Native Forest Silviculture

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High Altitude *Eucalyptus dalrympleana* and *Eucalyptus pauciflora* Forests

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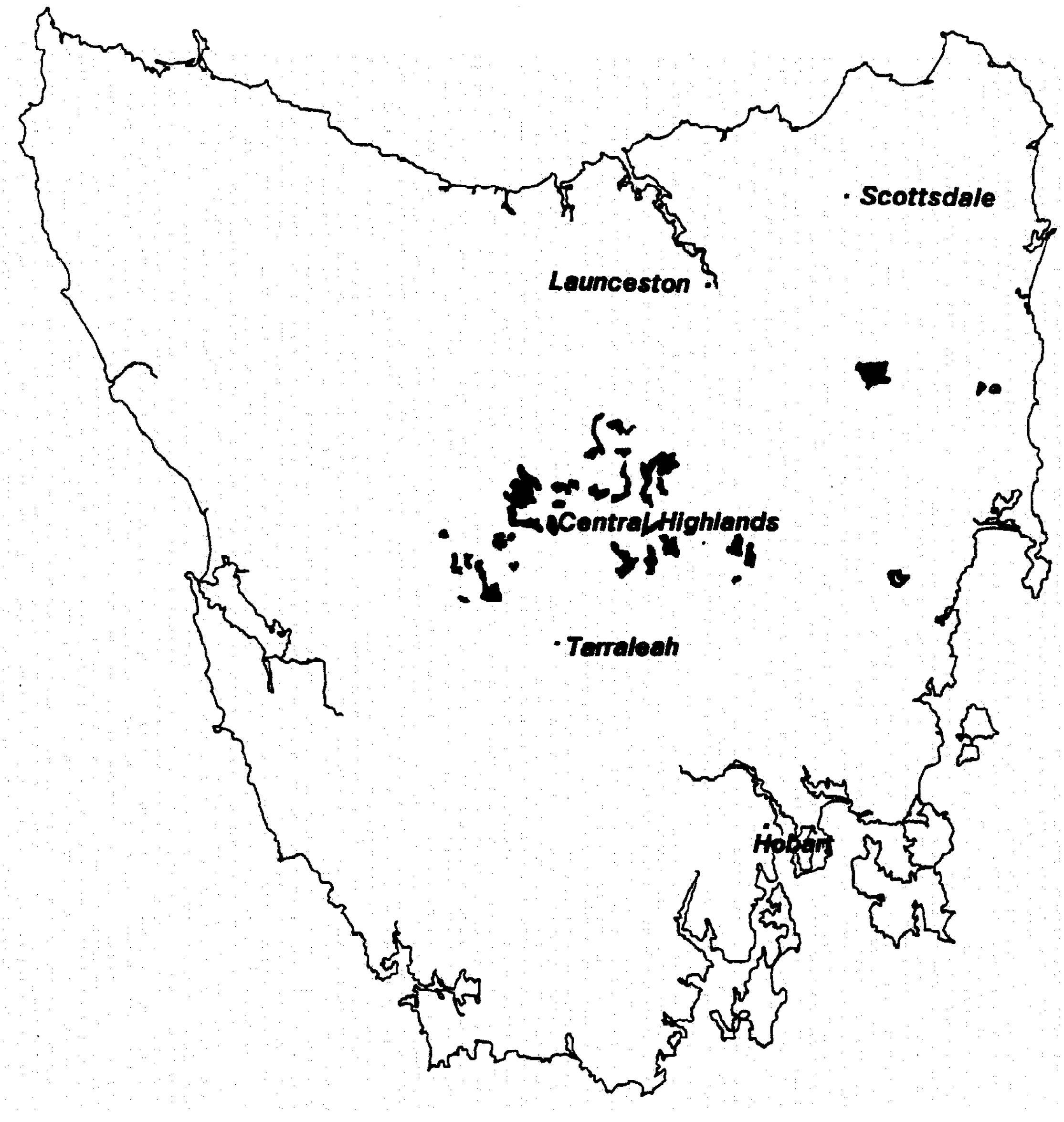


Eucalyptus dalrympleana and *Eucalyptus pauciflora* dominated forests within Tasmania

PART A: Prescriptions for Silvicultural Treatment

1. INTRODUCTION

Forests dominated by *Eucalyptus dalrympleana* and *Eucalyptus pauciflora* at altitudes over 600m have not been extensively managed for wood production. Approximately 20 000 ha of this forest type occurs on Crown land where it is currently reserved pending investigations into appropriate silvicultural techniques. A further 50 000 ha occurs on private land. Fifty to 100 ha of this forest type is harvested annually for the production of sawn timber and pulpwood.

A history of firing and grazing has shaped many of these forests, particularly on the Central Plateau. Up until the last couple of decades long term grazing leases were an integral part of many farms in the high country. Firing of the forests was carried out to increase the herbaceous and grass components of the understorey. Many small plains were increased in size by the ringbarking of edge trees.

The silviculture of this alliance is still very rudimentary. Low volume yields have meant that until recently these forests have been managed for non wood values or as protection forests. Some areas cleared for grazing have regenerated prolifically, while others have remained as subalpine grasslands. Areas harvested recently provide a limited guide to likely outcomes of different silvicultural techniques.

2. PRESCRIPTIONS

Interim prescriptions pending further silvicultural research are as follows.

1 Areas over 950m elevation should not be logged.

2 Areas between 600m and 950m elevation should only be logged where the species occurs as small pockets (<20% by area) contained within larger coupes of *Eucalyptus delegatensis* forest.

3 Areas where regeneration may not readily establish should not be logged.These areas might be rocky knobs, swampy areas, frost hollows or the edges of grassy plains .

4 If there is insufficient advanced growth over one metre tall to provide a 50% stocking by 16m^2 plots after logging, gaps in the canopy after logging should be less than two crown diameters in size.

5 When harvesting old growth, avoid damage to potential sawlogs and advanced growth.

6 All old growth trees and culls should be felled unless they are to be kept as habitat, shelter or seedtrees. This is to remove their suppressive effect on the regeneration and advanced growth.

7 A high degree of seedbed disturbance is required in all understorey types, particularly in grassy understories, for successful regeneration. Burning disturbance is acceptable unless there is a high stocking of advanced growth. At least 50% of the area should have acceptable seed bed following harvesting operations.

Silvicultural Prescriptions
for
E. dalrympleana and *E. pauciflora* forests
at altitudes greater than 600m

Is the Altitude over 950m ?

Yes

Do Not Log.

Yes

Does the forest type occupy more than 20% by area of the logging coupe ?

No

No

Yes

Does the type comprise areas of rocky knobs, swamps, frost hollows or edges of grassy plains ?

No

Is there existing advanced growth (> 1m height) sufficient to provide 50% $16m^2$ stocking after logging ?

Yes

No

Partial logging with priority for retention of potential sawlogs and other advanced growth.

Shelterwood system with canopy gaps no greater than two crown widths or 50m in diameter. Seed bed disturbance to at least 50% of the ground area is required.

PART B: Description of Forest Types

1. FOREST ECOLOGY

1.1 The Types.

Three main forest types may be recognised on the basis of understorey composition. Understorey is in turn determined by drainage, fertility and soil depth, and fire frequency (Duncan and Brown, 1985).

a) Grassy forests

Grassy understoreys are typically found on well drained sites with comparatively deep soils, particularly near the margins of frost hollows. In this type the shrub layer is sparse on most sites. Species include *Bellendena montana, Tasmannia lanceolata, Lissanthe montana, Olearia algida* and *Pultenaea juniperina.* The ground layer is dense and dominated by *Poa* spp. together with many other grasses.

b) Sedgy forests

Forests with sedgy understoreys occupy flats and hollows subject to frosts, cold air drainage and waterlogging. The shrub layer is generally intermittent consisting of such species as *Epacris* spp., *Sprengelia incarnata, Baeckea gunniana, Leptospermum* spp. Where sites are better drained species such as *Cyathodes* spp., *Lomatia tinctoria* and *Olearia* spp. may be found. The ground layer is dense and may include *Poa* spp., *Danthonia* spp., *Deyeuxia* spp., *Restio australis, Lepidosperma filiforme* and occasional species such as *Gymnoschoenus sphaerocephalus, Gleichenia alpina* and sphagnum moss.

c) Shrubby forests

Shrubby understoreys generally occur on rocky, free draining slopes. The shrub layer is typically dense and multi-layered, except on very exposed or frequently burnt sites. Species typically include *Olearia* spp., *Helichrysum* spp., *Cyathodes* spp., *Leucopogon hookeri, Telopea truncata, Lomatia tinctoria, Orites revoluta, Hakea lissosperma* and *Leptospermum* spp.

High fire frequencies will promote the development of sedgy or grassy understories because grass and sedges have the capacity for vegetative recolonization. The ability of shrubs to shade out ground species tends to increase the shrub component in the understorey if fire is removed for longer periods.

1.2 The Environment.

a) Location

The most extensive stands of *E. dalrympleana* and *E. pauciflora* occur on the southern and eastern edges of the Central Plateau throughout the upper catchment of the Derwent River.

These forests are mostly found on plateau surfaces above 600m. Some stands, particularly *E. pauciflora*, may occur at lower altitude, on frost flats and hollows where other species are not able to tolerate both the severity of winter frosts and dry summers.

b) Climate

Key climatic features of the area of distribution are:

- Rainfall is generally in the range of 700 to 1500mm. In some areas both species may occur at lower rainfall. However, *E. pauciflora* rarely occurs at higher rainfall.

- Rainfall exhibits a seasonal bias with a summer dry period and a rainfall maximum in the late winter, early spring.

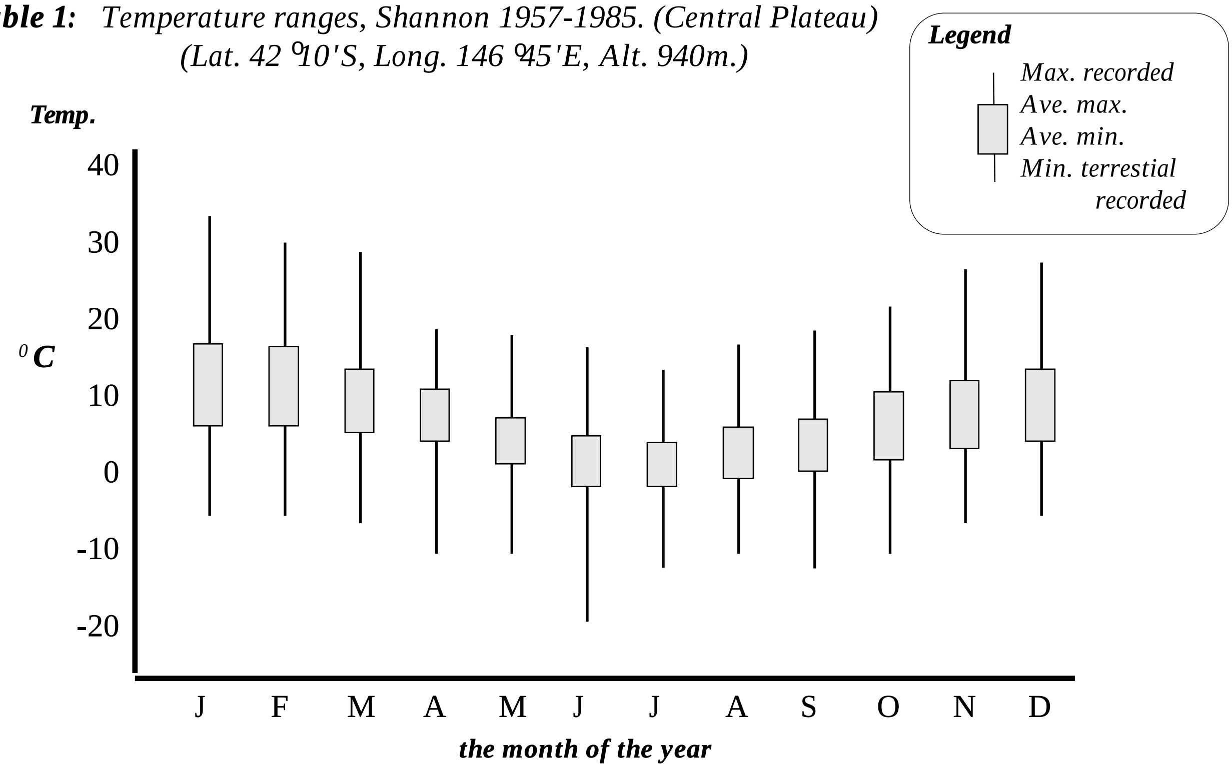
- Snow is likely to lie for approximately 20-50 days per year but is generally light and the period of lie is short.

- The average summer maxima are in the high teens, with extremes rarely exceeding 30°C.

- The period between May and September is typified by maximum temperatures of less than 10°C, allowing negligible growth.

- Frosts below -5°C may be experienced in any month of the year, with between 100 and 200 frosts per annum. The average minimum terrestial temperature is below zero for the period April to November.

Table 1: *Temperature ranges, Shannon 1957-1985. (Central Plateau)*
(Lat. 42 °10'S, Long. 146 °45'E, Alt. 940m.)



1.3 Ecological Relationships.

E. dalrympleana and *E. pauciflora* forests grade into other forest types. The change in over-storey dominance appears to be largely determined by summer heat, drainage, drought and frost frequency. (Duncan and Brown 1985, Kirkpatrick and Duncan 1987, Ashton and Hargraves 1983, Moore and Williams 1976). Changes due to altitude and droughts tend to have wide transition zones whereas changes caused by drainage, both water and cold air, tend to be sharp. Table 2 indicates the interplay of species dominance and two major environmental parameters: temperature and drainage.

Table 2: *Species Dominance and Ecological Factors*

poor drainage	*E. pauciflora*		*E. gunnii/ E. archeri*
		E. rodwayi	
		E. rodwayi	
	E. pauciflora		
	E. dalrympleana		
	E. pauciflora		
	E. delegatensis	*E. delegatensis*	*E. coccifera*
good drainage	dominated, often with *E. amygdalina*	*E. dalrympleana*	
	E. dalrympleana	*E. pauciflora*	

Increasing frost, cold air accumulation or decrease in summer heat

At any given altitude the effects of drought frequency and rainfall will be superimposed over the effects of temperature and drainage. As rainfall increases so will the proportion of *E. delegatensis* and *E. dalrympleana* and possibly *E. nitida*. As rainfall decreases the proportion of *E. amygdalina*, *E. pauciflora* and *E. coccifera* can be expected to increase.

Frost and fire have major effects on plant distribution in this forest type. Both have had a major role in the loss of tree cover from natural frost hollows. (Jackson 1973) Periodic killing frosts may have a greater long term effect on plant distribution than fire by killing trees, (Jackson 1973) but not preparing a receptive seedbed. In contrast, fire tends to remove the frost resistant grass and the deep layer of litter on the forest floor, exposing a receptive mineral seedbed.

Forest structure is dependent on fire frequency, past logging and the history of grazing. Past selective logging has tended to increase the unevenness of forests whereas high fire frequency and grazing have prevented or destroyed regeneration. Its likely that infrequent fires allow the forests to regenerate in patches of different ages. (Jacobs 1955, Mount 1970).

2. REGENERATION REQUIREMENTS

2.1 Seeding Habits.

From bud formation to seed fall can take four years for both species, with most seed being shed in the third and fourth years.

E. dalrympleana flowers March to May and the seed collection months are December to May. The number of viable seed per 10g of seed and chaff is estimated at about 2034 $\pm$ 1250 (Turnbull and Doran 1987).

E. pauciflora flowers between October and January and the seed collection months are December to February. It is estimated that there are 620 $\pm$ 230 viable seeds per 10g of seed and chaff (Turnbull and Doran 1987).

2.2 *Regeneration Establishment.*

There is little experience in regeneration establishment for this alliance but it is expected that systems used in high altitude *E. delegatensis* forests are applicable.

On grassy sites or sites with a deep litter layer it seems likely that burning or disturbance of the understorey is necessary for regeneration establishment. When overstorey trees are killed without the disturbance of the understorey, the sites may become grasslands (Jackson 1973). Many of the stands exhibit an unevenaged structure indicating the capacity for regeneration to establish following disturbance under a partial canopy. These forests occur well within the ecological limits of subalpine grasslands. In frost hollows and valley floors where colder temperatures prevail, grass has a competitive advantage over trees (Moore and Williams 1976). Following disruption of the canopy by clearfelling lower surface temperatures are likely to occur (Nunez and Bowman 1986). This change in micro environment will slow the growth rates of the regenerating trees, and if the new environment exceeds the tolerance ranges of the seedlings, may prevent re-establishment altogether (Billings and Mark 1957). It is unlikely that every year will provide conditions suitable for eucalypt regeneration.

The principal factors affecting regeneration survival appear to be fire, frost and browsing. Higher intensity fires may result in extensive death of trees up to mature age. Browsing can also significantly affect regeneration success (Bryant 1971). There appears to be a critical height, about one metre, above which grazing and browsing pressure has little effect on regeneration success.

Low intensity burning, wildfire, or control burning coupled with grazing can have a severe impact on regeneration (Bryant 1971).

Coppice can be a major component of regeneration. In cut over stands, *E. dalrympleana* appears to coppice more readily than *E. pauciflora*, yet *E. pauciflora* seems to regenerate more readily from lignotubers.

3. *GROWTH AND YIELD.*

Growth and yield of these forests is highly variable. Many stands would be below the current commercial limit of 50 tonnes per ha total merchantable volume. Very few stands contain sawlog standard trees.

3.1 *Volume Relationships.*

The following analysis contains information obtained from the examination of 62 permanent and temporary forest inventory plots randomly located within this forest type on the Central Highlands.

The plots examined range in total gross bole volume from a minimum of 18 m^3 per ha to a maximum of 593 m^3 per ha with an average of 191 m^3 per ha. Total pulpwood volume ranged from a minimum of 10 m^3 per ha to 246 m^3 per ha with an average of 98 m^3 per ha. Total sawlog volume ranged from zero to 289 m^3 per ha with a mean of 31 m^3 per ha. These relations are shown in Figure 1.

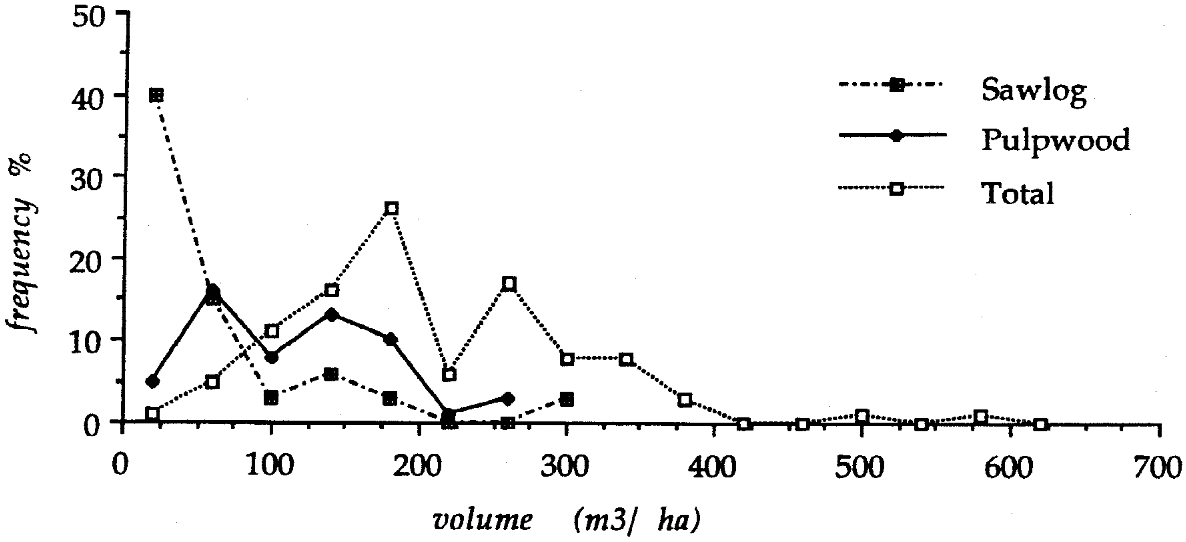


Figure 1. *Relative frequency of timber volume (from T.F.C. forest inventory plots)*

3.2 Altitudinal Relationships

All measurements are closely related to altitude. Regression analysis of total gross bole volume data (figure 2.) indicates that volume would be zero at 1150m (i.e. the altitudinal limit). Height development, total sawlog volume and total pulpwood volume are very highly correlated with altitude. Sawlogs are not likely to be produced above 950m altitude.

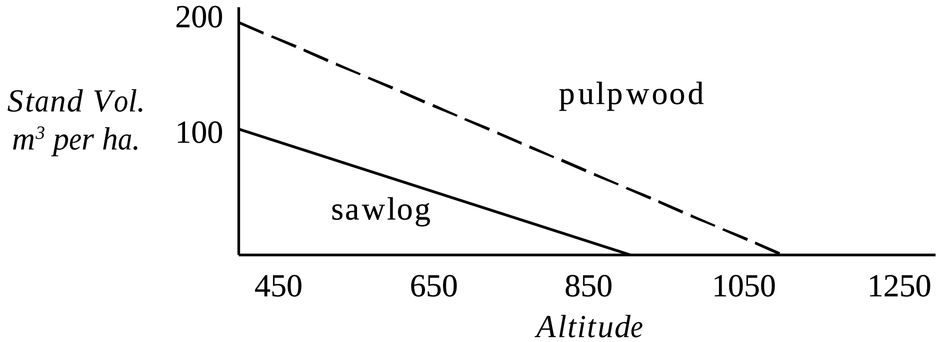


Figure 2: *Relationship between altitude and volume (from T.F.C. forest inventory plots)*

3.3 Relationship between volume and height class

	Total Gross Bole Volume. m^3 per ha		Total Sawlog m^3 per ha	
Height Class	Mean	95% Confidence limits	Mean	95% Confidence limits
E2 (41-55m)	348	239 - 456	108	46 - 171
E3+ (34-41m)	257	219 - 296	65	43 - 88
E3- (27-34m)	195	158 - 231	19	0 - 40
E4 (15-27m)	133	103 - 164	6	0 - 24

Table 3: *Volume by Height Class (from T.F.C. forest inventory plots)*

3.4 Relationship between species and volume.

Sawlog volumes in these forests are mainly derived from *E. dalrympleana* . Only E2 stands contain *E. pauciflora* sawlogs to any significant extent. Poor form and susceptibility to fire damage appears to limit sawlog yield from *E. pauciflora*.

3.5 Growth Rates

Growth rates are very slow. On high quality sites at comparatively low altitudes (<700m) growth rates of 8mm diameter increment per year may be achieved by vigorous young trees. Older trees will rarely exceed 5mm per year. The shorter growing season at higher altitudes (>900m) can be expected to slow the rates to between 2 and 5mm per year.

3.6 Response to Thinning.

A survey of a thinned stand at Waddamana (F.C.T. RP 270-58456) has indicated that a substantial increase in annual diameter increment can be obtained following competition reduction. Twenty two trees were examined. Of the seventeen with some reduction in competing basal area, twelve at least doubled their diameter increment in the three years following logging, and the remaining five had at least a fifty percent increase in annual diameter increment.

4. DAMAGE TO OLDER STANDS

4.1 Fire.

Fire is a major cause of damage in these forests and can result in extensive butt damage to both species. Frequently burnt stands will have a high proportion of cull trees and a very low proportion of sawlogs. Both species have relatively thin bark, hence little thermal insulation, and may suffer cambial death caused by the high temperatures.

Saplings are highly fire sensitive. Fires of low intensity may not kill regeneration but extensive basal sprouting may occur. Such stands will ultimately have many trees with poor form.

Generally fire intensities are relatively low due to the slow fuel accumulation rates and the infrequent occurrence of severe fire weather.

4.2 Frost.

Infrequent but severe frosts may result in the wholesale death of mature stands. The explorer *Calder* told of a severe frost in the nineteenth century which killed large tracts of forests on the Central Highlands (Hooker 1844). The frequency of such major frosts is not known.

4.3 Snow.

Cremer (1983) made some observations about snow damage in high altitude eucalypt forests.

- snow may cause damage to regeneration less than 4m in height by breaking stems, but most stems bent by snow are undamaged,

- mature trees may have crowns damaged by limbs breaking under snow weight,

- the worst snow damage occurs with wet snow, in relatively sheltered locations, when snow loads persist during violent storms,

- epicormic shoots and secondary crowns are particularly susceptible to snow damage because they are attached weakly to the stem.

4.4 Insects and Fungal Attack.

The termite, *Porotermes adamsoni*, is a common cause of damage in these forests. Infestations begin in damaged tissues such as fire scars, and lead to the development of a hollow core or pipe in the tree (Elliott and Bashford, 1984). Fungal heart rots are usually associated with this termite damage.

The cold environments of these forests restrict the fungal attack of trees and confine it to the immediate area of any wound.

5. SILVICULTURAL MANAGEMENT

These forests have been traditionally used for conservation, catchment protection and for the supply of fuelwood and roundwood. They are currently reserved as conditional, pending further silvicultural investigations (where they occur over 900m or where they are classed as E4 quality).

The silviculture of these forests is not well understood. The few operations carried out to date suggest that regeneration establishment will be difficult and initial growth rates slow. Observations suggest that where this forest type is logged the silvicultural treatment should be the same in all instances as for *E. delegatensis* on sites prone to growth check. Where possible advanced growth and small potential sawlogs should be retained. Where this is not possible a partial canopy should be maintained and a good seedbed prepared.

The combined effects of winter cold and summer drought result in a short growing season and slow growth rates. At least 120 years will be required on most sites to produce trees of a size suitable for sawlog production.

The economic limit of operations can be expected to be 950m. Above this altitude the pulpwood volume is likely to be less than 50 tonnes per ha and sawlog production zero.

Fire should be excluded from stands at least 10 years prior to logging to the protect the valuable advanced growth which will be the next rotation's crop trees. Regenerating stands also require extreme fire protection as repeated burning of this type of forest results in extensive fire scarring. Repeatedly burnt stands contain few, if any, sawlogs and a high proportion of cull trees.

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