Trap spacing and layout: experiments in stoat control in the Dart Valley, 1992-95

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CONTENTS

Abstract

Control of stoat (*Mustela erminea*) populations in southern beech (*Nothofagus* spp.) forests is required to maintain the viability of threatened bird populations. Intensive stoat control using a grid of traps, with trap spacing of 100 m (grid trapping), increases the breeding success of mohua (yellowhead: *Mohoua ochrocephala*), but is expensive. An alternative is to set traps only around the perimeter of an area to be protected (perimeter trapping). We tested whether perimeter trapping could be as effective at reducing stoat numbers as is intensive grid trapping. During trials we obtained similar catch rates on perimeters as on intensive grids. Assuming that stoat populations were similar in each study area, we conclude that perimeter trapping around a 100 ha (1 km ^{2}) block can be as effective as intensive grid trapping with 100 m trap spacing. Trials were undertaken while stoat densities were low, and the implications of this are discussed.

1. Introduction

In New Zealand beech forests (*Nothofagus* spp.), irregular but severe predation by stoats (*Mustela erminea*) has been implicated in the decline of several indigenous bird species, in particular mohua (yellowhead: *Mohoua ochrocephala*) (Elliott 1996a; O'Donnell 1996; O'Donnell et al. 1996). Development of methods to control stoats, and thus prevent further decline in these bird species, has occurred over the last two decades. The present study is part of this ongoing research.

King (1980, 1981), King & Edgar (1977) and King & McMillan (1982) reviewed and tested methods for controlling stoats. King (1984) concluded that stoat control is probably only worthwhile in specific situations, namely during the nesting season and only for the protection of a few endangered bird species that are most adversely affected by stoat predation. O'Donnell et al. (1996) evaluated the effectiveness of such control for mohua populations in the Eglinton Valley using mark IV Fenn traps to trap stoats. Nesting success in a 500 m × 900 m area containing a grid of trapping tunnels at 100 m intervals was compared to that in a similar non-treatment area 1 km away. Nesting success in the trapped area was 80% compared with 36% success in the area not trapped. During the same period, lines rather than grids of trapping tunnels were operated in the Dart, Routeburn and Hawdon Valleys. The mohua populations within 600 m of these lines collapsed by 60% in consecutive spring territory censuses (B. Lawrence, C. O'Donnell unpublished data). From this we concluded that protection of mohua by lines of traps was unlikely to be successful.

In the Eglinton Valley, significantly more stoats were trapped on the perimeter than in the interior of the intensive trapping grid (Dilks et al. 1996). If a perimeter of traps at 100 m spacings is as effective in increasing mohua breeding success as a grid, the cost of a trapping operation could be reduced by over 50%—both in terms of traps and servicing time. During 1992–95 we tested whether perimeters of traps could be equally as effective at reducing stoat numbers as intensive grids in the Dart Valley.

2. Study area

The Dart Valley study area contained two sites, Lake Sylvan and Millflat, which were located on opposite sides of the Dart River at the head of the Lake Wakatipu catchment, partly in the Mt. Aspiring National Park (44°42–3'S, 168°20'E, Figure 1). The glacial valley is steep sided, with a large braided river, its floor being 3–5 km wide at this point. The two study sites were 2.4 km apart at the nearest point.

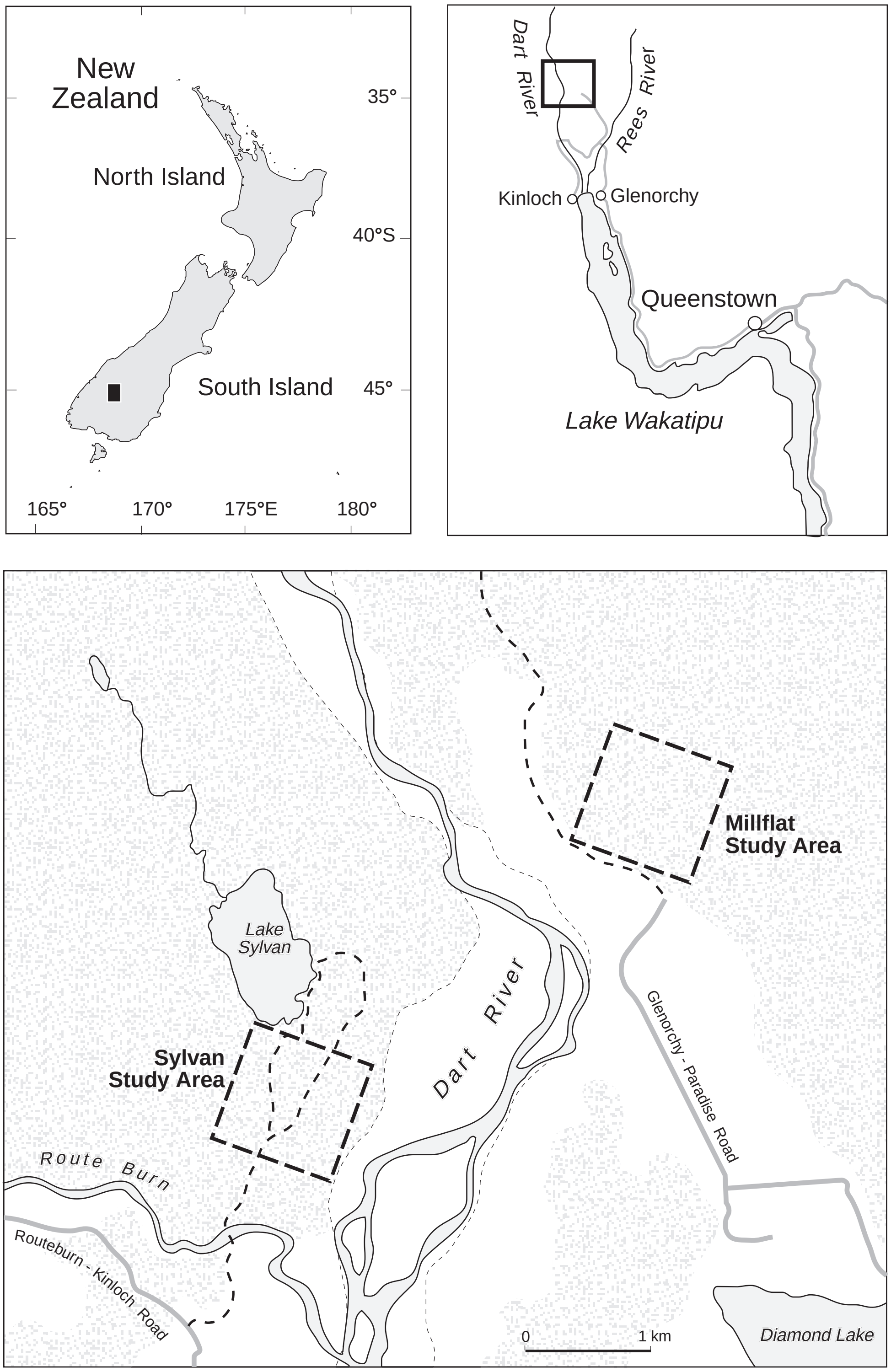


Figure 1. Location of study sites in the Dart Valley, South Island, New Zealand.

Both sites are 330–420 m a.s.l. and have similar forest dominated by red beech (*Nothofagus fucsa*) with a canopy 20–30 m tall. There are significant stands of silver beech (*N. menziesii*) and mountain beech (*Nothofagus solandri* var. *cliffortioides*) where soils are thin over glaciated rock knobs. The forest has been cut over in part, in both locations. The understorey is open, with little plant species variation in areas of beech regeneration subsequent to logging. The climate is wet, (2000 mm annual rainfall at Routeburn), but temperatures are moderated by the strong north-west airflows of the Dart Valley (lowest canopy temperature during the winter of 1996 was –6.8 ° C).

3. Methods

3.1 TRAPPING TUNNELS

Trapping tunnels were 600 mm long, made of rough sawn timber and had a square cross section of 150 × 150 mm (King et al. 1994). A wooden bar and two wire bars were placed horizontally over each end to prevent non-target species entering the traps. Two mark IV Fenn traps were set in each tunnel with two hens eggs as bait between them.

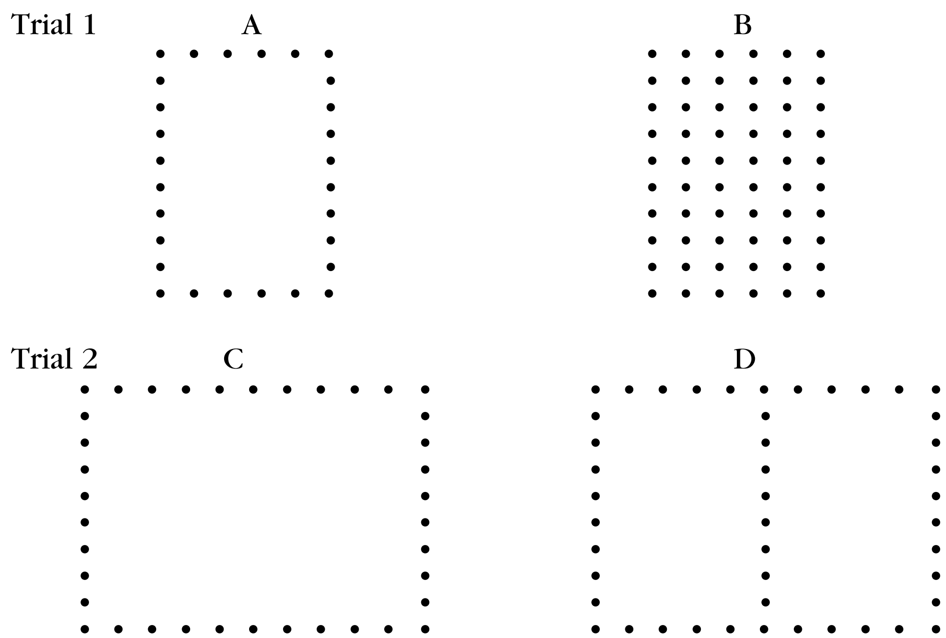


Figure 2. Trapping tunnel configurations in trials 1 and 2 (• • • denote tunnels at 100 m centres).
A, 500 × 900 m perimeter of 28 tunnels—Millflat 1992/33; Sylvan 1993/94.
B, 500 m × 900 m grid of 60 traps—Sylvan 1992/93; Millflat 1993/94.
C, 1000 × 900 m perimeter of 38 tunnels—Millflat 1994/95.
D, 1000 × 900 m perimeter and median of 46 tunnels—Sylvan 1994/95.

3.2 TUNNEL CONFIGURATION

The study consisted of two trials. The first trial compared the efficacy of perimeter trapping at killing stoats with that of grid trapping. The second trial was to test whether a perimeter enclosing 90 ha was as effective at killing stoats as the perimeters enclosing 45 ha used in the first trial (Figure 2).

Trial 1

The study sites were both 500 m × 900 m. In the 1992/93 season, the Lake Sylvan site was set out in a grid trapping format with tunnels at 100 m intervals (Figure 2), 60 tunnels of traps in total. At Millflat, the site was laid out in a perimeter trapping format, with a total of 28 tunnels of traps at 100 m intervals (Figure 2). In 1993/94 this configuration was reversed: the grid at Millflat and the perimeter at Lake Sylvan.

Trial 2

In 1994/95 both sites were enlarged to measure 900 m × 1000 m. Millflat was operated as a perimeter of 38 tunnels, while Lake Sylvan was a perimeter with a median line of 8 extra tunnels, 46 in total, effectively providing two 45 ha perimeters for comparision (Figure 2).

In all years the traps were set from the last week in November until the third week in February, a period of 12 weeks each season. Traps were checked weekly.

3.3 ANALYSIS

As low numbers of stoats were caught each year, the probability of occurrence of stoat kills was small, and a Poisson distribution was used to generate expected values for random location of kills. Fisher's exact test was used to test if kill rates on perimeters were different from internal kill rates.

4. Results

4.1 TRIAL 1

The first year both sites trapped caught the same number of stoats (seven stoats each). The second year the 'perimeter' site caught 11 stoats, the 'grid' site caught 10.

In the grid, the kill rate on the peripheral line of tunnels was compared to that of the interior positions each year. In year 1, four of the seven captures were on the peripheral line of tunnels (the difference peripheral tunnels to all interior tunnels was not significant, $P = 0.695$: Table 1). In year 2, two of the ten captures were on the peripheral line of tunnels.

In both years the central 12 traps caught fewer stoats than the outer two lines of traps, being zero to seven and two to eight, respectively. This difference was not significant ($P = 0.5191$).

TABLE 1. THE NUMBER OF KILLS AT PERIPHERAL TUNNELS COMPARED TO NUMBERS OF KILLS AT INTERNAL TUNNELS IN TWO GRID TRAPPING OPERATIONS (TRIAL 1). 'CENTRE' REFERS TO THE 12 TUNNELS AT THE CENTRE OF THE GRID

	NUMBER OF KILLS	NUMBER OF TRAPS	FISHER'S EXACT TEST
1992/93 Sylvan perimeter	4	28	$P = 0.695$ NS
1992/93 Sylvan internal	3	32	
1993/94 Millflat perimeter	2	28	$P = 0.0876$ NS
1993/94 Millflat Internal	8	32	
Outside 2 rows, 1992/93 and 1993/94	15	96	$P = 0.5191$ NS
'Centre' 12 traps, 1992/93 and 1993/94	2	24	

TABLE 2: X^2 TEST FOR GOODNESS OF FIT SHOWING THE CLOSE DISTRIBUTION OF KILLS WE WOULD EXPECT FROM A RANDOM POISSON DISTRIBUTION TO THE OBSERVED DISTRIBUTION.

	TUNNELS WITH 0 KILLS PER TUNNEL PER SEASON	TUNNELS WITH 1 KILL PER TUNNEL PER SEASON	TUNNELS WITH >1 KILL PER TUNNEL PER SEASON
Expected	206	46.36	5.5
Observed	207	45	6
$\chi^2 = 0.08$ $\chi^2_{(0.05),2} = 5.99$ $P > 0.05$			

4.2 TRIAL 2

The 'perimeter only site' caught 11 stoats, and the 'perimeter plus median site' caught 12 stoats. No stoats were caught on the median line.

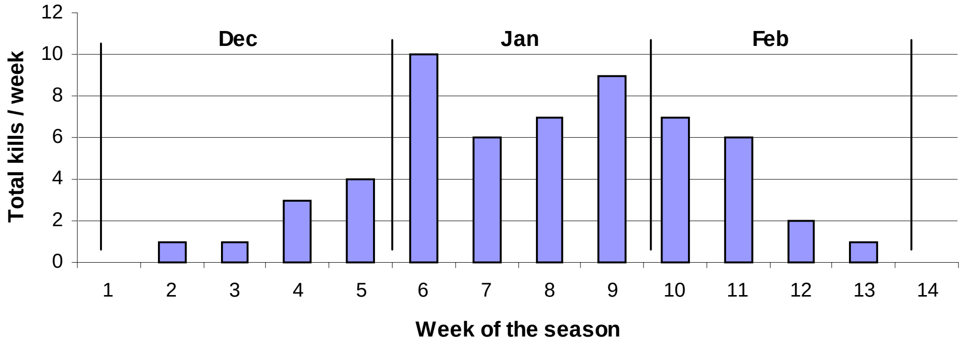
Distribution of catch

The expected probabilities of a kill at each location (generated from a Poisson distribution) were compared to the observed kills. Kills did not differ significantly from the Poisson random distribution (Table 2).

Timing of captures

Though the number of captures each season were very similar for both study sites, Sylvan and Millflat, the timing of captures varied markedly. In some years captures were spread throughout the season (Millflat 1992/93), while in other years most kills occurred over a short period (Sylvan 1994/95). When the kills are summed for three years and both areas, the erratic annual pattern of captures for each area shows a more general seasonal pattern. The total kills for each week of the season are shown in Figure 3.

Figure 3. Total stoat kills for each week of the season (1992–95 combined).



In trial 1 we compared the average length of time to kill the pool of available stoats between grids and perimeters. Grids took 8.4 (SD = 2.2) weeks on average to kill the available stoats while perimeters took 6.9 weeks (SD = 3.1). This difference was not significant ($P = 0.12$—two sample *t*-test assuming equal variance).

5. Discussion

Equal numbers of stoats were caught in each study area each year. This is despite varying numbers and densities of tunnels. Doubling the size of the perimeter caught no more stoats. Nor did putting twice as many traps in the same area. There may well have been no more trappable stoats available. It suggests that the population in both study areas is similar, but that the level fluctuates from year to year. If we assume this is true, it suggests that density of traps at the levels used, from 38 per 100 ha to 60 per 50 ha, has little influence on total stoat kill.

There was no significant difference in the average time it took to kill the available stoats in perimeters compared to grids. The fact that there was not even a trend towards perimeters taking longer, makes us confident that the less dense 'perimeter of traps' removed stoats just as quickly as the denser 'grid'. This leads to the conclusion that perimeters of this size are as effective at removing stoats as grids in terms of time.

The perimeter does not appear to stop stoat activity within the area concerned. In the grids of trial 1, more stoats were caught in the internal traps than on the peripheral traps. On this scale the trap perimeter is not acting as a protective barrier to further immigration once residential stoats are removed, because internal catches are spread in time in the same manner as peripheral catches.

Two possibilities could lead to the perimeter giving less protection.

The first possibility is that a stoat den is established in the centre of the perimeter, and the young may not come into contact with the trap sites until substantial predation has occurred in the den vicinity. This is based on the premise that young stoats stay within a few hundred metres of the den initially and the activity of the mother is concentrated there as well. If the site has been trapped in the previous year, as was usually the case in these trials, the likelihood of resident stoats and dens in the area is reduced. Millflat was trapped for the first time in 1992 and resulted in early catches. This was reinforced in the Dart Valley in 1995/96. A 2–3 week delay in poison egg take occurred in the two sites trapped the previous year, compared with eight other poison egg perimeters which had not been previously trapped (B. Lawrence and P. Dilks unpublished data). To ensure we test for effects of trapping on normal residential populations, future trials should be in areas where stoats have not been controlled the previous year.

The second possibility is that in a period of high stoat numbers, when territories are significantly smaller (Murphy & Dowding 1995), greater stoat activity in smaller geographic areas may mean a grid does drop the general stoat population more quickly than a perimeter does. However, this is regarded as unlikely as the reduction in average home range areas in irruption years (160 ± 35 to 80 ± 7 ha: Murphy & Dowding 1995) is similar in scale to the trial perimeters enclosing 50–100 ha. Stoats should encounter traps at the same rate in either year.

The perimeter design was suggested by Dilks et al. (1996). They found that river edges and perimeter traps running at right angles to the Eglinton Valley floor caught more stoats than forest interior traps. Given individual ranges of stoats in an irruption year of 50 to 105 ha (n = 7: Murphy & Dowding 1995), the size of trapping perimeters trialled during the present study ensures a high probability that stoats within the perimeter will encounter traps at some time. But how much larger could perimeters be while ensuring that both resident and migrant stoats still encounter traps? More knowledge of how stoats behave within their home ranges and how new stoats invading an area behave, is needed before an optimum theoretical perimeter size can be designed. The following questions still need to be addressed. What proportion of stoats are likely to be resident or transient? How important is trap encounter rate in determining kill rate? How important is hunger in determining trap rate? How do sedentary stoats patrol their territories—randomly or around a set pattern?

Future research could focus on establishing the theoretically best pattern of traps to optimise encounter rate by resident and immigrant stoats. The probability of stoats encountering traps at the edge of their home ranges is lower than if traps are at the centre of the range. For example, Murphy & Dowding (1995) found that 70% of stoat activity was occurring in ‘core ranges’ of 20 ha within the home range. Trap layout should reflect these varying probabilities.

Timing of trapping is critical. The ‘stoat removal period’, 6-8 weeks from early December, coincides with the highest at risk period for mohua, particularly where they are nesting for a second time (O’Donnell et al. 1996). Late spring trapping in irruption years has shown it is unlikely that female stoats can be trapped then (King 1994). Trapping in July/August would be worth trialling as one female stoat caught then may prevent up to ten juvenile stoats becoming active in early December (King & Moody 1982).

These trials were undertaken in years of low stoat densities. They therefore need to be tested in a stoat irruption year: not only to test that the kill pattern is the same, but also to test that the perimeter is as effective at protecting mohua as are grids.

It is important that future trials provide clear answers. Using the data from the Eglinton Valley in 1987/98 (Elliott 1996b) and 1990/91 (O’Donnell et al. 1996) we can calculate the replications required to give us the power to detect the estimated differences. We need two replicates to establish a difference of five predation events in trapped to untrapped areas, and three replicates to establish a difference of four predation events. The 1990/91 results indicate the latter requirement.

6. Recommendations

To establish whether a perimeter of traps is sufficient to protect mohua in a stoat irruption year, it is recommended:

1. That 1000 m × 1000 m perimeters with traps at 100 m centres with a median line be established during the next stoat irruption, with a grid and non-treatment area to act as controls.
2. That productivity of mohua at each site be monitored closely enough to establish the level of predation and nest success.
3. That three replicates of the trial be carried out.
4. That future trials occur in areas where no stoat control occurred in the previous year.
5. That trials of the effectivenes of winter trapping on mohua productivity be carried out.

7. Acknowledgments

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