Monitoring yellow-crowned parakeets

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Part 1. Monitoring yellow-crowned parakeet numbers in mainland forests

Abstract

Yellow-crowned parakeets (*Cyanoramphus auriceps*) are one of a number of uncommon forest birds whose population changes may be useful indicators of the health of forest bird communities. This report (Part 1) describes a parakeet monitoring regime that will detect changes in parakeet populations with a minimum of effort and expertise. The technique uses standard five-minute bird counts, and requires two people for two fine days a year, for at least five years.

1. Introduction

The yellow-crowned parakeet is the most common of the two species of parakeet that used to be found throughout New Zealand. It is still widespread in forests in the North, South and Stewart Islands and is found on a few offshore islands. However, in most large forest blocks it is uncommon and it is absent from most small forest blocks.

It is one of a group of forest species, which includes kaka, yellowhead and robin, that have survived the initial impact of introduced predators and habitat loss, but which are now much less common and more patchily distributed than they used to be. These species are either still declining, or are particularly vulnerable to habitat changes and introduced predators.

The yellow-crowned parakeet is a good species to use as an indicator of the health of forest bird communities. More common species, while easier to monitor, have already proved themselves resilient to many of the deleterious changes in our forests; their numbers sometimes even increase with forest modification. Uncommon species such as parakeets are the species about which we have most concern, and since the have shown themselves to be vulnerable to habitat change and introduced predators, they are likely to provide early warning of further deterioration in the health of forest communities.

Monitoring bird numbers invariably involves recognising their calls. Even common species are heard much more often than they are seen, and to use a monitoring technique that involved counting only birds that are seen would dramatically increase the amount of time spent counting. Parakeets are good birds to count because they call often and their calls are loud and distinctive.

The down side of monitoring an uncommon species such as the yellow-crowned parakeet is that they are sometimes so uncommon that they are practically unmonitorable.

The most widely used technique for monitoring birds in New Zealand is the five-minute bird count which was developed in response to plans for commercial exploitation of large areas of the South Island's beech forests in the 1970s. The technique is simple and has already been used by a large number of DoC workers.

This report—Part 1—describes the field and analytical techniques necessary to carry out effective monitoring of yellow-crowned parakeet numbers. For a more detailed account of the statistics and sample size constraints, see Part 2.

2. Methods

This section describes the techniques used to set up a yellow-crowned parakeet monitoring programme. There are 5 parts:

1. developing bird identification skills.
2. a description of five-minute bird counts and appropriate data recording
3. Setting up a permanent monitoring line.
4. person-power and the timing and frequency of bird counts.
5. data analysis.

2.1 BIRD IDENTIFICATION SKILLS

Five-minute bird counts are usually carried out by experienced bird counters who are able to identify every bird call they hear. For the purposes of monitoring yellow-crowned parakeets it is only necessary to be able to distinguish parakeets from all other birds, though a bird-counting programme that recorded only parakeets and 'other birds' would have missed an opportunity to monitor a range of uncommon species. Bird counters should aim to identify all bird calls, but if this is not possible they should at least be able to identify yellow-crowned parakeet, kokako, kaka, robin, yellowhead, whitehead and brown creeper before they attempt to undertake bird counts.

Attempting to learn bird calls from a tape is ineffective, though it is a useful way of initially identifying calls. Bird counters should learn bird calls by spending time in the forest with a pair of binoculars, moving around trying to see everything they hear.

2.2 FIVE-MINUTE BIRD COUNTS

The observer stops and stands quietly at a counting station for five minutes and all birds seen or heard are recorded. The five minutes is timed accurately using a stop watch and no birds heard either just before or just after the count are included in the count. Each count is treated separately so that, even if it is thought that an individual bird was included in a previous count, it is counted again. Within a count no bird is knowingly counted twice, nor are birds assumed to be present without being seen or heard. For flocks o birds the number of birds seen or heard calling is recorded rather than the number the observer guesses is in the flock. If a bird calls in one place and later one of the same species is heard some distance away, they are recorded as two birds unless there is evidence that the first bird moved to the second place.

For each count the following is recorded:

Locality: Station number if a regularly counted spot, or grid reference, altitude, aspect, vegetation etc. if not regularly counted.

Date: dd/mm/yy

Time: 24 hour clock at the beginning of each count.

Temperature: In °C or:

freezing	<0°C
cold	0–5
cool	5–11
mild	11–16
warm	16–22
hot	>22

Wind: The average for each five-minute count on a modified Beaufort scale:

0 Leaves still or move without noise (Beaufort 0 and 1)
1 Leaves rustle (2)
2 Leaves and branchlets in constant motion (3 and 4)
3 Leaves or branches sway (5,6 and 7)

Other noise: (water, cicadas, traffic, chainsaws, etc.), the average for the five minutes on the following scale:

0 Not important
1 Moderate
2 Loud

Cloud cover: Estimate in eighths: 1/8, 2/8, 3/8, 4/8, 5/8, 6/8, 7/8, 8/8

Precipitation: Mist—M, Rain—R, Hail—H, Snow—S, on scale as follows:

0 None
1 Dripping foliage
2 Drizzle
3 Light
4 Moderate
5 Heavy

Birds: The bird species and number seen or heard. Experienced bird counters will be able to identify all bird calls heard during a five minute spell, but less experienced counters may not identify some calls—these should be recorded as unknown in the same way that identified species are recorded.

Field data recording

Unless special forms are printed, the bird counts are most appropriately recorded in small notebooks.

Small ‘star’ diagrams (figure 1) are useful aids to keeping track of the number of more common bird species, with each line representing the distance and direction from which one bird was heard. An example bird count including all the required information is shown in figure 2.

FIGURE 1. STAR DIAGRAM SHOWING THE LOCATION OF 4 BIRDS SEEN OR HEARD BY THE BIRD COUNTER. THE CENTRAL DOT REPRESENTS THE BIRD COUNTER, AND THE LINES REPRESENT THE DIRECTION AND DISTANCE TO THE BIRD.

FIGURE 2. AN EXAMPLE BIRD COUNT THAT INCLUDES ALL THE NECESSARY INFORMATION.

Storing data on computer

Although data analysis is likely to be undertaken using a statistics package on a PC, it is almost certainly easier to enter and store data in a spreadsheet—in DoC's case this means an Excel document. Figure 3 shows an appropriate layout for a bird counting spreadsheet.

FIGURE 3. AN EXAMPLE LAYOUT OF AN EXCEL SPREADSHEET DOCUMENT FOR STORING BIRD COUNT INFORMATION.

Subsequent data analysis will be made much easier if a zero is entered in the column of any species not recorded in a bird count.

2.3 SETTING UP A PERMANENT MONITORING LINE

Choose two sites on easy country and cut and mark out two lines of 10 counting stations at 100 m intervals. Both lines should be readily accessible by road at one end, so that you don't spend too much time getting to and form the counting line. Mark the counting stations permanently and give each a unique number. Counting stations should be away from sources of noise such as roads and streams, and should be at least 100 m inside the forest.

2.4 PERSON-POWER AND THE TIMING AND FREQUENCY OF COUNTS

Person-power and a suitable counting regime

Counting should be undertaken by two people, one to count each line. Starting at 9 am, each counter walks along one of the lines doing bird counts, and returns back along the line by about midday. In the afternoon they repeat the exercise. 10 counting stations 100 m apart can easily be counted four times a day using this regime. On the following day the two counters should swap lines. With two lines, two counters and two days of counting, 160 bird counts will be recorded. This is sufficient to monitor even quite small numbers of parakeets.

In an ideal world it would be best to have only one person doing all the counts, but since the counting programme may need to last for more than 10 years it is more sensible to have two people involved so that at least one of the previous year's counters is available each year.

Time of day and weather conditions

Bird counts should be undertaken only between 9 am and 4 pm and only on fine days—light winds and clear or partly cloudy skies. these restrictions will considerably reduce the variability between counts and thus reduce the number of days that need to be spent counting.

Frequency of counts

Counts should be undertaken once a year between May and October inclusive. Counts should be undertaken at the same time of the year, or at least within a month of the same time of the year. Counts should not get later and later or earlier and earlier as the study progresses. For example, if you decide to do the counts in July, then if they are occasionally done in June or August it's probably not a problem, but if they are initially done in July, but subsequently done in August, then September, then October, they will be uninterpretable.

Duration of monitoring

To determine the length of time that the monitoring will have to be continued before changes in parakeet populations can be detected, the average number of parakeets per count for the first two days counting will have to be calculated. If there are more than 0.25 parakeets per count, declines will be obvious after only 5 years, but for small initial parakeet densities much longer periods of time will be required (see figure 4).

FIGURE 4. THE NUMBER OF YEARS OF MONITORING REQUIRED TO DETECT A 5% PER ANNUM DECLINE IN PARAKEET NUMBERS (α=0.5, β=0.2).

2.5 DATA ANALYSIS

After five years of counts it is appropriate to have a look at the data collected.

There are no simple statistical tests that one could apply to parakeet counts and which would be convincing to a statistician. However, I have devised the following rough and ready test, which will identify parakeet populations that are declining at such a rate that the data should be subjected to a more rigorous statistical analysis.

1. Find the average number of parakeets per count for each year of monitoring.
2. Find the natural log of the average number of counts, either on a calculator or in Excel.
3. Enter the year, average number of parakeets per count and log of the average in an Excel spreadsheet like this:

Year	Average count	Log count
1997	1	0
1998	0.95	-0.05129
1999	0.87	-0.13926
2000	0.78	-0.24846
2001	0.65	-0.43078

4. From the tools menu in Excel choose ‘data analysis’ (if ‘data analysis’ doesn’t show up in your tools menu then you’ll have to get your local computer whiz to install the Excel add-ins) and choose ‘Regression’ from the list. Select the contents of the ‘Input Y range’ box then drag the cursor over the numbers in the log count column in the spreadsheet. Then select the contents of the ‘Input X range’ and drag the cursor over the contents of the year column. Click on ‘OK’
5. Examine the output. It should be something like this:

The value in the box is the natural log of the rate of decline. If the number in the box next to ‘X Variable 1’ in the bottom line is more negative than -0.03 then it is likely that there is a significant decline going on in the population and you should get a statistician to have a good look at the numbers.

Part 2. Monitoring yellow-crowned parakeet numbers and nesting success: statistical methods and sample sizes

Abstract

A series of 1300 five-minute bird counts undertaken between 1990 and 1993 in the Eglinton Valley, Fiordland were examined to determine the optimum number and timing of counts necessary to monitor population changes in yellow-crowned parakeets (*Cyanoramphus auriceps*). Counts are best undertaken in the winter and spring, but it may require up to 200 counts per annum for up to 10 years to reliably detect changes in most parakeet populations.

Yellow-crowned parakeet nesting success in an area trapped for stoats (*Mustela ermina*) in the Eglinton Valley was compared with nesting success in surrounding untrapped forest during a year when stoats were uncommon. Stoat trapping appeared to have a beneficial effect on parakeet nesting success, but sample sizes were too small to get a statistically significant result.

1. Introduction

The yellow-crowned parakeet (*Cyanoramphus auriceps*) belongs to a small genus (6 Species) of mainly forest-dwelling parakeets endemic to the south-west Pacific with their centre of distribution in New Zealand (Fleming 1976). Three species of parakeet were once common on the main islands of New Zealand, but only the yellow-crowned parakeet remains widespread, although it is absent from most small isolated forests and is uncommon in most large unmodified forest areas.

Although populations of yellow-crowned parakeets on the main islands of New Zealand have recently been regarded as stable, having perhaps increased slightly after a dramatic decline early this century (Taylor 1985), there is evidence that they may be limited by stoat (*Mustela erminea*) predation (Elliott and O'Donnell 1988).

As part of a larger study of the effect of stoats on hole-nesting birds, the breeding biology and behaviour of yellow-crowned parakeets and the effect of stoat trapping on their demography were studied in the Eglinton Valley in Fiordland National Park. This study aimed to fill some of the gaps in knowledge of the species' biology, to describe aspects of its ecology in mainland forests, and to assess the role of predators in limiting populations. The major parts of this study have already been reported on by Elliott *et al*. 1996) and this paper documents only two aspects of the study: the effect on yellow-crowned parakeets of stoat trapping during years when stoat numbers are low, and the methods and sample sizes necessary for detecting changes in parakeet populations.

Elliott *et al*. (1996) concluded that while small scale trapping was not effective in reducing the impact of stoat predation on parakeets during summers when stoat numbers were very high, trapping during years when stoats were less common might have a greater beneficial effect on parakeet populations. To test the prediction parakeet nests in two areas were monitored during a breeding season when stoat numbers were low. One area was trapped for stoats, the other was a control.

Monitoring long-term changes in parakeet numbers using standard bird counting techniques is made difficult by the fact that parakeet numbers and conspicuousness vary seasonally and because counts of parakeets are never normally distributed. In this paper I examine a series of counts to identify the optimum time to count birds for monitoring purposes, and the distribution of counts to identify useful techniques for analysis and minimum useful sample sizes.

Parakeets were studied in forest in the middle reaches of the Eglinton Valley in Fiordland National Park (168°01'E, 44°58'S). The Eglinton Valley is glaciated with steep sides and a flat floor 0.5–1.0 km wide. The forest was dominated by red and silver beech (*Nothofagus fusca* and *N. menziesii*) (see O'Donnell 1996 for full study area description). A fifty ha rectangle of forest at Deer Flat was trapped for stoats, but no trapping was carried out in surrounding forests.

2. Methods

2.1 COUNTING PARAKEETS

To monitor the population density of parakeets and other species in the study areas, five-minute bird counts (Dawson and Bull 1975) were carried out at 20 stations, 100 m apart, on two transect lines—one the trapped area at Deer Flat, and one about 1 km away in untrapped forest at Knobs Flat. During August or September in 1990, 1991 and 1992, and in April or May in 1991, 1992 and 1993, 8 five-minute bird counts were undertaken at each counting station over 2 days. On the first day, one observer counted each station in one study area 4 times, twice in the morning and twice in the afternoon. On the second day, the observers swapped study areas. This protocol gave a total of 80 counts per study area.

A further series of 40 bird counts by only one observer over one day at Knobs Flat during January and March 1993 was used to assess changes in parakeet conspicuousness associated with breeding.

2.2 MONITORING NESTS

Parakeet nests were searched for and monitored during January, February and March 1994 within the trapped area at Deer Flat and in surrounding forests. Stoat numbers were low during this period, having declined from a peak following a beech mast in 1993 (O'Donnell *et al*. 1996).

Nests were found when parakeets were seen entering holes in trees, when female parakeets or nestlings were heard being fed by their mates or parents, and when known nest sites were checked to see if they were being re-used. Once found, nests were checked at regular intervals to monitor their progress. Methods of finding and monitoring nests are described in detail by Elliott *et al*. (1996).

3. Results and discussion

3.1 BIRD COUNTS

Table 1 summarises the bird counts carried out in the Eglinton Valley between August 1990 and May 1993.

TABLE 1. YELLOW-CROWNED PARAKEETS RECORDED IN FIVE-MINUTE BIRD COUNTS IN THE EGLINTON VALLEY.

PLACE	DATE	MEAN PARAKEET COUNT	NUMBER OF COUNTS
Deer Flat	August 1990	2.9	80
	September 1990	2.3	80
	April 1991	0.1	80
	August 1991	0.2	80
	September 1991	0.5	80
	April 1992	0.2	80
	August 1992	0.4	80
	May 1993	0.3	80
Knobs Flat	August 1990	4.1	80
	September 1990	3.7	74
	April 1991	0.2	80
	August 1991	0.2	80
	September 1991	0.8	80
	April 1992	0.4	80
	August 1992	0.1	80
	January 1993	0.6	20
	March 1993	2.8	40
	May 1993	0.3	80
Mean		1.1	1334

Optimal time of year for counts

There are substantial seasonal fluctuations in parakeet counts, which probably reflect not only changes in abundance but changes in conspicuousness (Elliott *et al*. 1996). Parakeets are more conspicuous when breeding, and the number of birds recorded during breeding seasons is influenced by the intensity of breeding, the number of young parakeets fledged, as well as the abundance of adult birds. Furthermore, in beech forests breeding intensity and success are strongly correlated with the availability of beech seed. One would normally undertake counts at a time of year when parakeets were most numerous, i.e., when they are breeding, since this would give the best power to detect real change in parakeet abundance. However, the changes detected would probably not be long-term trends in parakeet density, but short-term changes in parakeet abundance and conspicuousness associated with the availability of beech seed. Winter and spring counts, though lower, are less variable, but even they show marked increases during a beech seedfall. Probably the best monitoring regime is to count in winter and spring, but ignore counts taken in beech forests during beech mast.

Methods of analysis

Parakeet counts are not normally distributed (Figure 1), and the presence of high numbers of zero counts even at times when parakeets are common. precludes the use of transformations that are often used to make non-normal distributions normal. This in turn precludes the use of anova and regression to analyse parakeet counts—the probabilities produced by these procedures if used on highly non-normal parakeet counts will be meaningless.

FIGURE 1. FREQUENCY DISTRIBUTION OF PARAKEETS RECORDED IN FIVE-MINUTE BIRD COUNTS AT KNOBS FLAT IN SEPTEMBER 1991.

Since bird counts involve counting, one could reasonably expect parakeet counts to have an approximately Pousson distribution, but they don't. In fact, they closely approximate a negative binomial distribution. Negative binomial distributions are often observed in nature when the variance of counts is higher than expected. (Baker and Nelder 1978). Such an observation is easily explained for parakeets which usually travel in flocks. The incidence of flocks is probably a Poisson process, but the variability of flock size increases the variability of counts above the predictable variability of Poisson processes.

There are no parametric analytical techniques for carrying out anova and regression-like analyses on counts with negative binomial errors, but they can be closely approximated by carrying out analysis of deviance, assuming a Poisson error distribution, but with an estimated scale parameter (Baker and Nelder 1978). Such analyses can be carried out on a range of statistical packages, such as SYSTAT, SAS and APSS, though they are not as straight-forward as anova and regression and will require expert assistance for all but the most statistically able biologists.

Number of counts required

I undertook a power analysis to determine the number of counts required to detect changes in parakeet density of 5% per annum with a significance of 10%, 80% of the time. I assumed that although parakeet counts are not normally distributed, the rate of change of counts (the slope of a fitted line) is approximately normally distributed.

I then simulated a parakeet population declining at 5% per annum by generating a series of gradually decreasing parakeet counts with negative binomial distributions, and calculating the rates of decline with varying sample sizes.

Figure 2 summarises the results of this simulation

Most five-minute bird counts in the literature (Elliott *et al*. 1996) recorded less than 0.5 parakeets per count, and it is the populations with the lower counts which we are most likely to want to monitor. It is clear from this simulation that to monitor these populations and reliably check changes, more than 150 counts will have to be carried out per year for at least 5 years .

This analysis assumes that short-term influences on parakeet abundance, such as weather and seasonal changes, have been entirely controlled for, and that the inherent variability of parakeet counts and any long-term trends account for all of the observed variation. To minimise the effect of season and weather on our ability to detect long-term trends, counts will have to be carried out at the same time of year each year, and only during fine weather. Confining counts to one time of year and to fine weather effectively limits the number of counts that can be done each year, since all the counts need to be made within a few days of each other to eliminate seasonal variation.

FIGURE 2. THE RELATIONSHIP BETWEEN THE NUMBER OF COUNTS REQUIRED PER ANNUM (NUMBER), THE NUMBER OF PARAKEETS PER FIVE-MINUTE BIRD COUNT (COUNT), AND THE NUMBER OF YEARS (YEAR) OF MONITORING NECESSARY TO DETECT A 5% ANNUAL CHANGE IN PARAKEET NUMBERS (α=0.10, β=0.80).

3.2 MONITORING NESTS

During the 1993–1994 breeding season parakeet nests were searched for throughout the trapped forest at Deer Flat, and in the surrounding untrapped forest. During this breeding season there was almost no beech seedfall and very little parakeet breeding occurred. Only 12 nests were found, 9 in the trapped area and 3 in the surrounding untrapped forest. One of the 3 nests in the untrapped area failed when it was preyed upon.

I used the Mayfield method (Mayfield 1961) to calculate nest success rates in the trapped and untrapped areas and compared them using the methods of Johnson (1979). Despite the dramatic difference between the nest success rates in the two areas, the small sample sizes meant that the difference between them was not significant (Table 2).

These results are rather unsatisfactory because they suggest that trapping reduced the rate of predation, but the sample sizes were too small to produce convincing results. While a reasonable sample of nests was found in the trapped area, very few were found outside it, presumably because nests failed before they were found. I did a power analysis using the formula provided by Sokal and Rohlf (1981) to determine the number of nest-days in the untrapped area that would need to be monitored for differences in rates of nesting success of the magnitude we detected to be significant at the 10% level 80% of the time. This

TABLE 2. DAILY SURVIVAL RATES OF YELLOW-CROWNED PARAKEET NESTS AN AREAS TRAPPED FOR STOATS AND NOT TRAPPED FOR STOATS.

	DAILY SURVIVAL	STANDARD ERROR	NO. OF NEST-DAYS MONITORED	ESTIMATED SURVIVAL TO FLEDGING (%)	PROBABILITY (H_0 - SURVIVAL IS EQUAL)
Trapped area	1.00	0.00	145	100.0	0.29
Untrapped area	0.89	0.10	9	0.1	

analysis showed that we would need more than 63 days of observation of nests in an untrapped area to get a statistically significant result. One person worked full-time through the peak of the parakeet breeding season so it is likely that most of the parakeet nests in and around the study area were found. To find sufficient nests would require seven times as many people searching and area seven times as large.

Where does this leave wildlife managers wanting to enhance or protect parakeet populations? There is statistically compelling evidence that trapping stoats in small areas during stoat plagues has no detectable impact on parakeet breeding success (Elliott *et al*. 1996). However, there is a logical argument that suggests that trapping a large area during a stoat plague, or trapping during low-stoat years will have a significant impact (see Elliott *et al*. 1996) and there is experimental evidence (albeit not statistically significant evidence) that this is so. Managers have the choice of either investing in a larger experiment or accepting the existing evidence. A larger experiment would require about 4 person years to complete.

4. Conclusions

1. Five-minute bird counts of parakeets are highly variable and their error distribution has an approximately negative binomial distribution.
2. Analysis of five-minute bird counts of parakeets is best carried out using analysis of deviance, rather than analysis of variance or least squares regression.
3. To detect changes in parakeet populations, parakeets are best counted in the winter and spring, but counts need not be undertaken during beech mast.
4. Attempts to monitor changes in low density parakeet populations will require about 200 counts per annum, carried out on fine days at the same time of year for at least 5 years.
5. This study suggests that stoat trapping when stoat numbers are low has a beneficial effect on yellow-crowned parakeet breeding success, though the

evidence is derived from a small sample and the results are not statistically significant.

5. Acknowledgements

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