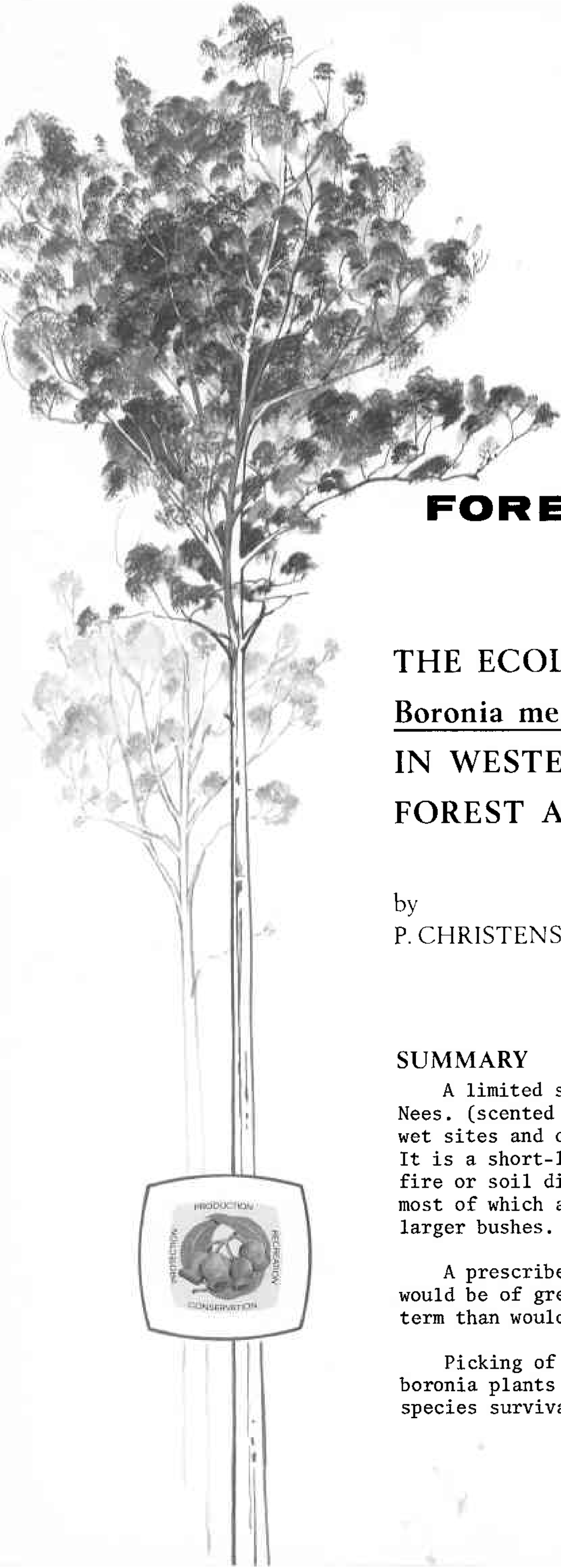

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THE ECOLOGY OF Boronia megastigma (Nees.) IN WESTERN AUSTRALIAN FOREST AREAS

by
P. CHRISTENSEN and P. SKINNER

SUMMARY

A limited survey suggests that Boronia megastigma Nees. (scented boronia) occurs on moist or seasonally wet sites and on various soil types of near-neutral pH. It is a short-lived seral species, regenerating after fire or soil disturbance from soil-stored seed reserves, most of which appear to be contributed by the older and larger bushes.

A prescribed burning regime of periodic spring burns would be of greater benefit to this species in the long term than would more intense autumn burns.

Picking of sprays increases the mortality rate of boronia plants and could eventually prove detrimental to species survival.

INTRODUCTION

Scented boronia (Boronia megastigma Nees.) is one of the more important and better known Western Australian wildflowers. It is a woody shrub 1 to 2 m in height, bearing a profusion of strongly scented brown, purple and yellow flowers. It is picked commercially for sale as flower sprays, and oils used in perfumery may be distilled from the petals.

The species is restricted to sandy swamps in the Warren and Stirling districts of the Southwestern Province (Beard, 1970). Most sites are located within State Forest areas, particularly in the southern sector, and for this reason the species was singled out for special attention in the fire ecology research programme undertaken by the Forests Department of Western Australia.

The characteristics of boronia sites and the effect on boronia of rotational prescribed spring burning on a 5- to 7-year cycle and of picking are the main concerns of this paper.

ECOLOGICAL INVESTIGATION

Site characteristics

A survey of 34 sites listed in a Departmental report by Thompson (1969) and covering a wide area (Fig. 1) was carried out in 1970.

All sites were in wet or seasonally wet situations mostly in jarrah (Eucalyptus marginata Sm.) forest, and

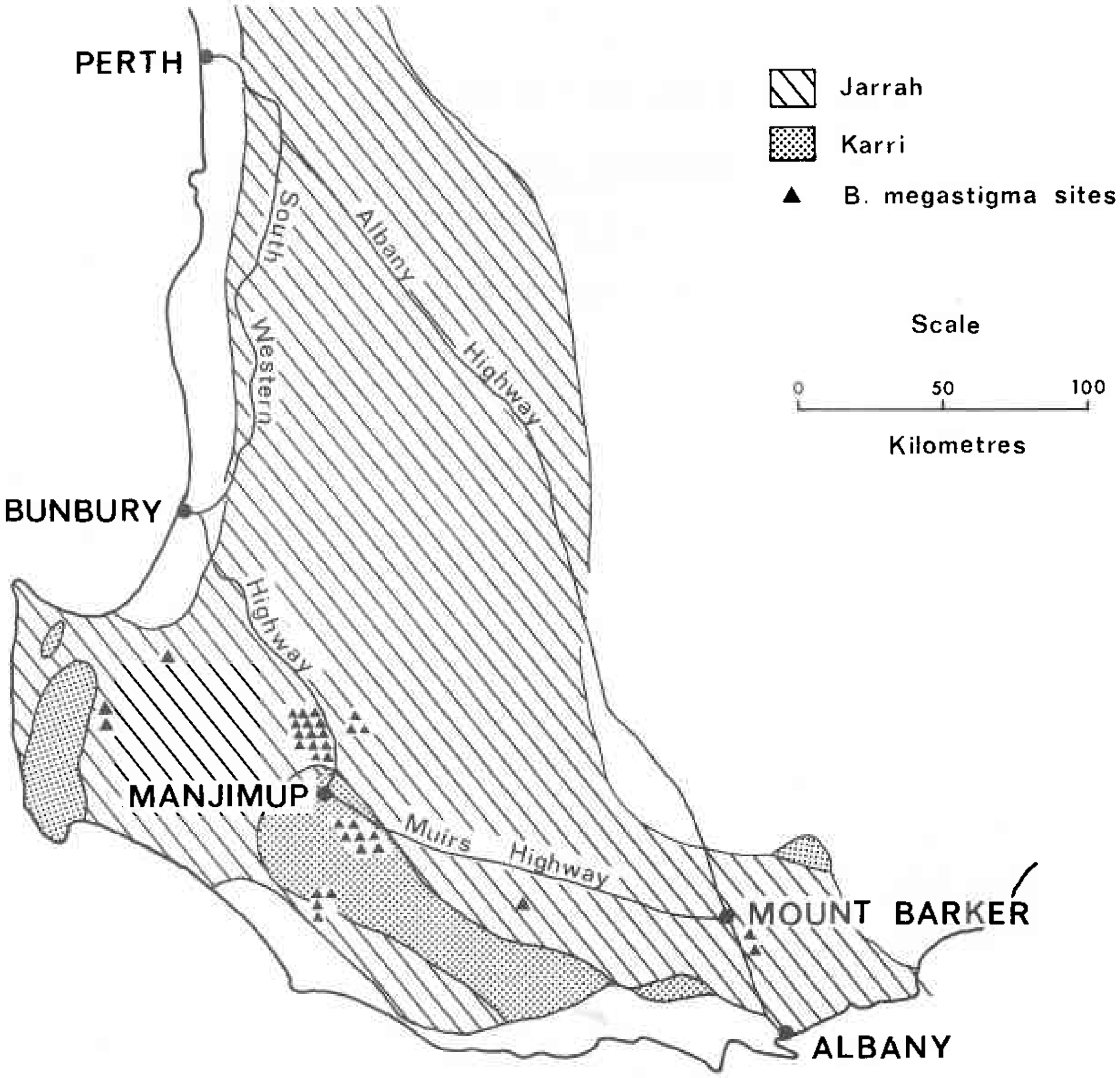

FIGURE 1: Location of 34 B. megastigma sites assessed during the 1970 survey

TABLE 1

Main species associated with B. megastigma and their occurrence expressed as a percentage of the total number of B. megastigma sites

Species	Occurrence (percentage)
Xanthorrhoea preissii Endl.	90
Acacia divergens Benth.	70
Melaleuca parviflora Lindl.	50
Banksia littoralis R.Br.	50
Hakea varia R.Br.	30
Agonis linearifolia (DC.) Schau.	30
Lepidosperma effusum Benth.	30
Eucalyptus megacarpa F. Muell.	30
Acacia saligna Wendl.	30
Dasypogon hookeri Drumm. ex F. Muell.	30

usually along the edges of paperbark (Melaleuca parviflora Lindl.) flats or close to creeks. Throughout the survey (in September) all sites were waterlogged, and on many the water was up to 30 cm deep.

The main species found in association with the boronia on these sites are listed in Table 1; these species are all indicative of seasonally waterlogged or poorly drained areas (Havel, 1975).

In general the boronia occupied shady sites, but it was also frequently found growing in the open.

Soils ranged from white, grey or yellow sands to yellow, brown or red clay loams. The most common was a grey sandy soil, which is the most common soil type in low-lying swampy sites, but the plants also occurred frequently on clayey soils or soils overlying clay.

All soils on which boronia was found growing were neutral or very slightly acidic; no plants were found on the more strongly acidic swampy flats of the southern forest areas. The mean pH of the soils on the 34 sites was 6.5 (95% confidence limit $\pm$ 0.5). Since waterlogged soils commonly contain sulphides which may be oxidized to sulphates, causing a fall in pH (Russell, 1956), soil samples were air-dried and tested again for pH; the mean was 6.4 (95% confidence limit $\pm$ 0.5).

Pot trials (soil types)

Ten pots each of kraznozem, lateritic gravel, sand-loam mixture and grey sand from a boronia swamp were prepared. Small boronia plants between 5 and 10 cm in height were transplanted from their natural sites into the pots, kept in a glasshouse and given routine waterings. Survival and mean heights were recorded after 2 years (Table 2).

Although no definite conclusions can be drawn from so limited a trial, it is evident that boronia is able to survive on a range of soil types provided it receives adequate water. However, the plants growing on grey sand collected from a boronia swamp clearly showed the best survival rate and growth.

TABLE 2

Survival and growth of boronia plants in glasshouse pot trials 2 years after planting

(initial number of plants per soil type = 10)

Soil type	No. of survivors	Mean height (cm)
Kraznozem	4	27.7
Lateritic gravel	4	27.9
Sand-loam mixture	7	29.7
Boronia swamp soil	7	47.2

Seed dispersal and regeneration

Four sites were selected on which to study seed dispersal from parent plants and germination after fire:
Site A - a gully situation with dense, high growth of Agonis linearifolia (DC.) Schau, Xanthorrhoea preissii Endl. and various Lepidosperma species on a grey sandy soil.
Site B - an open, treeless flat with a shallow clayey soil and low, open cover of Hakea varia R.Br. and various small herbaceous species.
Site C - a shaded site dominated by Melaleuca parviflora and Xanthorrhoea preissii on a shallow clayey soil.
Site D - an open, treeless flat with a shallow clayey soil and low, open cover of Hakea varia, Astartea fascicularis (Labill.) DC. and several small herbaceous species.

Site A had not been burnt for approximately 12 years; Sites B, C and D had not been burnt for 6 years.

All boronia plants within a 20 m square plot on Site D were marked with wire pegs, and a number of the larger bushes within plots of similar size on Sites A, B and C were marked in the same way.

Sites A, B and C were burnt in November 1970; Site D was not burnt and served as a control area. Eighteen months after burning, seed dispersal from the large bushes on Sites A, B and C was estimated by placing quadrats measuring 65 cm square at various distances from the marked plants and recording the number of seedlings within them (Fig. 2).

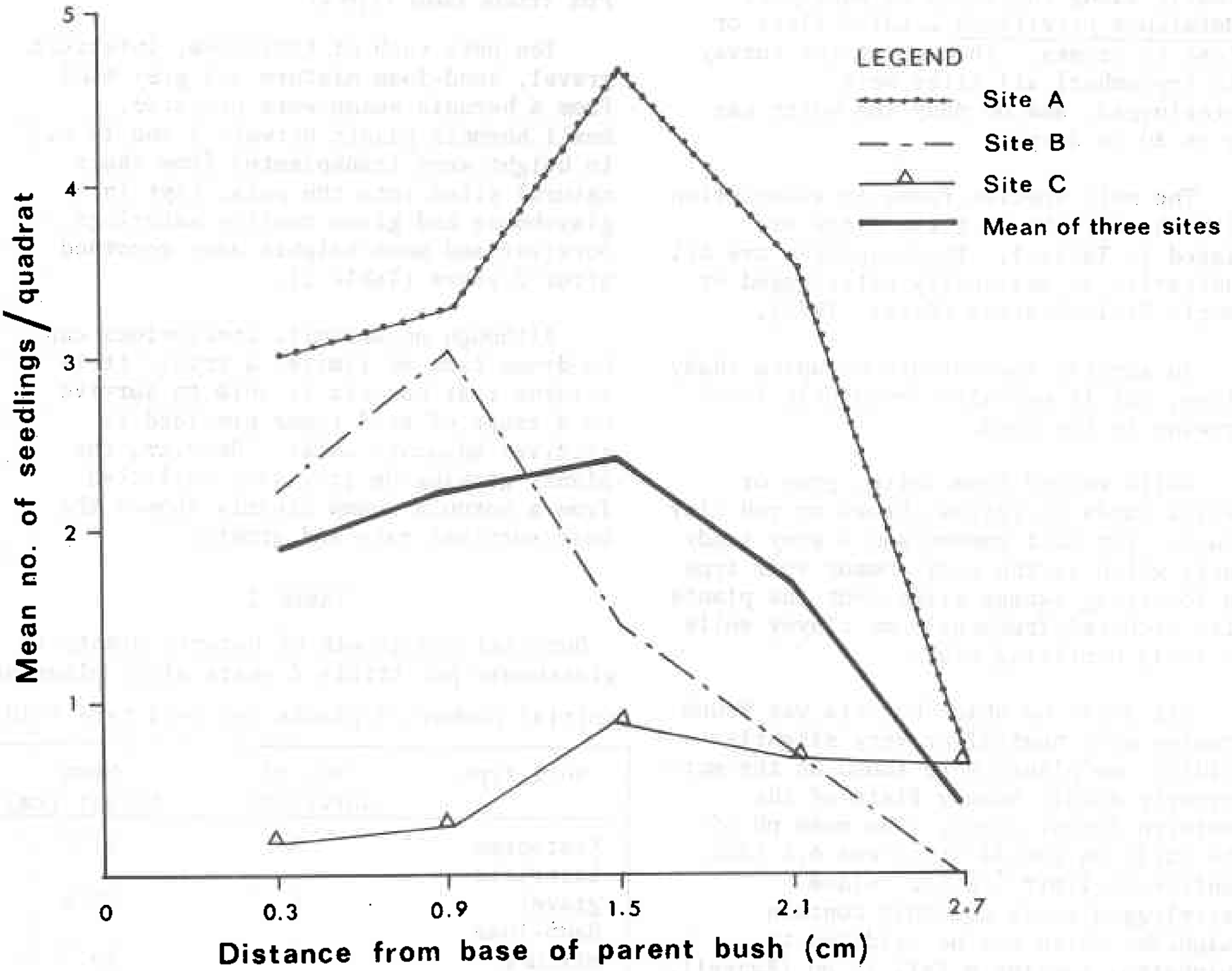

FIGURE 2: Boronia regeneration following spring burning - seedling distribution in terms of distance from parent plants. (Site A: 8 parent plants sampled; Site B: 7 plants; Site C: 7 plants)

Clearly, seed dispersal is limited to the immediate proximity of the parent plants, the greatest density of seedlings occurring within a radius of 2 m. This pattern of dispersal, which is particularly marked in the case of Site A, indicates that most of the seed on a particular site probably originates from the older surviving boronia plants.

To sample seedling numbers and dispersion, the 20 m square plots on all 4 sites were gridded, and counts were made using 65 cm square quadrats placed at random within the grids. Raw data for the burnt sites are given in Table 3.

TABLE 3

Frequency of seedlings on burnt sites 18 months after fire

Seedlings per quadrat	No. of quadrats			
	Site A	Site B	Site C	Total
0	29	16	28	73
1	7	8	1	16
2	4	4	4	12
3	3	4	2	9
4	2	4	4	10
5	2	1	0	3
6	2	1	1	4
> 7	1	2	0	3
Total	50	40	40	130

Chi-square test for goodness of fit for contagious distribution: $p < 0.001$

Seedling numbers were high on all three burnt sites. The proportion of quadrats within each plot which contained seedlings ranged from 30% of the total on the open Site C to 42% on Site A and 60% on Site B. No germination was recorded on the plot on Site D, the unburnt control. Furthermore, only 6 of the 61 boronia bushes originally marked on this plot in 1970 were still alive in 1976.

The numbers of dead seedlings were also recorded; the percentage was particularly high on the open treeless flat (Site B) where 83.3% of the total number of seedlings were dead, compared with 6% and 6.2% on Sites A and C respectively. Since Site B was particularly dry during the summer months, the high mortality rate here is probably attributable to drought stress.

On all sites, seedlings showed typical contagious (non-random) distribution.

Seedling survival

Seedling survival was monitored on Site E, a shaded flat with *Melaleuca parviflora* and *Banksia littoralis* R.Br. on a clayey loam soil. The site had been burnt in spring 1969. The seedlings on 11 plots of area 4 m^2 located at random over the site were marked with wire pegs, and their survival was recorded over a 6 year period (1970 to 1976) (Fig.3).

The graph shows a steady drop in live seedling numbers over the period of study. As may be seen from the data for percentage survival on each plot at the end of the study period (Table 4), mortality was greatest on those plots where seedling density was high. As before, this is attributable to drought stress during the summer months.

Scrub competition

Two 20 m square plots were selected in a swampy area with grey sandy soil The vegetation was dense; the upper storey consisted of *Melaleuca parviflora* and *Banksia littoralis*, whilst *Agonis linearifolia*, *Acacia divergens* Benth. and various *Lepidosperma* species dominated the lower storey.

In 1970 one of the plots, which contained 62 boronia plants, was cleared by cutting all vegetation except the boronia to ground level; the vegetation was subsequently cut at 2-year intervals until 1977. Survival of the boronia over this period was compared with that of 70 boronia plants on the other plot which had not been cleared (Fig. 4).

In addition, the height of 10 selected plants on each of the plots was recorded each year (Table 5).

Clearing the competing vegetation resulted in only a marginal improvement

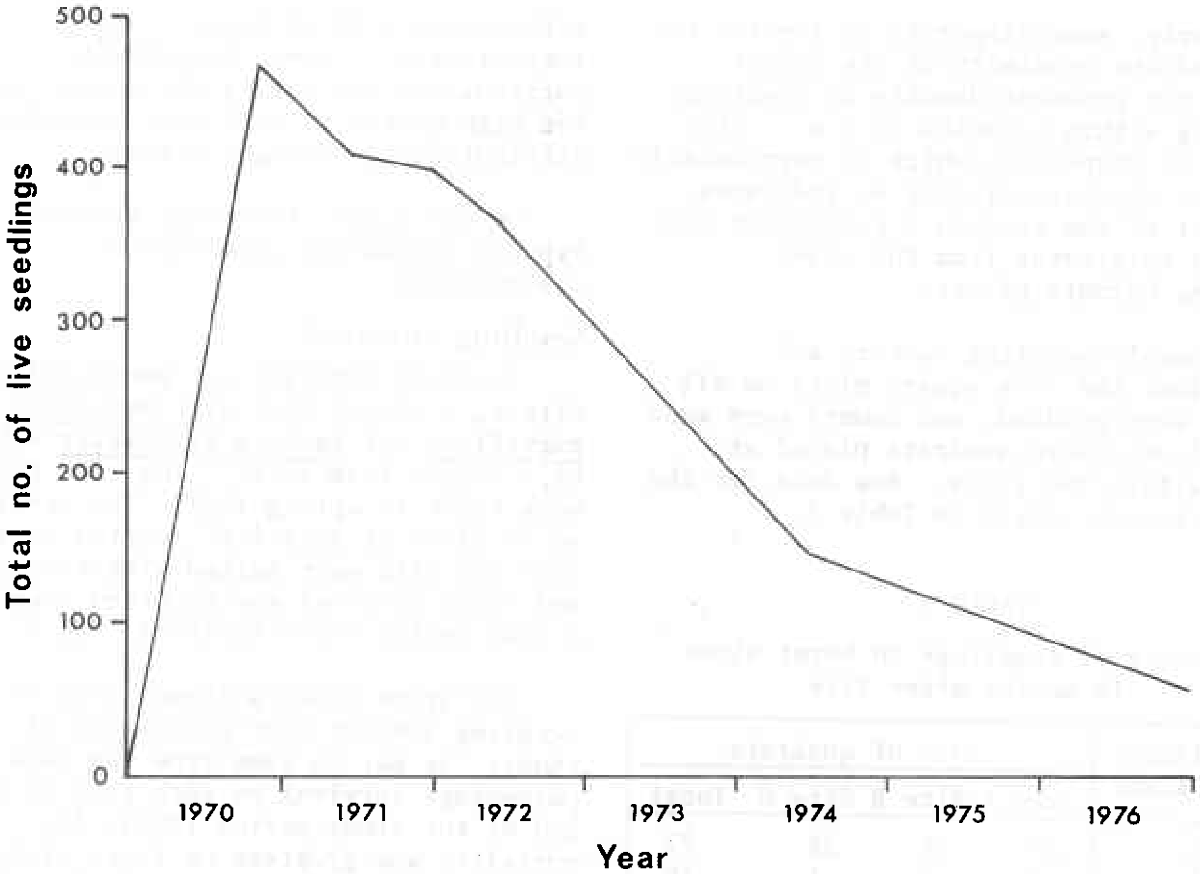

FIGURE 3: Survival of boronia seedlings over a 6-year period after spring burning (in 1969)

TABLE 4

Percentage survival of boronia seedlings 6 years after germination

Seedlings per 4 m^2 plot (Sept. 1970)	Mean no. of survivors (Dec. 1976)	Percentage survival (Dec. 1976)
> 40	7.3	9.9
30 - 40	4.7	9.5
20 - 30	7.5	30.6
10 - 20	6.0	40.0

TABLE 5

Mean height (cm) of boronia plants on cleared and uncleared plots

Plot	Month and year of assessment						
	Sept. 1970	May 1971	March 1972	June 1973	July 1974	Dec. 1976	Aug. 1977
Cleared	50	65	75	100	105	130	135
Uncleared	50	65	80	80	55*	-*	-*

*The plants on this plot which were chosen for measurement died

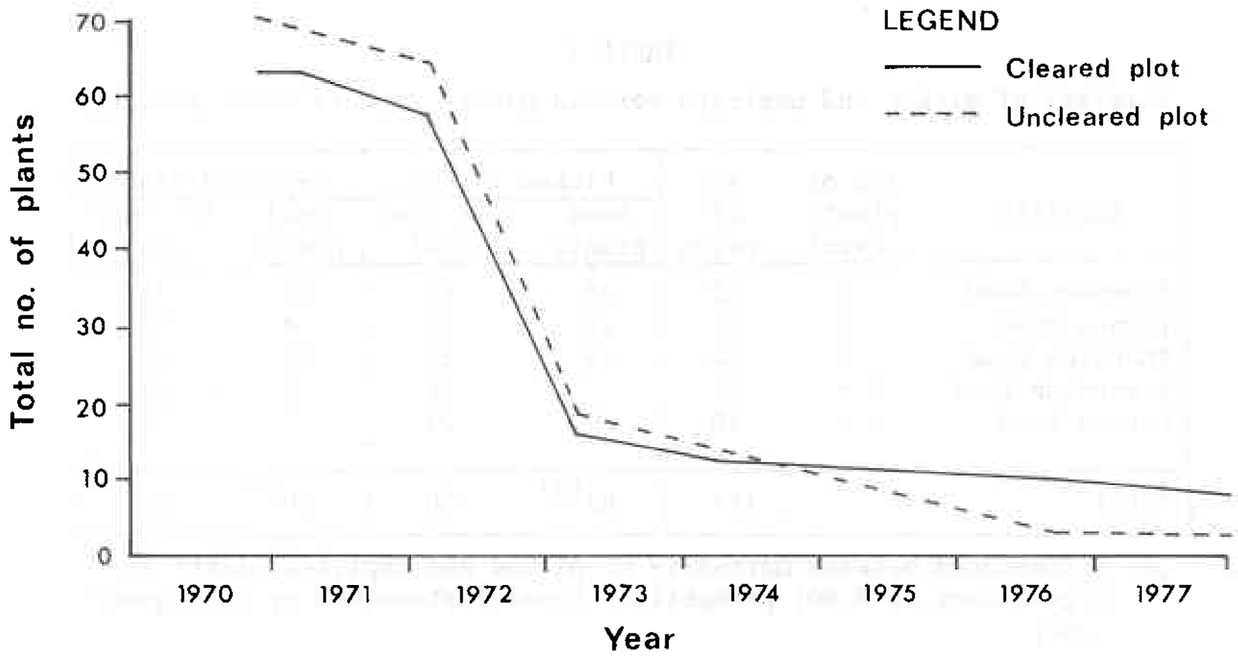

FIGURE 4: Survival of boronia plants on cleared and uncleared plots

TABLE 6

Growth and survival of picked and unpicked boronia plants (pilot trial)

Treatment	Initial number of plants	Mean height (cm)				Number of survivors
		Before picking 24.9.70	After picking 24.9.70	Final height 27.6.73	Height increase	
Site 1 - Unpicked	10	50	-	78	28	4
Picked	10	50	33	61	28	1
Site 2 - Unpicked	10	86	-	119	33	6
Picked	10	86	53	81	28	3

in survival 4 years after clearing, but height growth was greater and the plants appeared more healthy and vigorous on the cleared plot.

Picking

A small pilot trial was established in September 1970 to determine the effects of picking on the growth and survival of wild boronia. Twenty pairs of bushes on each of 2 sites were selected for study. On one plant of each pair, picking was carried out as in commercial flower picking by removing the main flowering branches, whilst the second plant of each pair was left unpicked. The growth and survival of the bushes were recorded over the next 21 months (Table 6).

Both picked and unpicked bushes continued to grow at a uniform rate, one of the side branches taking over as a leading shoot in the picked bushes. However, mortality amongst the picked bushes was higher than that amongst the unpicked controls.

In order to further investigate boronia survival, a more extensive picking trial was initiated in September 1972. Pairs of boronia plants of similar size were selected in each of 5 separate localities; one plant from each pair was picked and the other served as an unpicked control. On smaller bushes the leading shoot bearing the greatest number of blossoms was picked, whereas on the older bushes the sprays were taken from side branches.

TABLE 7

Survival of picked and unpicked boronia plants 2 years after picking

Locality	Age of plants (yrs)	No. of pairs	Picked plants		Unpicked plants	
			Dead plants	Per cent dead	Dead plants	Per cent dead
Thomsons Road	2	52	35	67	20	38
Yornup Road	2	50	22	44	9	18
Thornton Road	3	50	19	38	10	20
Riverside Road	> 6	22	7	32	4	18
Caters Road	> 6	10	9	90	7	70
Total		184	92[a]	50	50[a]	27

(a) Differences between mortality of picked and unpicked plants are significant at 0.001 probability level (determined by Chi-square test)

Survival counts after 2 years revealed a significantly higher mortality rate for the picked bushes than for the unpicked controls (Table 7).

DISCUSSION

Scented boronia is restricted to moist and seasonally moist low-lying sites which are usually waterlogged during winter. Although the species most frequently occurs on grey sand, it is also found growing on clayey and loamy soils. It tolerates only neutral or slightly acid soil conditions and is not found on strongly acidic soils.

Boronia is a short-lived species of the early seral stages following fire, regenerating naturally after fire from soil-stored seed. No natural regeneration was observed in the absence of fire, except occasionally in areas where soil had been disturbed at the edge of forest tracks.

Some plants bloom as early as their first year, and the bushes continue to flower annually throughout their life. The pattern of distribution of seedlings around the large, old boronia bushes suggests that these plants, which are few in number, may be the ones that contribute most significantly to soil seed reserves. Since early mortality is high, seed contribution by the younger and smaller boronia bushes is probably relatively unimportant.

If these assumptions are correct, it is vital that boronia sites remain unburnt for 10 to 15 years to allow the larger surviving bushes to build up flowering capacity and hence soil seed reserves. The current Forests Department practice of rotational prescribed burning on a 5-to 6-year cycle under cool spring conditions (Peet, 1967) successfully protects boronia sites from being burnt too frequently. The sites, which are invariably moist or seasonally moist, rarely burn every rotation; only after 10 to 15 years or more has enough dry fuel built up to allow them to burn under the cool spring burning conditions. In contrast, prescribed burning under hot, dry conditions results in frequent burning of boronia habitats unless these are specifically protected. For this reason, the introduction of broadscale autumn burning along with the short cycle of burning which is currently practised could prove detrimental to the species in the long term. However, observation of germination following autumn fires suggests that an occasional autumn burn results in germination patterns similar to those observed after spring fires.

Picking has a detrimental effect on the survival of boronia bushes. Furthermore, the loss of flowers by picking is the loss of a potential seed source. The fact that boronia pickers concentrate on the larger bushes is consequently of significance in relation to the survival of the species.

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