such control. Broom, *Cytisus scoparius*, has not been recorded from Coolah Tops, but poses a very serious flora conservation threat in broadly similar habitats on Barrington Tops. Any outbreak of this species should be immediately controlled.

Management issues

The change in tenure from State Forest to National Park has secured the reservation of a large area of *Eucalyptus laevopinea*-dominated grassy forest, which otherwise would have been subject to continued selective logging. This is likely to have some flora conservation advantage, although the impacts of past logging are not clear. The other communities of conservation significance would have remained unaffected by current logging practices, although past exploitation for fencing timber by adjacent landholders probably would have continued at a low level. The changes in tenure formalise the reservation of some of these communities (the proportion not still held under lease tenure) but otherwise have little effect on flora conservation status.

Ferals pigs and goats have the potential to reduce flora conservation values. If possible, they should be eliminated from the area, or at least their numbers should be maintained at low levels by appropriate control measures. Grazing may have greater impact on floristic composition than other previous disturbance such as logging. Domestic grazing should be excluded from the area. Weeds are not considered to be a serious threat in the short term, and to some extent their spread will be controlled by controlling grazing and feral animals which are likely to be important vectors. Two species which currently occur as small localised populations but will need specific control if populations increase are Blackberry and St. John's Wort, *Hypericum perforatum*. The former has been controlled previously by herbicide and may spread in future if left unchecked. The latter occurs mainly on private land but small populations occur in the study area adjacent to the private property boundary and isolated plants occur sporadically elsewhere in the forest, mostly not far from private property.

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Appendix 1

Species are listed alphabetically by family within classes, and nomenclature follows the National Herbarium of New South Wales. Frequency of occurrence is shown for each species, as a percentage of the total number of plots in each broad floristic group (indicated beneath the heading). There is an overall total of 50 plots. Floristic groups are derived from classification of all species as indicated below and described in the text.

- . species not recorded in that group.
- + species recorded in that group but not in a survey plot
- * naturalised species
- H specimen from area retained at State Forests herbarium, Research Division, West Pennant Hills
- M recorded in Management Plan but not during survey, details unknown

Floristic group: (refer to text)
MF=Moist Forest (group 1)
RpF=Riparian Forest and Woodland (group 2)
PGF=Plateau Grassy Forest (group 3)
DW=Dry slopes forest and woodland (group 4)
Sw=Swamp and Sedgeland (group 5)

Logging category:
L1=logged <10yr
UL1=unlogged,loggable
L2=logged >20yr
UL2=unlogged,unloggable (steep, non-commercial or non-forest)

			Floristic Group					**Logging Category**			
		Tot. freq.	**MF (1)**	**RpF (6)**	**PGF (31)**	**DW (9)**	**Sw (3)**	**L1 (6)**	**L2 (9)**	**UL1 (14)**	**UL2 (21)**
Class FILICOPSIDA											
ADIANTACEAE											
Adiantum aethiopicum		10	.	1.00	0.03	0.33	.	.	.	0.07	0.43
Adiantum formosum		1	.	0.17	.	.	.	.	.	.	0.05
Cheilanthes austrotenuifolia	M	+									
Cheilanthes distans		4	.	.	.	0.44	.	.	.	.	0.19
Cheilanthes sieberi subsp. *sieberi*		3	.	0.17	.	0.22	.	.	.	.	0.14
ASPLENIACEAE											
Asplenium flabellifolium		5	1.00	0.33	0.03	0.11	.	.	.	0.07	0.19
Asplenium trichomanes											
subsp. *quadrivalens*	H	1	.	0.17	.	.	.	.	.	.	0.05
ATHYRIACEAE											
Diplazium australe	M	+									
BLECHNACEAE											
Blechnum minus	H	4	.	0.67	.	.	.	.	.	.	0.19
Blechnum nudum		1	.	0.17	.	.	.	.	.	.	0.05
Doodia aspera		7	1.00	0.33	0.10	0.11	.	0.17	0.11	0.07	0.19
Doodia caudata var. *caudata*	H	3	.	0.50	.	.	.	.	.	.	0.14

			Floristic Group					Logging Category			
		Tot. freq.	MF (1)	RpF (6)	PGF (31)	DW (9)	Sw (3)	L1 (6)	L2 (9)	UL1 (14)	UL2 (21)
DENNSTAEDTIACEAE											
Histiopteris incisa		+	+	.	.	.	.	.	.	.	+
Hypolepis glandulifera		4	.	0.67	.	.	.	.	.	.	0.19
Pteridium esculentum		31	1.00	0.67	0.77	0.11	0.33	1.00	0.89	0.64	0.38
DICKSONIACEAE											
Calochlaena dubia		3	.	0.17	0.06	.	.	0.17	.	0.07	0.05
DRYOPTERIDACEAE											
Polystichum fallax	H	5	.	0.67	0.03	.	.	.	.	0.07	0.19
Polystichum proliferum	H	4	1.00	0.17	0.06	.	.	0.17	0.11	.	0.10
OPHIOGLOSSACEAE											
Botrychium australe		1	.	.	.	0.11	.	.	.	.	0.05
Ophioglossum lusitanicum	H	1	.	0.17	.	.	.	.	.	.	0.05
PTERIDACEAE											
Pteris tremula		4	.	0.50	.	0.11	.	.	.	.	0.19
SINOPTERIDACEAE											
Pellaea falcata var. *falcata*		9	1.00	0.50	0.03	0.44	.	.	.	0.07	0.38
Class CONIFEROPSIDA											
CUPRESSACEAE											
Callitris endlicheri		+	.	.	.	.	+	.	.	.	+
Class CYCADOPSIDA											
ZAMIACEAE											
Macrozamia concinna (D.L. Jones ined.)	H	2	.	.	.	0.22	.	.	.	.	0.10
Class MAGNOLIOPSIDA–MAGNOLIIDAE											
ACANTHACEAE											
Brunoniella australis		2	.	.	.	0.22	.	.	.	.	0.10
APIACEAE											
**Berula erecta*	H	4	.	0.67	.	.	.	.	.	.	0.19
Daucus glochidiatus		9	.	0.33	0.13	0.33	.	.	0.11	0.21	0.24
Hydrocotyle laxifolia		45	1.00	0.83	1.00	0.89	.	1.00	1.00	1.00	0.76
Hydrocotyle peduncularis		15	1.00	1.00	0.16	.	1.00	0.17	0.11	0.21	0.48
Hydrocotyle tripartita		3	.	0.33	.	.	0.33	.	.	.	0.14
Lilaeopsis polyantha	H	3	.	0.50	.	.	.	.	.	.	0.14
Oreomyrrhis eriopoda		3	.	.	0.10	.	.	.	.	0.21	.
Trachymene anisocarpa	M	+									

			Floristic Group					Logging Category			
		Tot. freq.	MF (1)	RpF (6)	PGF (31)	DW (9)	Sw (3)	L1 (6)	L2 (9)	UL1 (14)	UL2 (21)
ARALIACEAE											
Polyscias sambucifolia		4	.	.	0.13	.	.	.	0.22	0.14	.
ASCLEPIADACEAE											
Marsdenia rostrata		1	.	0.17	.	.	.	.	.	.	0.05
ASTERACEAE											
Ammobium alatum	H	+	.	+	.	.	.	+	.	.	.
**Bidens pilosa*		1	.	.	.	0.11	.	.	.	.	0.05
Brachycome dissectifolia	H	4	.	0.33	.	0.11	0.33	.	.	.	0.19
Brachycome microcarpa		27	.	.	0.81	0.22	.	0.83	0.56	0.93	0.19
Brachycome procumbens	M	+									
Cassinia compacta	H	5	.	0.17	0.10	0.11	.	0.33	.	0.07	0.10
Cassinia quinquefaria		12	.	0.17	0.06	1.00	.	.	0.11	.	0.52
**Chondrilla juncea*	H	+	.	+	.	.	.	+	.	.	.
**Cirsium vulgare*		35	.	1.00	0.74	0.67	.	0.83	0.56	0.79	0.67
**Conyza albida*	H	14	.	0.67	0.19	0.44	.	0.67	0.11	0.07	0.38
Craspedia variabilis	M	+									
Cymbonotus preissianus	H	2	.	.	0.03	0.11	.	0.17	.	.	0.05
Cymbonotus spp.		9	.	0.33	0.16	0.22	.	.	0.11	0.21	0.24
Gnaphalium gymnocephalum	H	35	.	0.83	0.74	0.44	1.00	0.83	0.89	0.57	0.67
Gnaphalium involucratum	H	6	.	0.33	0.03	0.33	.	.	0.11	.	0.24
**Hypochoeris radicata*		34	.	0.67	0.71	0.67	0.67	0.50	0.78	0.71	0.67
**Lactuca serriola*		5	.	0.17	0.10	0.11	.	.	.	0.21	0.10
Lagenifera stipitata		12	.	0.17	0.29	0.22	.	.	0.56	0.29	0.14
Microseris lanceolata	H	3	.	.	0.10	.	.	0.17	0.11	0.07	.
Olearia alpicola	H	5	.	0.33	0.10	.	.	.	0.11	0.14	0.10
Olearia chrysophylla	M	+									
Olearia elliptica		12	.	0.33	0.06	0.89	.	.	.	0.07	0.52
Picris angustifolia		26	.	0.83	0.39	1.00	.	0.17	0.22	0.57	0.71
Rhodanthe anthemoides	H	2	.	0.17	.	0.11	.	.	.	.	0.10
Senecio biserratus	H	4	.	0.33	0.03	0.11	.	.	.	0.07	0.14
Senecio diaschides	H	24	.	0.33	0.61	0.33	.	0.67	0.56	0.64	0.29
Senecio hispidulus var. *dissectus*	H	1	.	.	.	0.11	.	.	.	.	0.05
Senecio hispidulus var. *hispidulus*		1	.	.	.	0.11	.	.	.	.	0.05
Senecio lautus subsp. *dissectifolius*	H	4	.	0.17	0.03	0.22	.	.	.	0.07	0.14

			Floristic Group					Logging Category			
		Tot. freq.	**MF (1)**	**RpF (6)**	**PGF (31)**	**DW (9)**	**Sw (3)**	**L1 (6)**	**L2 (9)**	**UL1 (14)**	**UL2 (21)**
Senecio linearifolius		2	.	0.17	0.03	.	.	0.17	.	.	0.05
**Senecio madagascariensis*		2	.	.	0.03	0.11	.	.	.	0.07	0.05
Senecio quadridentatus		6	.	0.17	.	0.56	.	.	.	.	0.29
Senecio sp. E (aff. *apargiaefolius*)		2	.	0.17	0.03	.	.	.	.	.	0.10
Sigesbeckia australiensis	H	7	.	0.17	.	0.67	.	.	.	.	0.33
**Sigesbeckia orientalis*		6	.	0.33	.	0.44	.	.	.	.	0.29
Solenogyne bellioides	H	1	.	.	.	0.11	.	.	.	.	0.05
Solenogyne gunnii	H	9	.	0.33	0.16	0.22	.	.	0.11	0.14	0.29
**Sonchus asper*		5	.	0.17	0.10	.	0.33	0.17	0.11	0.07	0.10
**Sonchus oleraceus*		10	.	0.17	0.29	.	.	0.50	0.22	0.29	0.05
**Taraxacum officinale*		13	.	0.50	0.19	0.44	.	0.67	0.11	0.07	0.33
Triptilodiscus pygmaeus	H	1	.	.	.	0.11	.	.	.	.	0.05
Vittadinia cuneata var. *hirsuta*	H	3	.	.	.	0.33	.	.	.	.	0.14
Vittadinia tenuissima	H	+	.	.	.	.	+	.	.	.	+
BIGNONIACEAE											
Pandorea pandorana		+	+	.	.	.	.	.	.	+	.
BORAGINACEAE											
Austrocynoglossum latifolium		3	.	0.17	0.03	0.11	.	.	.	0.07	0.10
Cynoglossum australe		20	.	0.33	0.52	0.22	.	1.00	0.78	0.21	0.19
BRASSICACEAE											
Cardamine paucijuga	H	5	1.00	0.17	0.10	.	.	0.17	.	0.14	0.10
Rorippa laciniata	M	+									
CAMPANULACEAE											
Wahlenbergia luteola	H	1	.	.	.	0.11	.	.	.	.	0.05
Wahlenbergia planiflora subsp. *planiflora*	H	2	.	.	0.06	.	.	.	.	0.14	.
Wahlenbergia stricta	H	37	.	0.67	0.90	0.56	.	1.00	1.00	0.86	0.48
Wahlenbergia spp.		3	.	.	.	0.33	.	.	.	.	0.14
CAPRIFOLIACEAE											
Sambucus gaudichaudiana		1	1.00	.	.	.	.	.	.	.	0.05
CARYOPHYLLACEAE											
**Cerastium fontanum* subsp. *vulgare*	H	2	.	0.17	.	0.11	.	.	.	.	0.10
Gypsophila tubulosa	H	2	.	.	.	0.22	.	.	.	.	0.10
**Paronychia brasiliana*	H	1	.	.	.	0.11	.	.	.	.	0.05

			Floristic Group					Logging Category			
		Tot. freq.	MF (1)	RpF (6)	PGF (31)	DW (9)	Sw (3)	L1 (6)	L2 (9)	UL1 (14)	UL2 (21)
**Petrorhagia velutina*		3	.	.	.	0.33	.	.	.	.	0.14
**Polycarpon tetraphyllum*		4	.	.	0.03	0.33	.	0.17	.	.	0.14
Scleranthus biflorus		7	.	0.17	0.13	0.22	.	.	.	0.21	0.19
Stellaria angustifolia	H	4	.	0.33	.	.	0.67	.	.	.	0.19
**Stellaria media*		3	.	0.33	.	0.11	.	.	.	.	0.14
Stellaria pungens		15	.	0.33	0.42	.	.	0.50	0.56	0.36	0.10
CASUARINACEAE											
Allocasuarina torulosa		3	.	.	.	0.33	.	.	.	.	0.14
Casuarina cunninghamiana		1	.	0.17	.	.	.	.	.	.	0.05
CHENOPODIACEAE											
**Chenopodium album*		1	.	.	0.03	.	.	.	.	0.07	.
Chenopodium pumilio		1	.	.	0.03	.	.	.	0.11	.	.
Einadia nutans subsp. *nutans*	H	3	.	.	.	0.33	.	.	.	.	0.14
Einadia trigonos subsp. *leiocarpa*	H	2	.	0.17	.	0.11	.	.	.	.	0.10
CLUSIACEAE											
Hypericum gramineum		20	.	0.17	0.35	0.67	0.67	.	0.11	0.57	0.52
Hypericum japonicum		9	.	0.67	0.06	.	1.00	.	.	0.14	0.33
**Hypericum perforatum*		3	.	0.17	0.03	0.11	.	.	.	.	0.14
CONVOLVULACEAE											
Dichondra repens		41	.	0.83	0.87	0.89	0.33	1.00	0.78	0.93	0.71
Dichondra species A		1	.	.	.	0.11	.	.	.	.	0.05
Polymeria longifolia	H	2	.	.	.	0.22	.	.	.	.	0.10
CRASSULACEAE											
Crassula sieberiana		10	.	0.67	0.06	0.44	.	.	.	0.14	0.38
CUCURBITACEAE											
Zehneria cunninghamii		1	.	0.17	.	.	.	.	.	.	0.05
DILLENIACEAE											
Hibbertia acicularis	M	+									
Hibbertia obtusifolia		29	.	0.33	0.71	0.56	.	0.67	0.78	0.64	0.43
Hibbertia obtusifolia-linearis		5	.	.	0.16	.	.	0.17	0.11	0.21	.
EPACRIDACEAE											
Acrotriche serrulata	H	7	.	.	0.16	0.22	.	.	.	0.21	0.19
Leucopogon hookeri		5	.	0.17	0.13	.	.	.	0.11	0.14	0.10
Leucopogon lanceolatus		7	.	0.17	0.19	.	.	0.17	0.11	0.29	0.05

			Floristic Group					Logging Category			
		Tot. freq.	**MF (1)**	**RpF (6)**	**PGF (31)**	**DW (9)**	**Sw (3)**	**L1 (6)**	**L2 (9)**	**UL1 (14)**	**UL2 (21)**
Melichrus urceolatus		6	.	.	0.10	0.33	.	.	0.11	0.07	0.19
EUPHORBIACEAE											
Bertya sp.	H	+	.	.	.	.	+	.	.	.	+
Beyeria viscosa	H	+	.	.	.	.	+	.	.	.	+
Omalanthus populifolius		+	+	.	.	.	.	.	.	+	.
Phyllanthus virgatus	H	1	.	.	.	0.11	.	.	.	.	0.05
Poranthera microphylla		14	.	.	0.35	0.33	.	0.33	0.44	0.29	0.19
FABACEAE–CAESALPINOIDEAE											
Senna aciphylla	H	+	.	.	.	+	.	.	.	.	+
FABACEAE–FABOIDEAE											
Daviesia genistifolia	H	3	.	0.17	0.03	0.11	.	.	.	.	0.14
Daviesia mimosoides	H	+	.	+	.	.	.	.	.	+	.
Daviesia ulicifolia		3	.	.	0.10	.	.	.	0.11	0.14	.
Desmodium brachypodum		3	.	.	.	0.33	.	.	.	.	0.14
Desmodium varians		38	.	1.00	0.74	1.00	.	0.67	1.00	0.57	0.81
Glycine clandestina	H	38	.	0.83	0.81	0.89	.	0.67	0.89	0.86	0.67
Hardenbergia violacea		11	.	0.17	0.23	0.33	.	0.33	0.11	0.29	0.19
Hovea lanceolata	H	1	.	0.17	.	.	.	.	.	.	0.05
Indigofera adesmiifolia	H	+	.	.	.	.	+	.	.	.	+
Indigofera australis		1	.	.	0.03	.	.	0.17	.	.	.
Lespedeza juncea subsp. *sericea*		1	.	0.17	.	.	.	.	.	.	0.05
**Lotus corniculatus*	H	1	.	0.17	.	.	.	.	.	.	0.05
Pultenaea polifolia	H	1	.	.	.	.	0.33	.	.	.	0.05
Pultenaea retusa	H	1	.	.	.	0.11	.	.	.	.	0.05
Pultenaea species G	H	1	.	.	0.03	.	.	.	.	0.07	.
Pultenaea species I	H	2	.	0.17	.	0.11	.	.	.	.	0.10
Swainsona galegifolia	H	24	.	1.00	0.39	0.67	.	0.50	0.44	0.36	0.57
**Trifolium arvense*		4	.	0.17	.	0.33	.	.	.	.	0.19
**Trifolium campestre*		2	.	.	.	0.22	.	.	.	.	0.10
**Trifolium glomeratum*		2	.	.	.	0.22	.	.	.	.	0.10
**Trifolium repens*		13	.	0.67	0.06	0.44	1.00	.	.	0.07	0.57
FABACEAE–MIMOSOIDEAE											
Acacia dealbata	H	19	.	.	0.58	.	0.33	0.83	0.56	0.57	0.05
Acacia implexa		1	.	.	.	0.11	.	.	.	.	0.05
Acacia melanoxylon		14	1.00	0.83	0.23	0.11	.	.	0.22	0.29	0.38
Acacia neriifolia		1	.	.	.	0.11	.	.	.	.	0.05

			Floristic Group					Logging Category			
		Tot. freq.	MF (1)	RpF (6)	PGF (31)	DW (9)	Sw (3)	L1 (6)	L2 (9)	UL1 (14)	UL2 (21)
Acacia paradoxa	H	1	.	.	.	0.11	.	.	.	.	0.05
GENTIANACEAE											
**Centaurium erythraea*	H	6	.	0.50	.	0.33	.	.	.	.	0.29
GERANIACEAE											
**Erodium cicutarium*	M	+									
Geranium homeanum	H	6	.	0.17	0.06	0.33	.	0.17	0.11	.	0.19
Geranium potentilloides	H	13	.	0.50	0.26	0.22	.	0.17	0.11	0.36	0.29
Geranium retrorsum	H	4	.	0.33	0.03	0.11	.	.	0.11	.	0.14
Geranium solanderi var. *grande*	H	1	.	.	0.03	.	.	.	.	.	0.05
Geranium solanderi var. *solanderi*	H	10	.	0.33	0.23	0.11	.	0.33	0.11	0.21	0.19
GOODENIACEAE											
Goodenia gracilis	H	+	.	+	.	.	.	.	.	+	.
HALORAGACEAE											
Gonocarpus humilis	H	15	.	0.33	0.39	0.11	.	0.33	0.11	0.50	0.24
Gonocarpus micranthus subsp. *micranthus*		1	.	.	.	.	0.33	.	.	.	0.05
Haloragis heterophylla		7	.	0.33	0.03	0.11	1.00	.	.	0.07	0.29
Myriophyllum pedunculatum	H	3	.	0.17	.	.	0.67	.	.	.	0.14
Myriophyllum variifolium	H	1	.	0.17	.	.	.	.	.	.	0.05
Myriophyllum verrucosum	H	1	.	0.17	.	.	.	.	.	.	0.05
LAMIACEAE											
Ajuga australis		30	.	0.17	0.74	0.67	.	0.33	0.89	0.79	0.43
**Lamium amplexicaule*	M										
**Marrubium vulgare*	M										
Mentha diemenica	H	8	.	0.33	0.10	0.33	.	.	.	0.07	0.33
Plectranthus parviflorus		4	.	0.33	.	0.22	.	.	.	.	0.19
Prostanthera ?caerulea	H	+	.	.	.	.	+	.	.	.	+
Prostanthera lasianthos		1	.	0.17	.	.	.	.	.	.	0.05
Prunella vulgaris		2	.	0.33	.	.	.	.	.	.	0.10
Scutellaria humilis		2	.	.	0.03	0.11	.	0.17	.	.	0.05
Scutellaria mollis	H	2	.	0.17	0.03	.	.	0.17	.	.	0.05
Teucrium species D	H	+	.	.	.	.	+	.	.	.	+
LOBELIACEAE											
Isotoma fluviatilis subsp. *borealis*	H	4	.	0.17	.	.	1.00	.	.	.	0.19

			Floristic Group						Logging Category			
		Tot. freq.	**MF (1)**	**RpF (6)**	**PGF (31)**	**DW (9)**	**Sw (3)**	**L1 (6)**	**L2 (9)**	**UL1 (14)**	**UL2 (21)**
Lobelia gibbosa		+	.	+	.	.	.	.	+	.	.
LORANTHACEAE											
Amyema congener	H	1	.	.	.	0.11	.	.	.	.	0.05
Amyema miquelii	H	1	.	.	.	0.11	.	.	.	.	0.05
Amyema pendulum subsp. *pendulum*		4	.	.	0.13	.	.	.	.		0.29
MYRSINACEAE											
Rapanea howittiana		1	.	0.17	.	.	.	.	.	.	0.05
MYRTACEAE											
Angophora floribunda		8	.	0.50	.	0.56	.	.	.	.	0.38
Callistemon pallidus	H	3	.	0.50	.	.	.	.	.	.	0.14
Callistemon sieberi	H	1	.	0.17	.	.	.	.	.	.	0.05
Eucalyptus bridgesiana	H	6	.	0.17	0.06	0.33	.	.	.	0.07	0.24
Eucalyptus dalrympleana subsp. *heptantha*	H	10	.	0.17	0.23	.	0.67	0.17	0.22	0.21	0.19
Eucalyptus goniocalyx	M	+									
Eucalyptus laevopinea	H	35	.	0.83	0.71	0.89	.	1.00	1.00	0.43	0.67
Eucalyptus melliodora		8	.	.	0.03	0.78	.	.	.	.	0.38
Eucalyptus moluccana	M	+									
Eucalyptus nobilis	H	20	1.00	0.67	0.48	.	.	0.50	0.44	0.57	0.24
Eucalyptus nortonii	H	3	.	.	.	0.33	.	.	.	.	0.14
Eucalyptus pauciflora		10	.	0.17	0.29	.	.	0.17	0.11	0.50	0.05
Eucalyptus praecox	H	3	.	.	0.10	.	.	.	0.11	0.07	0.05
Eucalyptus stellulata		11	.	0.33	0.26	.	0.33	0.33	0.11	0.29	0.19
Leptospermum gregarium	H	5	.	0.33	.	.	1.00	.	.	.	0.24
Leptospermum polygalifolium subsp. *montanum*	H	1	.	.	.	.	0.33	.	.	.	0.05
OLEACEAE											
Notelaea microcarpa var. *microcarpa*		2	.	0.17	0.03	.	.	0.17	.	.	0.05
ONAGRACEAE											
Epilobium billardieranum subsp. *hydrophilum*	H	5	.	0.67	.	.	0.33	.	.	.	0.24
Epilobium billardierianum subsp. *cinereum*	H	24	.	0.83	0.48	0.33	0.33	0.50	0.44	0.43	0.52
Epilobium hirtigerum	H	2	.	.	.	.	0.67	.	.	.	0.10
OXALIDACEAE											
Oxalis chnoodes		6	.	.	0.16	0.11	.	.	0.22	0.14	0.10

		Floristic Group						Logging Category			
		Tot. freq.	MF (1)	RpF (6)	PGF (31)	DW (9)	Sw (3)	L1 (6)	L2 (9)	UL1 (14)	UL2 (21)
PHYTOLACCACEAE											
**Phytolacca octandra*		1	.	.	0.03	.	.	.	0.11	.	.
PITTOSPORACEAE											
Billardiera scandens		2	.	.	0.06	.	.	0.17	0.11	.	.
Bursaria spinosa		11	.	.	0.16	0.67	.	.	0.22	0.14	0.33
Pittosporum undulatum		5	.	0.17	.	0.44	.	.	.	.	0.24
PLANTAGINACEAE											
Plantago debilis	H	14	1.00	0.50	0.06	0.89	.	.	.	0.14	0.57
Plantago varia	H	2	.	.	0.03	0.11	.	.	.	0.07	0.05
POLYGALACEAE											
Polygala japonica		7	.	.	0.10	0.44	.	0.17	.	0.14	0.19
POLYGONACEAE											
Persicaria decipiens	H	2	.	0.33	.	.	.	.	.	.	0.10
**Polygonum aviculare*	H	+	.	+	.	.	.	+	.	.	.
Rumex brownii		15	.	0.83	0.13	0.44	0.67	0.17	.	0.14	0.57
PROTEACEAE											
Hakea microcarpa		2	.	.	.	.	0.67	.	.	.	0.10
Lomatia arborescens		7	1.00	0.50	0.10	.	.	0.17	.	0.14	0.19
RANUNCULACEAE											
Clematis aristata		12	1.00	0.33	0.19	0.33	.	0.17	0.33	0.14	0.29
Clematis glycinoides		7	.	0.33	.	0.56	.	.	.	.	0.33
Clematis microphylla var. *microphylla*		1	.	.	0.03	.	.	.	0.11	.	.
Ranunculus amphitrichus	H	1	.	0.17	.	.	.	.	.	.	0.05
Ranunculus inundatus	H	1	.	0.17	.	.	.	.	.	.	0.05
Ranunculus lappaceus		34	.	0.50	0.84	0.56	.	0.83	0.89	0.79	0.48
RHAMNACEAE											
Cryptandra amara var. *amara*	H	1	.	.	.	0.11	.	.	.	.	0.05
Discaria pubescens	H	1	.	.	0.03	.	.	.	.	0.07	.
ROSACEAE											
Acaena echinata	H	5	.	.	0.03	0.44	.	.	.	0.07	0.19
Acaena novae-zelandiae		39	.	1.00	0.74	0.89	0.67	1.00	0.44	0.79	0.86
Geum urbanum	H	2	.	0.33	.	.	.	.	.	.	0.10
**Rosa rubiginosa*	H	2	.	0.17	0.03	.	.	.	.	0.07	0.05
**Rubus discolor-ulmifolius*		2	.	0.34	.	.	.	.	.	.	0.10
Rubus parvifolius		13	.	1.00	0.16	0.22	.	.	0.11	0.21	0.43

		Floristic Group						Logging Category			
		Tot. freq.	MF (1)	RpF (6)	PGF (31)	DW (9)	Sw (3)	L1 (6)	L2 (9)	UL1 (14)	UL2 (21)
RUBIACEAE											
Asperula conferta	H	33	.	0.50	0.81	0.56	.	0.83	0.67	0.86	0.48
Coprosma hirtella	M	+									
Coprosma quadrifida		3	.	0.33	0.03	.	.	.	0.11	.	0.10
Galium binifolium		1	.	.	.	0.11	.	.	.	.	0.05
Galium ciliare	H	4	.	.	0.10	0.11	.	.	0.11	0.14	0.05
Galium gaudichaudii	H	4	.	.	0.03	0.33	.	.	.	0.07	0.14
Galium migrans	H	20	1.00	0.83	0.35	0.33	.	0.33	0.44	0.36	0.43
RUTACEAE											
Correa reflexa var. *reflexa*		2	.	0.17	.	0.11	.	.	.	.	0.10
SANTALACEAE											
Exocarpos cupressiformis		2	.	.	0.06	.	.	.	.	0.14	.
SAPINDACEAE											
Dodonaea viscosa subsp. *angustissima*	H	1	.	0.17	.	.	.	.	.	.	0.05
SCROPHULARIACEAE											
Derwentia derwentiana	H	1	.	0.17	.	.	.	.	.	.	0.05
Euphrasia collina											
subsp. *paludosa*	H	+	.	.	+	+	.	.	.	.	+
Glossostigma diandrum	H	1	.	0.17	.	.	.	.	.	.	0.05
Gratiola peruviana	H	4	.	0.67	.	.	.	.	.	.	0.19
**Verbascum virgatum*		1	.	.	0.03	.	.	.	.	0.07	.
Veronica calycina	H	36	.	0.33	0.84	0.89	.	0.83	1.00	0.71	0.57
SOLANACEAE											
Solanum opacum		7	1.00	.	0.19	.	.	.	0.33	0.21	0.05
Solanum prinophyllum		1	.	.	.	0.11	.	.	.	.	0.05
Solanum pungetium		3	.	.	0.10	.	.	0.17	0.11	0.07	.
STERCULIACEAE											
Brachychiton populneus		1	.	.	.	0.11	.	.	.	.	0.05
STYLIDIACEAE											
Stylidium graminifolium		2	.	.	0.06	.	.	.	.	0.14	.
THYMELAEACEAE											
Pimelea curviflora subsp. *curviflora*	H	3	.	0.17	0.03	0.11	.	.	0.11	.	0.10
Pimelea ligustrina subsp. *ligustrina*	H	4	.	0.67	.	.	.	.	.	.	0.19
Pimelea linifolia	M	+									

		Floristic Group						Logging Category			
		Tot. freq.	MF (1)	RpF (6)	PGF (31)	DW (9)	Sw (3)	L1 (6)	L2 (9)	UL1 (14)	UL2 (21)
Pimelea microcephala	H	2	.	.	0.03	0.11	.	0.17	.	.	0.05
Pimelea strigosa	H	3	.	.	.	0.33	.	.	.	.	0.14
URTICACEAE											
Australina pusilla	H	5	1.00	0.67	.	.	.	.	.	.	0.24
Urtica incisa		15	1.00	0.83	0.23	0.22	.	0.33	0.22	0.21	0.38
VERBENACEAE											
**Verbena bonariensis*	H	5	.	0.33	.	0.33	.	.	.	.	0.24
**Verbena officionalis*		+	.	.	.	+	.	.	.	.	+
**Verbena rigida*		1	.	.	.	0.11	.	.	.	.	0.05
VIOLACEAE											
Hymenanthera dentata		7	1.00	0.67	.	0.22	.	.	.	.	0.33
Viola betonicifolia		35	.	0.50	0.84	0.67	.	0.83	0.89	0.79	0.52
Viola hederacea		6	.	0.33	0.13	.	.	0.17	0.22	0.07	0.10
Class MAGNOLIOPSIDA–LILIIDAE											
ANTHERICACEAE											
Arthropodium milleflorum		35	.	1.00	0.65	0.89	0.33	0.83	0.67	0.64	0.71
Arthropodium species B	H	2	.	.	.	0.11	0.33	.	.	.	0.10
Caesia calliantha	H	2	.	.	0.06	.	.	.	.	0.14	.
ARACEAE											
Gymnostachys anceps		1	.	.	0.03	.	.	0.17	.	.	.
ASPHODELACEAE											
Bulbine bulbosa		3	.	0.17	0.06	.	.	.	.	0.14	0.05
COLCHICACEAE											
Wurmbea dioica	M	+									
CYPERACEAE											
Bulbostylis densa		1	.	.	.	.	0.33	.	.	.	0.05
Carex appressa		1	.	0.17	.	.	.	.	.	.	0.05
Carex breviculmis		37	.	0.83	0.81	0.67	0.33	1.00	0.67	0.86	0.62
Carex chlorantha	H	1	.	0.17	.	.	.	.	.	.	0.05
Carex declinata		1	.	0.17	.	.	.	.	.	.	0.05
Carex fascicularis		1	.	0.17	.	.	.	.	.	.	0.05
Carex incomitata	H	9	.	0.33	0.16	0.22	.	0.17	0.22	0.14	0.19
Cyperus lucidus		1	.	0.17	.	.	.	.	.	.	0.05
Cyperus sanguinolentus	H	4	.	0.17	.	.	1.00	.	.	.	0.19
Cyperus sphaeroideus		4	.	0.17	.	.	1.00	.	.	.	0.19

			Floristic Group					Logging Category			
		Tot. freq.	MF (1)	RpF (6)	PGF (31)	DW (9)	Sw (3)	L1 (6)	L2 (9)	UL1 (14)	UL2 (21)
Eleocharis dietrichiana	H	3	.	0.17	.	.	0.67	.	.	.	0.14
Fimbristylis dichotoma	H	1	.	.	.	0.11	.	.	.	.	0.05
Isolepis australiensis	H	1	.	.	.	.	0.33	.	.	.	0.05
Isolepis cernua	H	1	.	0.17	.	.	.	.	.	.	0.05
Isolepis hookeriana	H	1	.	.	.	.	0.33	.	.	.	0.05
Isolepis inundatus	H	1	.	.	.	.	0.33	.	.	.	0.05
Isolepis sp.	H	2	.	0.33	.	.	.	.	.	.	0.10
Lepidosperma laterale		7	.	.	0.06	0.56	.	0.17	.	0.07	0.24
Schoenus apogon		11	.	0.50	0.06	0.33	1.00	.	.	0.14	0.43
HYPOXIDACEAE											
Hypoxis hygrometrica		2	.	.	.	.	0.67	.	.	.	0.10
IRIDACEAE											
Libertia paniculata		3	.	0.50	.	.	.	.	.	.	0.14
JUNCACEAE											
Juncus alexandri subsp. *melanobasis*	H	2	.	0.33	.	.	.	.	.	.	0.10
**Juncus bufonius*	H	1	.	.	.	.	0.33	.	.	.	0.05
Juncus filicaulis	M	+									
Juncus fockei	H	4	.	0.17	.	.	1.00	.	.	.	0.19
Juncus pauciflorus	M	+									
Juncus polyanthemus	M	+									
Juncus sandwithii	H	2	.	0.33	.	.	.	.	.	.	0.10
Juncus vaginatus		1	.	0.17	.	.	.	.	.	.	0.05
Luzula flaccida	H	35	.	0.33	0.80	0.67	0.67	1.00	0.67	0.78	0.57
Juncus spp.		2	.	0.17	.	.	0.33	.	.	.	0.10
LEMNACEAE											
Lemna trisulca	H	1	.	0.17	.	.	.	.	.	.	0.05
LOMANDRACEAE											
Lomandra confertifolia subsp. *pallida*		2	.	.	.	0.22	.	.	.	.	0.10
Lomandra filiformis		12	.	.	0.35	0.11	.	0.50	0.33	0.21	0.14
Lomandra longifolia		32	.	1.00	0.71	0.44	.	0.67	0.56	0.86	0.52
Lomandra longifolia –*confertifolia* intergrade	H	2	.	.	.	0.22	.	.	.	.	0.10
Lomandra multiflora	H	6	.	.	0.10	0.33	.	0.17	0.11	0.07	0.14
LUZURIAGACEAE											
Eustrephus latifolius		34	1.00	0.83	0.71	0.67	.	0.50	1.00	0.64	0.62

		Tot. freq.	MF (1)	RpF (6)	PGF (31)	DW (9)	Sw (3)	L1 (6)	L2 (9)	UL1 (14)	UL2 (21)
			Floristic Group					Logging Category			
ORCHIDACEAE											
Acianthus fornicatus		2	.	.	0.03	0.11	.	.	.	.	0.10
Acianthus spp.		2	.	.	0.03	0.11	.	.	.	0.07	0.05
Chiloglottis trilabra	H	8	.	.	0.26	.	.	0.33	0.33	0.21	.
Corybas fimbriatus		2	.	.	0.06	.	.	0.33	.	.	.
Cyrtostylis reniformis	M	+									
Dendrobium cucumerinum		+	+	.	.	.	.	.	.	+	.
Dipodium roseum	H	3	.	.	0.10	.	.	.	0.11	0.14	.
Diuris sulphurea		1	.	.	0.03	.	.	0.17	.	.	.
Eriochilus cucullatus	M	+									
Genoplesium sp.		1	.	.	0.03	.	.	.	.	0.07	.
Pterostylis coccina		12	.	0.33	0.32	.	.	.	0.22	0.50	0.14
Pterostylis decurva		1	.	.	0.03	.	.	.	.	0.07	.
Pterostylis laxa		2	.	.	.	0.22	.	.	.	.	0.10
Pterostylis nutans	M	+									
Pterostylis obtusa		1	.	0.17	.	.	.	.	.	.	0.05
Pterostylis species B		7	.	.	0.13	0.33	.	.	0.22	0.14	0.14
Spiranthes sinensis		5	.	0.33	.	.	1.00	.	.	.	0.24
PHORMIACEAE											
Dianella caerulea		3	.	.	0.10	.	.	.	0.11	0.14	.
Dianella longifolia		7	.	.	0.23	.	.	0.17	0.22	0.21	0.05
Dianella revoluta		1	.	.	.	0.11	.	.	.	.	0.05
POACEAE											
Agrostis avenacea	H	4	.	0.17	0.03	.	0.67	.	.	0.07	0.14
Agrostis venusta	H	3	.	0.33	0.03	.	.	.	.	.	0.14
**Anthoxanthum odoratum*		1	.	.	.	0.11	.	.	.	.	0.05
Aristida ramosa var. *speciosa*	H	1	.	.	.	0.11	.	.	.	.	0.05
Bothriochloa macra	H	4	.	0.17	.	0.33	.	.	.	.	0.19
Cymbopogon refractus		1	.	.	.	0.11	.	.	.	.	0.05
Danthonia eriantha	H	1	.	.	.	0.11	.	.	.	.	0.05
Danthonia laevis	H	17	.	0.17	0.45	0.22	.	.	0.44	0.57	0.24
Danthonia pilosa var. *pilosa*	H	10	.	0.17	0.26	0.11	.	.	0.33	0.36	0.10
Danthonia racemosa	H	25	.	0.33	0.52	0.67	0.33	0.33	0.44	0.57	0.52
Dichanthium sericeum	H	1	.	.	.	0.11	.	.	.	.	0.05
Dichelachne crinita	H	3	.	.	0.10	.	.	0.33	.	0.07	.
Dichelachne micrantha		24	.	0.17	0.52	0.67	0.33	.	0.44	0.71	0.48

			Floristic Group					Logging Category			
		Tot. freq.	MF (1)	RpF (6)	PGF (31)	DW (9)	Sw (3)	L1 (6)	L2 (9)	UL1 (14)	UL2 (21)
Dichelachne rara	H	6	.	0.17	0.10	.	0.67	0.17	.	0.07	0.19
Echinopogon caespitosus		4	.	0.33	0.03	0.11	.	0.17	.	.	0.14
Echinopogon cheelii	H										
Echinopogon ovatus	H	41	1.00	1.00	0.84	0.89	.	1.00	0.89	0.71	0.81
Elymus scaber var. *scaber*		27	.	1.00	0.45	0.78	.	0.33	0.44	0.50	0.67
Eragrostis benthamii	H	1	.	.	.	.	0.33	.	.	.	0.05
Festuca asperula	H	1	.	.	0.03	.	.	.	.	0.07	.
Glyceria latispicea	H	3	.	.	0.10	.	.	.	0.11	0.14	.
Microlaena stipoides		43	1.00	1.00	0.87	0.89	0.33	0.83	0.89	0.86	0.86
Oplismenus imbecillus		3	.	0.17	.	0.22	.	.	.	.	0.14
Panicum effusum		1	.	.	0.03	.	.	0.17	.	.	.
Paspalidium gracile	H	1	.	.	.	0.11	.	.	.	.	0.05
**Poa annua*	M	+									
Poa labillardieri		30	.	0.83	0.68	0.44	.	0.67	0.67	0.71	0.48
Poa sieberiana var. *sieberiana*		21	.	0.33	0.45	0.44	0.33	0.33	0.44	0.50	0.38
Sorghum leiocladum		1	.	.	0.03	.	.	.	.	0.07	.
Stipa rudis subsp. *nervosa*	H	18	.	0.33	0.42	0.33	.	0.67	0.44	0.29	0.29
POTAMOGETONACEAE											
Potamogeton tricarinatus	H	1	.	0.17	.	.	.	.	.	.	0.05
SMILACACEAE											
Smilax australis		14	1.00	0.50	0.32	.	.	0.33	0.44	0.29	0.19
XANTHORRHOEACEAE											
Xanthorrhoea glauca subsp. *glauca*		+	+	+	.	.	.	.	+	+	+

Note: The following additional species or names are recorded in the Management Plan (Forestry Commission of NSW 1982) but are excluded from the above list for various reasons as stated.

Asperula scoparia	Possibly confused with the related *A. conferta*.
Callistemon citrinus	Probable misidentification, from confusion with *C. pallidus* which is common in the area.
Callistemon shiressii	Misidentification (confused with *C. sieberi*).
Cerastium glomeratum	Possibly confused with *C. fontanum* subsp. *vulgare*.
Dianella laevis	Synonymous with *D. longifolia*.
Erodium malacoides	This naturalised species is otherwise recorded only from the South Western Plains subdivision in NSW, and the record from Coolah Tops requires confirmation.
Eucalyptus mannifera subsp. *maculosa*	Populations in the area are currently referred to *E. praecox*.
E. viminalis	Probably *E. nobilis*, a recently described species common in the area.
Leptospermum myrtifolium	Coolah Tops populations now referred to *L. gregarium*.
Leucopogon suaveolens	Synonymous with *L. hookeri*.
Haloragis tetragyna	This species (syn. *Gonocarpus tetragynus*) and *G. humilis* were not clearly distinguishable during survey.
Hypolepis punctata	Synonymous with *H. glandulifera*.
Sium latifolium	Synonymous with *Berula erecta*.
Teucrium corymbosum	Possibly confused with the recently recognized T. species D. Occurrence at Coolah Tops requires confirmation.
Veronica arvensis	This naturalised species may have been confused with the native *V. calycina* and its occurrence in the area requires confirmation.
Xanthorrhoea australis	Probable misidentification of *X. glauca*. *X. australis* is not otherwise recorded north of Nowra.

Appendix 2. Location and survey date for flora survey plots

Plot	Date	Zone	Map	AMG E	AMG N	Altitude (m)
BUN001	19930222	56	8934	219100	6488330	1070
BUN002	19930224	56	8934	219280	6489400	1060
BUN003	19930224	56	8934	218900	6489400	1050
BUN004	19930226	55	8834	784150	6486550	1000
BUN005	19930228	56	8934	216950	6488230	1040
BUN006	19930925	56	8934	221580	6485750	1150
BUN007	19930925	56	8934	216430	6485950	1080
BUN008	19930925	56	8934	215250	6484980	1050
OL1-3	19930227	55	8834	782750	6484000	1050
OL2-3	19930228	56	8934	217100	6484780	1110
OL3-3	19930227	56	8934	223680	6483550	1140
OL4-3	19930301	56	8934	233530	6476230	1140
RL1-3	19930228	56	8934	216380	6484180	1070
RL2-3	19930224	56	8934	216400	6485350	1050
RL3-3	19930227	56	8934	225830	6480950	1160
RL4-3	19930226	56	8934	224450	6481250	1160
UL1-3	19930228	56	8934	216200	6483630	1070
UL2-3	19930227	56	8934	226480	6482500	1180
UL3-3	19930226	56	8934	229980	6481680	1190
UL4-2	19930301	56	8934	234550	6475630	1120
WAR001	19930223	56	8934	235150	6474480	880
WAR002	19930223	56	8934	235000	6475200	1050
WAR003	19930223	56	8934	233550	6475350	830
WAR004	19930223	56	8934	233130	6477130	1120
WAR005	19930225	56	8934	219100	6481130	1070
WAR006	19930225	56	8934	220430	6482930	1090
WAR007	19930225	56	8934	219380	6482450	1080
WAR008	19930225	56	8934	218250	6483930	1070
WAR009	19930225	56	8934	218830	6484950	1100
WAR010	19930225	56	8934	220080	6485550	1120
WAR011	19930228	56	8934	217280	6482530	1040
WAR012	19930226	56	8934	232350	6478350	1080
WAR013	19930226	56	8934	230600	6479750	1120
WAR014	19930226	56	8934	227950	6481580	1200
WAR015	19930227	55	8834	782730	6482680	950
WAR016	19930227	55	8834	785780	6482950	940
WAR017	19930227	56	8934	224100	6482830	980
WAR018	19930228	56	8934	218550	6484850	1090
WAR019	19930301	56	8934	230580	6475200	1120
WAR020	19930301	56	8934	238700	6475380	1100
WAR021	19930301	56	8934	237730	6475200	1140
WAR022	19930301	56	8934	231450	6476680	1240
WAR026	19940517	56	8934	238230	6471380	760
WAR027	19940517	56	8934	234800	6471550	660
WAR028	19940518	56	8934	229430	6748100	800
WAR029	19940518	56	8934	227930	6476380	770
WAR030	19940519	56	8934	223280	6482200	900
WAR031	19940519	56	8934	228880	6476730	1060
WAR032	19940519	56	8934	232880	6774900	740
WAR033	19940519	56	8934	233130	6473230	670