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CONTROL OF A STOAT POPULATION IRRUPTION TO ENHANCE YELLOWHEAD BREEDING SUCCESS

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by

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ABSTRACT

Recent research has shown that yellowheads *(Mohoua ochrocephala,* a threatened, hole-nesting forest bird) suffer periodic population crashes in response to stoat (*Mustela erminea*) irruptions that follow heavy beech seeding. Heavy seedfall in 1990 provided an opportunity to experimentally control stoats during one of their periodic population irruptions to determine if this constituted a viable management option to assist yellowhead recovery.

Yellowhead productivity was compared in two study areas, one trapped and one untrapped, in the Eglinton Valley, Fiordland, during summer 1990-91. Sixty-two stoats were caught in the 50 ha trapped area during the summer. The fledging of many first clutches and timing of second clutches coincided closely with the period when high numbers of stoats were being caught in traps. There was a significant difference between the nesting success of yellowheads in the trapped and untrapped areas with 80% of the nests in the trapped area fledging young, compared to only 36% in the untrapped area. Pairs produced nearly twice as many young in the trapped area from fewer nests. A higher proportion of breeding females disappeared in the untrapped area than the trapped area.

The high rate of nest predation recorded during the stoat irruption confirmed that predation by introduced mammals poses a significant threat to remaining yellowhead populations. The experiment suggested that the reduction in stoat numbers caused by trapping was sufficient to increase yellowhead breeding success significantly and that further development of stoat control techniques is warranted.

1 INTRODUCTION

The yellowhead *(Mohoua ochrocephala)* is a small, insectivorous, forest passerine bird, endemic to the South Island. The yellowhead has disappeared from large, relatively unmodified forests and is continuing to decline. Last century yellowheads were one of the most abundant and conspicuous forest birds in the South Island but they have all but disappeared from 75% of their former range (Gaze 1985). The species is now classed as threatened (Bell 1986).

The results of a yellowhead monitoring programme and from intensive research have indicated that yellowheads suffer periodic population crashes in response to predator irruptions that follow heavy beech seeding. Yellowheads are particularly vulnerable to predation because they nest in holes, have prolonged nesting and breed at a time when predator numbers are highest (Elliott 1990). Furthermore the effect of predation is exacerbated by the fact that only females incubate; most predation is of females. In populations with low productivity the period between crashes is probably insufficient for yellowhead numbers to recover fully (Elliott & O'Donnell 1988, Elliott 1990).

The primary predator of yellowheads within their current range is the stoat (*Mustela erminea*) (Elliott 1990). During most breeding seasons stoats are uncommon and less than 10% of nests are preyed upon. However, high stoat numbers occur in beech forests in the summer following heavy seeding of beech trees which occurs on average every 4-6 years (Wardle1984). With increased food availability insect, mouse (*Mus musculus*) and then stoat numbers irrupt as a result of increased litter sizes and survival of young stoats (King 1983, B.M. Fitzgerald pers. comm.). In two areas studied during seed years a high proportion of yellowhead nests were preyed upon, apparently by stoats, and about 50% of incubating females disappeared (Elliott & O'Donnell 1988).

A heavy beech in autumn 1990 over much of the South Island provided an opportunity to assess the impact of stoat predation on yellowheads by experimentally controlling stoats during one of their periodic population irruptions.

Experimental control of the stoat irruption would enable us to determine if we could reduce yellowhead predation significantly by using traditional trapping techniques. If we could successfully enhance the breeding of yellowheads, then further development of stoat control techniques would be warranted. The approach we chose was to compare yellowhead productivity in two comparable study areas, one trapped and one untrapped.

Methods for controlling stoats have been reviewed and tested by King (1980, 1981), King and Edgar (1977) and King and McMillan (1982). King (1984) concluded that stoat control is probably only worthwhile in the most sensitive areas during the nesting season, and only for a few endangered species. Such control has been attempted in New Zealand but its effectiveness has never been assessed.

The objective of our trapping operation was to reduce the numbers of stoats in a small area of yellowhead habitat during the time when the birds were most vulnerable to predation, and to assess the effectiveness of our trapping programme by monitoring the predation rate and productivity of yellowheads.

2 STUDY AREAS

The study areas were located in the Eglinton Valley in Fiordland National Park (168°01'E, 44°58'S). The Valley is glaciated with steep sides and a flat floor which is 0.5-1.0 km wide.

The trapped area was located at Deer Flat (50 ha) and the untrapped area 1 km further up-valley at Knobs Flat (40 ha). Both areas were on fans on the valley floor at c.380 m a.s.l. (Figure 1). The areas had similar forest types and topography. The forest was dominated by red and silver beech (*Nothofagus fusca, N. menziesii*) with the forest composition ranging from pure stands of silver beech c.20 m tall along the forest margin to tall stands of red beech up to c.40 m further into the forest. Mountain beech (*N. solandri* var. *cliffortioides*) occured occasionally in the canopy. Under the canopy the forest was generally open with few understorey plants and a ground cover of mosses. The most common understorey plants were mountain toatoa (*Phyllocladus alpinus*) and broadleaf (*Griselinia littoralis*).

3 METHODS

3.1 Beech seedfall

Eight trays with a collection area of 0.279 m^2 were placed at approximately 50 m intervals in the Knobs Flat area in autumn 1990. Seedfall was collected at the end of March, April and May 1990. The seeds were counted, viability checked, number/m^2 calculated and the results calibrated with other data to determine the magnitude of seeding (Wardle 1984).

3.2 Mouse trapping

Twenty-five tunnels, each with two mouse traps, were laid at 25 m intervals in lines through the forest in both study areas. Traps were set for three nights in mid-September and November 1990, and February 1991. Traps were checked and reset daily, dead mice were collected for autopsy and the number of mice caught/100 trap nights was calculated allowing for trap interference (Cunningham and Moors 1983).

3.3 Predator trapping

The Mk 4 Fenn Humane Trap was used for trapping stoats. The Fenn trap is designed to operate in a tunnel only a little wider than the trap. The trap's jaws close across the stoat's back, killing it almost instantly.

Two traps were placed in each tunnel with bait placed between them. This gave the stoat two options for entering the tunnel and ensured that it must cross a trap to get to the bait. Two bait combinations were used: (a) two eggs, one cracked to provide a scent and one left whole to provide a long-term visual lure; (b) a whole egg and a synthetic lure, 2-propylthietane, a lure based on components of mustelid anal sac secretions

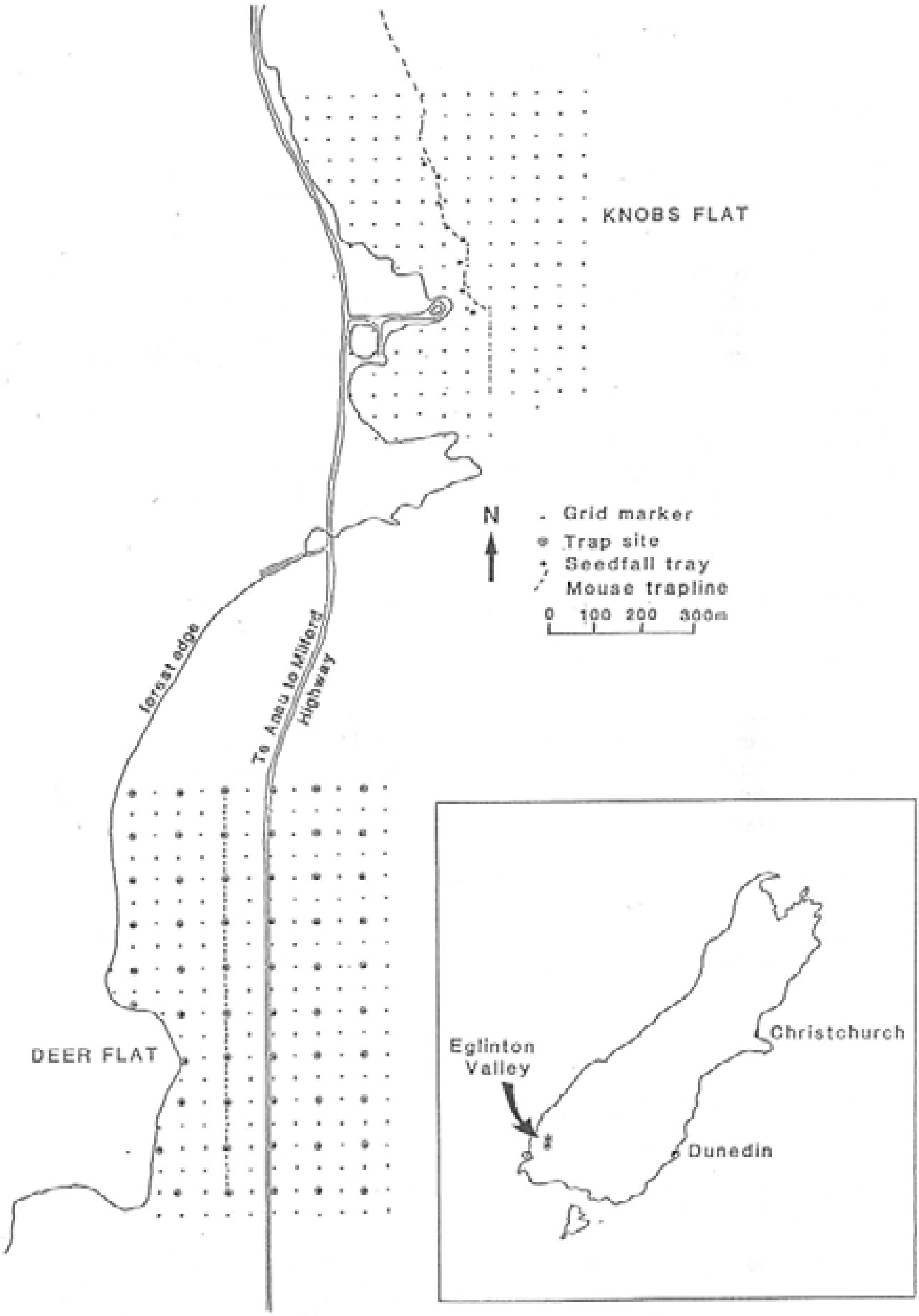

Figure 1. Location of the Knobs Flat and Deer Flat study areas, Eglinton Valley, South Island, New Zealand

(Clapperton *et al*. 1989). Results of trapping and lure trials are summarised by Dilks *et al*. (1992).

Fifty-six tunnels were arranged on a 100 m grid in the Deer Flat area, to maximise the chance of stoats encountering them (Figure 1).Traps were first set on October 12 1990 and operated until 14 March 1991. Traps were checked approximately every three days, dead stoats were removed and stored for autopsy, baits replaced if necessary, sprung traps reset and any necessary repairs made to the tunnels.

3.4 Yellowhead study groups

Ten yellowhead groups were located in the untrapped area and eight in the trapped area. Groups contained 2-6 individuals. We attempted to individually colour-band at least one bird from each group to aid monitoring their breeding status and movements. At the end of summer all but four groups had at least 1 banded bird. We were able to identify and monitor unbanded groups by knowledge of adjacent colour-banded ones, the location of territories, and the age and size of their fledglings.

3.5 Breeding success

Twenty-four nests from 18 yellowhead groups were monitored intensively. All groups that nested within the trapped area, or within 70 m of it, were assumed to have benefitted from trapping (70 m was the greatest distance any nest within the trapped area was from a trap).

All yellowhead groups were monitored weekly from 10 October 1990 to 22 February 1991. When breeding commenced, the contents of nest holes were checked regularly.

The timing of breeding for each group was estimated using known dates (egg laying, hatching or fledging) and back-dating using the average incubation period of 20 days and nestling period of 22 days (Elliott 1990). The date of egg laying, hatching or fledging was known for 19 nests and estimated for the remaining five.

3.6 Fate of nests and females

Nest success and female survival were monitored. When females disappeared we assumed that they had died once extensive searches of the whole study areas and suitable surrounding habitat were completed. In most cases the presence of a lone colour-banded male or males with young from the first clutch confirmed the loss of the female. Stoats often leave little sign of having killed yellowheads, usually only a few feathers, but rat predation is more obvious with the gnawed remains being left in the nest.

The cause of nest failure could not always be determined. Possible causes include predation by stoats, rats, long-tailed cuckoos (Eudynamis taitensis) and moreporks (Ninox novaeseelandiae), accidents and abandonment, and possibly interference by other yellowheads (McLean & Gill 1988, Elliott 1990). We assume that the cause of nest loss,

Table 1. Clutch size and numbers of successful fledglings of yellowhead groups at Knobs (untrapped) and Deer Flat (trapped) study areas, Eglinton Valley, 1990-91.

	Knobs Flat			Deer Flat			Significance	
	mean	SD	n	mean	SD	n	t	P
Clutch size	2.83	1.17	6	2.50	0.55	6	0.63	0.55
No. fledged	1.83	0.75	6	2.14	0.69	7	0.77	0.45

Table 2. Beech seedfall at Knobs Flat, Eglinton Valley, autumn 1990 (No. seeds from 8 trays)

	Red Beech		Silver Beech		Mountain Beech	
	Viable	Total	Viable	Total	Viable	Total
March	50	85	2944	4145	175	631
April	25	58	1414	2486	17	63
May	18	63	1135	2124	14	78
Totals	93	206	5493	8755	206	772
% Viable	45	-	63	-	27	-
Total/m^2	42	92	2461	3922	92	346

Table 3. Number of mice (M) per 100 Trap nights (/TN)(corrected) at Knobs and Deer Flats, Eglinton Valley, 1990-91

	Knobs Flat		Deer Flat	
Month	M	/TN	M	/TN
September	6	4.3	28	21.9
November	29	22.6	24	18.0
February	23	17.8	19	14.1

apart from predation by stoats and rats, was the same in each study area. Bird counts (all species) in the trapped and untrapped areas (unpubl.) indicated that bird population densities were similar. Clutch sizes and the number of young yellowheads fledged from successful nests also did not differ significantly (Table 1).

4 RESULTS

4.1 Beech

Beech was high with an average of 4361 seeds/m^2, of which 60% (2595/m^2) were viable. was dominated by silver beech with few red beech seeds being present despite its dominance as a canopy tree (Table 2).

4.2 Mouse numbers

High numbers of mice were caught in all months. Counts of up to 22.6 mice/100 trap-nights (Table 3) confirmed that mouse numbers had reached plague proportions. Mice were often seen in the forest during the day.

4.3 Predator trapping

Totals of 62 stoats and 4 ship rats (*Rattus rattus*) were caught during the summer. The rats were all caught before mid-December and three animals which were autopsied were pregnant females. The majority of stoats were caught over only six weeks, from December to the end of January (Figure 2). Only one stoat was caught during November, but the capture rate increased after mid-December and remained high until the end of January. From the beginning of February to mid-March the capture rate decreased, although stoats were still being caught up to the time trapping ceased.

4.4 Timing of yellowhead breeding

Yellowhead nesting commenced in mid-October and the median laying date was 2nd November, earlier than median dates recorded previously (Table 4). Most first clutches were laid in November and most second clutches in late December (Appendix 2). The fledging of many first clutches and timing of second clutches coincided closely with the period when high numbers of stoats were being caught in traps (Figure 2).

Table 4. Variation in the onset of nesting (first clutches) of yellowheads in the Eglinton Valley.

Year[1]	Median	Earliest	Latest	n=
1984	5 Nov	9 Oct	11 Dec	12
1985	13 Nov	30 Oct	25 Dec	12
1986	7 Nov	26 Oct	22 Nov	12
1987	10 Nov	30 Oct	22 Nov	12
1990	2 Nov	16 Oct	3 Dec	16

1. Source of 1984-87 data: Elliott 1990.

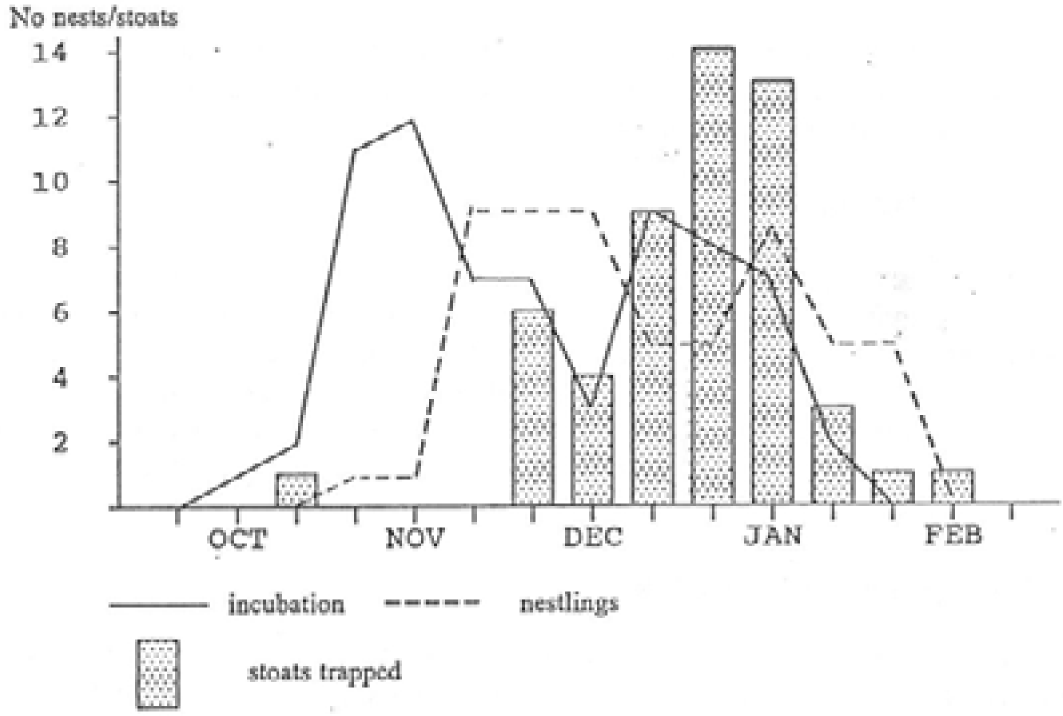

Figure 2. The relationship between the timing of the yellowhead breeding season and the occurrence of stoats (based on numbers caught per 10 day period), Eglinton Valley, 1990-91

4.5 Breeding success in trapped and untrapped areas

Summaries of nest success are given in Appendix 1. There was a significant difference between the nesting success of yellowheads in the trapped and untrapped areas, with of the nests in the untrapped areas fledging young, compared to only 36% in the untrapped area (Table 5). Pairs produced nearly twice as many young in the trapped area from fewer nests, though this difference was not significant. An additional group of fledglings was produced in the trapped area which was not included in the analysis because the original nests(s) was not found. A higher proportion of females disappeared in the untrapped area than the trapped area, but again this difference was not significant. An additional female seemed to have disappeared in the untrapped area, but because it was not colour-banded, it was not possible to confirm this. The remains of one female were found in its nest in the trapped area, the appearance of the remains being consistent with rat predation.

A slightly higher proportion of nests failed and females were lost in second clutches than first, but this difference was not significant (Table 6). There was slightly less nesting at Deer Flat, possibly reflecting the lower predation rate there.

5 DISCUSSION

Following heavy beech seeding, plagues of mice and stoats occurred during 1990-91 as predicted. No stoats were seen in previous non-plague years in the Eglinton Valley (Elliott 1990). Less intensive trapping during summer 1989-90 yielded only one stoat (D. Crouchley pers. comm.), and a similar trapping experiment at Arthur's Pass which used 30% more traps, captured 65% fewer animals (S. Phillipson pers. comm.). The effect of even greater on rodent and stoat irruptions if red beech were to seed heavily at the same time as silver beech is not known.

The high rate of nest predation recorded during two stoat plagues (this study and Elliott and O'Donnell 1988) confirms that predation by introduced stoats poses a significant threat to remaining yellowhead populations.

The difference between breeding success in the trapped and untrapped areas indicates that the reduction in stoat numbers caused by trapping was sufficient to increase yellowhead breeding success significantly. In fact the effect of trapping is likely to be even greater than we detected because our trapped and untrapped areas were so close that stoat numbers were likely to have been reduced in both areas. Four stoats caught and ear-tagged in the control area (Murphy & Dowding 1991) were later killed in the trapped one.

Trapping may enhance breeding success in years when stoat irruptions do not occur. The cause of many nest failures in such years could not always be determined (Elliott 1990), and some may have been caused by predators. The number of nests fledging young in the trapped area was from 11 to 21% higher than previous years, although the number of

Table 5. Yellowhead breeding success in trapped and untrapped study areas in relation to stoat control, Eglinton Valley, 1990-91.

	Trapped	Untrapped	χ^2	U	P
No. yellowhead groups	8	10	-	-	-
No. nests monitored	10	14	-	-	-
No. successful	8	5	4.6	-	0.032*
%	80	36			
No. females lost	1	4[1]	2.1	-	0.149
%	13	44			
Mean No. fledglings/group[2]	2.13[3]	1.10	-	23.5	0.126

1. One further female was unaccounted for but because it was not colour-banded its disappearance could not be confirmed.
2. One long-tailed cuckoo fledgling was produced in each area.
3. One additional group of fledglings was recorded in the trapped area, but was not included in the analysis because the nest was not found.

Table 6. Timing of yellowhead nest failures at Knobs (untrapped) and Deer Flat (trapped), Eglinton Valley, 1990-91.

	First Clutch			Second Clutch		
	No. nests	No. fail(%)	Females lost (%)	No. nests	No. fail (%)	Females lost (%)
Knobs Flat	8	5 (63)	2 (25)	6	4 (67)	2 (33)
Deer Flat	7	1 (14)	0 (0)	3	1 (33)	1 (33)
Total	15	6 (40)	2 (13)	9	5 (55)	3 (33)

Comparison of first and second clutches:

	Nest success		Female loss	
	χ^2	P	χ^2	P
Knobs Flat	0.026	0.872	0.117	0.733
Deer Flat	0.476	0.49	2.593	0.107
Total	0.548	0.459	1.364	0.243

Table 7. Breeding success of yellowheads at Knob's Flat, Eglinton Valley, 1984-91.

Season[1]	Nests fledging young (%)	Females lost (%)	Fledglings/ breeding pair	Predator level
1984-85	67	0	2.6	Low
1985-86	68	0	2.0	Low
1986-87	58	0	2.5	Low
1987-88	40	50	0.9	High
1990-91	36	44	1.1	High
1990-91 (Deer Flat)	80	13	2.1	High/TRAPPED

1. Source of 1984-88 data: Elliott 1990

fledglings produced per pair was similar (Table 8 and Elliott 1990). Management of predator populations will be essential if yellowhead populations are to recover in the future. In 1990 yellowheads in the Eglinton were still recovering from the previous stoat plague, there were low numbers of birds, they had large territories and there were large gaps between territories (Appendix 3). Some form of predator control may be needed each breeding season, not just those when a plague is predicted, at least until numbers recover to near carrying capacity.

The role of ship rats as predators of hole-nesting birds in beech forest may have been underestimated. Capture of ship rats in the Eglinton Valley, and large numbers in the

Routeburn Valley (B. Lawrence pers. comm.) and Arthur's Pass (S. Phillipson pers. comm.) indicates that rat numbers also increase after a beech mast. Rat populations may be higher in areas of beech forest where yellowheads have already disappeared. Rats preyed upon both yellowheads and yellow-crowned parakeets (*Cyanoramphus auriceps*) in the study areas, although apparently not to the same degree as stoats.

Timing of breeding may control to some degree the extent of predation during a stoat irruption. Commencement of breeding during the 1987 plague was eight days later than in 1990. Earlier breeding may have enabled most females to survive to raise their first clutches.

The success of experimental control of stoats suggests that further development of stoat control techniques is warranted. This work has begun (S. Phillipson, E. Murphy pers. comm., Dilks *et al*. 1991). Development should focus on both refining techniques for cost-effective trapping, and on searching for new techniques (e.g. poison, biological control). Trapping could be developed by finding more effective lures, tunnel designs and trapping grid layout.

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Appendix 1A. Yellowhead nesting details:
Knobs Flat, Eglinton Valley, 1990-91

Group	Nest No.	Height (m)	Distance from bush edge (m)	Eggs	Fledglings	Female OK	Fail	Cause
2	2	12	250	2	0		Yes	unknown
	16	23.5	50	1	0		Yes	unknown
	25	3	50	4	0	No	Yes	predator
4	4	29	225	?	0		Yes	unknown
	27	?	250	?	0		Yes	unknown
8	8	5	500	?	0		Yes	predator
	23	3.5	475	3	2			
9	9	23.3	425	?	2			
10	28	14	400	?	3			
11	11	18	100	3	2*			
12	12	31	425	?	2			
	29	?	425	?	0	No	Yes	predator
13	13	5	1	4	0	No	Yes	predator
19	30	14	300	?	1	No	Yes	predator

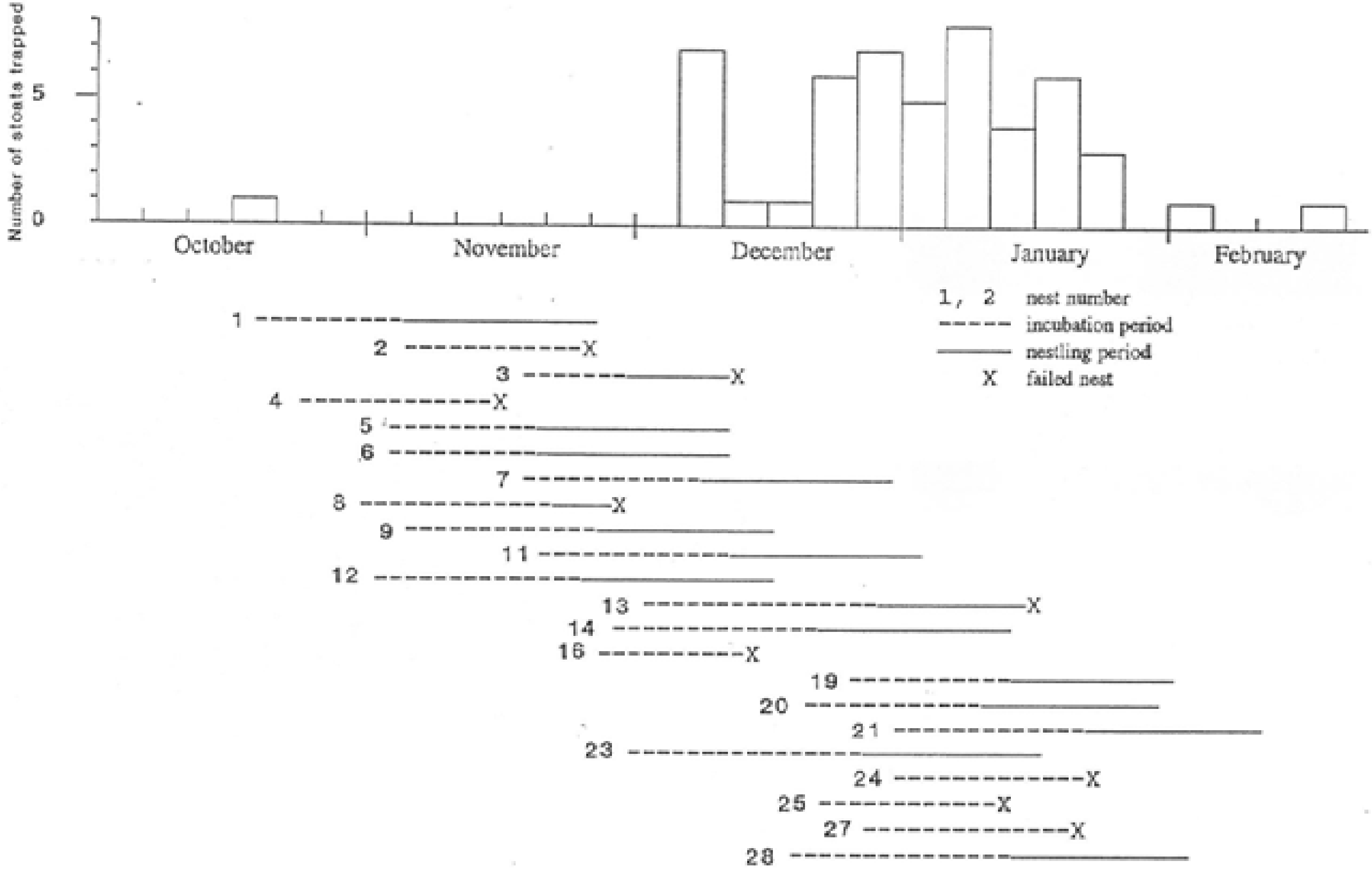
* = 1 yellowhead and 1 long-tailed cuckoo chick.

Appendix 1B. Yellowhead nesting details:
Deer Flat, Eglinton Valley, 1990-91

Group	Nest No.	Height (m)	Distance from bush edge (m)	Eggs	Fledglings	Female OK	Fail	Cause
1	1	13	300	3	3			
	19	13	300	3	2			
3	3	17	500	2	0		Yes	Unknown
	20	22	400	?	2			
5	5	16.5	75	3	3			
6	6	7.8	5	?	2			
	24	7.8	5	2	0	No	Yes	Rat
7	7	14	275	?	2			
14	14	14.9	125	2	1*			
17	21	20	300	?	1			

* = long-tailed cuckoo chick.

APPENDIX 2. The relationship between the timing of yellowhead breeding in the Eglinton Valley and the number of stoats caught on the Deer Flat trapping grid (graphed at five day intervals).



APPENDIX 3. Breeding territories of yellowheads in the Eglinton Valley 1990-91