Regeneration Establishment in Dry Grassy Forests

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Abstract

Grazing and fire management practices adopted by Tasmanian private forest owners have led to the development of open grassy understoreys and even-aged structures in much of their dry eucalypt forest. If forest cover is to be maintained, regeneration must be established to replace those trees that are lost through harvesting or natural causes. Eucalypt establishment on these dry grassy sites presents significant problems caused by competition, browsing and grazing. Where maintaining forest cover or productivity is a primary objective, those responsible for managing these areas must be encouraged to adopt the best available silvicultural practices.

Private dry grassy forests in Tasmania

The extent of Tasmania's private dry forests is indicated in Figure 1. In general, they are eucalypt forests with a mature height of between 15 and 41 m and occur where the annual rainfall is less than 900 mm.

Most dry eucalypt forests are naturally shrubby and have an uneven age structure. Grazing and frequent fires of low intensity encourage the development of a grassy understorey (Photo 1) that frequently is devoid of young eucalypts. These practices maximise the forest's immediate value for grazing and stock shelter, but could result in the eventual loss of tree cover.

Forests are not static. Trees grow old and ultimately must be replaced if continuity of forest cover is to be maintained. If an area is being harvested, regeneration must be obtained to replace the trees that are removed. While most forests regenerate readily, eucalypt establishment is less certain on dry grassy sites. The complexity of the inter-relationships that influence the survival of individual seedlings means that general statements such as 'grass cover and grazing by sheep will prevent regeneration' can inevitably be shown not to apply in some instances. This in no way detracts from the theme of Figure 2, which is that these forests are at risk of becoming degraded if not managed for regeneration. The major contributors to the regeneration problems of dry grassy forests are outlined below.

Factors affecting regeneration

Drought

Regeneration failures associated with grassy understoreys occur mainly on sites with low rainfall and during periods of summer drought. Rainfall records for Stonehouse, a homestead 30 km east of Oatlands, demonstrate the level of variability that can occur in the Tasmanian Midlands. As indicated in Figure 3, one summer in three has rainfall less than 70% of average, while in one in eight, it is less than 40% of average. The 1983/84 summer, with a rainfall less than 30% of average, is well recognised as a period associated with substantial regeneration failures in logged dry forests in the Midlands (N. McCormick, pers. comm.).

Silvicultural systems applied to the logging of dry grassy forests must possess the robustness necessary to accommodate occasional years of severe drought.

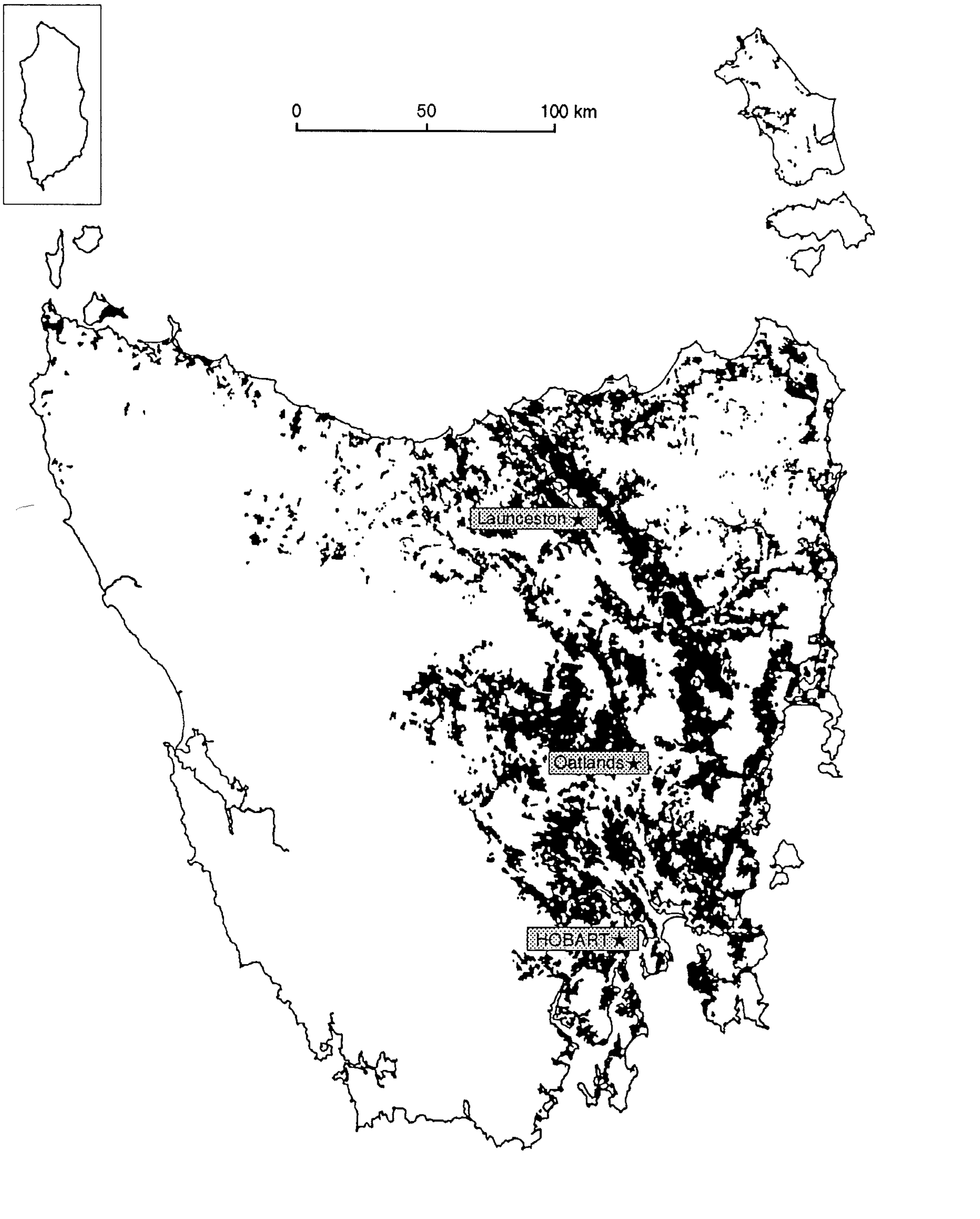

Figure 1. Privately owned dry forests in Tasmania.

Photo 1. Dry grassy forest.

On particularly harsh sites, it is possible that a period of several consecutive years of weather that is favourable for the establishment of regeneration may occur only once every 10-20 years.

Competition from grass

Grass inhibits and can prevent the establishment of eucalypt seedlings. Competition for moisture is probably the most important mechanism through which this occurs. Hence, the effect of grass is more pronounced on dry sites and in dry years.

Changes to soil microbiology that are thought to occur with the establishment of a grass cover can also make a site less favourable for growth of eucalypt seedlings. This inhibition has been observed by Ellis (1984) in high altitude *Eucalyptus delegatensis* forests with a *Poa* (snow) grass understorey and is thought to extend to lower altitude dry grassy forests (R. Ellis, pers. comm.). While the mechanism by which this inhibition occurs is poorly understood, it may involve the absence in grassland of the mycorrhizal fungi that are associated with healthy growth of eucalypt seedlings. Ellis *et al.* (1985) found that organic matter in soils associated with grasses (*Poa* species) is highly resistant to decomposition, and this may contribute to long-term deficiency of nutrients such as nitrogen and phosphorus.

The rapidity with which inhibition develops following the invasion of grass remains unclear. The extent to which it can be ameliorated by ground disturbance and low intensity fire is also unclear. While not necessarily preventing eucalypt regeneration, it may be an important contributor to the slow growth rates of eucalypt seedlings frequently observed in dry grassy forests.

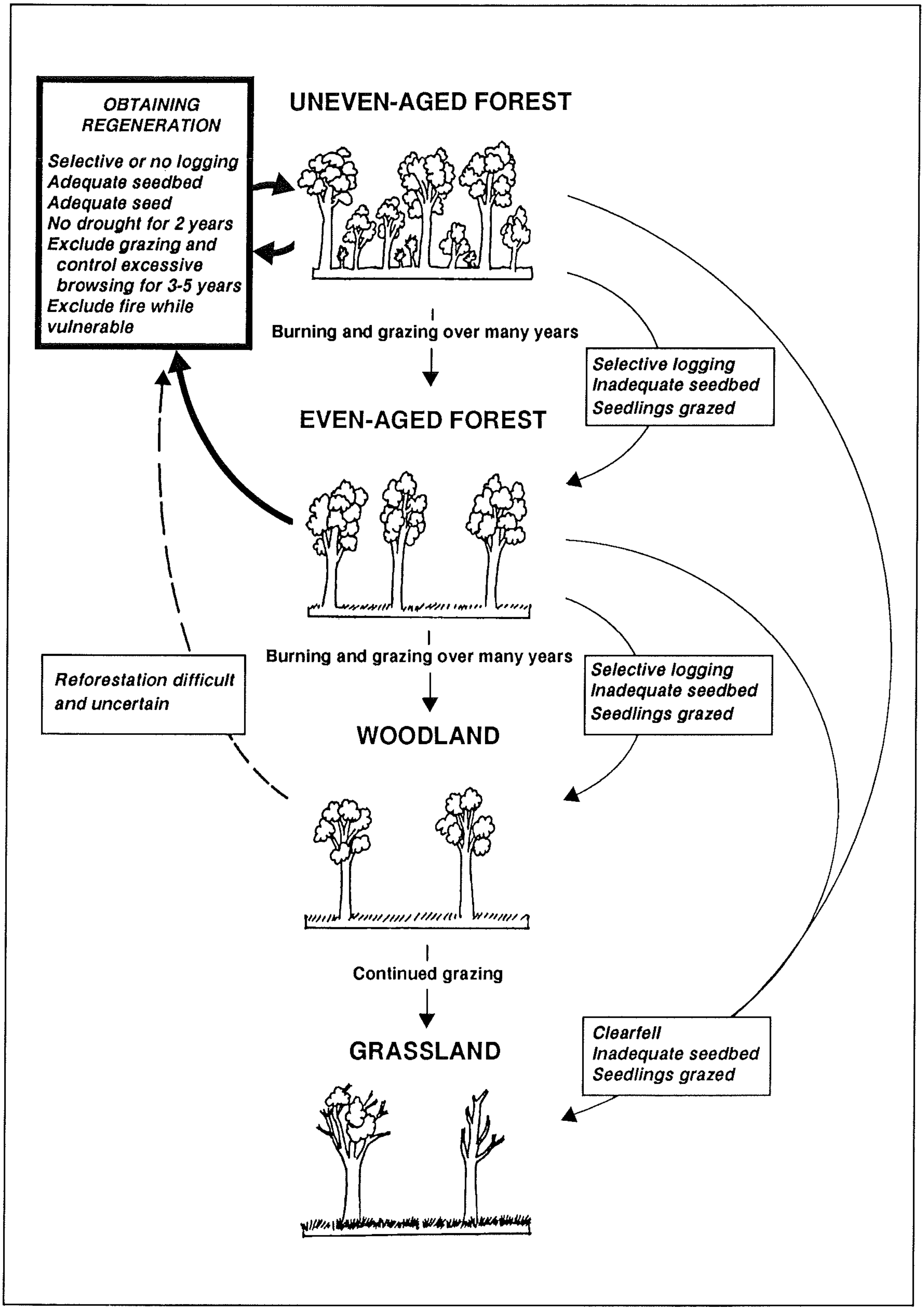

Figure 2. Management and forest-loss pathways in dry grassy forests.

Grazing and browsing

The presence of large populations of brush-tailed possums, Bennetts wallabies or red-bellied pademelons in the critical first years of seedling establishment is likely to prevent or severely retard regeneration. Defoliation of seedlings to the extent demonstrated by Photo 2 is a typical consequence of heavy browsing.

Recently germinated eucalypt seedlings are also highly vulnerable to grazing by sheep and can be lost without trace. Larger seedlings are more resilient, gradually gaining the capacity to tolerate repeated episodes of partial defoliation. Damage caused to these larger seedlings by sheep will vary with the level and duration of stocking, the availability of other feed, the previous grazing experience of the sheep, and the size and species of eucalypts involved. Landowners will be under the greatest pressure to let sheep into regeneration areas in drought periods, when feed is in short supply. They need to recognise that it is at this time that the seedlings are most stressed and vulnerable.

Probably the most important message foresters can present to forest owners is that grazing and regeneration establishment are incompatible, and yet some graziers are unwilling to accept this. This is despite the ease with which regeneration failures directly attributable to grazing can be found. Many graziers make assertions which do not recognise the impact of the grazing habits of sheep on young seedlings.

Frost

Some eucalypt seedlings are highly susceptible to frost, and the sensitivity of different species varies over only a narrow range of temperatures. Resistance to lower temperatures can be increased by a period of exposure to near freezing temperatures. Paton (1980) found that seedlings of *E. viminalis* that were subjected to a ten-day period at 2°C incurred only a low level of damage from a -8°C frost which killed

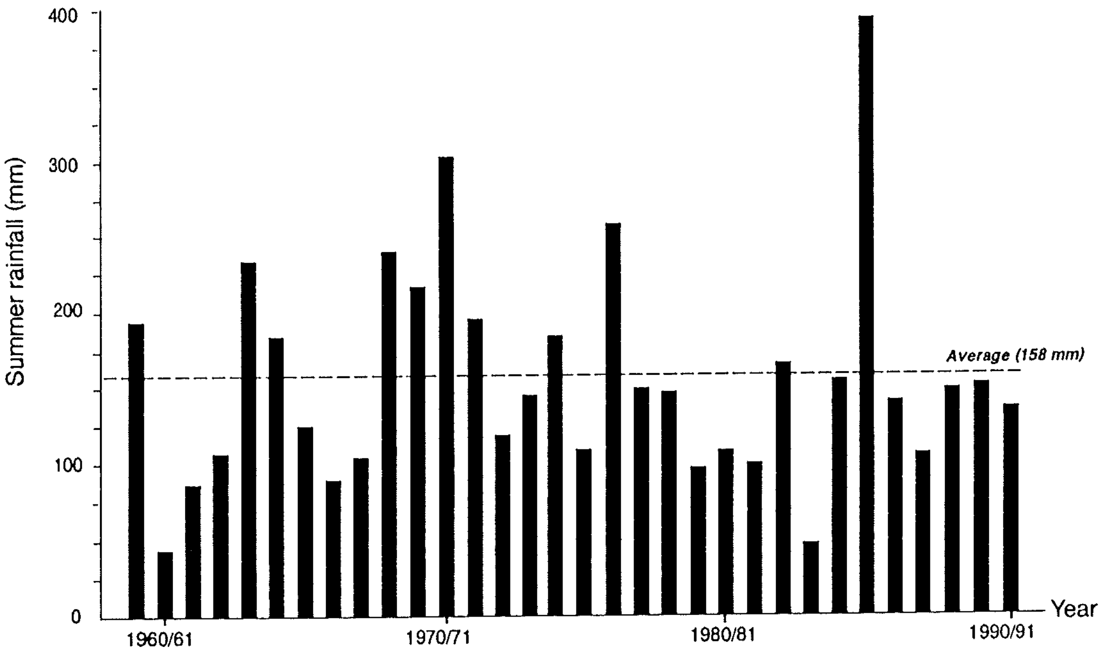

Figure 3. Rainfall over summer (December-February) at Stonehouse 1960-1991.

Photo 2. One-year-old Eucalyptus globulus *seedlings from inside (left) and just outside (right) a fenced grazing and browsing exclosure in a dry forest logging coupe.*

equivalent unhardened seedlings. Damage can be caused by unseasonal frosts in autumn or spring, as well as the low temperatures experienced in winter.

Mortality due to frost damage in areas from which cold air can readily drain is usually limited to small seedlings, although the loss of saplings more than 3 m in height has been recorded. Extreme frosts recorded in winter 1837 and June 1972 caused widespread dieback or mortality of trees of all ages.

Fire

The risk of wildfire is largely dependent on the attitudes to fire use and protection held by individual landowners and their immediate neighbours. More significant are fires deliberately lit to promote grazing at the expense of seedling regeneration.

Defining successful regeneration

The Forestry Commission has developed prescriptions for delineating areas that are fully stocked with seedlings and/or with retained trees following logging operations (Forestry Commission 1991). Regeneration is then considered to be acceptable where 80% or more of the area is fully stocked. This recognises the presence of natural gaps in unlogged forests. These standards have been set with the goal of maintaining forest productivity while reducing the development of low branches. No stocking standards exist for areas that have a low density of tree cover and that are used for grazing, on the basis that such land management is considered potentially unsustainable.

This standard for minimum stocking was developed initially for wet sclerophyll forests, and it can be argued that it is unnecessarily high for dry forests, since the latter are naturally more open in structure. A countervailing argument is that other factors such as drought, browsing or poor soils lead to higher levels of seedling mortality during early growth in dry forests than would be encountered in wet forests. The Forestry Commission is planning a comprehensive review of these standards within the next several years.

Regeneration success must be viewed as extending beyond simply obtaining a prescribed early stocking of seedlings. Regeneration surveys for the purposes of this assessment occur at age one or two, in order that any additional sowing necessary can be undertaken while some seedbed remains exposed. At this age, seedlings that are counted as contributing towards the stocking may sometimes be only a few centimetres tall. A survey at this age makes no allowance for the continued vulnerability of these seedlings. Seedlings sometimes grow very slowly, with poor apical dominance. This can persist for many years. Growth check of seedlings is normal in a forest that is fully stocked with older trees, but is of concern in logged areas where it will increase effective rotation length and leave seedlings vulnerable to damage for longer.

Past regeneration practices in dry grassy forests

Eighteen dry grassy forest coupes aged from three to nine years and from a range of locations throughout eastern Tasmania were re-surveyed to give an indication of trends in early growth rates and stocking. These were selected without bias from the private property operations of one representative forestry company. All of these sites were essentially clearfell operations, with broadcast or top disposal burning followed by sowing and scattered non-merchantable trees acting

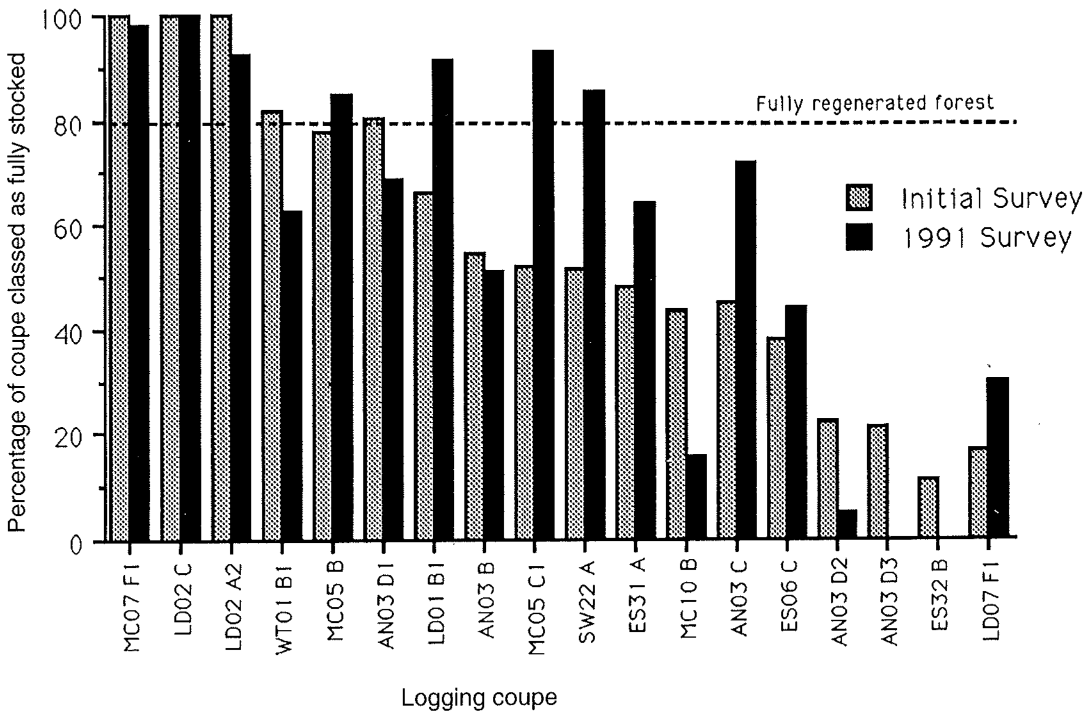

Figure 4. Percentage of total coupe area classed as stocked at the time of initial survey and the 1991 survey.

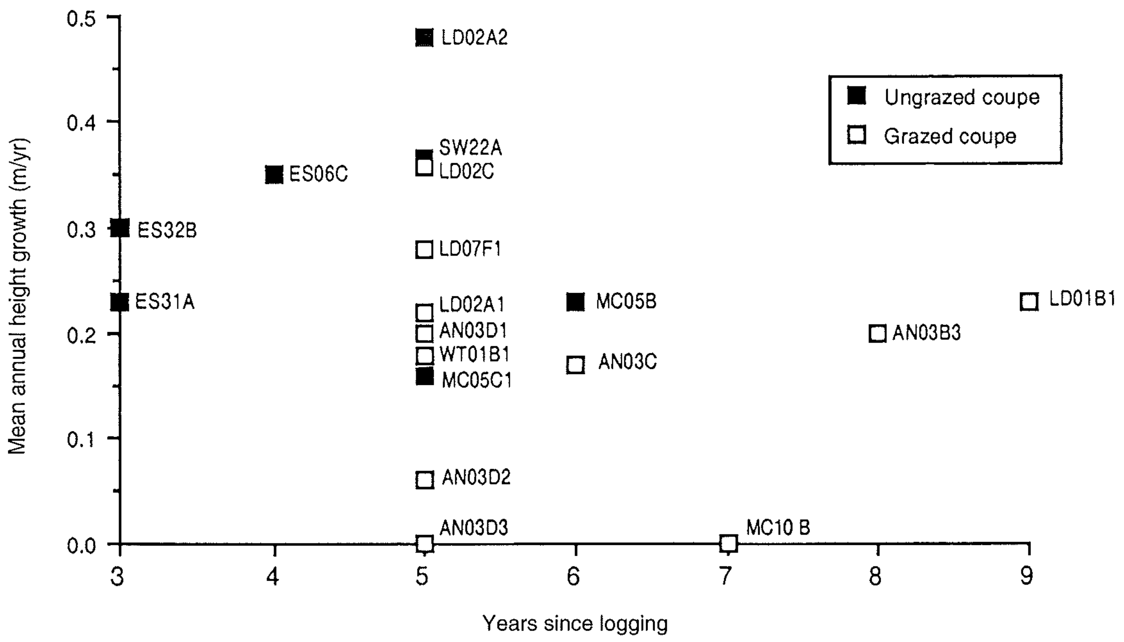

Figure 5. Mean annual rates of height growth for seedlings on each coupe surveyed.

as potential seed trees. The proportion of each of these areas that was rated as fully stocked by each survey is indicated in Figure 4. It should be stressed that a value of 0% in this graph does not necessarily indicate a total absence of trees. Rather, it shows that in all parts of the coupe, the seedling density is below that required by the Forestry Commission's stocking standards. The mean annual growth rates of seedlings on each site are compared in Figure 5.

Seven of the 18 coupes in Figure 4 meet the Forestry Commission's minimum acceptable regeneration standard of 1991. Substantial increases in stocked area were recorded at five of the sites in the years following the first survey. This probably reflects the presence of a limited on-going seed source at these sites. Some areas failed totally. MC10B was first sown in a dry summer, was also grazed, and now possesses few eucalypts. The difficulty of re-establishing forest in failed areas with no remaining seedbed and no seed trees is demonstrated by MC07D (not graphed) which, although fenced off in one part and resown several times at considerable expense to the forestry company, is still only 49% stocked, seven years after logging. AN03D1 exhibits substantially greater regeneration than AN03D2 and AN03D3, despite their close proximity, the absence of fences between them and all being logged in the same year. AN03D1 is on a steeper slope than the other two coupes, has deeper soils, and a substantially shrubbier understorey with less grass. While sheep have access to this area, there was evidence that they stayed mostly on the flatter grassier ground of coupes AN03D2 and AN03D3. These two coupes also have significant areas of loose surface rock which reduces the available seedbed. It should be noted that these results reflect past silvicultural practices which have advanced considerably since some of these areas were logged (McCormick and Cunningham 1989). It is also significant that the regeneration on WB01B1 has been damaged by a recent fire.

The grazing and browsing histories for the critical first few years following logging are generally unavailable for these sites. Inherent differences in productivity among the sites are a further source of variation which adds to the difficulty of drawing conclusions from Figure 5. What this graph does demonstrate is the very slow growth rates that are exhibited by seedlings on many of these dry forests coupes. Mean growth rate of the coupes (other than WT01B1) with some record of grazing is 0.19 m/yr, compared to 0.28 m/yr for the seven coupes without any grazing.

Obtaining regeneration

Where maintaining forest cover or productivity is a primary objective following logging, the application of the best possible silviculture looks beyond the short-term goal of fulfilling survey requirements. It seeks to minimise the uncertainty of regeneration establishment and to maximise early growth rates. The principles of this silviculture are discussed below.

1. *Ensure adequate seed is available*

Seed crops present in a particular area can be predicted by examining the outer crowns of trees of each species for capsules. It cannot be assumed that these capsules still contain seed, or that the seed is mature — it is important to examine individual capsules as well. Adequate seed is usually available in dry forests. In some instances, additional seed of an appropriate provenance may need to be sown. Any sowing should occur as soon as possible following seedbed preparation.

2. *Plan operations for optimal timing of germination*

The timing of logging and regeneration operations is dictated by conflicting operational, logistical and silvicultural constraints. Particular efforts should be taken to achieve silviculturally optimal timing in dry grassy forests where regeneration problems can be anticipated. Figure 6 indicates the preferred timing of operations in these forests. It will allow seedbed preparation when the soils are relatively dry, allows autumn germination and thus allows seedlings to become well established before the first summer. The exception to this general rule of autumn germination is on sites prone to heavy frosts, where low temperatures rather than dry conditions pose the greatest threat to newly germinated seedlings. In these areas, spring germination is preferable.

3. *Log selectively or regenerate before logging*

The retention of a partial canopy following logging can be an important means of moderating the intensity of frosts experienced by seedlings on sites where this represents a significant threat to regeneration. Another advantage of selective logging systems or the retention of seed trees is that these trees can provide an ongoing seed source if there are problems obtaining sufficient regeneration immediately following logging, or if the regeneration is burnt in a bushfire. An alternative approach to providing seed is to establish regeneration before logging and then to take care to protect this from excessive damage during harvesting. The principles of preparing a seedbed at a time of good seed crops, then excluding fire, grazing and excessive browsing, apply equally where regeneration is required but no logging is planned.

4. *Obtain an adequate seedbed*

A mild fire immediately prior to logging should be considered as a means of providing a short-term reduction in grass cover. Such fires are not always practical. Mild fires can also stimulate grass growth and can hence exacerbate the problem if regeneration is not immediately successful. Fires in the year before logging can increase the difficulty of de-barking, making them unpopular with logging contractors.

Seedbed scarification can be a highly effective means of exposing mineral soil and inhibiting the growth of grasses. This mechanical disturbance should have a maximum depth of 10-15 cm, with the surface material 'churned' to expose uncompacted mineral soil and a maximum of microsites for seedling establishment. Our recommendation based on the experience of Forestry Commission staff is that at least 70% of the seedbed in areas requiring additional regeneration should be exposed, providing this is compatible with the requirements of the Forest Practices Code.

Disturbance beyond that which occurs with normal logging is required on grassy sites. This is most effectively achieved using a scarifier such as that recently developed by a Tasmanian landowner, Mr Rodger Shaw, in conjunction with the company Forest Resources (Photo 3). Its hinged design allows the scarifier to be cleaned of debris by reversing the D6 bulldozer on which it is mounted, an important advantage over any root rake used for the same purpose. Scalping with a bulldozer blade is inappropriate as it can lead to the displacement of topsoil and the development of a hard pan.

Scarification is most effective when soils are moist, but not wet. The scarifier should be worked across slopes to increase moisture retention and mitigate erosion problems. The friable, high grade seedbed prepared in this way is rapidly degraded by weathering. It is important that seed is applied as soon as possible after disturbance.

5. *Retain logging slash unburnt*

Top disposal burns should generally be avoided in dry grassy forests. Tree heads felled on to an exposed seedbed and left well dispersed and unburnt can provide a concentrated source of seed, while helping to protect seedlings from frost damage, dry hot conditions, browsing and grazing. Photo 4 illustrates how regeneration can develop beneath an unburnt tree head. In the absence of an adequate seedbed and where browsing can be controlled, top disposal burning can become appropriate as a means of creating a seedbed. This is particularly true in more

Photo 3. The Rodger Shaw – Forest Resources seedbed scarifier.

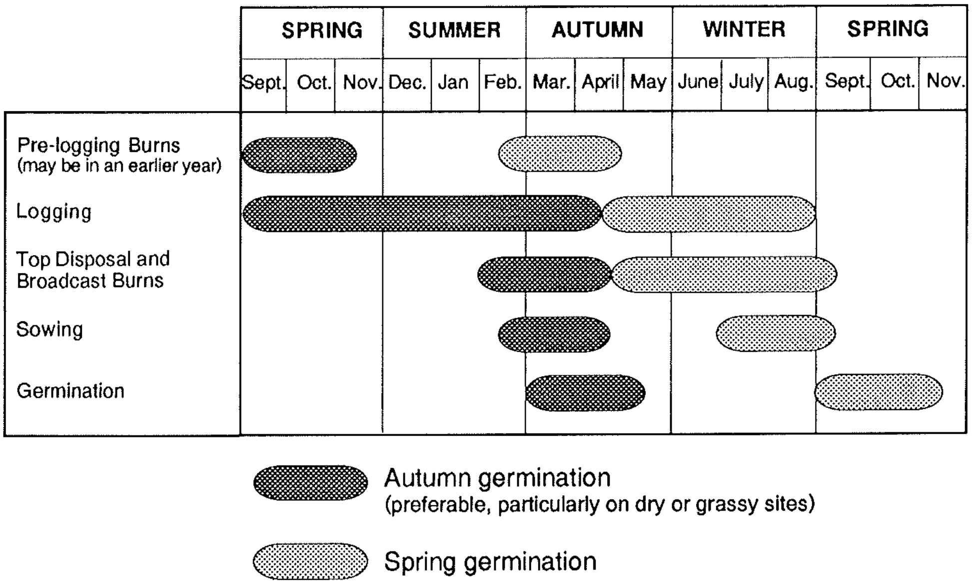

Figure 6. Planning timetable for autumn and spring germination.

productive dry forests, where it can also be desirable as a means of reducing the fire hazard.

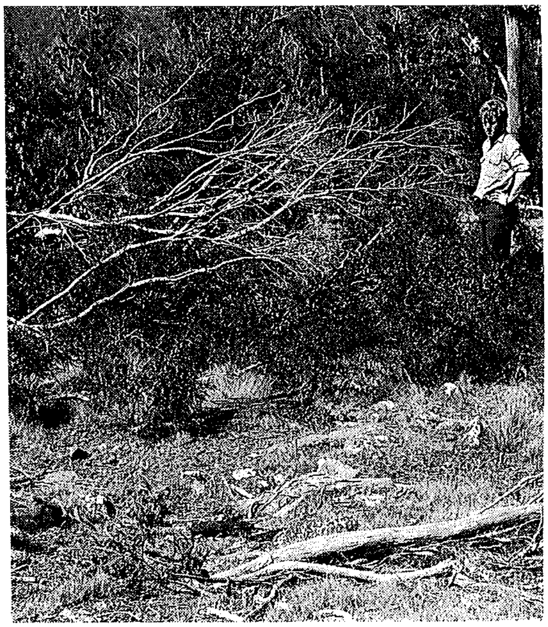

Photo 4. Regeneration developing under an unburnt tree head.

6. *Exclude grazing and control browsing for three to five years*

Two avenues exist for reducing excessive populations of wallabies and possums during the critical years of seedling establishment. Shooting is frequently viewed as being only partially effective: it must be conducted intensively and over an extended period to provide acceptable control. Poisoning with 1080 is far less time consuming and when used as prescribed, is humane, specific and non-residual in the environment (Statham 1983). Its use is presently permitted only for instances of heavy browsing and under strict guidelines and supervision, usually from the Department of Parks, Wildlife and Heritage. Its continued availability for use under these conditions is important for forest managers.

Grazing within two years of logging an area cannot be reconciled with the establishment of reliable regeneration. Management for regeneration should include the exclusion of sheep until the seedlings are at a height where their growing tips will not be eaten. The company Forest Resources requires the exclusion of sheep for a period of seven years.

While we applaud this requirement, many landowners will find this an unacceptably long period. Lower stockings of sheep may be acceptable when seedlings are above perhaps 30 cm tall, provided that the seedlings are carefully monitored and sheep stockings reduced if the regeneration is being excessively damaged.

This conflict between grazing and regeneration establishment must ultimately be resolved by the individual landowner. It is often difficult to fence off a logged area which forms part of a much larger grazing run. Also problems of forest decline that might take decades to eventuate are likely to take second place to short-term financial needs in periods when money is in short supply.

Conclusion

Dry grassy forests present an unfavourable environment for the establishment of tree seedlings. The survival of new seedlings in any particular year is not assured and re-establishing trees on grassy clearfell areas where regeneration has failed is very difficult. Surveys conducted at age one or two do not provide a conclusive indication of success or failure of regeneration in these forests. A permanent seed source can permit continuous recruitment of seedlings, while grazing and browsing can lead to their loss. The very slow early growth rates currently achieved on some of these sites need to be recognised within the yield predictions used for these forests.

Tasmanian forest companies fulfil federal regeneration requirements associated with woodchip exports which include, in part, reforesting four hectares of native forest for each 1000 tonnes of pulpwood harvested. The Public Land (Administration and Forests) Act (1991) now empowers Tasmanian forest owners to make land-use decisions regarding their logged forest areas. If woodchip exports are replaced by local processing, wood prices in contestable markets, together with the accompanying range of indirect benefits of forest cover, should then determine the sustainable yield of wood possible from private forests. This will be the maximum harvest permitted for the forest companies.

It is more important than ever that landowners who wish to maintain the integrity of their wood production and grazing forests become fully aware of the principles of reliable silviculture. They must also recognise the long-term implications of failing to establish regeneration at intervals in grazed unlogged forests. Since problems of forest decline may be expressed only over periods of decades, the implementation of solutions must also be considered as part of long-term land-use planning.

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More detailed information regarding the management of dry grassy forests for wood production is contained in the booklet Managing Your Dry Forests *and in the Native Forests Technical Bulletin series available from offices of the Forestry Commission.*

Tasforests