Lignum (*Muehlenbeckia cunninghamii*) control in the Channel Country

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Summary

Lignum (*Muehlenbeckia cunninghamii* (Meissn.) F. Muell.) and the associated small tree, belalie (*Acacia stenophylla* A. Cunn. ex Benth), grow profusely in the Channel Country of south-west Queensland. They reduce the area's carrying capacity for cattle and make mustering difficult and expensive. This paper reports the effects of herbicides (glyphosate, 2,4,5-T ester, and hexazinone) and fire on topkill and regrowth of lignum and belalie. Fire was the cheapest and most practical method of containing both species, although herbicides were necessary to control root suckers of belalie.

Management options are proposed which involve lightly stocking after a summer flood, burning early in the following summer, then restocking for 2 or more years prior to the commencement of a new cycle.

Introduction

Lignum (*Muehlenbeckia cunninghamii* (Meissn.) F. Muell.) is a perennial woody shrub with many slender, tangled branches and few leaves (Cunningham *et al.* 1981). It grows in ephemerally flooded areas particularly in south and central Northern Territory, south-western Queensland, north-western New South Wales and north-eastern South Australia (Briggs 1981). The Channel Country of Queensland (Figure 1) is one such area (Skerman 1947) where lignum occurs on *c.* 36 000 km of the most productive range, more than half of which is covered by almost impenetrable thickets.

Cattlemen in the Channel Country estimate that carrying capacity is reduced by up to 20% and that mustering costs increase from $2 to $3 per head, to $10 to $15 per head in areas with dense lignum. Of national importance are the delays and increased cost of the National Tuberculosis and Brucellosis Eradication Scheme (N.T.B.E.S.) owing to the additional herd testing involved when there is not clean mustering.

Lignum is a problem requiring a prompt solution. However, CSIRO in its response to a request from the Standing Committee on Agriculture's Animal Health Committee (A.H.C. 1983), stated that 'Lignum is a dominant plant well adapted to its site conditions ... [it] is considered by ecologists to have been well established in its present sites long before European settlement of Australia and not to have spread on a large scale beyond them ... On the basis of what is known and deduced about lignum, it is concluded that lignum would be very difficult to control, remove or replace ...'. Though accepting these arguments, we also realize that clean musters are essential if the N.T.B.E.S. programme is to be finalized.

The only published account of lignum control is that by Campbell (1973) for western New South Wales. He considered that herbicides were generally too expensive and fire had limited application. However, mechanical removal of lignum, or grazing with sheep at a high stocking rate provided satisfactory control. The effects of cattle grazing were variable, possibly because of the low stocking rates normally imposed in lignum areas. Like cattle, goats eat lignum, but higher stocking rates than those usually found in these areas would be needed before they could exert acceptable control.

We addressed the problem of lignum control in three parts. Firstly, we assessed the effectiveness of chemicals and fire in a preliminary study on one site (Maxvale) close to our headquarters at Charleville. Secondly, and in response to the early results from the first part, further studies were undertaken on lignum and an associated low tree, belalie (*Acacia stenophylla* A. Cunn. ex Benth) at Tanbar station in the Channel Country. Finally, the effect of fire on lignum and belalie was assessed on a property near Tanbar, namely Durham Downs, which had been burnt by the owner. Recommendations designed to facilitate mustering in lignum-infested areas are given in the light of the results.

Field studies: Methods

Maxvale

A site at Maxvale station, 10 km north of Charleville (26° 25′S., 146° 17′E.), supporting scattered clumps of lignum

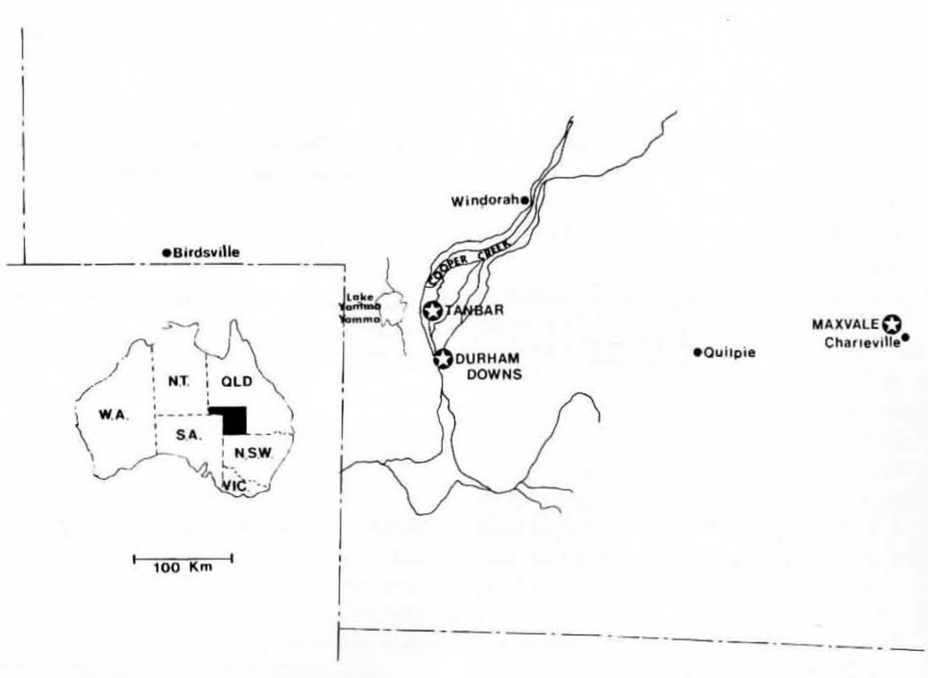

Figure 1 Location of the Tanbar, Durham Downs and Maxvale study sites in south-western Queensland.

growing in intermittently flooded alluvial clay soil was chosen for the preliminary study (Figure 1). In October, 1981, small plots (*c.* 10 m × 20 m) were pegged and three herbicidal treatments were applied to randomly selected unreplicated plots as follows: (i) 2,4,5-T ester (Shirweed 80[R]) at rates of 4 and 8 g L^{-1} and glyphosate (Roundup[R]) at rates of 1.8 and 3.6 g L^{-1} as a high volume, low pressure (knapsack) spray mixed in water; (ii) as for (i) except that the chemicals were applied as low volume, high pressure mist mixed in distillate; and (iii) hexazinone (Velpar[R]L) as a ground application.

Hexazinone was applied to clumps of lignum at rates of 0.5, 1.0 and 2.0 g per clump. A Du Pont Spotgun[R] was used to apply the chemical to the soil surface near the base of each clump.

In July 1982 the effects of the chemical treatments were assessed visually. In October 1982 a portion of each treated area and an untreated control were burnt. The intensity of the fire was rated as 'cool' or 'hot' depending on the height of the flames and the rate of spread of the fire; a fire having flames in excess of *c.* 2 m high and a speed greater than *c.* 0.2 m sec^{-1} was rated 'hot'.

The effectiveness of the treatments was determined in March 1983 by counting the number of clumps in each treatment and noting those showing regrowth.

The test statistic U (Johnson and Leone 1968) was used to determine treatment differences in the proportion of lignum clumps showing regrowth such that

$$U = \frac{A - B}{\sqrt{\left\{ \frac{A*N_A + B*N_B}{N_A + N_B}\left(1 - \frac{A*N_A + B*N_B}{N_A + N_B}\right)\left(\frac{1}{N_A} + \frac{1}{N_B}\right) \right\}}}$$

where A and B are the proportions of clumps showing regrowth from treatment A and B, and N_A and N_B are the total number of clumps assessed for the respective treatments A and B. Differences were considered significant at $P < 0.05$ when $1.96 < U < 2.58$, and at $P < 0.01$ when $U > 2.58$.

It was not possible to differentiate between clumps which were dead prior to treatment and those which died subsequently. However, prior knowledge of the proportion of dead clumps would make the test more sensitive to treatment differences; hence the U values are conservative.

Figure 2 Lignum swamp at Tanbar. The tree is belalie (*Acacia stenophylla*).

Tanbar

As a result of the studies at Maxvale, larger scale studies of the effect of fire and herbicides on lignum and on the associated low tree, belalie, were conducted at Tanbar station south-west of Windorah (Figure 1). An area of lignum swamp to the east of Lake Yamma Yamma (26° 20'S., 141° 40'E.) within the Cooper Creek channels was selected for study (Figure 2). The area is flooded irregularly, and may be inundated for long (6 month) periods. It is impossible to drive a motor vehicle through the lignum, and mustering by horse is slow, especially on account of fallen belalie. Live belalie shrubs occurred at a density of about 550 ha^{-1}.

Standard experimental design could not be adopted because inaccessability prevented delineation of permanent conventional 'plots'. Accordingly, we utilized cattle pads as access routes, and marked these at the edge of the swamp. We imposed our treatments to the left-hand (downwind) side of each track, while the right-hand side was used as an untreated control. Treatments were applied for a distance of *c.* 200 m along each track and a width of of *c.* 10 m.

Treatments, based partly on the results of the Maxvale study, were imposed in July 1982 (Table 1). The 'bash and burn' treatment involved driving over lignum clumps with a 4-wheel drive vehicle to flatten the scrub before setting it alight by means of drip torches. A power sprayer was

Table 1 Treatments imposed at Tanbar

Treatment		Comments
Chemical	Rate ($g\ L^{-1}$)	
2,4,5-T ester in water (Shirweed 80[R])	4.0	Duplicated along two cattle pads
glyphosate in water (Roundup[R])	3.6	As above
2,4,5-T ester in distillate (Shirweed 80[R])	4.0	Basal bark to belalie
hexazinone (Velpar[R]L)	0.5	
burn only		
bash and burn		

used to apply the 2,4,5-T ester and glyphosate (both mixed in water) to the canopy of lignum and belalie. The 2,4,5-T ester in distillate was applied as a basal spray to the belalie only. Hexazinone was applied to the ground surface within the drip-ring of lignum and belalie by means of a Du Pont Spotgun[R].

Owing to the cool weather and the greenness of the grass and lignum, fire would not carry when attempted in July, but a successful burn was achieved in October. In addition, and after the effectiveness of the chemical treatments had been assessed, one replication each of the 2,4,5-T ester in water and glyphosate in water treatment was fired in October.

Lignum clumps and belalie were assessed on a 4-point scale in October 1982 for their immediate response to treatment. The ratings were: 0, no topkill; 1, slight topkill; 2, moderate topkill; 3, complete topkill. It was sometimes necessary to combine two or more of these classes (e.g. 0 and 1; 2 and 3) during the analysis to ensure an adequate size of N_A and N_B in the calculation of U.

In October 1983 and August 1984, regrowth of lignum and belalie was assessed on the following scale: 0, no regrowth (dead); 1, slight regrowth; 2, abundant regrowth. The presence of root suckers on belalie was noted.

Durham Downs

A lignum-infested area of several thousand hectares on Durham Downs, a property on the southern boundary of Tanbar, was burnt by the manager in December 1982. We took advantage of this and in October 1983 recorded lignum and belalie regrowth using the same ratings as for Tanbar. In addition, we used the step-point procedure (Evans and Love 1957) to estimate the proportion of herbaceous plants (defined as grasses or herbs) and woody plants (defined as lignum and belalie) in the burnt area and in an adjacent unburnt area. A total of 1000 points in each area was recorded.

Results

Maxvale

Visual assessment of the effect of chemicals, made in October 1982, indicated that 2,4,5-T ester induced more topkill on lignum than glyphosate, and that high volume spraying (knapsack) was more effective than low volume (misting).

The data collected in March 1983 showed that hexazinone killed more lignum than other chemical treatments (Table 2). Glyphosate at the lower rate was less effective than glyphosate at the higher rate ($P < 0.01$) and 2,4,5-T at either rate with fire. There was no difference between the two rates of 2,4,5-T ester used, nor between glyphosate at the higher rate and 2,4,5-T ester at either rate.

Regrowth occurred on clumps burnt in a 'cool' fire but not a 'hot' fire.

Table 2 Proportion (P) of lignum clumps regrowing at Maxvale following herbicide treatment (n, number of observations)

Treatment	P	n
hexazinone	0.07	284
2,4,5-T ester	0.47	160
glyphosate	0.39	230

Tanbar

Rainfall recorded at the Tanbar house – 40 km from the Tanbar study site – between treatment and the 1983 recordings was low: 1 July to 31 October 1982 – 26 mm; 1 November 1982 to 30 September 1983 – 175 mm, all but 7 mm falling in March, April and May. However, rainfall in 1984 resulted in floods down Cooper Creek, and it was not until August 1984 that the Tanbar site was accessible; the Durham Downs site was then still waterlogged.

Fire had an immediate and devastating effect on lignum (Figure 3) and to a lesser extent on belalie (Figure 4). 2,4,5-T ester was as effective against belalie as was fire, and it and fire induced more topkill in both species than any other treatment ($P < 0.01$). Basal bark application of 2,4,5-T ester to belalie produced better topkill than the foliage sprays ($P < 0.05$).

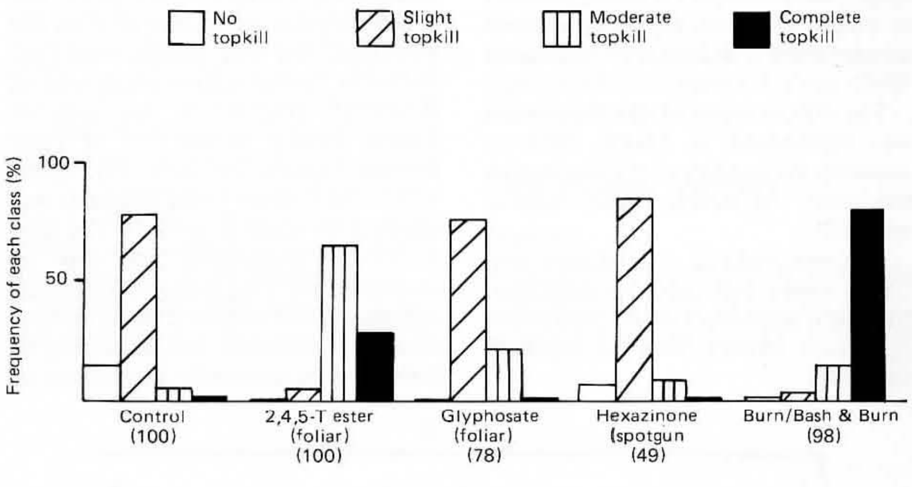

Figure 3 Immediate effect of fire and chemicals on lignum (October 1982). The number of lignum clumps in each treatment is shown below each treatment in parentheses.

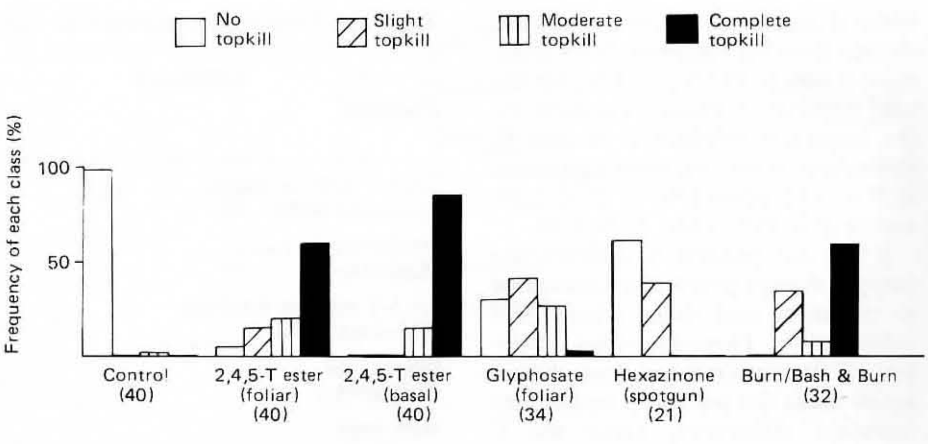

Figure 4 Immediate effect of fire and chemicals on belalie (October 1982). The number of trees treated is shown below each treatment in parentheses.

Regrowth of lignum recorded in October 1983 (i.e. 12 to 14 months after treatment) was substantial (Figure 5). Hexazinone, which had no significant effect on lignum at the recording in October 1982 (Figure 3), now suppressed regrowth better than any other treatment ($P < 0.01$). 2,4,5-T ester and glyphosate, though less effective than hexazinone, performed equally well and significantly decreased the incidence of regrowth ($P < 0.01$). However, fire, either alone or in conjunction with chemicals, was at least as effective as the other agents used against lignum. The recordings made in August 1984 confirmed these findings when 40% of lignum clumps treated with hexazinone, and 24% of those subjected to bash and burn or burn alone showed no regrowth. Most other clumps, regardless of having been treated or not, had recovered.

All treatments adversely affected belalie (Figure 6), but fire and 2,4,5-T ester, either as a foliage spray or a basal bark spray, were considered most effective in both October 1983 and August 1984. Only the application of herbicides suppressed suckering from the roots: fire alone, and bash and burn resulted in suckering (Figure 7). Some suckers which were present in October 1983 died before the August 1984 recordings.

Durham Downs

The results from the Durham Downs fire were consistent with the foregoing, although there was less regrowth of lignum: all lignum suffered topkill, but 52% showed regrowth ($n = 147$). All belalie suffered complete topkill, but 82% of those assessed ($n = 92$) supported root suckers.

The step-point assessment of the ground flora showed the following relationships between the proportion (%) of herbaceous and woody plants in the pasture: 87% herbaceous plants and 13% woody plants were burnt, and 52% herbaceous plants and 48% woody plants were unburnt.

Observations were also made on the condition of lignum and belalie in burnt and unburnt areas. Burnt lignum was < 1 m in both height and diameter and was selectively grazed. Unburnt lignum was > 1 m high—often > 2 m high—and 2 to 3 m in diameter; it was ungrazed. Growth of lignum was more vigorous following burning than when unburnt.

Belalie suckers were grazed by stock—presumably cattle, because on those areas where cattle had been removed, the suckers were about 75 cm in height, whereas in stocked areas this growth was usually less than 40 cm high.

Discussion

The work detailed in this paper indicates that herbicides and fire can open up lignum swamps in the Channel Country and elsewhere to facilitate mustering and to improve accessibility to forage. However, the rough and intermittently flooded terrain, together with high costs, preclude the use of herbicides from ground-operated machinery; the cost of aerial application is also likely to be excessive. For example, aerial application of a 2,4,5-T–distillate mix to brigalow (*Aca-*

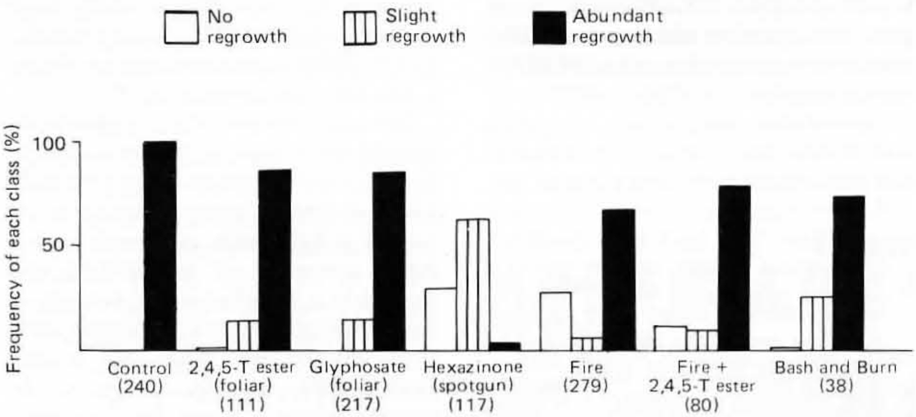

Figure 5 Regrowth of lignum following treatment (October 1983). The number of lignum clumps in each treatment is shown below each treatment in parentheses.

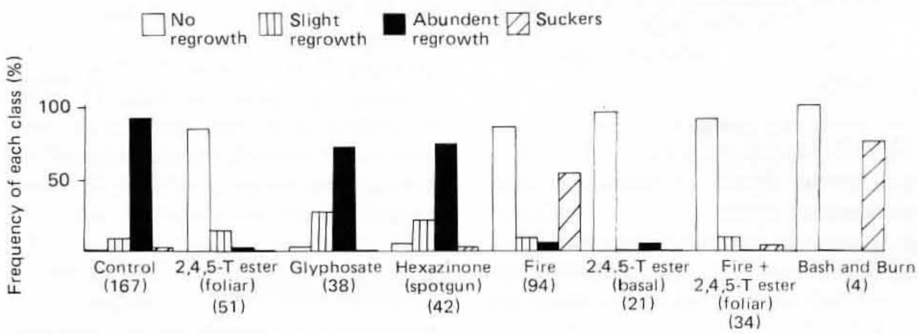

Figure 6 Regrowth and suckering of belalie following treatment (October 1983). The number of trees in each treatment is shown below each treatment in parentheses.

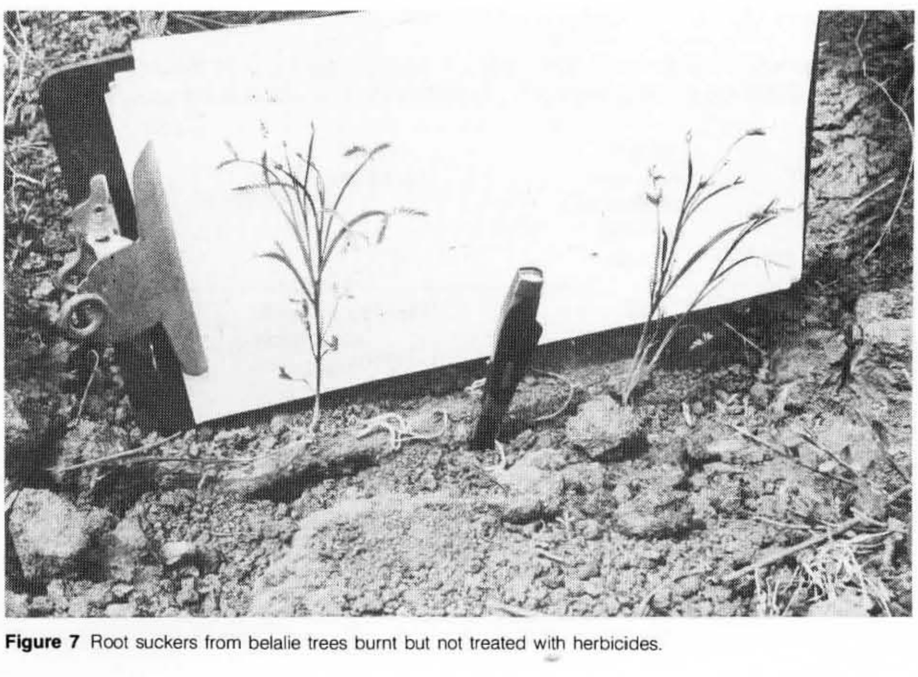

Figure 7 Root suckers from belalie trees burnt but not treated with herbicides.

cia harpophylla) scrub costs about $20 ha^{-1} plus travelling time. Moreover, herbicides only temporarily controlled lignum, although they provide long-term suppression of belalie.

There may be some justification in the use of herbicides as a dessicant to increase the flammability of lignum, but fire is more effective than chemicals in quickly and deleteriously affecting lignum. It also induces a complete topkill in belalie, although suckers will grow subsequently; and it is cheap. Fire also increases the proportion of edible forage species in the pasture.

Accordingly, the problem of lignum and belalie can be managed in one of two ways. Both involve the use of fire.

Option 1

1. Lightly stock (or preferably destock) infested areas after summer flood to encourage development of good grass and herb cover.
2. Fire whenever the weather is suitable (probably November/December).
3. Restock burnt area in the following winter.
4. Stock normally for 2 more years, unless lignum regrowth and belalie suckers become large.
5. Destock after summer rains.
6. Recommence cycle.

Option 2

1. Lightly stock (or destock) after summer flood.
2. Fire in November/December.
3. Stock heavily for first year after fire so lignum and belalie regrowth are grazed.
4. Destock or stock lightly the following year so that fuel can build up, and burn in November/December.

'Lignum control must be a permanent part of the management programme' (Campbell 1973). It is important that the landholder recognize when lignum and/or belalie is getting out of hand, and prepare for burning accordingly. Fire lighting is difficult unless there is adequate fine, dry fuel. This fuel comprises dried lignum branches and the swamp grasses. Our experience indicates that a day of constant but not strong wind, high temperature ($> 36°C$) and low humidity ($< 20\%$) is also required to obtain a hot fire that spreads rapidly.

We consider that the fire should be ignited on a face to ensure sufficient heat to allow the fire to carry. One technique currently being assessed is the use of a helicopter equipped with a 200-L container of fire-lighting mix carried in a sling below the aircraft. A small volume of fuel, released electronically by the pilot and ignited immediately, falls in flames to the ground where it burns for 5–10 min. This technique ensures that a fire-front can be quickly established and maximum heat generated in a short period. Sufficient fine and dry fuel is necessary for the technique to work adequately.

Large-scale fires such as that on Durham Downs are an effective way of opening up lignum swamps. In order to achieve clean musters and to complete the N.T.B.E.S. programme, simple fire-lighting techniques such as those proposed here are essential.

Acknowledgments

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