INITIAL RESPONSES OF *BOTRYCHIUM AUSTRALE* AND *FESTUCA NOVAE-ZELANDIAE* TO FIRE AT CASS

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INTRODUCTION

While fire has been important in the past in replacing *Nothofagus solandri* forest with grassland through much of the eastern Canterbury high country 600-800 years ago, and for management of grazing properties in that area until early this century, there has been a tendency to think of this as being of historical interest only. A major wildfire which burnt 580 ha of grassland, shrubland and forest at Cass in May 1995, started by a faulty railway wagon, has shown in graphic detail exactly how powerful the current effects of fire on the New Zealand vegetation can be. In this report I document the initial responses of two native plants: *Festuca novae-zelandiae* (hard tussock) and *Botrychium australe* (parsley fern).

The nature and extent of the Cass fire was described in last year's Journal (Kelly, 1995). Briefly, the fire was blown from west to east by a north-west wind, travelling the length of Waterfall Terrace beneath Mt Horrible and Mt Misery. It had most effect on tall (2 m) diverse shrublands covering the terraces. More closely grazed areas, dominated by browntop (*Agrostis capillaris*) often had little fuel and were largely unburnt; the wetlands in Horrible Bog were only lightly singed on top, with most plant material being too wet to burn; and *Nothofagus* stands did not carry the fire well, so only the numerous isolated trees and the fringes of larger stands were killed. (In passing at this point it is worth saying that, fortunately, the fire bypassed the main area with *Nothofagus fusca* on Corner Knob described by Burrows & Lord (1993), so this important evidence of a long-distance dispersal event still survives.)

However, much of the shrublands on Waterfall Terrace were completely burnt; only small refuges here and there escaped the flames. These refuges may prove to be very important in supplying seed for recolonisation of the whole slope, but this will be a slow process. The effects of the fire on the native shrubs will not be addressed here; a detailed study of these is currently under way by Ashley Sparrow, so expect to see some description of findings on those plants in the next year or so. Here I focus on two native herbaceous species growing in the area.

FESTUCA NOVAE-ZELANDIAE

In last year's article I reported that in some areas of mixed grassland/shrubland the fire was patchy. Embers or flames had set light to the taller vegetation (shrubs and tussocks of *Festuca*), which burnt to ground level, while the shorter turf of browntop between did not carry the fire. The result was a "leopard spot" effect with burnt *Festuca* surrounded by unburnt browntop (*Agrostis capillaris*). I was therefore interested to see in 1996 how the *Festuca* had survived the fire. To do this, with the help of some second year ecology students, I ran out quadrats 5 m by 20 m along the lower slopes of Waterfall Terrace where the shrubland intergraded with grazed, semi-improved pasture. This was the zone where *Festuca* was most common. Within these quadrats, all discrete *Festuca* tussocks were examined for signs of regrowth.

There were substantial numbers of *Festuca* plants in two of the quadrats, and of these about half were showing some signs of resprouting (31 of 89 in quadrat one, giving 35% resprouting; and 62/121 in quadrat two = 55.6%). Combined with the small number in a third quadrat further upslope, where 5 of 9 plants had survived, the overall survival of *Festuca* was 44.7%. Therefore one initial effect of the fire seems to have been to reduce by half the population of tussocks. Moreover, the ultimate effect is likely to be even worse than this. The identified *Festuca* tussocks had pre-fire been a range of sizes from small (1-2 cm diameter) up to relatively large (15 cm diameter). Almost without exception the resprouting *Festuca* was from only a small part of the original clump, so most surviving tussocks were severely reduced in size.

If all other vegetation had also been burnt, then the *Festuca* may have been able to regrow rapidly and retain its former ground cover within 10-20 years. This was not the case; as noted above, browntop was largely unburnt. One of the most striking features of Waterfall Terrace in 1996 is the vigorous growth of browntop across much of the area. The lower slopes were oversown with browntop seed after the fire (A.D. Sparrow, pers comm); presumably, reduced plant competition and increased available nutrients from ash have also promoted its regrowth. (This, along with "control" of shrub encroachment, is exactly why the early runholders were so fond of fire.)

This leads to the first conclusion from my observations at Waterfall Terrace. In the presence of browntop, each fire acts as a ratchet, steadily reducing the cover of the native tussocks. This is consistent with earlier observations about the rapid increase to dominance of browntop in the Cass area this century (White, 1991). The tussocks are important both for their landscape values, and because they provide some shelter from grazing for smaller herbaceous native plants. It seems that minimizing fire frequency is important if browntop is not

to take over in the area. This is obvious in relation to fire preventing re-establishment of native shrubs and forest, but was less obvious to me beforehand in relation to *Festuca* (which, after all, owes its current abundance largely to forest destruction by fire - but in the absence of browntop).

BOTRYCHIUM AUSTRALE

As noted in last year's article, the fire burned right through an area on Waterfall Terrace where I have monitored a population of the uncommon native fern *Botrychium australe* since 1986. The demography of this population pre-fire was described by Kelly (1994a); in essence, plants are long-lived with a swollen underground storage organ from which arises a single leaf per year, which lasts for 12 months. The single frond (which looks more like a parsley leaf than a fern, hence the common name of parsley fern) may or may not bifurcate below ground level to produce a fertile spore-producing segment (the fertile frond). In 1986-93, the majority of plants on Waterfall Terrace did not produce fertile fronds (in the various years from 1987-93, between 9 and 19% of plants were fertile, mean 13%). I also showed that plants in deep shade underneath shrubs were much less likely to be fertile than plants on the edges of shrubs or out in the open.

Therefore I speculated last year that *Botrychium* would not be likely to be killed by the fire; and (searching for a silver lining to this particular cloud) that decreased shading by shrubs may even benefit this one species. Braggins (1980) in the definitive description of *Botrychium* biology reported that it seemed to be adapted to life in disturbed areas such as fire scars.

During the fire all but one of my 118 marked plants were singed or burnt, so their leaves were removed. This year's survey in May 1996 showed good survival, as expected. Measurement of survival in *Botrychium* is complicated by the fact that plants may "skip" a year, sitting quiescent underground without an above-ground leaf, but returning to "life" one or two years later. Until 1997 I can't tell the difference between new deaths and quiescent plants; but 91% of last year's plants have put up a leaf this year and hence are survivors. This is about the same as the equivalent data from non-fire years (76-97% in-leaf each year; mean 89%) so there is no evidence at this stage of fire-induced mortality.

There is also a suggestion that fertility is higher than usual this year; fully 27% of plants had a fertile frond, although many of these fertile fronds were small. This is a higher percent fertile than in any previous year (excluding 1986, which may have been biased by the greater ease of finding fertile plants; Kelly, 1994a). So *Botrychium* may be responding to the higher light (Kelly, 1994a) following shrub canopy death, or to increased nutrients, by increasing its reproductive

output. Of course, conditions for establishment of new individuals by spore or seed are usually particularly favourable post-fire, and many other species are known to flower heavily after fire, such as *Chionochloa* (Kelly, 1994b).

However, growth of browntop was vigorous throughout the *Botrychium* area too. There was already quite a dense mat of grass leaves and litter by May 1996. I now suspect that grass competition may end up being at least as severe as competition with the now-dead shrubs had been, reducing the "window of opportunity" for *Botrychium* establishment and growth.

CONCLUSIONS

The fire had strong negative effects on *Festuca* where the native tussocks were burnt. *Botrychium* has come through relatively unscathed and produced many spores in 1996. However, the real winner post-fire seems to have been browntop, and this may make recovery by *Festuca* and establishment of new *Botrychium* plants more difficult. In balance, the fire has not been much of a blessing even to the native plants that survived it.

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