

PARAKEET NESTING SUCCESS WITH AND WITHOUT PREDATOR CONTROL IN THE HURUNUI VALLEY, NORTH CANTERBURY

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INTRODUCTION

The orange fronted parakeet (*Cyanoramphus malherbi*) is one of New Zealand's rarest forest birds, with numbers on the mainland estimated to be less than 200 (van Hal and Duncan 2004). Apart from two recently established island populations they are known from only 3 inland Canterbury valleys, the South Branch of the Hurunui, the Hawdon and the Poulter, where intensive predator control is undertaken to protect them. The predator control regimes involve the poisoning and trapping of rats, stoats and possums but their effectiveness at protecting orange-fronted parakeets has yet to be tested; this test is the primary aim of this research.

Parakeet abundance is difficult to monitor using counting techniques (Elliott 1998), and counting can only be used to assess the effectiveness of predator control over long periods of time. In this study we monitor parakeet nesting success to give a quicker indication of the effect of predator control. Parakeets are particularly vulnerable to predators while nesting because they nest in holes in tree trunks. This habit prevents them seeing and escaping from approaching predators (O'Donnell 1996). Parakeet nesting success is high only when predator numbers are low either because they were naturally low or because predator control was been effective.

Because of the scarcity of orange-fronted parakeets, any nests found are protected with aluminium around the nest tree trunk (to prevent predators climbing) and extra traps around the tree to further reduce the risk of predation. The success rates of these protected orange-fronted parakeet nests give no indication of the success of unprotected nests. We therefore monitor the nesting success of yellow-crowned parakeets (*Cyanoramphus auriceps*) as a surrogate. Yellow-crowned parakeets are more abundant in the study area and their nesting habits are similar to those of orange-fronted parakeets (Kearvell, 2002). It is not clear why yellow-crowned parakeets are more abundant than orange-fronted parakeets but it is probably due to their higher productivity rather than differences in their nesting sites.

In beech forests the effect of predators on parakeets varies with the stage in the beech mast cycle. Rats reach peak densities 6-8 months after the beech seed falls in March, and they usually decline to low levels within another 6 months. Stoats reach peak densities in the summer following a beech seedfall and their abundance declines over the following two years. Although parakeets suffer high rates of predation when stoats are abundant this is offset by their prolific breeding during the beech seedfall (Elliott *et al.* 1996a). Elliott *et al.* (1996a) concluded that predation when stoats were not at peak densities might have just as great an effect on parakeets as predation at peak stoat densities. Because of this variation in

predator abundance the effectiveness of predator control in beech forests has to be assessed at every stage in the beech mast cycle.

This report covers 3 seasons of yellow-crowned parakeet nest monitoring in the Hurunui:

January – April 2006 in the South Branch

A beech (*Nothofagus* spp.) flowering in the November 2005 had yet to cause increases in the abundance of rats and stoats, and stoat and rat trapping and poisoning was keeping their numbers low.

September 2006 – January 2007 in the South Branch

Rat and stoat numbers were rising during this period due to the beech seeding but were controlled in the South Branch by ongoing ground-based poisoning and trapping and an aerial 1080 drop in October. Outside the predator controlled area rat numbers rose to moderate levels, and stoats to high levels.

November 2007 – April 2008 in both North and South branches.

Stoat numbers were low in the South Branch because of the trapping and poisoning, while in the North Branch, stoats had risen to high densities during the summer of 2006/07 and had remained high thereafter. Rat numbers in both valleys had declined to low or undetectable levels following high abundance in the summer of 2006-07.

The nest monitoring aimed to answer three questions

1. Was predator control effective during and after a beech mast in the South Branch of the Hurunui.
2. Was stoat control necessary in the summer following peak stoat abundance caused by a beech mast when stoat numbers are still elevated.
3. Were any parakeets poisoned during the 1080 drop in October 2006.

METHODS

Study areas

The South and North Branches of the Hurunui are steep-sided glaciated valleys east of the main divide and about 100km north-west of Christchurch. Both valleys are clothed with mosaics of forests dominated by red beech (*Nothofagus fusca*) on the valley floors and lower slopes and silver (*N. menziesii*) and mountain beech (*N. solandri* var. *cliffortiodes*) elsewhere. The lower reaches of both valleys are at about 700m above sea level. The North Branch is closer to the main divide than the South Branch and this results in higher rainfall and some minor vegetation differences.

Bird species assemblages are similar in the two valleys, although mohua (*Mohoua oculocephala*) have not been recorded in the North Branch since 2002, and orange fronted parakeet sightings are rare.

Stoats and possums have been trapped and poisoned in the South Branch since 1995 and rats since 2003, but no predator control has been undertaken in the North Branch.

Finding and monitoring parakeet nests

We found nests by watching adult parakeets for “suspicious behaviour” – birds entering or exiting holes, soft chattering below the canopy or near holes, and males feeding females. When a suspect nest was located, the tree was climbed using rope and ascenders to see if eggs or chicks were present. The monitoring period was from the first check where the cavity was confirmed to be in use for nesting purposes (i.e. tree climbed and eggs or chicks seen), until the nest failed or the brood reached an estimated age of 32 days. Brood age was estimated once nestlings had hatched, using a set of reference photos of captive parakeet chicks of known age. Where a brood had a large age disparity (for example an apparent age difference of 8 to 10 days between the oldest and youngest chick in a large brood was not uncommon) the 32-day cut-off point was when the midrange of the brood reached 32 days (for example an estimated brood age of 28-36 days). After a nest was confirmed to be in use by climbing, it was sometimes checked by observation from the ground and if no activity was observed during a ground check, the tree was subsequently climbed. Nests were checked at least fortnightly, until they fledged or failed, with a check just before the 32-day cut-off. We climbed all the nests again as soon as possible after their expected fledge date to check for any obvious predation events outside of the monitoring period, and to measure and record a description of the nest.

We did not include data from nests more than 32 days after hatching in our analysis. This is because it is difficult to interpret the fate of mature broods. We could be confident that nests found empty before 32 days had failed, but after 32 days nests found empty could either have fledged or failed, since predators do not always leave sign (Brown *et al.*, 1998), and recently fledged chicks often leave the vicinity of the nest (Elliott *et al.* 1996a).

When a nest was confirmed active a fur snag was placed around the trunk of the nest tree and any adjacent trees that might provide easy alternative access to the nest cavity. The fur snag consisted of 100mm galvanised nails placed at intervals around the trunk, with string or rubber bands encircling the tree attached to the heads of the nails. The string and nails were then painted with a thin coat of a rat and mice trapping glue (Trapper[®], made by Bell Laboratories). We recoated the glue as necessary to maintain stickiness. These “sticky bands” were checked for predator hairs at every nest check. Any hairs found were collected for identification. Possum fur is easily recognised by its frizzy, wool-like appearance; other hairs were sent for DNA testing at the Landcare Research lab in East Tamaki. Sticky bands were removed at each nest’s final nest check of the season.

Monitoring periods

Nests were monitored in what was probably the second half of the breeding season in early 2006. There had been a beech mast in the autumn of 2005 and parakeets had probably been breeding through the winter and spring of 2005 as well between January and April of 2006. There was another beech mast in autumn 2006 and birds nested in the winter and spring of 2006 and we monitored nests from mid August 2006 until the end of the year, after which nesting all but stopped. In our most recent season (Nov 2007 – March 2008) we looked for nests in late November and through December, with very little success – the few we found were either close to fledging, or at the pre-lay stage and didn’t become active until January 2008. The nesting period monitored was therefore over the first 3 months of 2008.

Estimating nest survival

We estimated nest survival using the methods of Dinsmore *et.al.* (2002) implemented in program Mark (White & Burnham, 1999). This method removes bias caused by the fact that failed nests are invariably under-represented in nest survival studies because many nests fail before they are found. It estimates daily nest survival (essentially the number of failure events divided by the number of days over which nests were monitored) and nest survival rates are then estimated as the daily nest survival raised to the power of the number of days from laying to fledging, which is about 60.

When estimating nest survival we did not differentiate between nests that failed due to predation and nests that failed for other reasons. Often when there is no sign of predation at a failed nest we assume it has simply been abandoned by the parents for some reason, however it is possible that one or both of the parents have been caught by predators while away from the nest.

Initially we simply estimated nesting success at the five combinations of site and season for which we had data, but we also examined the possible effect of two covariates on nesting success:

1. Stage in season (Number of days since the start of the nesting season).
During beech mast years seed runs out during the season and this might affect nesting success.
2. Nest age (Number of days since first egg was laid).
As nests age they become smellier and nestlings become noisier, possibly increasing the likelihood of predation.

We compared models with and without combinations of the above covariates and used corrected AIC values (Burnham & Anderson, 2002) to choose the model best supported by the data.

We compared nest survival estimates from this study with those from the Eglinton Valley in the early 1990s, when there were very few rats and stoats in the forest and estimated nesting success was 71%. Survival estimates similar to, or greater than those in the Eglinton we regard as being "good" and estimates lower than in the Eglinton indicating that the predator control was probably unsuccessful.

Mortality during the 1080 drop

Any parakeet nests found before the 1080 was dropped in the South Branch of the Hurunui in October 2006 were checked immediately before the 1080 was dropped and 2 or three times in the 2 weeks following the drop. We assumed that both adults were still alive at nests that were still being incubated or still had live chicks two weeks after the 1080 drop. We spent extra time watching any nests that failed during the period of the 1080 drop in an attempt to determine whether any of the adults were still alive. The contents of any nests that failed were assayed for 1080.

Predator monitoring and control

The predator control carried out in the South Branch of the Hurunui during the 3 seasons we monitored parakeets is shown in Table 1. The main difference between the first and second seasons was the advent of the 1080 drop early in the second season. The 07/08 season had reduced predator control as there had been no beech mast and predator numbers were expected to be low.

The 2006 aerial 1080 drop in the South Branch of the Hurunui comprised a 2kg per ha drop of non toxic, 6g, pre-feed baits lured with cinnamon which was undertaken on 14 September 2006, followed by a 5kg per ha drop of 6g baits containing 0.15% 1080, lured with cinnamon.

Table 1. Predator control in South Branch Hurunui during parakeet monitoring periods.

| | Trapping | Poisoning |
|-----------------------|---|--|
| Jan-Mar 2006 | 27km of stoat trap lines along the valley floor bush edge with alternating double and single set Fenn traps at 50m intervals baited with pricked eggs. A 50 × 150m grid of rat traps covering about 470 ha in the central part of the valley. | 55km of rodent bait stations (yellow subs) containing brodifacoum. 50m intervals between stations with stations placed midway between stoat and rat traps. |
| Aug 2006 - Jan 2007 | As above, but all traps baited with chocolate buttons and pricked eggs. | As above, with 1080 aerially sown over 2515ha in early October. |
| Nov 2007 - April 2008 | 27km stoat trap line and 12.8km rat trap lines run (upper lines only, 300m from the stoat line). All traps baited with pricked eggs only; traps checked monthly. | 55km rodent bait stations containing brodifacoum. Poison removed from stations in January |

The North Branch of the Hurunui has had neither rat nor stoat control but has had occasional localised possum control. Possum control was last undertaken at the end of 2006 when Feratox (cyanide) capsules were placed in bait stations at 100m spacing along the bush edge on both sides of the valley.

Predator monitoring is usually carried out quarterly, with tracking tunnels run in February, May, August and September. Fifteen lines of 10 tunnels in both the North and South Branch are baited overnight with peanut butter to track rodents, and then alternate tunnels on ten of these lines in each valley are baited for 3 nights with rabbit meat to track mustelids. However since the start of 2008, mustelid monitoring is run in January, February, August and November, to coincide more closely with the expected population peaks, and the number of rat monitoring lines in the South Branch treatment area has increased to twenty. From August 2006 to March 2007 rat surveys were carried out monthly in the South Branch.

RESULTS

Nesting success

Nesting successes and the causes of nest failure are summarised in Table 2 and detailed in Appendices 1-4.

Table 2. Nesting success and the causes of nest failure in the North (NB) and South Branches (SB) of the Hurunui between 2006 and 2008. Apparent nesting success is the number of nests successful divided by the number of nests observed and is a biased estimate of actual nesting success. Estimated nesting success is an unbiased estimate of nesting success calculated using the methods of Dinsmore *et.al.* (2002). *2006.5 refers to nests in the second half of 2006.

| When | Where | Nests | Days observed | Estimated success | Apparent success | Failed unknown (%) | failed natural (%) | unknown predator (%) | stoat (%) | rat (%) | possum (%) |
|---------|-------|-------|---------------|-------------------|------------------|--------------------|--------------------|----------------------|-----------|---------|------------|
| 2006 | SB | 18 | 619 | 0.90 | 0.94 | | | | | | 1 (6) |
| 2006.5* | SB | 29 | 806 | 0.70 | 0.83 | 1 (3.4) | 2 (7) | 1 (3) | 1 (3) | | |
| 2008 | SB | 22 | 954 | 0.76 | 0.68 | | 1 (5) | 2 (9) | 2 (9) | 1 (5) | 1 (5) |
| 2008 | NB | 10 | 234 | 0.18 | 0.40 | | 2 (20) | 1 (10) | 3 (30) | | 1 (10) |

Of the fourteen nests that we know were depredated over the three seasons, the predator was able to be identified from fur on the sticky bands on eight occasions. Of the remaining six predation events possum DNA was identified from swabs taken from the freshly dead carcasses at one nest; both possum and stoat fur were found on the sticky bands at another nest found empty at least 12 days before it should have fledged; three nests were found empty before they should have fledged but no predation sign was found, and we found a headless female parakeet and broken eggshells but were not able to identify the predator at one nest. In 62 percent of cases where sticky bands were in use, they helped us identify the predator.

We also collected hair off the fur snags of a number of nests that were still in use; some of these were subsequently eaten, others were successful. Appendix 5 shows all nests where hairs were collected during the 2008 season (this information is not available from the previous seasons). It is interesting to note that the two nests that were still going after stoat hair was collected from the sticky bands (S313 and N113) were subsequently eaten by stoats.

Also of interest is the difference in synchronicity between the North and South Hurunui last season. In the South Branch nesting activity was highly synchronous; all except one of the twenty-five nests found there this season had their first egg laid during a nineteen day window, between 14 Jan and 2 Feb (Appendix 3). In contrast, only six of the fourteen nests found in the North Branch were laid during a twelve day period, from 3 to 15 January, with the remaining eight nests were laid between late September 2007 and mid Feb 2008 (Appendix 4).

Figure 1 shows the nesting success rates recorded in this study and compares them with those recorded in the Eglinton in the 1990s. The best model of nesting success (Table 3) grouped the nesting successes from the South Branch of the Hurunui with those from the Eglinton.

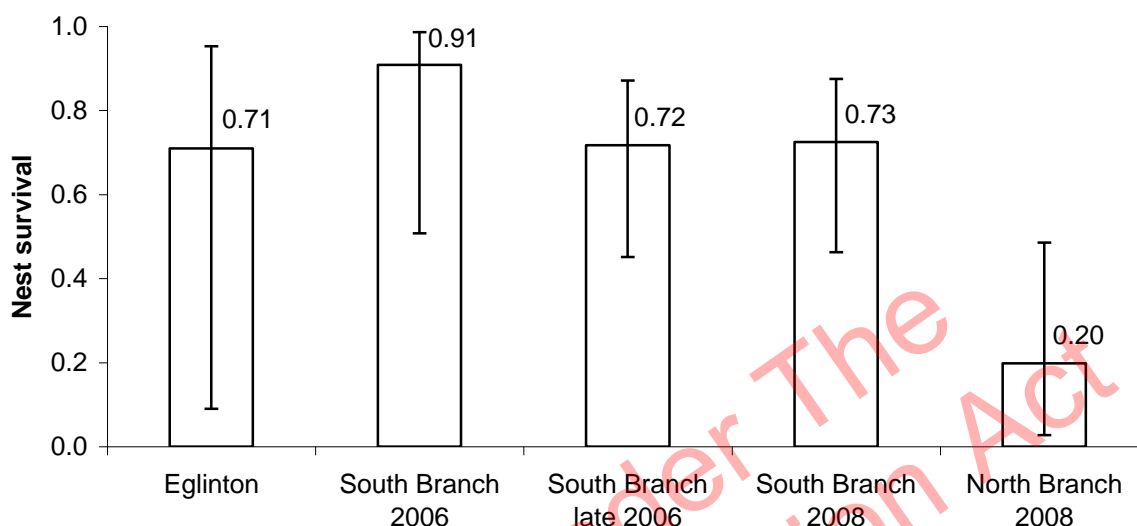


Figure 1. Nesting success of yellow-crowned parakeets in the North and South Branches of the Hurunui Valley between 2006 and 2008 and in the Eglinton in the 1990s. Error bars are 95% confidence intervals.

Table 3. Corrected AIC values for 4 different models of parakeet nesting success.

| Model | AICc | Number of parameters | Deviance |
|---|---------|----------------------|----------|
| Eglinton and South Branch the same - North Branch different | 122.36 | 2 | 118.35 |
| All places and seasons different | 126.41 | 5 | 116.40 |
| All places and seasons the same | 130.01 | 1 | 128.01 |
| South Branch and North Branch the same – Eglinton different | 132.001 | 2 | 127.997 |

Mortality during the 1080 drop

Fifteen parakeet nests were monitored during the 1080 operation, and all but one continued successfully after the poison drop on 6 October 2007. Dead chicks from the failed nest were found to have traces of 1080 in their tissues and the female was not seen after the nest failed, though the male was. This suggests a mortality rate of parakeets of 3.3% with 95% confidence intervals from 0.1-17%.

At about the same time seven yellow-crowned parakeets nests were monitored during a similar 1080 drop in the Dart Valley in west Otago. The Dart operation differed only in that 3kg per ha of pre-feed and 3kg per ha of toxic bait was applied. Two yellow-crowned

parakeets were found dead with 1080 in their tissues just after the 1080 drop in the Dart Valley, but all monitored nests were successful. The combined estimate of mortality of nesting parakeets from both 1080 drops was 2.27% (95% confidence interval 0.1 - 12%).

Predator Numbers

Figures 2 and 3 show predator indices in the North and South Branch during the 3 seasons nests were monitored. Numbers of both rats and stoats were low throughout in the South Branch. In the North Branch no rats were tracked during the season that we monitored nests, but stoats were tracked at 100%.

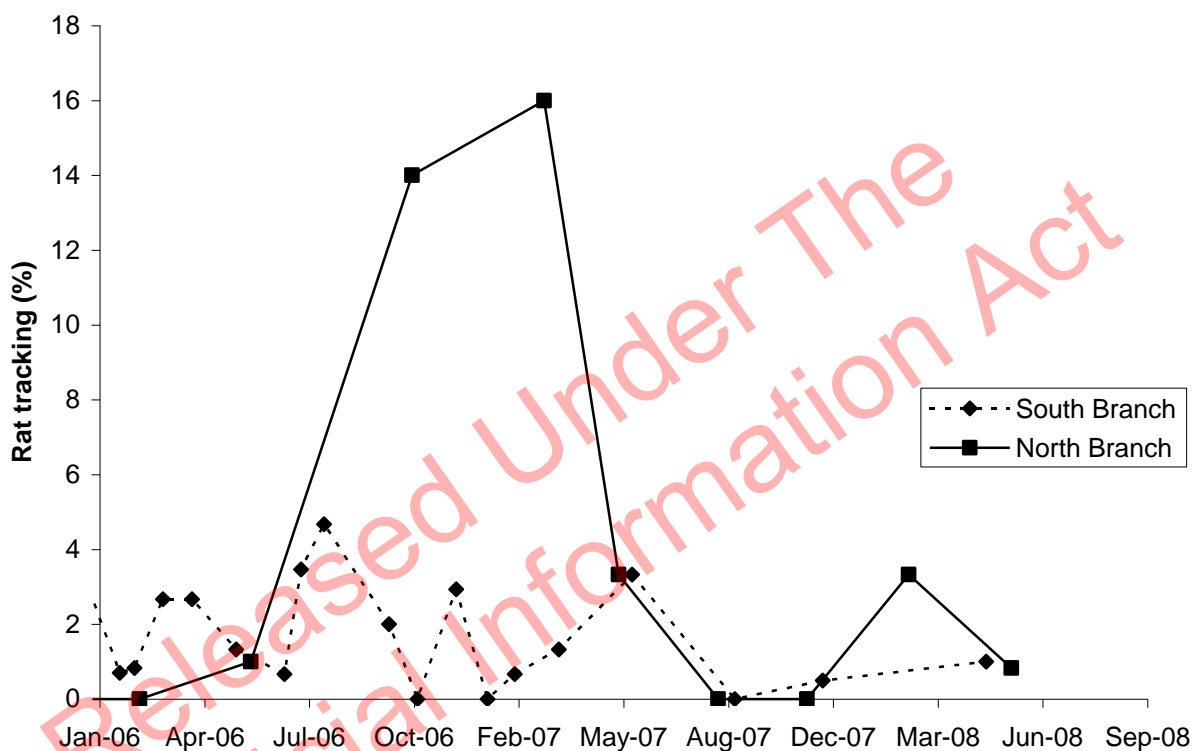


Figure 2. Rat tracking rates in the North and South Branches of the Hurunui.

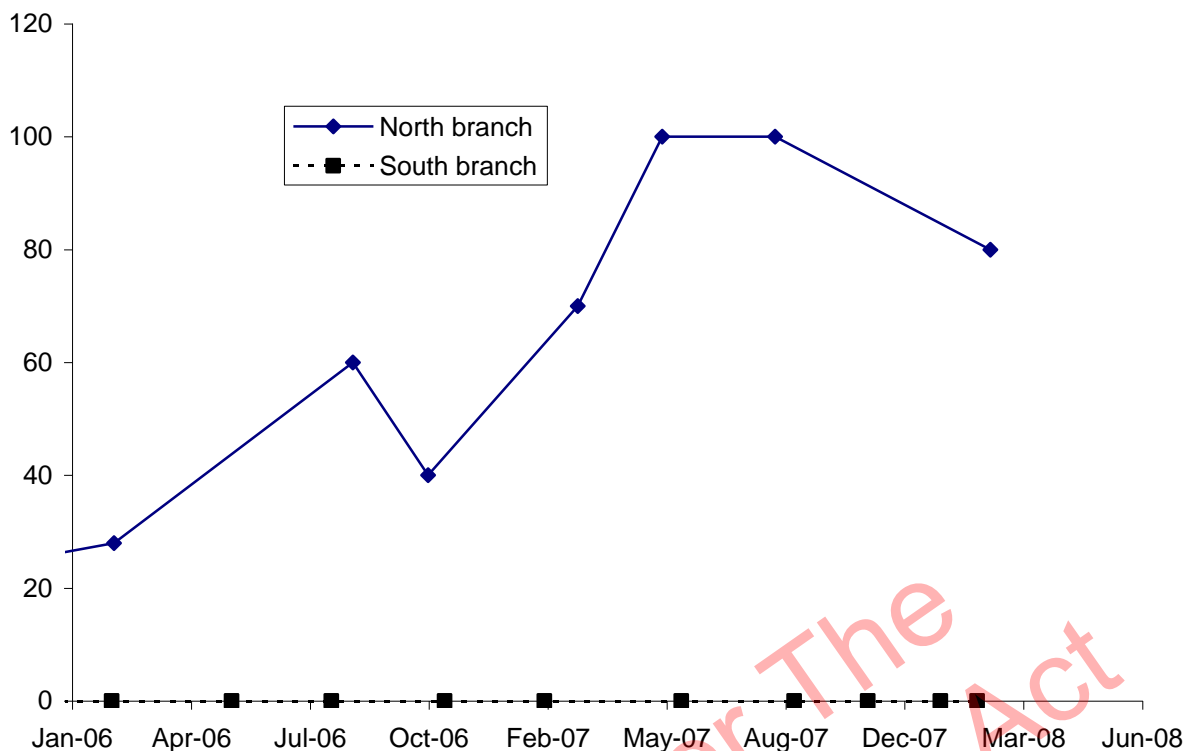


Figure 3. Stoat tracking rates in the North and South Branches of the Hurunui.

Effects of stage in season and age

The best model of nesting success included terms for both stage in season and age, and both had a negative effect on nesting success, i.e., nests late in the season were less successful than nests early in the season, and old nests (nests with near fledging chicks) were less successful than nests with eggs or small chicks.

DISCUSSION

The best model of parakeet nesting success suggests that we might reasonably regard the nesting successes that we observed in the five combinations of site and season as falling into two groups; "high" and "low". Since two of the high nesting successes occurred when rat and stoat numbers were very low, it is also reasonable to assume that "high" nesting success is sufficient to support a healthy parakeet population.

Nesting success was high in the Eglinton and the South Branch of the Hurunui in early 2006 when stoat and rat numbers were naturally low and when there was rat poison in bait stations in the South Branch. This implies either that the rat and stoat control was successful or that it was unnecessary.

Nesting success was also high in the South Branch in late 2006 when rat and stoat numbers were high in untreated areas but low in the South Branch. This suggests that the predator control (traps for stoats, poison in bait stations in combination with aerial 1080 for rats and stoats) was necessary and reduced stoat and rat densities to acceptable levels. Nesting success in the South Branch was also high in 2008 while it was very low in the North Branch. Stoat

numbers were very high in the North Branch in 2008 and would presumably have been similarly high in the South Branch if it had not been for the predator control. This suggests that the stoat control was necessary in the South Branch in 2008 and that it reduced stoat density to an acceptable level. This control was achieved using traps as well as poison (laid primarily for rats but which also kills stoats through secondary poisoning).

Although nesting success rates in predator controlled areas appear acceptable, the predator control was not perfect. Stoat, rat and possum predation was detected at nests in every season, even in those when nesting success was high (Table 2). For critically endangered species, such as the orange-fronted parakeet, such predation is undesirable, but this study provides no guide as to whether any increase in predator control effort would be cost-effective.

Some parakeets are killed by aerial 1080 poison of the type used in the Dart and Hurunui Valleys, but given the rate of nest predation observed when no predator control was carried out in the North Branch of the Hurunui, the net effect of a predator control regime that includes aerial 1080 is undoubtedly positive.

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APPENDIX 1: Nests found in South Branch Hurunui Jan-Feb 2006

| Nest I.D. | Date found | Stage found | Lay date 1 st egg (approx) | Outcome | # days exposure |
|-----------|------------|---------------|---------------------------------------|-----------------------------|-----------------|
| 58 | 05/01/06 | Prelay | 10/01/06 | Assume success | 58 |
| 101 | 06/01/06 | Eggs | 03/01/06 | Assume success | 43 |
| 102 | 07/01/06 | Eggs | 05/01/06 | Assume success | 41 |
| 103 | 07/01/06 | Prelay | 16/01/06 | Assume success | 32 |
| 104 | 07/01/06 | Eggs | 02/01/06 | Assume success | 40 |
| 64 | 09/01/06 | Prelay | 16/01/06 | Assume success | 25 |
| 105 | 09/01/06 | Eggs | 01/01/06 | Assume success | 45 |
| 106 | 10/01/06 | Prelay | 19/01/06 | Assume success | 48 |
| 107 | 11/01/06 | Prelay | ? | Unknown, too deep to see | 0 |
| 108 | 22/01/06 | Eggs | Pre14/01/06 | Eaten, possum | 36 |
| 110 | 02/02/06 | Eggs | 11/01/06 | Assume success | 36 |
| 111 | 02/02/06 | Prelay | 07/02/06 | Unknown (last visit 26days) | 48 |
| 113 | 16/02/06 | 10 day chicks | 17/01/06 | Assume success | 20 |
| 114 | 16/02/06 | Prelay | 03/03/06 | Unknown (last visit eggs) | 19 |
| 115 | 16/02/06 | Prelay | 21/02/06 | Unknown (last visit 12days) | 32 |
| 116 | 17/02/06 | Prelay | 21/02/06 | Unknown (last visit 12days) | 32 |
| 117 | 18/02/06 | Eggs | 12/02/06 | Unknown (last visit 19days) | 37 |
| 119 | 21/02/06 | Prelay | 21/01/06 | Assume success | 0 |
| 120 | 21/02/06 | 16 day chicks | 14/01/06 | Assume success | 12 |
| 121 | 21/02/06 | Eggs | 15/02/06 | Unknown, too deep to see | 0 |
| 122 | 23/02/06 | 16 day chicks | 18/01/06 | Assume success | 15 |
| 123 | 23/02/06 | 26 day chicks | 08/01/06 | Assume success | 0 |

APPENDIX 2: Nests found in South Branch Hurunui Aug 2006-Jan 2007 (2006.5)

| Nest I.D. | Date found | Stage found | Laydate 1 st egg (approx) | Outcome | # days exposure |
|-----------|------------|---------------|--------------------------------------|------------------------------|-----------------|
| 201 | 18/08/06 | Eggs | 16/08/06 | Assume success | 48 |
| 202 | 19/08/06 | Prelay | 29/08/06 | Assume success | 30 |
| 203 | 24/08/06 | 12 day chicks | 20/07/06 | Assume success | 25 |
| 204 | 24/08/06 | 18 day chicks | 14/07/06 | Assume success | 0 |
| 123.2 | 07/09/06 | 25 day chicks | 19/07/06 | Assume success | 7 |
| 205 | 07/09/06 | 20 day chicks | 25/07/06 | Assume success | 11 |
| 36a | 08/09/06 | Eggs | 30/08/06 | Success | 32 |
| 216 | 08/09/06 | 14 day chicks | 01/08/06 | Assume success | 9 |
| 206 | 09/09/06 | Eggs | 03/09/06 | Eaten, unidentified predator | 42 |
| 207 | 10/09/06 | Eggs | 31/08/06 | Assume success | 29 |
| 208 | 17/09/06 | Laying | 17/08/06 | Assume success | 47 |
| 209 | 20/09/06 | Laying | 19/09/06 | Assume success | 36 |
| 210 | 20/09/06 | Chicks | 15/08/06 | Assume success | 16 |
| 211 | 13/09/06 | Prelay | 29/09/06 | Assume success | 48 |
| 212 | 20/09/06 | Eggs | 12/09/06 | Success | 41 |
| 213 | 21/09/06 | Eggs | 05/09/06 | Failed, non-predation | 5 |
| 217 | 23/09/06 | unknown | ? | Survived 1080 | 0 |
| 218 | 12/09/06 | Laying | 11/09/06 | Assume success | 48 |
| 117.2 | 20/09/06 | Prelay | ? | Uncertain | 0 |
| 49.2 | 25/09/06 | Eggs | 11/09/06 | Assume success | 33 |
| 215 | 02/10/06 | Eggs | 18/09/06 | Assume success | 41 |
| 220 | 07/10/06 | 13 day chicks | 15/09/06 | Assume success | 0 |
| 58.3 | 11/10/06 | Eggs | 07/10/06 | Failed, non-predation | 37 |
| 221 | 11/10/06 | Prelay | 16/10/06 | Assume success | 36 |
| 222 | 31/10/06 | Eggs | 08/11/06 | Assume success | 19 |
| 223 | 31/10/06 | Eggs | 26/10/06 | Failed, non-predation | 10 |
| 224 | 03/11/06 | Laying | 01/11/06 | Assume success | 36 |
| 226 | 05/11/06 | Prelay | 08/11/06 | Assume success | 15 |
| 227 | 11/11/06 | Eggs | 08/11/06 | Assume success | 27 |
| 228 | 23/11/06 | 2 day chicks | 27/10/06 | Assume success | 17 |
| 229 | 27/11/06 | Eggs | 22/11/06 | Assume success | 29 |
| 230 | 21/11/06 | Eggs | 01/11/06 | Assume success | 0 |
| 233 | 05/01/07 | Eggs | 16/12/06 | Failed, cause unknown | 25 |
| 234 | 08/01/07 | 14 day chicks | 03/12/06 | Eaten, stoat? | 7 |

APPENDIX 3: Nests found in South Branch Hurunui Dec 2007 – Feb 2008

| Nest I.D. | Date found | Stage found | Lay date 1 st egg (approx) | Outcome | # days exposure |
|-----------|------------|---------------|---------------------------------------|------------------------------|-----------------|
| S301 | 09/12/07 | 10 day chicks | 04/11/07 | Failed, non-predation | 0 |
| S302 | 19/12/07 | Prelay | 17/01/08 | Assume success | 57 |
| S58 | 19/12/07 | Prelay | 14/01/08 | Assume success | 58 |
| S303 | 05/01/08 | Prelay | 21/01/08 | Assume success | 60 |
| S301.2 | 09/01/08 | Prelay | 21/01/08 | Eaten, unidentified predator | 0 |
| S305 | 10/01/08 | Prelay | 29/01/08 | Failed, non-predation | 0 |
| S307 | 20/01/08 | Laying | 18/01/08 | Eaten, stoat (post-obs) | 56 |
| S308 | 20/01/08 | Laying | 17/01/08 | Assume success | 53 |
| S309 | 20/01/08 | Laying | 19/01/08 | Eaten, ship rat | 11 |
| S310 | 21/01/08 | Laying | 20/01/08 | Assume success | 65 |
| S311 | 21/01/08 | Prelay | 02/02/08 | Assume success | 57 |
| S312 | 21/01/08 | Laying | 17/01/08 | Success | 56 |
| S313 | 23/01/08 | Laying | 22/01/08 | Eaten, stoat (post-obs) | 57 |
| S314 | 23/01/08 | Laying | 17/01/08 | Assume success | 54 |
| S315 | 24/01/08 | Laying | 19/01/08 | Assume success | 54 |
| S316 | 30/01/08 | Incubating | 23/01/08 | Eaten, unidentified predator | 38 |
| S317 | 31/01/08 | Laying | 29/01/08 | Failed, non-predation | 26 |
| S318 | 01/02/08 | Laying | 30/01/08 | Assume success | 54 |
| S105 | 05/02/08 | Incubating | 17/01/08 | Eaten, possum | 27 |
| S319 | 05/02/08 | Incubating | 25/01/08 | Outcome unknown | 42 |
| S320 | 19/02/08 | 4 day chicks | 20/01/08 | Outcome unknown | 23 |
| S321 | 19/02/08 | 3 day chicks | 21/01/08 | Assume success | 27 |
| S322 | 19/02/08 | 1 day chicks | 23/01/08 | Assume success | 28 |
| S324 | 20/02/08 | 1 day chicks | 22/01/08 | Assume success | 35 |
| S325 | 29/02/08 | 10 day chicks | 26/01/08 | Failed, don't know why | 16 |

APPENDIX 4: Nests found in the North branch of the Hurunui Nov 07-Feb 08

| Nest I.D. | Date found | Stage found | Lay date 1 st egg (approx) | Outcome | # days exposure |
|-----------|------------|---------------|---------------------------------------|------------------------------|-----------------|
| N101 | 25/11/07 | 35 day chicks | 29/09/07 | Assume success | 0 |
| N102 | 28/11/07 | 40 day chicks | 27/09/07 | Assume success | 0 |
| N103 | 18/01/08 | 36 day chicks | 20/10/07 | Assume success | 0 |
| N104 | 19/01/08 | 13 day chicks | 14/12/07 | Assume success | 17 |
| N105 | 20/01/08 | Incubating | ? | Failed, non-predation | 6 |
| N106 | 21/01/08 | Incubating | 10/01/08 | Assume success | 45 |
| N107 | 24/01/08 | Incubating | 06/01/08 | Eaten, stoat | 30 |
| N108 | 01/02/08 | Laying | 28/01/08 | Assume success | 48 |
| N109 | 03/02/08 | 1 day chicks | 08/01/08 | Assume success | 32 |
| N110 | 02/02/08 | Prelay | 13/02/08 | Failed, non-predation | 0 |
| N111 | 07/02/08 | 1 day chicks | 15/01/08 | Eaten, possum or stoat | 19 |
| N112 | 15/02/08 | Laying | 13/02/08 | Eaten, unidentified predator | 26 |
| N113 | 19/02/08 | 18 day chicks | 11/01/08 | Eaten, stoat | 7 |
| N114 | 21/02/08 | 25 day chicks | 03/01/08 | Eaten, stoat | 4 |

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APPENDIX 5: Predator hairs collected from nest trees 2008, and final nest outcome.

| Nest I.D. | Final check date | Nest contents at final check | Hairs found on stickies | Comments. |
|-----------|------------------|---|---|--|
| S307 | 01/04/08 | Broken eggshells and lots of feathers | Stoat hair 01/04/08 | Eaten (post cutoff) |
| S309 | 17/02/08 | Feathers and broken eggshells | Ship rat 17/02/08 | Eaten |
| S313 | 31/03/08 | Lots of feathers and possible carcass | Possum fur 01/02/08; Stoat hair 03/03/08; Stoat hair 31/03/08 | Nest still going 03/03/08. Eaten 31/03/08 (post cutoff) |
| S314 | 31/03/08 | Nest empty | Possum fur 01/02/08 | Success assumed |
| S317 | 04/03/08 | 2 intact eggs & 3 intact chicks of varying age and state of decay | Possum fur 14/02/08 | Still going when possum fur found. Assumed abandoned 04/03/08. |
| S319 | 01/04/08 | Nest empty | Stoat hair 01/04/08 | Success at 32d. Final fate uncertain (last check after expected fledge date) |
| S320 | 01/04/08 | Could not climb. No activity at nest in 80min | Stoat hair 01/04/08 | Success at 32d. Final fate unknown. Should have fledged by 01/04/08. |
| S324 | 02/04/08 | Nest empty | Possum fur 02/04/08 | Hole deemed "not possumable" (too deep). Assume success |
| S325 | 26/03/08 | A few feathers | Unidentified hair 26/03/08. No DNA retrieved at testing | Success at 32 days. Final fate uncertain. Chicks should have been 36-40d on 26/03/08. |
| N104 | 17/02/08 | Nest empty | Stoat fur & parakeet feathers 17/02/08 | 2 of 3 chicks seen on the ground on 07/02/08, one heard still on nest. The two on the ground looked about 34 days – very early fledge. |
| N107 | 29/02/08 | Adult parakeet body and head, dead chicks | Stoat hair 29/02/08 | Eaten |
| N108 | 19/03/08 | 1 chick c.30 days and 7 eggs | Possum fur 15/02/08 | Success to cutoff (19/03/08); not monitored past this date. |
| N110 | 19/02/08 | 4 cold eggs | Possum fur 19/02/08 | Abandoned |
| N111 | 02/03/08 | Nest empty | Possum fur and stoat hair 02/03/08 | Eaten; chicks should have been 23days at this check |
| N113 | 29/02/08 | Nest empty | Stoat hair 21/02/08; stoat hair 29/02/08 | Nest still going 21/02/08. Eaten 29/02/08; chicks should have been 28 days at this check. Stoat seen by cavity 29/02/08 |
| N114 | 28/02/08 | Nest empty | Stoat hair 28/02/08 | Eaten; chicks should have been 31-33 days at this check. |