Clearcutting and burning trials to maintain frost-flat communities, Rangitaiki, Central North Island

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ABSTRACT

A research-by-management trial was established in 1993 at Rangitaiki Conservation Area, Eastern Volcanic Plateau. It aimed to find ways of maintaining the shrub component (monoao, *Dracophyllum subulatum*) of frost-flat communities in the absence of wildfires, and was remeasured in 2002. A randomised block design with five treatments was used: control; cutting and leaving in situ; cutting and removing; cutting and burning; and adding accelerant and burning. Vegetation cover was assessed by point intercept and analysed using a generalised linear model. Monoao cover had decreased with cutting and/or burning, from 54% to 7% or less; seedlings had begun establishing only in burnt plots, but at a much slower rate than on more intense natural or artificial burns. Ground cover of silver tussock (*Poa cita*) had increased dramatically with cutting and or/burning, from 10% to 29% with cutting and 44% with burning. Cover of coral lichen (*Cladia retipora*) had increased dramatically with burning, from 26% to 46%. Control plots remained as monoao shrubland. Burnt plots supported silver tussock grassland. Clearcut plots supported a lichenfield of coral lichen. Clearcutting had not re-invigorated monoao. Neither clearcutting nor burning had promoted invasion by mouse-ear hawkweed (*Hieracium pilosella*). It was considered that the other component of the trial (burning and herbicide treatment) should be remeasured. Further controlled burning experiments in mature heathland are necessary before effective prescriptions for operational burning can be formulated.

Keywords: frost-flat heathland, *Dracophyllum subulatum*, monoao, weed invasion, *Hieracium pilosella*, clearcutting, burning, Rangitaiki Conservation Area, Kaingaroa Ecological District, New Zealand.

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1. Introduction

In summer/autumn 1993, a randomised block trial involving combinations of cutting, burning, and herbicide treatments was set up by Landcare Research and Tongariro/Taupo Conservancy of the Department of Conservation in frost-flat heathland at Rangitaiki Conservation Area. The cutting and burning component of the trial, in old monoao shrubland, was remeasured by Landcare Research nine years later, in winter 2002.

1.1 BACKGROUND

Heathland dominated by monoao (*Dracophyllum subulatum*) formerly covered tens of thousands of hectares of the Volcanic Plateau on sites prone to cold air ponding ('frost-flats') but has been much reduced in area in the last 70 years by afforestation with exotic conifers, clearance for pasture, and invasion by aggressive adventive plants such as broom (*Cytisus scoparius*). Now only one substantial relic (Rangitaiki Conservation Area) and two smaller ones (Waimarama Conservation Stewardship Land and Otangimoana CSL) have reasonable prospects for long-term survival. Like most low open native plant communities, frost-flat heathland is susceptible to invasion by aggressive adventive species, especially mouse-ear hawkweed (*Hieracium pilosella*). This hawkweed was already locally common at the time of the first detailed survey of Rangitaiki in 1988, and is continuing to expand its range there (Smale & Fitzgerald, unpubl. data). In the past, occasional fires have perpetuated monoao dominance by initiating new populations, but fire also promotes the spread of hawkweed. This project aims at finding ways of perpetuating monoao while minimising hawkweed spread, and of maintaining some hawkweed-free samples of frost-flat heathland.

1.2 OBJECTIVES

- Find ways of maintaining the shrub (monoao) component of frost-flat communities in the absence of wildfires.
- Test the practicality and effectiveness of mechanical cutting and of burning monoao shrubland as a means of reinvigorating it, in order to prevent mouse-ear hawkweed from gaining a foothold.

2. Methods

Forty 2 × 2 m plots were established in February 1993 in Rangitaiki Conservation Area using a randomised block design in about 90-year-old monoao shrubland with no hawkweed present. Five treatments were carried out in autumn (March) 1993: (1) control; (2) cut monoao at ground level and leave; (3) cut monoao at ground level and remove; (4) cut monoao at ground level and burn; (5) add accelerant and burn.

Vegetative cover (canopy layer *sensu* Atkinson 1990) was monitored by point intercept method at 96 points in each plot before treatment in February 1993, 20 months after treatment in November 1994 (Smale et al. 1995), and again in June 2002, nine years after treatment.

A generalised linear model (Splus function 'GLM: Splus 6 Release 2 for Windows, Insightful Corporation, Seattle, 2001) was used to fit, firstly blocks, then treatments, to the cover percentages, although in some cases of low percentages, 0.5 had to be added for the model to converge. The variance was assumed to be proportional to the mean, an assumption which was based on residual plots.

3. Results

3.1 INDIVIDUAL SPECIES COVER

After nine years, significant changes attributable to treatment effects had occurred in the cover of coarse woody debris ($P < 0.05$), litter ($P < 0.05$), monoao ($P < 0.01$), silver tussock (*Poa cita*) ($P < 0.05$), coral lichen (*Cladia retipora*) ($P < 0.05$), woolly moss (*Racomitrium lanuginosum*) ($P < 0.01$), and unidentified mosses ($P < 0.01$).

Coarse woody debris—monoao stems left behind after burning or clearcutting—covered 9% of the ground on average in plots burnt with accelerant, 3% in burnt plots, and 4% in clearcut plots, but was negligible elsewhere.

Litter covered 2% of the ground on average in plots burnt with accelerant, but was negligible elsewhere.

Monoao cover decreased dramatically in all treatments, from 54% on average in control plots down to 6–7% in clearcut treatments and 2% or less in burn treatments. Monoao seedlings had begun establishing in burnt plots, but were still at very low densities. No monoao seedlings were present in control or clearcut plots.

Silver tussock cover increased dramatically in all treatments, from 10% on average in control plots to 29% in clearcut plots and 41–48% in burnt ones.

Coral lichen cover increased dramatically in burn treatments, from 26% to 45–47%.

Woolly moss cover decreased from 9% to 2% in plots burnt with accelerant, and to 5% in clearcut plots where monoao was removed.

Changes in the cover of unidentified mosses were significant but very small (Table 1).

No other changes in species cover or species richness were significant.

TABLE 1. MEAN PERCENTAGE COVER OF SPECIES NINE YEARS AFTER CLEARCUTTING AND BURN TREATMENTS IN FROST-FLAT HEATHLAND AT RANGITAIKI

	CONTROL	CUT AND LEAVE	CUT AND REMOVE	CUT AND BURN	ADD ACCELERANT AND BURN
Dracophyllum subulatum	54	5.6	7.3	2.3	0.1
Cladia retipora	25.5	45.3	47	25.8	22.3
Racomitrium lanuginosum	9	10.3	5	9	2.3
Poa cita	9.8	28.8	28.8	41.3	47.5
Pimelea prostrata	0.1	0.8	1	1.8	0.5
Leucopogon fraseri	0.1	0.3	0.3	0.3	0.3
Deyeuxia avenoides	0.5	1	3	2.1	1.9
Cladonia capitellata	0.6	0.4	0.7	1.7	0.5
**Hypochoeris radicata*	0.1	0.1	0.4	0.6	0.6
Cladonia spp.	0.6	1.8	3.3	1.8	3.3
Cladia sullivanii	0.3	0	0.1	0	0
Cladina leptoclada	0	0.3	0	0.3	0
Polytrichum juniperinum	0	0	0	1.4	1.6
Celmisia gracilenta	0	0	0.1	0.4	0.1
Geranium sessiliflorum	0	0	0	0.4	0.3
Uncinia rubra	0	0	0	0.1	0
Unidentified mosses	0	0.1	0	3	0.5
Species richness	7.3	7.8	9	11.3	9.8
Litter	0	0.8	0.3	0.3	2
Coarse woody debris	0	4	0.8	2.8	9.3
Bare soil	0.8	1.8	5.5	7.5	11.5

3.2 PLANT COMMUNITIES

After nine years, control plots remained as lichen–shrubland of monoao–coral lichen (Fig. 1). Burnt plots had become lichen–grassland of silver tussock–coral lichen (Figs 2 and 3), while clearcut plots had become grass–lichenfield of coral lichen–silver tussock (Figs 4 and 5).

Figure 1. Control plot, monoao shrubland, Rangitaiki Conservation Area.

Figure 2. Burnt plot, silver tussock grassland, nine years after cutting and burning.

Figure 3. Burnt plot, silver tussock grassland, nine years after adding accelerant and burning.

Figure 4. Clearcut plot, lichenfield of coral lichen, nine years after cutting and leaving monoao.

Figure 5. Clearcut plot, lichenfield of coral lichen, nine years after cutting and removing monoao.

4. Discussion

The small-scale controlled burns in this experiment were effectively 'crown fires', removing only the monoao canopy and leaving much of the ground layer vegetation unaffected. Most natural fires in frost-flat heathland are much more intense, eliminating most of the ground layer as well and creating large areas of bare soil. One year after a natural fire ignited by a lightening strike at Rangitaiki in 1994, bare soil comprised up to half of the ground area (Smale & Fitzgerald unpubl. data), compared with less than 7% initially in this experiment, and virtually none of the pre-existing vegetation remained alive. Thus the burns in this experiment were much less intense than most natural ones.

The reduction in monoao in burn treatments is directly due to fire; the species is highly flammable and promotes fire (Smale 1990). The reduction in monoao in clearcutting treatments results from its inability to coppice after removal of the existing crown; plants are killed when their crowns are removed entirely. Large increases in silver tussock cover in clearcutting and particularly burn treatments result from the species' well-known ability to colonise bare ground. Eight years after the 1994 lightning fire at Rangitaiki, silver tussock now covers over half the ground (Smale & Fitzgerald unpubl. data). Coral lichen survived mild experimental burning here and its cover has expanded greatly since. It was similarly conspicuous 14 years after a large accidental fire nearby (Smale 1990). The large immediate increases in woolly moss cover in nearly all treatments (Smale et al. unpubl. 1995) have not been maintained; the pre-existing moss carpets have not survived the sudden removal of the monoao canopy above them.

Monoao seedlings began establishing after five years on the much more intense 1994 lightning fire, but after eight years they are still at extremely low densities and cover only 0.2% of the ground (Smale & Fitzgerald unpubl. data). Fourteen years after the large accidental fire at Rangitaiki, monoao constituted only 0.5% of total cover (Smale 1990). Twenty years later, seedlings were still establishing on this area (authors, pers. obs). Nine years after the experimental fire here, monoao densities in the burn treatments (1875 plants/ha) are well below those in established communities (c. 30 000 plants/ha) (Smale 1990) and cover is negligible. Monoao is evidently establishing more slowly here than on more intensely burnt sites.

Substantial increases in average cover of bare soil are still evident in burn treatments, although not significant, and smaller increases in clearcutting treatments. Ultimately, they should enhance opportunities for the establishment of a new cohort of monoao, but only as long as mouse-ear hawkweed remains absent from the site. Despite the plots being hundreds of metres from the nearest known seed source, hawkweed began establishing within two years on the 1994 lightning burn. Hawkweed is not yet present in the existing trial, but plants that had established a few metres away in intact mature heathland were removed during remeasurement. A close seed source now exists alongside the old Lochinver Station access road.

5. Conclusions

Nine years after clearcutting old heathland, there is no evidence of another cohort of monoao establishing. Clearcutting mature frost-flat heathland does not appear to be an effective means of re-invigorating the shrub component of frost-flat communities. In contrast, after experimental fire, another cohort of monoao has begun establishing, but at a slower rate than on more intense burns of natural or artificial origin. In the absence of treatment, there is no evidence of another cohort of monoao establishing in old heathland.

Neither clearcutting nor burning have promoted the spread of *Hieracium pilosella* in old heathland. However, every effort should be made to contain its spread by controlling populations along roads in the northern part of Rangitaiki C.A. (old Lochinver Station access road and the boundary road around the Taupo District Council plantation on Omeruiti Hill).

Further monitoring of the existing trial is needed to document the re-establishment of monoao in burnt plots. In addition, the burning and herbicide component of the trial in lichenfield should be remeasured.

Should the Department of Conservation adopt controlled burning as a management tool for frost-flat heathland, further controlled burning experiments in mature heathland at a range of scales and involving a variety of fire intensities are necessary before effective prescriptions for operational burning can be formulated.

6. Acknowledgements

Taupo Field Centre of the Department of Conservation under Ralph Turner carried out the treatments. Harry Keys (DOC Tongariro/Taupo Conservancy) liaised over the trial. Greg Arnold (Massey University/Landcare Research) carried out the statistical analyses.

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Erratum

Smale, M.C.; Fitzgerald, N.B. 2004: Clearcutting and burning trials to maintain frost-flat communities, Rangitaiki, Central North Island. *DOC Science Internal Series 157*. Department of Conservation, Wellington. 12 p.

Readers should note that cover of coral lichen (*Cladia retipora*) increased dramatically from c. 26% to c. 46% with clearcutting—and not with burning, as originally stated in the Abstract, Section 3.1 and Section 4.