NATIVE VEGETATION

Classification

Eleven major groups of dominant species have been recognised in the catchment (Table 4). Although the various species of each group may differ in relative proportion from place to place, consistent ecological relationships are shown. Each, except the group of alpine communities, approximates to an alliance as defined by Beadle and Costin (1952).

Substantial areas of the first three groups, and a small section of the fourth, have been cleared or ringbarked for grazing or cultivation.

As the land systems have been identified primarily according to vegetation, a detailed description of each of the vegetative groups has been included with the description of the appropriate land system.
Eucalypt Species in the Catchment

Some closely related species of eucalypts are not readily distinguishable, and distinction has not been attempted where the resulting land use information did not appear to warrant doing so.

Thus, the name *Eucalyptus radiata* denotes narrow-leaved peppermint and includes trees that have been called *E. australiana, E. amygdalina* and *E. robertsoni*, and the snow gum is referred to as *E. pauciflora*, including *E. niphophila* and *E. corriacae.* Similarly, *E. dives* (broad-leaved peppermint), *E. camaldulensis* (red gum), and *E. microcarpa*b (grey box) include some trees to which other specific names have been given. The white gums include three well known species, *E. rubida*, *E. viminalis* and *E. dalrymplkeana* the areas of high rainfall. Where the distinction could not be made readily, they all have been termed *E. rubida*.

Except in the Straithbogie Ranges, the long-leaved box (*E. goniocalys*, formerly *E. elaeophora*) and mountain grey gum ((*E. cypellocarpa*, formerly *E. goniocalyx*) do not intermingle to any extent. The name *E. delegatensis* (formerly *E. gigantea)* has been used for wollybutt or alpine ash, and the blue gums have been identified with *E. st-johnii*. Swamp gums have all been called *E. ovata*, although some dark trees correspond to the description of *E. camphora*. No obvious difference in lacal habitat has been observed between these similar forms.

On this basis, twenty-one species of eucalypts comprise most of the dominant species in the catchment:

E. camaldulensis	Red gum
E. ovata	Swamp gum
E. rubida	Candlebark (white gum)
E. viminalis	Manna gum (white gum)
E. dalrympleana	Mountain gum (white gum)
E. pauciflora	Snow gum (white sally)
E. stellulata	Black sally
E. st-johnii	Blue gum
E. cypellocarpar	Mountain grey gum
E. goniocalyx	Long-leaved box
E. microcarpa	Grey box
E. melliodora	Yellow box
E. radiata	Narrow-leaved peppermint
E. polyanthemos	Red box
E. macrorhyncha	Red stringybark
E. dives	Broad-leaved peppermint
E. obliqua	Messmate
E. delegatenisis	Alpine ash (woollybutt)
E. regnans	Mountain ash
E. cephalocarpa	Mealy gum
E. kybeanensis	Tingi-ringi gum

Of these, four species (E. *cypellocarpa*, *E. stellulata*, *E. cephalocarpa* and *E. kybeanensis*) occur I much smaller proportion than the others; two, (*E. viminalis and E. st-johnii)*, and not numerically important. The other species are widespread, particularly *E. dives, E. rubida, E. radiata* and *E. delegatensis.*

Patterns of Vegetation and the Factors Involved

As with the soils, the broad scale pattern of vegetation in the catchment is related to the three associated sequences of altitude, large scale topography, including aspect, and the climate.

Plate 11 – Young red gums in the Mansfield land system

Plate 12 – Forests of stringybark, box, peppermint and gum occur in the Maintongoon and adjacent land systems

Table 4 – Classification of the Plant Communities

Vegetation Group	Structure		Florists		Comparable Units of Other Authors	Land system on which Unit Prominent
	Formation	Sub-formation	Alliance	Association		
1. Red gum-yellow box	Woodland	Savanah	E. camaldulensis	*E. camaldulensis-W. melliodora* *E. camaldulensis-E. rubida* *E. melliodora- E. microcarpa*	E.camaldulenis Savanah woodland, alliance of Rowe (1967)	Mansfield
2. Red box-long leaf box		tall	*E. polyanthemos*	*E. polyanthemos-E. goniocalyx* *E. goniocalys-E, microcarpa* E. polyanthemos-. Melliodora *E. polyanthemos-E. macrorhyncha-E. dives*	Part of *E. macrorhyncha* dry sclerophyll forest, alliance of Costin (1954), of Rowe (1967) and of Morland (1958)	Eildon
3. Red stringy bark	Sclerophyll Forest	dry	*E. macrorhyncha*	*E. macrorhyncha-E. dives* *E. dive -E. microcarpa* *E. dives – E. goiocalyx* *E.macrorhyncha- E. polyanthemos-E. dives*	Part of *E. macrorhyncha* dry sclerophyll forest alliance of Costin (1954)	
4. Dry peppermint-gum			*E. dives- E. rubida*	*E. dives- E.rubida* *E.dives- E.radiata- E. st-johnii* *E. ovata – E. st-johnii*	Part of *E. radiata – E. rubida-E. dives* wet aclerophyll forest alliance of Rowe (1967)	
5. Wet peppermint-gum		wet	*E. radiata – E.rubida*	*E. radiata-E.rubida* *E.radiata-E. dives – E. rubida –E. viminalis*	*E. fastigata- E. viminalia* wet sclerophyll forest alliance (in part) of Costin (1954) *E. radiata-* alliance (in part) of Morland (1958) *E. radiata-E. rubida –E. dives* alliance (part of Rowe (1967)	
6. Messmate-wet peppermint-gum			*E. obliqua- E. radiata*	*E. oliqua-E. radiata* *E. radiata- E. rubida* *E. radiata – e. goniocalyx*		
7. Alpine ash (woolly butt)			*E. delegatensis*	*E. delegatensis* *E. obliqua* also with we peppermint gum species: *E. radiata – E. rubida- E. viminalis – E. rubida- E. goniocalyx – E. viminalis*	*E. delegatensis – E. dalrympleanna* wet sclerophyll forest alliance of Costin (1954) *E. gigantea* wet sclerophyll forest alliance of Moreland (1958)	
8. Mountain ash			*E. regnans*	*E. regnans* *E. regnans-E. obliqua-E. radiata- E. rubida-E. goniocalyx- E. viminalis*		

Vegetation Group	Structure		Florists		Comparable Units of Other Authors	Land system on which Unit Prominent
	Formation	**Sub-formation**	**Alliance**	**Association**		
9. Beech	Rainforest	temperate	*Nothofagus cunninghamii*	*Nothofagus cunninghamii*		
10. Snow gum	Woodland	sub-alpine	*E. pauciflora*	*E. pauciflora (E. niphophila)* *E. pauciflora –E. rubida*	*E. niphophila* sub-alpine woodland alliance of Costin (1954)	
11. Alpine communities	Bog	alpine	*Spagnum cristatum*		*Epacris paludosa-spagnum cymbifolium (cristatum)* raised bog alliance of Costin (1954)	
	Grassland	sod-tussock	*Pao australia (poa caespitosa)*	*Poa australis*	*Poa caespitosa- Anthonia mudiflora* sod tussock grassland alliance of Costin (1954)	
	Scrub	alpine	*Hovea longifolia* *Oxylobium ellipticum*	*Hovea longifolia-Orites lancifolia* *Prostanthera cuneata* *Oxylobium ellipticum* and others	Probably mainly *Oxylobium ellipticum- Podocarpus lawrencei* heath alliance of Costin (1954)	
	Herbfield	alpine	*Celemisia asteliifolia*	Celmisia asterliifolia *Poa australis*	*Poa caespitosa – Celmisia asteliifolia* tall alpine herbfield alliance of Costin (1954); *Brachycome nivalis – Danthonia alpicola* alliance, probably also present.	
		short alpine			*Plantago mulleri- Montia austrasica* short alpine herbfield alliance of Costin (1954)	
	Fjeldmark				Fjeldmark of Costin (1954)	

Thus, the region with the lowest altitude (300 metres), a relief precipitation 650-750 millimetres, is occupied by a savannah woodland of red gum, fringed by yellow box and grey box. The adjacent slopes are dominated by a tall woodland of box species, mainly red box and long-leaved box. As altitude and rainfall increase to about 600 metres and 1000 millimetres respectively, that community gives way to a dry sclerophyll forest of corad-leaved peppermint and candlebark with an admixture of red stringybark. As rainfall increase to about 1200 millimetres at about 750 metres, the narrow-leaved peppermint replaces the broad-leaved and eventually, at about 900 metres, messmate becomes common and may dominate the wet sclerophyll forest.

Here, the sequence diverges. Where the rainfall increase without a corresponding increase in altitude, at elevation of 450-1050 metres, there is forest dominated by mountain ash (in the south-western part of the catchment) and ultimately, in gullies in areas with 1500-2000 millimeters, rainfall, a temperate rain forest dominated by beech. On the other hand, with increases in both rainfall and altitude, at elevations about 1050 metres where snow is a feature, the next stage in the sequence is a forest dominated entirely by alpine ash to an altitude of about 1350 metres. There it gives way abruptly, on peaks, to a narrow zone of mountain gum and snow gum and then to a sub-alpine woodland of snow gum. Finally this in turn may give way at about 1750 metres to alpine grassland and herbfield, with specialised communities in particular places.

Plates 13 and 14 – Peppermint gum forests characterise the extensive Howqua and Jamieson land systems

This latitude-climatic sequence is typical of the montane regions generally of south-eastern Australia.

At any part of this altitude sequence, where there is a range of topographic sites, such as on undulating plateaux, the vegetation will be further differentiated or even modified, according to the local topography. The local topographic sequences thus formed are the basis of variation within land systems, and result from differences in the drainage status of the site and also, at high altitudes, from cold air drainage which causes a local inversion of the broad scale temperature changes.

Thus, at about 300 metres elevation with 700 millimetres rainfall, the topographic sequence from knoll through gentle slopes to flats carries a woodland of long-leaved box, red box, yellow box and red gum, in that order. This vegetation sequence is characteristic of the Mansfield and Eildon land systems, with their solodic soils and pallid leptopodsols.

Plate 15 – Sub-alpine herbfields and grasslands are found in the cold air drainage basins of the Bindaree, Taponga and Buller land systems

At about 500 metres elevation with 900 millimetres rainfall, the comparable topographic sequence carries a dry sclerophyll forest of red stringybark, long-leaved box, broad-leaved peppermint, narrow-leaved peppermint and swamp gum. This applies to many section within an elevation range of about 300-600 metres and 750-1000 millimetres rainfall. This vegetation sequence is characteristic of the Maintongoon land system, with its red leptopodsols.

Around 700 metres elevation and 1150 millimetres rainfall (range 600 to 750 metres and 1000-1200 millimetres) the sequence carries red stringybark, merely persisting on the ridges, and a dry to wet sclerophyll forest consisting mainly of broad-leaved peppermint and candlebark, and some swamp gum. This vegetation sequence is characteristic of the Jamieson land system, with its red amphipodsols and red leptopodsols.

At 850 metres elevation and around 1275 millimetres rainfall (range 750-900 metres and 1200-1350 millimetres) the sequence carries a wet sclerophyll forest mainly consisting of narrow-leaved peppermint, black sally and some swamp gum, with broad-leaved peppermint just persisting and some candlebark. This vegetation sequence is characteristic of the Howqua land system, with its cryptopodsols and some acid brown earths and red amphipodzols.

Around 1000 meters elevation and 1400 millimetres precipitation (range 900 and 1100 metres and 1350-1450 millimetres), the sequence carries a wet sclerophyll forest of messmate, candlebark, mainly narrow-leaved peppermint, and, in cold air drainage basins, possibly a woodland of clack sally and snow gum. This vegetation sequence is characteristic of the Taponga land system, with its acid brown earths. If however, at the same elevation in southern parts of the catchment, the precipitation should be higher than 1400 millimetres, mountain ash may also be found.

From about 1050 metres to 1350 metres elevation, the precipitation, including light winter snow, caries from roughly 1400 millimetres to 1500 millimetres. These condition permit growth to alpine ash, mountain gum and snow gum.

Thus, the topographic sequence at 1200 metres elevation and 1450 millimetres precipitation is a wet sclerophyll forest of alpine ash, mountain gum, a sub-alpine woodland of snow gum, open sub-alpine grassland and valley bog in descending order with the snow gum and grassland resulting from the cold air drainage. So a wide range of vegetation structure is embraced on plateaux at this elevation.

Plate 16 – Coppice woodlands of snow gum are a feature of the Bindaree and Buller land systems

There are transitions from this alpine ash zone to adjacent sequences. Thus on the lower fringe at about 110 metres and 1400 millimetres precipitation, messmate and narrow-leaved peppermint may be present in the sequence, whilst on the upper fringe at 1300 metres, alpine ash is just persisting, and the mountain gum (the mountain form of candlebark), snow gum and the grassland are more widespread. The whole of this alpine ash zone forms the Bindaree land system, with its transitional alpine humus soils predominating.

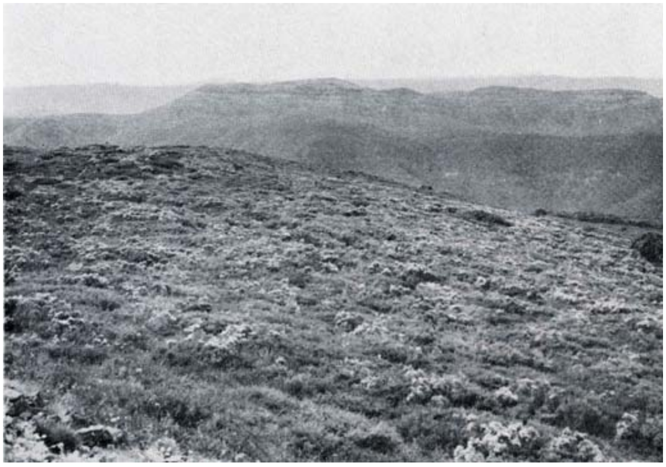

Plate 17 – Alpine herbfields and alpine heaths grow above the tree line in the Buller land system

Above about 1350 metres alpine ash is not found, and the vegetation of the sub-alpine zone, from 1350 metres to 1750 metres, takes over. The lower fringe is transitional, with a tall woodland of mountain gum and snow gum on well drained slopes and transitional alpine humus soils. The rest of the sub-alpine zone however, is exemplified by the sequence of plateaux at 1450 metres and with 1600 millimetres precipitation, most of its as persistent winter snow. This topographic sequence is from a mallee-heath woodland of snow gum on the ridges, through a sub-alpine woodland of snow gum, a fringe of sub-alpine heath, a broad stretch of herbfield and grassland, all on alpine humus soil, succeeded by a narrow belt heath on humified peat, to valley peat bogs and soaks in the lower places, the bogs being humified in places and active in others. This is the Buller land system. With increasing altitude within this sub-alpine zone, the herbfield, grassland and bogs extend in the topographic sequence, the snow gums assume a more stunted, mallee form and become more sparse until, at about 1750 metres, and according to shelter and aspect, the treeless alpine zone is reached.

In this zone, fjeldmark, which is a discontinuous stand of prostrate shrubs, appears in the most exposed places and, with further increase in altitude, both the fjeldmark and herbfield extend. Figures 14 and 15 illustrate these various trends.

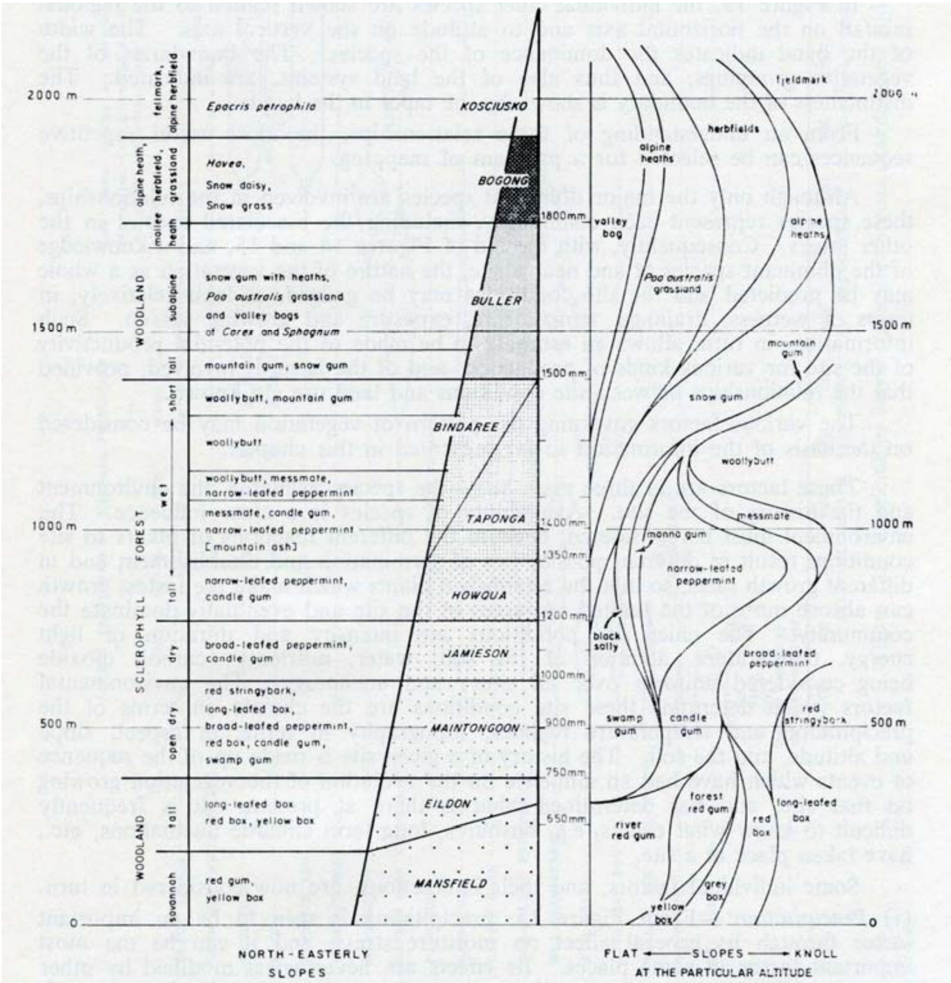

Figure 14 – Relationships of dominant Vegetation in North-Eastern Victoria

In Figure 14, the relationship of vegetation to altitude and to local topography are shown for both the montane slopes (left side of diagram) and the undulating plateaux (right side of diagram). The positions of the main zones, sequences or land systems are indicated. On the right side of Figure 14, referring to the undulating areas at various altitudes, a horizontal line at any altitudinal position will indicate the places occupied by the chief species and the structure of the formation at that altitude, in a sequence from knoll (on right) to swale (on left). There is a general tendency for the zones occupied by each species to form wedges from lower left to upper right, reflecting to upslope progression of sites having particular water status or ground temperature with increasing rainfall, lower evapotranspiration and lower temperature. This general tendency however, is obstructed by the presence of certain species and is reversed at the upper altitudes considered. The two chief obstructing species are narrow-leaved peppermint and alpine ash, which apparently require or thrive under particular altitudinal conditions and so displace other more pliable species. At high altitudes exposure, rather than cold air drainage, becomes the critical factor.

In Figure 15, the individual chief species are shown related tot he regional rainfall on the horizontal axis and to altitude on the vertical axis. The width of the band indicates the dominance of the species. The boundaries of the vegetative groupings, and thus also of the land systems, are indicated. The distinctness of the boundary is shown by the taper in the bands.

From an understanding of these relationships, the most useful repetitive sequences can be selected for a program of mapping.

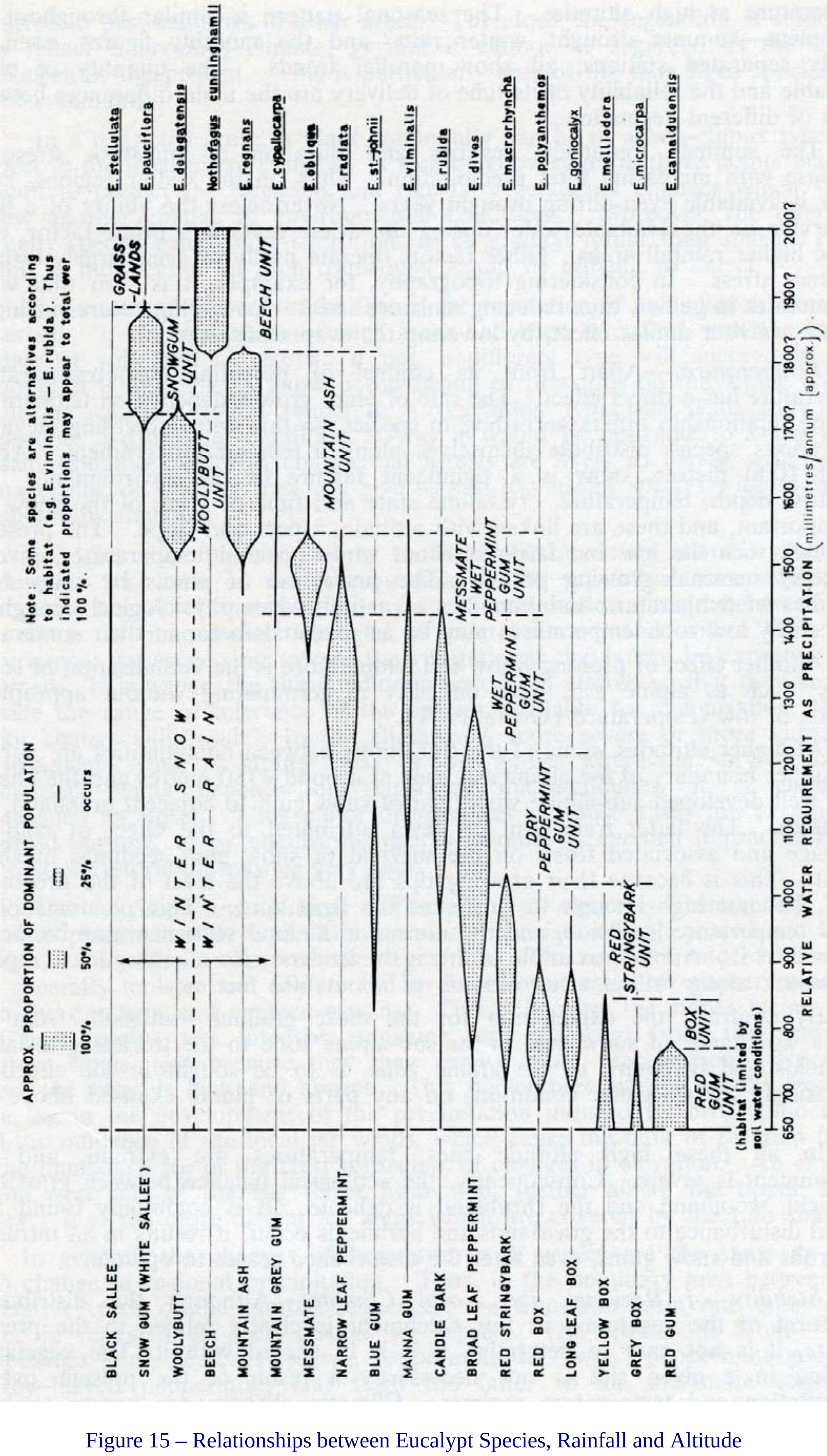

Figure 15 – Relationships between Eucalypt Species, Rainfall and Altitude

Although only the major dominant species are involved in the relationships, these species represent each community, including the associated species in the other layers. Consequently, with the aid of Figures 14 and 15, and a knowledge of the dominant species at and near site, the nature of the vegetation as a whole may be predicted and the site conditions may be gauged, at least relatively, in terms of wetness, drainage, temperature, exposure and growing season. Such information, in turn, allows an estimate to be made of the potential productivity of the site for various kinds of production, and of the hazards involved, provided that the relationships between site conditions and land use are known.

The various factors governing the pattern of vegetation may be considered on the basis of the information so far presented in this chapter.

These factors are in three main sets – the species available, the environment and the history of the site. Availability of species is a clear influence. The environment must be considered, because the different reactions of plants to site conditions result in different possibilities of germination and establishment and in different growth rates, so that the established plants which make the fastest growth can absorb more of the limited resources of the site and eventually dominate the community. The chief site conditions are intensity and duration of light energy, temperature, aeration of the soil, water, nutrients (carbon dioxide being considered uniform over all sites) and anchorage. The environmental factors which determine these site conditions are the climate in terms of precipitation and temperature regimes, topography in terms of aspect, slope and altitude, and the soil. The history of a given site is made up of these sequences of events which have had an influence on the evolution of the vegetation growing on that sire, and has determined what is there at present. It is frequently difficult to know what events, e.g., bushfires, long term climatic fluctuations, etc., have taken place at a site.

Some individual factors, and their interactions, are now considered in turn.

(i) ***Precipitation*** – From Figure 15, precipitation is seen to be an important factor through its general effect on moisture stress, and it can be the most important factor in some places. Its effects are nevertheless modified by other factors, and in particular situations these latter may be dominant, as is temperature at high altitudes. The seasonal pattern is similar throughout the catchment – summer drought, winter rain-and the monthly figures, even for widely separated stations, all show parallel trends. The quantity of water available and the reliability of its time of delivery are the main differences between areas of different vegetation.

The summer frequency, severity and duration of moisture stress all decrease with increasing total precipitation. Thus, in the wetter regions, some water is available even during drought years. Nevertheless the ability of a plant to survive on the available water during the driest years is a prime factor, even in the higher rainfall areas. Other factors operate partly or even largely through moisture stress. In considering topography, for example, it is seen that water accumulates in gullies, thus reducing moisture stress. Low temperatures at higher altitudes have a similar effect, by lowering the evapotranspiration.

(ii) ***Temperature*** – Apart from its control of potential evapotranspiration, temperature has a direct effect. The rate of plant growth depends on temperature but the relationship differs according to species, so that with increasing elevation the various species distribute themselves along a temperature gradient. Above about 1000 metres, snow is a significant feature of the environment. The quantity, depth, temperature, crystalline state and time of lying of the snow are all important, and these are linked with altitude, aspect and slope. The presence of snow, with the low but fairly constant winter ground temperatures, gives a markedly seasonal growing period. The protection of plants by snow from extremes of temperature and humidity at a time when physiological drought is induced by low root temperatures may be an essential factor in their survival.

Another effect of prolonged low soil temperatures is the vernalisation of seeds. Many, such as alpine ash, have difficulty in germinating without appropriate periods of low temperature (Grose 1961).

At higher altitudes, some of the transitions between communities are abrupt. The upper boundary of the alpine ash zone at around 1350 metres and the change from well developed sub-alpine woodland and snow gum to adjacent grassland, are examples. The latter transition has been attributed tot he effect of cold air drainage and associated frosts on the survival of snow gum seedlings at shrub height.

This is because their growing tips are above the level of the protecting snow, but not high enough to surmount the frost zone. This phenomenon is called temperature inversion, and the normal altitudinal sequence ma be locally reversed by it. Another example of this is the tendency for manna gum to replace candlebark along valleys at an altitude of about 600 metres.

By contrast, the explanation for the more gradual transition, from the mallee woodlands of snow gum in the sub-alpine zone to the treeless grasslands, herbfields and fjeldmark of the alpine zone, is to be sought in the effects of increasingly sever winter conditions on any parts of plants exposed above the snow.

In all these high altitude sites, temperatures are extreme and the environment is severe. Consequently, the ecological balance between grassland, herbfield, woodland and the shrubland is delicate. It is commonly found that should disturbance to the grassland and herbfields occur, it results in an intrusion of shrubs and snow gums, even after the disturbance ceases to operate.

(iii) ***Stability of Regional and Local Climate****:* - Although the distribution and form of the vegetation in this catchment is clearly related to the present climate, it is not easy to determine if it is in accord with it. The vegetation growing in a given site is not necessarily a result of the present overall precipitation and temperature regimes. Climatic changes are now to have occurred in past centuries in other areas. Therefore, the vegetation at some sites may reflect a previous climate, so that it cannot be regarded as the climax vegetation of the present. This is particularly true of the long lived species in a forest community.

In a restricted sense, a plant community can be of a non-climax type with respect to the local micro-climate. A lack of knowledge on these points makes it difficult to predict the direction and rate of vegetational changes which should follow another change in environmental conditions. Moreover, the tolerances of many species cause most transitions to be gradual rather than sharp. Hence, a shift in the location of such transitions would be difficult to detect.

This uncertainty bears on the fate of the vegetation of areas which have been disturbed. If the vegetation of such areas had been in accord with the present climate, it will tend to return; if not, a different type will succeed it. For example, it is desirable to know id the easing of pressures on the alpine country would be sufficient for a return to a vegetation type that lease to a more favourable hydrological condition. Also it would be desirable to know if the present valuable species in commercial forests are likely to persist with normal management, or whether they will give way to less useful species without special regeneration methods.

In either case there seems to be a little evidence that climatic change is responsible for some of the deterioration of the vegetation since activity by Europeans began. Consequently, any such deterioration should ascribed to the effects of man-caused changes in micro-climate and soil. With mild disturbance, the succession toward the vegetational climax can be expected to be resumed. If however, the site conditions have been altered so that they are now outside the range of tolerance of the species available for colonisation, then a major change will result. In the climatically more severe or more vulnerable environments, such as alpine areas or wet gullies where the survival of the specialised plants depends on particular micro-climates, it is easier to cause such an upset. Thus major disturbances of those sites, for example by repeated burning, or by engineering works, should be avoided if practicable, as the cost of restoration may be very high.

(iv) ***Aspects, Slope and Altitude****:* - The effect of aspect is pronounced. There are few plateaux, and most of the country consists of a repeated mosaic of aspects, each with its characteristic vegetation. The southern and eastern sides are generally moister and cooler, and so have lower rates of evapotranspiration that the northern and western aspects. This is because the slopes facing south and east receive less intensive sunshine, are protected from the prevailing summer winds, and because they may receive more precipitation, particularly where the ridge is high and abrupt. This higher precipitation results from the time lag in the development of the precipitation induced by orographic uplift, and the influence of the local lee winds, which cause the bulk of the rain to fall in the immediate lee of the crest regardless of changes in elevation. An example is the west side of the Big River basin and, further afield, the upper Kiewa valley. It is the more distance lee areas which are covered by the rain shadows.

In general, the changes of vegetation with aspect are the same as those with change in regional precipitation. Thus, in the boundary area between two vegetative types of the rainfall sequences, the transition from one type to the other is repeated at each change of aspect. The transitions from "dry" peppermint gum, i.e. broad-leaved peppermint, to "wet" peppermint gum, i.e. narrow-leaved peppermint, and from the latter to the messmate zone, are good examples. The phenomenon however, is general and is reflected in the size and shape of trees and the luxuriance of ground cover, as well as the species present. The change from the north-west to south-east aspect has an effect comparable with that of a regional rainfall increase of about twenty per cent of the general local value. This accords with the result of rainfall measurements in the Parwan Valley (SCA unpublished data). Thus, the red box-long-leaved box vegetation on drier aspects gives way to the red stringybark forest on the wetter aspect; dry peppermint gum on the dryer aspects in area with rainfall of 1150 millimetres gives way on the southerly and easterly aspects to the wet peppermint gum forest characteristics of areas with rainfall of nearly 1400 millimetres; wet peppermint gum with messmate on dry aspects gives way on the south side in the gullies to patches of mountain ash characteristic of areas with over 1650 millimetres average annual rainfall.

Plate 18 – Aspect and seepage markedly control the distribution of the drier stringybark, box-peppermint forest and the wetter peppermint gum forest

Steepness and length of slope both produce changes n vegetation. Long and steep slopes tend to dry out at midslope but remain moister at the base and the ridge. This change occurs often enough to determine the local distribution of species. In this catchment, in areas where the regional rainfall is enough to support a luxuriant forest, there are many examples of long, steep, northerly slopes which exhibit a sparse and dry plant cover. Slope also effects cold air drainage; the nocturnal drainage of radiation cooled air from the steeper slopes tends to keep the slopes frost free and intensifies the drop in temperature on the valley floors.

The effects of altitude and its associated temperature change become confused and disordered amongst those of aspect, slope and precipitation, which themselves usually vary with altitude. Higher altitudes are cooler with less diurnal variation and temperatures, and in general have more precipitation and steeper, longer slopes; lower temperatures result in higher relative humidities and lower rates of evapotranspiration.

Until low temperatures become limiting, the cooler, moister, less variable conditions associated with increasing altitude favour more rapid growth. This results in a taller and denser vegetation of an improved form; for example *E. rubida*, which at lower altitude generally has a twisted, open-branched form has, at higher altitudes, a tall bole and high crown, and produces a millable log.

(v) ***Soil***: - It is difficult to determine relative dependency of soil and vegetation because both are affected by those factors such as precipitation and temperature, which carry with altitude, and so co-vary.

Two effects of these trends in soil properties on the vegetation should be noted. First, with altitude, there is a progressive increase in infiltration rate and in storage capacity for the progressively greater amounts of water available at higher altitudes (greater because of increased precipitation and decreased evapotranspiration). This allows (again, progressively with altitude) those species which do not tolerate moisture stress to take advantage of the greater precipitation, to survive and to grow without the restriction of moisture stress.

The other effect is that the vegetation is restricted, in structure and floristics, by altitude. This is thought to be due in part to the higher acidity of the soils at high altitudes. The pH of transitional alpine humus soils on Silurian sediments is less than 5, which would probably limit the growth of many species.

(vi) ***Interaction***: - Topography, soil physical features and climate interact to produce the soil-water and temperature conditions which play a major part in determining the distribution of the main species.

Thus, in the lower rainfall areas, where the availability of water controls the spacing of trees and the proportions of red gum and yellow box, these are seen to be related to the local topography. The red gum grows only where its roots are waterlogged for part of the year, whilst the better drained adjacent sites are occupied by yellow box. Blue gum, which occupies gullies in low rainfall areas, often facing north, and messmate, which occupies the gullies in the moister areas, and favours the south side, both have their particular requirements for soil moisture and temperature met by different combinations of topography, rainfall and aspect. Candlebark and manna gum are plentiful in wetter hollows at low altitudes but, in higher positions where precipitation is greater, they favour the ridges. At any altitude up to 1430 metres, the soil features, topography, precipitation and temperature combine to produce the conditions which are required for these species.

The importance of adequate internal and surface drainage increases with higher precipitation, so that at higher altitudes where precipitation is also generally higher, a lessening of the slope or of the depth to impervious rock can create poor drainage conditions resulting in a water logged soil. Extreme wetness gives rise to a bog peat of sphagnum moss with gum growing in it.

(vii) ***Fire***:- Forest fire is a feature of the natural environment, and has marked effects on the vegetation. Some of the natural effects of wildlife and those of the traditional burning practices since the early days of settlement are briefly dealt with here. The effects of the recent increase in frequency of burning are considered in the next chapter.

Both of the two types of fire survival – persistence and fire-induced regeneration – have affected the vegetation in this catchment.

In the case of persistence, shoots develop in some eucalyptus from subterranean lignotubers or from bud strands, normally dormant, located along the stems and branches. The re-growths produce bunched, short branches, or coppice, at the base of the stem. Inspection of stands of messmate and of the box species in the catchment reveals many such examples of persistence survival.

In regeneration by fire, the eucalypts most affected are alpine ash and mountain ash. Although they may have been destroyed by a hot fire, regeneration after the fire may be prolific because of the release of seed on to the ash bed of the fire. Thus, a fire may favour the invasion of wet peppermint gum areas by the ash types. Possible examples are in the upper Jamieson valley, where alpine ash has become dominant, and east of Mount Torbeck, where mountain ash has spread. However, other conditions are also requires for successful regeneration, such as seasonal conditions before and after the fire, and the state of the forest. The frequency and intensity of the fire is important. Frequent and intense fires may destroy the young trees before they bear fruit, resulting in a change of species. Complete absence of fire would eventually cause species that can exploit the changed environment.

Fire may have secondary effects in that fire damaged trees are usually weakened, damaging the bark and so permitting insect and fungal attacks. In this catchment, the spread of mistletoes, e.g *Amyema pendula*, seem to be confirmed largely to fire damaged trees. Fire induced changes in forest habitat are thought to have only temporary effects on animal populations but detailed information is lacking for this catchment.

The understorey has also been strongly affected by fire. In the earlier stages of settlement, grassy vegetation was burned in order to provide fresh grazing. The initial effect was to destroy the old growth, open up the sward, and release mineral plant nutrients from the litter. This boosted the young grass growth and provided a "fresh pick" for stock. The practice has been used in many countries but, in Australia, two factors make it inadvisable – the questionable concentration of nutrients in the topsoil of some soils, and the abundance of leguminous species adapted for fire survival form seeds. As already described, in the forested parts of this catchment with high rainfall and deeply leach soils, the principal plant nutrients have accumulated in the topsoil, where they are quickly released by organic decay. If fire should release these nutrients in forms in which they are more quickly available to growing plants, they will also be susceptible to leaching to a greater depth and they may be removed in the ground water (Rowe and Hagel 1974). Over a period of time would be the detriment of the vegetation, particularly shallow rooted grasses and herbs.

The abundant legumious trees and shrubs in the forests of the catchment produce seeds which are hard coated and long lived. The seeds germinate only after fire and moreover are produced by young plants. Consequently, repeated burning may favour other shrub growth, according to the type of land involved. Thus sub-alpine grassland and woodlands have been invaded but such shrubs as rusty pods (*Hovea longifolia),* alpine oxylobium *(Oxilobium alpestre),* and hickory wattle *(Acacia oliquinerva*). Alpine ash forest, which originally was open with a grassy floor, nor carries hop bitter pea (*Daviesia latifolia)* and *A. obliquinerva* with narrow-leaved bitter pea (*D. virgata*) at low elevations after fire. In the forest and woodland, wattles (mainly *Acacia dealbata*) and parrot peas (*Dillwynia* spp.). Some composites, for example *Cassina aculeata* and *Senecio* spp. Are successful colonisers after fire.

(viii) ***Grazing***: - Grazing has had an effect on the distribution and form of species in alpine and sub-alpine areas, mainly because of a preference for certain species by browsing and grazing animals, and partly through mechanical damage in some sensitive areas. Animals tend to select plants such as daisies (*Celmisia* spp), trigger plants (*Stylidium graminifolium*) and most of the annual leafy herbs. Some snow grass is eaten, particularly the long seed bearing plumes, but it does not seem to be highly preferred. The overgrazing of "sweet" areas by cattle is a feature of the high country, such as areas being usually composed of tussocks of *Poa* spp, with herbs in between. The net result of such continued selective grazing is a deterioration in the degree of cover and an increase in the proportion of grasses on the area. After the removal of stock, at least initially, these is an invasion for the bare areas by shrubs, or heaths (S. Zallar personal communication). The alpine and subalpine areas have been grazed and burnt since the very early days of settlement and, in places, the changes from original conditions have been of such long standing that the present condition is presumed t be natural by some observers.

Intensive grazing in parts of the freehold land, particularly the red gum areas, has already prevented the regeneration of timber because the seedlings are eaten. It seed is available from older trees, exclusion of stock for a few years until the young trees are established will allow regeneration. Grazing by stock and wildlife has an effect on the forest floor conditions but it has not been severe enough to suppress regeneration of eucalyptus. Even a quite small population of rabbits in forests can have a marked effect on regeneration (Mitchell and Farrington 1966). Browsing by many wombats is usually apparent.

(ix) ***Insects****:* - chewing and sucking insects defoliate eucalypts, rarely killing them but inhibiting the growth of commercial timber stands. The leaf eating phasmatids have been prominent in recent years, sometimes in plague proportions. Insect attacks in combination with grazing may have marked effects. In one instance, at Mansfield, the mature red gums were killed by insects, regeneration was suppressed by grazing and the area is now virtually treeless. In the Eildon catchment, it is unusual to find a branch on which there is no obvious foliage or bud damage, or to see a bole clear of the marks indicating burrowing insects. It follows that the ecology of forest insects is an important field of study. Not all the forest insects are harmful to timber production and obviously all play a role in complex ecological processes. Consequently, a blanket disturbance of the ecosystem, for example by treatment with sprays or by frequent burning, may have unexpected and possibly undesirable results. Moreover, because the size of insect populations can fluctuate widely, efforts at direct control of economically harmful insects may have little effect on their number.

Summary

Even though the distribution of the major vegetation communities appears to be a static feature of the catchment, it is in reality a dynamic phenomenon. In broad outline, it is controlled by altitude and the associated local climates, topography and soil types. In detail, it follows the complex interactions of these same factors, but is compounded by aspect, fire history, possible recent climatic changes, grazing pressures, insect plagues, forest and pasture management techniques, etc. in any given locality.

Enough experience and knowledge has been accumulated to know which communities are the most vulnerable to extraneous human or biological interference. Existing knowledge is quite inadequate however, as a basis for manipulating the ecology of the area in attempts to achieve certain stated aims over a specified period of time. While it is feasible now to remove or restrict human and unnatural biological interference, much research and experimentation will have to be conducted before positive management techniques can be formulated for each vegetation community.