Broom control monitoring at Tongariro National Park

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Abstract

Monitoring was undertaken in Tongariro National Park to determine the level of control achieved for patches of broom *(Cytisus scoparius)* on the western side of the Park in 1997 and 1998. Control was achieved by cutting broom stems and painting the stump with herbicide (Roundup 150 ml per 15 L and vegetable dye) or by pulling plants. The control work and thus the monitoring focused on isolated patches of broom that were thought to represent invasion loci. Flowering plants were targeted for control in order to reduce the amount of seed produced. The fate of tagged plants was followed. Eighty-two percent of flowering broom were killed (i.e. those over 30 cm). Of plants over 1 m, 90% were killed. After two years, control of patches was variable (71% ± SE 11). This study demonstrates the need for staff to be as thorough as possible when they are controlling weeds with a patchy distribution. The cost of getting to each patch is significant, so staff need to be sure they have achieved all they can before they move on to the next patch. Increased care and effort could raise the proportion of plants killed in each patch; ideally this should be as close to 100% as possible (at least 95%).

1. Introduction

Reviewing the performance of weed control operations is an important part of the cost benefit analysis that one must undertake in the management of any weed problem. This study looks at the level of control achieved in patches of flowering broom treated in 1997 and 1998.

The control of broom *(Cytisus scoparius)* along Highway 47 has been part of the work programme for staff in Tongariro National Park since well before 1987 when the Department of Conservation was formed. When the potential for the plant to invade the area was realised in the 1960s, the goal was to keep broom from crossing the highway into the Park. Broom has crossed the road and now occurs in large high-density patches within the Park but only near the highway. There is also a scattering of isolated patches further upslope and away from the highway. These areas are called the "low-density patches'.

Various weed control methods have been tried, including spraying patches with 2,4-D from a helicopter in the 1970s and 1980s (Paul Green pers. comm.). This method was unacceptable because native plants were killed, and it appeared to facilitate invasion of weeds (both re-invasion by broom, and invasion by grasses). Current weed control methods are described below.

1.1 FOCUS ON LOW-DENSITY PATCHES

The low-density patches (outliers) are the focus of this study and recent control work. This is because it is believed that the effective control of broom will best be achieved by controlling the low-density patches in the first instance (as opposed to the high-density patches near Highway 47). A focus on low-density outliers is widely considered to be good practice (Hobbs 1993; Robertson 1994). This is partly because low-density areas represent the leading edge of the invasion into the Park and therefore the main threat. Furthermore, this strategy is favoured because the clearance of small patches of weeds causes smaller disturbances. Recolonisation of the cleared patches by weeds is less likely when sites are less disturbed and colonisation by natives is more likely (Robertson 1994). Accumulation of a large seed bank may also be prevented by getting in early and controlling flowering plants before they set seed.

Broom plants produce anywhere between 100 and 20 000 seeds per plant (Williams 1981, Rees & Paynter 1997). Broom seed banks are patchy and slowly depleted (Allen et al 1995) so it is essential to prevent the formation of large patches of seed-producing plants. Seed banks near broom plants can range from 114 to 30 000 seeds per m^2 but average around 3000 per m2 in old stands (Williams 1997). Killing mature broom plants in the first instance and then killing remaining plants before they set seed will slow down the accumulation of large seed banks in and around isolated patches. As control work is undertaken in patches, this will increase light levels at ground level which could lead to a "release" of the seed bank. Seed germination effectively depletes the population of live viable seeds stored in the soil seed bank. As long as these sites are re-visited and control is achieved before the young plants mature, progress will be made, i.e. no new seeds will be added to the seed bank.

2. Methods

2.1 CONTROL METHODS

The aim of this ongoing control programme is to control outlying patches that are up-slope of the high-density broom infestations near the highway, thereby lowering the upper altitude limit of broom in Tongariro National Park. Control is undertaken while plants are in flower and readily spotted from the air. The aim is kill all the flowering broom in isolated patches. We found that most plants over 30 cm were in flower.

Control is achieved by cutting broom stems and painting the stump with herbicide (Roundup 150 mL per 15 L and vegetable dye) or by pulling plants. Although the control is done on the ground, a helicopter is was used to ferry people, one or two at time, from broom patch to broom patch. Anywhere between 6 and 20 people may be involved. The helicopter pilot and the staff member in charge of the control operation decide on an area to cover during that day. The pilot then drops people off at the patches in this area and they control target plants in the patch. The pilot then moves on and picks up others and ferries them on to other patches. The pilot and control crews seek out patches as they fly. The success of the method relies heavily on the ability of the pilot to keep track of broom patches and people. Eventually the pilot returns to pick up people at each patch and they look for another patch to control. At this point people may or may not have finished controlling all the target plants in a patch.

2.2 MONITORING METHODS

The methods used in this study are designed to cope with the wide spatial distribution of the broom - approximately 5000 hectares of land was searched in the National Park between Mangatepopo Road and National Park township (Map 1).

Control occurred once in December 1997 and once in December 1998 during the course of the study.

Because the control methods are reliable (Peter Morton pers. comm.), we are not measuring the efficacy of the control techniques per se (see above) but the ability of staff to find the broom plants for control. It is assumed that a record of a treated tagged plant is a record of a successfully killed plant. Clearly this is a reasonable assumption for pulled broom plants and we are confident that, as long as cut stumps are treated with herbicide, plants will die.

Monitoring before control in December 1997

Broom patches were mapped in early December 1997 using a *differential* Global Positioning System (GPS) fitted to a Hughes 300 helicopter. A simple map of broom patches was produced from the logged data (Map 1). Sixty-five patches were recorded and logged into the computer in four hours. Contemporaneous notes were kept while the pilot was logging the locations into the GPS computer. Unfortunately the print-out received back from the pilot did not match exactly the number of patches recorded on paper. The contemporaneous notes provided the more reliable information. The map records a smaller number of patches but illustrates the distribution of patches adequately. A thorough search of approximately 5000 ha was achieved and taken to be a complete census of the broom patches in the "low-density" area.

Of the 65 patches logged/mapped from the low-density zone, 11 were selected for monitoring. Thus about 16% of all the of patches were monitored. GPS readings were taken at patches selected for monitoring ("sites") so that they could be relocated in the following year. However, only five of the eleven sites were successfully relocated in the second year (February 1999). At each patch, a one-metre wooden marker peg was hammered into the ground and a maximum of 15 plants were tagged. Where possible, plants were evenly selected in three size classes: under 30 cm, 30-100 cm, and over 1 metre. Plants in the two larger size classes were the target of the control operation. Bearings and distances from the each plant to the peg were recorded so that the individually tagged plants could be relocated.

On a subjectively chosen bearing from each marker peg, a 2 m wide swath was searched until a minimum of 30 individual plants in the three size classes (above) was found. The number of plants in each size class was recorded. This was done in order to characterise the size class distribution of the broom at the sites. This was repeated after control, i.e. in February 1999 after the control in December 1998.

Monitoring during control

The weed control staff recorded any tagged plants they treated.

Monitoring after control in December 1998

Follow-up monitoring occurred in February 1999 after control in December 1998. This was in order to find plants that may have been killed but not recorded by the control team. We had to rely on data collected by field staff during control.

3. Results

Nine of the eleven patches were controlled in December 1997. In that year one small patch of a few plants was not found and one was left out of their control until later (because it was accessible from the road). In December 1998, control was undertaken in 10 patches (the small patch was not found). The proportion of plants killed in each patch provides meaningful information about the thoroughness and consistency of control in isolated patches (Table 2).

Of the three size classes, best control was achieved in the largest (Table 1). For plants over 30 cm, 100% control was achieved in 2 of the 11 patches, with good control (80%) achieved in a further 5 patches. For plants over 1 m, 100% control was achieved in 3 patches and good control in a further 2 patches.

The size class data show that there can be considerable variability from year to year in the abundance of broom plants in the three size classes (or possibly between December and February) (Fig. 1).

At patches that were actually visited, kill levels of 82-90% were achieved. When the patches missed by the control operations are included the percentage control of tagged individuals reduces to 80% (Table 1). One of the monitored patches appears to have been missed by the weed control operation in both years.

Results indicate that the level of control of tagged plants in patches was variable.

4. Discussion

4.1 INITIAL KNOCKDOWN

The first milestone to be achieved is the successful control of all the seeding broom plants present at this time. Estimates based on the above results indicate that this initial knockdown of tagged seeding plants could be achieved within 4 years.

It seems reasonable to suggest that, if more time was spent at each patch, individual broom plants and patches would be missed less frequently then and thus the initial knockdown phase could be shortened. In order to shorten this phase of the broom control programme by one or two years a 10-20% improvement in kill rates would be required.

The control levels achieved are widely variable between patches, and this variability should be minimised. One explanation for the variable control levels could have to do with the relationship between the control crews and the helicopter pilot. When the pilot arrives to pick up workers at a broom patch this may put people under some pressure to move before they have finished working the patch thoroughly. Therefore, some standard needs to be set. If workers decide that a 90% kill of flowering plants in each patch is the minimal acceptable, the initial knockdown might be achieved within two years. This means that they would need to stay at a patch until they are confident that they have achieved a high agreed level of control. The helicopter pilot would sometimes need to be waved on until they were satisfied with the job they had done.

4.2 FLOWERING PLANTS

Broom normally flowers in its third year (Rees & Paynter 1997, Williams 1997). Plants of this age were at least 50 cm tall. The rate of recruitment into the flowering/seeding size-class for broom in Tongariro National Park cannot be accurately determined from this study. However, the majority of plants (estimate 80%) in the 30 cm to 1 m size class appeared to be flowering and seeding, and all plants over 1 m were flowering.

4.3 APPROACHES TO BROOM CONTROL

Rees & Paynter (1997) modelled broom population dynamics and recommended an integrated approach, to reduce the number of sites occupied by broom. They identified methods most likely to succeed.

1. Removal of sources of disturbance reduces opportunities for broom to colonise, e.g. minimise disturbance during control and prevent fires.

2. Facilitating interspecific competition reduces the probability of recolonisation of broom following control, e.g. planting native plants.

3. Introducing biological control agents or other management techniques that reduce broom longevity, particularly in conjunction with seed-feeders, e.g. the broom seed beetle *(Bruchidius villosus)* that was released in 1996 and twig-miner damage have been observed in the area. These could be contributing to a reduction in the competitive ability of broom.

4. Senescence. In some cases, regeneration of broom from the seed bank appears to be prevented by a canopy cover of senescent broom plants (Rees & Paynter 1997). If control teams can encourage or mimic early senescence, the number of sites occupied by broom may decrease. One method that could be tested is the use of Triclopyr herbicide to control broom plants. In the USA this chemical is applied around the stem of broom, the herbicide penetrates the stem and kills the plant (Bassard 1996). This would leave standing dead plants similar to senescent ones, and may prevent the regeneration of broom to some extent.

If it worked, this latter method could reduce the competitive ability of broom while natives may be released from competitive pressure. However, this flies in the face of the present modus operandi: broom plants are removed to encourage regeneration from the seed bank and thus a depletion of the broom seed bank.

4.4 ALTITUDE LIMITS

The upper altitudinal limit of broom patches recorded in this study probably was about 1200 m. It does not represent the highest altitude it can reach; in the South Island plants grow as high as 1550 m a.s.l at Camp Stream in the Poulter River catchment (Stephen Phillipson pers. comm.). Coincidentally this is the upper limit identified in Europe, where populations are well established at 1550 m (Rees & Paynter 1997).

5. Monitoring issues raised

This study looks at tagged individuals, so all the conclusions should be viewed in those terms. When tagged individuals are studied you can be sure about the fate of these plants from year to year. But extending conclusions from this to all broom plants in the study area cannot be easily supported. This is because of the way in which tagged plants influence the weed control staff behaviour and the fact that patches were subjectively selected for spread across the study area. Random selection of patches to monitor would have allowed conclusions to be extended more widely.

Relocation of sites using the GPS was a problem. Only 5 of the 11 sites were relocated. This was largely due to the familiarity of the pilot to the GPS computer system in the first year, and was exacerbated by difficulties in communication while in flight. This meant that we had to alter our monitoring procedure and rely on whether or not staff recorded any tags they found during the course of control rather than our revisits of the sites.

A further difficulty with the monitoring method was that the presence of tags and marker pegs did encourage work to be undertaken at each site, with tagged plants or sites being the focus of control work (Peter Morton pers. comm.), although we tried to accommodate this to some extent by placing tags inconspicuously. The results of this study would have exaggerated the apparent performance of the broom control programme and the methods used. However, the fact that tagged plants and pegs were seen at all should be considered a success, since it indicates that most areas are being searched thoroughly.

In the first year, data were analysed and one patch was excluded from the analysis on the basis that the control crew thought it was too close to the road to warrant visiting from the helicopter (Peter Morton pers. comm.). That patch was controlled later in the same year. This demonstrates the difficulty of using a weed control target which involves subjective assessment in the field. It would be have been better to delineate the boundaries of the "low-density" target areas on the map in a more arbitrary way, e.g. using landmarks, so that there can could be no doubt whether a patch was "in" or "out" of the target area.

Approximately one-sixth of the observed low-density patches were sampled, and there was a good spread across the control area.

Monitoring weed control operations in the Department of Conservation are now supported by standard operating procedures described in the recently developed Weed Control Monitoring SOP (Geritzlehner 2000). The comparability of this study to other studies would have been helped if the methodology had been a standard one.

6. Recommendations

Take more care to get good control in patches so that consistent control is achieved. The combined costs of getting staff to the patch and then allowing poor control to occur while staff are at the patch is not sustainable.

Differential GPS cannot necessarily be relied upon to relocate plots and should be tested before it is used.

It is important to delineate boundaries for control and monitoring before either is undertaken. This prevents subjective decisions being made in the field.

Continue focusing control on low-density patches.

Use an integrated approach to broom control, i.e. consider removing sources of disturbance, facilitating inter-specific competition, introducing biocontrol agents, and capitalising on the ameliorating influence of senescent broom plants.

Randomly select patches for monitoring so that the conclusions can more easily be applied to the whole study area.

When doing monitoring of weed control operations follow the procedures of the Weed Control Monitoring SOP (Geritzlehner 2000).

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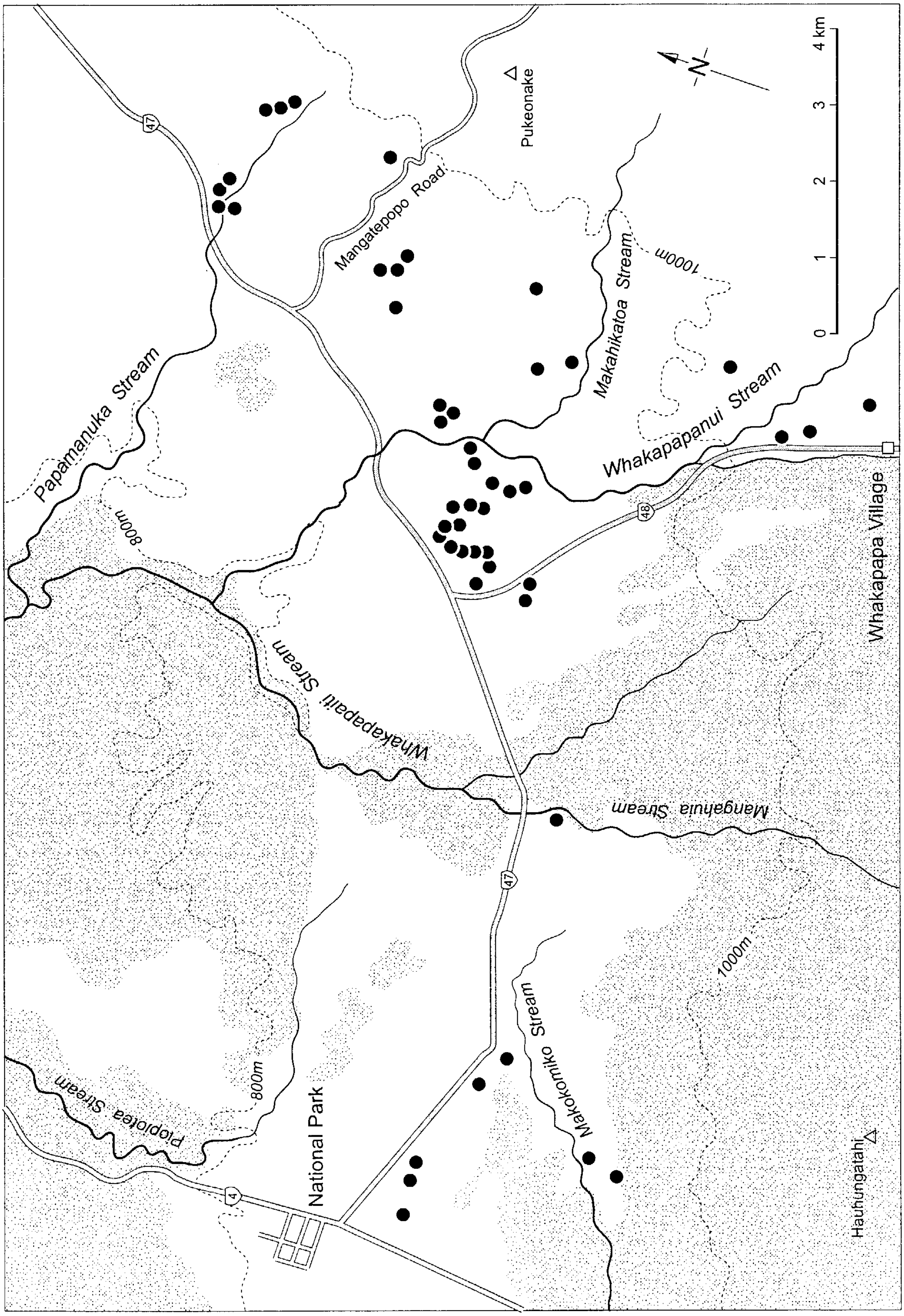


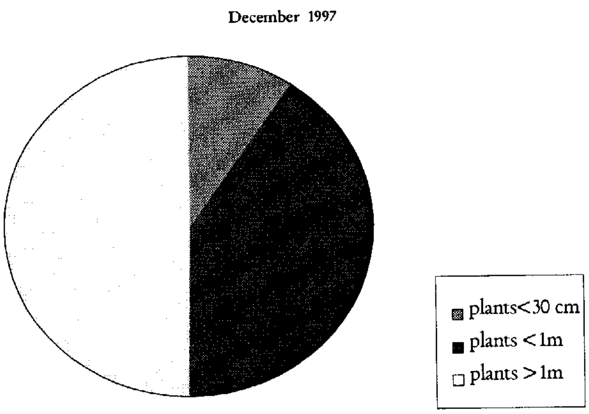
Map 1. Shows the area covered by the broom control programme (in Tongariro National Park west of Highway 47). The dots represent a subset of the 65 broom patches recorded from the helicopter. Eleven patches were selected for monitoring, as they were evenly spread across the study area, but monitored patches are not shown.

Table 1. Percentage of tagged broom plants killed in 1997 and 1998.

Size classes	<30 cm		≥30 cm-1 m		≥1 m	
	1997	1998	1997	1998	1997	1998
% of tagged plants killed overall	62	76	66	76	69	81
% of tagged plants killed, excluding sites not visited	62	76	80	82	85	90
Number of tagged plants in size class	29	29	59	59	58	58

Table 2. The average level of control for patches (± standard error).

	1997		1999	
Target size classes	Average %	± standard error	Average %	± standard error
% of tagged plants killed per **patch**	59	11	70	10
% of tagged plants killed per **patch** over 30 cm **and** over 1 m	65	11	71	11



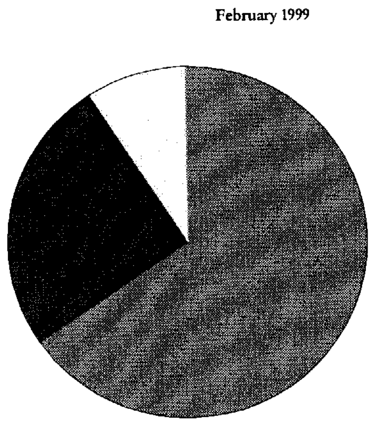


Fig 1. The size class distribution of broom plants along variable length transects. It was difficult to find seedlings in the under 30 centimetre size class December 1997 compared to February 1999.