# Research plan for kaka (*Nestor meridionalis*) 1996–2002

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Cover illustration: North Island kaka, from Little Barrier Island, August 1977. *Photo: C.R. Veitch, from the DoC Audio-visual Library Collection.*

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# CONTENTS

# Abstract

A research plan for kaka (*Nestor meridionalis*) is outlined for the period 1996–2002. This plan provides the framework for a nationally co-ordinated and prioritised programme of research into specific topics of interest. Preferred methods and appropriate outputs for each of the listed research topics are suggested. A list of recommendations outlining how these outputs can best be accomplished is also provided. It is hoped that the production of this research plan (along with an associated field guide) will stimulate further interest in kaka research throughout New Zealand and provide a standardised and co-ordinated approach to the conservation of this species.

# Introduction

The kaka (*Nestor meridionalis*) is designated a category "B" species (Molloy & Davis 1994) — threatened but not yet endangered. Although kaka have declined to the point where the species is rare or extinct within much of its former range, it is still found on all three main islands of New Zealand and remains locally common in Fiordland, southern South Westland and on several offshore islands. The conservation challenge with kaka is identifying the factors responsible for the birds' decline and developing management techniques which can reverse this trend, thereby ensuring the continued survival of kaka populations on all three main islands.

While forest clearance has been a major factor in the decline of kaka, the fact that the bird has become rare or virtually extinct within some large native forest remnants strongly suggests that introduced predators and competitors may now be the most important threats to its survival. Planned Mainland Restoration Projects provide an opportunity to test this hypothesis. By monitoring kaka survival and productivity in areas where introduced species are intensively managed and in similar unmanaged areas we can evaluate the impact of these species on kaka populations and assess whether pest control will benefit the bird. Because kaka have been known to breed as infrequently as once every four to five years (P. R. Wilson pers. comm.), this research will be conducted over a six year period (1996–2002). Identifying the factors that induce and support kaka breeding is itself an important research objective as this will allow prediction of breeding years and consequently far more cost-effective long-term management of kaka predator/competitor species.

Other areas of kaka biology also require investigation. Primary among these is the taxonomy of the two recognised sub-species and the biological validity of geographical populations. In the course of the study we also intend to obtain sufficient demographic data on kaka populations to construct a reliable model of population dynamics. This aspect of the project will be relevant to research on other long-lived bird species. As a part of this work we will be developing marking and census methods for kaka which may also be applicable to other species.

Such a comprehensive, long-term research programme is unusual for a category "B" species (and indeed for most species). Investment in research for such a species is, however, timely as it provides the opportunity to develop conservation strategies before it becomes endangered (category "A"). This plan is intended as a **discussion** document — we welcome your feedback.

## Arrangement of the Research Plan

To aid digestion, the following plan has been divided into a number of sections each dealing with a particular aspect of the planned research. Some overlap between the sections is, however, inevitable when dealing with such a variety of topics. Where applicable, the scope of the problem and the research requirement is briefly introduced, followed by a description of either the preferred or potential method(s) which may be useful in providing the required answer(s). This is then followed by a list of outputs (describing what we hope to achieve) and recommendations about how these outputs can best be accomplished.

The order of these sections reflects what we consider to be their priority for research effort. Sections 1. to 13. and 20. are considered to be core topics essential to the research programme being run by the Department of Conservation. Sections 14. to 18., although of interest, are not central elements and may be more appropriately investigated by external agencies.

# 1. Location of study sites

## 1.1 INTRODUCTION

Choosing appropriate study sites is the first step in a detailed examination of kaka population dynamics and general ecology within mainland habitats. Three potential study sites (Pureora in the North Island and Nelson Lakes and Windbag Valley in the South Island) have been identified. All of these sites include areas of proposed “mainland-island” habitat restoration in which significant potential predators and competitors of kaka will be intensively controlled or excluded.

## 1.2 METHODS

A number of minimum requirements for each study area must be met. These include:

- The kaka populations in both managed and unmanaged areas must be effectively part of the same population.
- Both of these areas should be similar in terms of size, habitat quality and habitat types.
- The potential pest populations should be similar both in terms of number and species composition.
- Effective pest control in one of these areas is logistically feasible.
- Both the terrain and access are amenable to long-term study.
- Habitat is representative of a significant proportion of remaining kaka range.

Smaller scale studies examining certain components of the much larger studies (e.g., reproductive output, sex ratio, etc.) should be encouraged providing methods of data collection are standardised and the results can be incorporated into the wider study.

## 1.3 OUTPUTS

Identification of those sites/habitats in which kaka still persist in reasonable numbers and where, with appropriate management, the status of kaka populations can be maintained or possibly improved.

## 1.4 RECOMMENDATIONS

Potential study areas (Pureora, Nelson Lakes and Southern South Westland) should be examined and ranked as to their suitability for both control and managed sites using the criteria listed under the methods above.

# 2. North Island kaka research by management — Experimental design

## 2.1 INTRODUCTION

Research on North Island kaka must by necessity be broad-based as very little is known about the ecology of kaka populations within podocarp or other northern mainland forests where they still occur. Work in the North Island will be conducted within the Waipapa Ecological Area and will attempt to cover most of the topics outlined within the current Research Plan, particularly those areas concerning productivity, mortality and the resources required for breeding.

Ideally, changes in the mortality and nesting success of a kaka population would be measured in areas where all significant potential competitors and predators are intensively managed (e.g., mainland island restoration projects) and compared directly with a suitable kaka population in an unmanaged or “control” area. An experimental design of this sort is not currently feasible within any of the designated North Island mainland island restoration projects as kaka are either entirely absent from them or only occur in very small numbers.

Although intensive pest control is occurring within 3,500 hectares of the Waipapa Ecological Area it is specifically targeted at possums and rats, populations of which have been reduced to very low levels. Potentially significant predators such as mustelids and cats are not being controlled at present but can be excluded from a sample of nests by “banding” the nest tree.

As the overall aim of the study is to determine whether appropriate management intervention can improve productivity and lower mortality of both adults and juveniles within kaka populations (see Introduction), an experimental design which “controls” for the effects of these predators (particularly stoats) is clearly required. A comparison of the success of individual nesting attempts using varying degrees of exposure to potential competitors and predators is one way of achieving this.

Another major problem with any experimental design of this type is the inability to replicate it given the scale (area required, logistics, etc.) and the cost of pest control. Nevertheless it is hoped that the results will be sufficient to encourage replication of the study in other areas.

## 2.2 METHODS

Diet, food availability (phenology), home-range and habitat use will be routinely monitored at monthly intervals throughout the year and productivity monitored intensively throughout the breeding season.

To examine the effects that various potential predators may have on kaka productivity and mortality (adult and juvenile) the following method is proposed:

- As many nests as possible will be located within the Waipapa study area. Each of these nests or nesting attempts will be regarded as a discrete sampling unit. (That is, what is the productivity of each nest in areas with different pest regimes?)

If adequate numbers of nests (power analysis suggests a minimum of 10 per treatment class, G. Elliot pers. comm.) are located within Waipapa:

- A proportion of the nests (n=10) will be left undisturbed and exposed to mustelids but not possums or rats which are being effectively controlled throughout Waipapa (+ mustelids / — rats / — possums).
- The remainder of the nests (n=10) within the Waipapa study area will be modified in an attempt to exclude mustelids or any other potential mammalian predator using metal bands above and below nest entrances (— mustelids / — rats / — possums).
- As many kaka nests as possible from outside the Waipapa study area will also be located and monitored throughout the breeding season. This group of nests (10 are required) will be left exposed to all potential predators (+ mustelids / + rats / + possums) and be used as a baseline comparison of productivity.

If less than the required 20 nests are found within the Waipapa study area:

- All nests will remain unmanaged (+ mustelids / — rats / — possums) for the 1997/98 breeding season and the nesting outcomes compared with those nests where no predator/competitor control is being conducted.

Providing nests outside the Waipapa experimental area can be considered representative of the current reproductive range of kaka, comparisons of productivity can be made with these nests and those nests within the experimental area. Any significant differences in productivity between groups of nests can then be identified and examined.

At least one nest within the Waipapa Study area and one nest in forest currently not being managed for pests will be followed throughout the breeding season using miniature video camera equipment.

## 2.3 OUTPUTS

- An indication of whether predator control can benefit kaka populations in terms of reducing female mortality and increasing breeding success.
- The development of an effective management mechanism for reducing predation pressure on kaka — particularly breeding females.
- Identification of the most significant predators for kaka within North Island podocarp forests.

- The development of effective measures for breeding success and mortality of kaka populations.
- Identification of those foods required to initiate successful breeding and the periodicity of production of these foods within the Waipapa study area.

## 2.4 RECOMMENDATIONS

- Ecological parameters such as diet, plant food phenology, habitat use and home-range should be recorded on a monthly basis using the minimum sample sizes and standardised recording methods outlined within this Research Plan and the Kaka Field Guide.
- Provided sufficient nests can be located, a comparison of productivity between nests with differing levels of exposure to pests should be made.
- At least two of the nests located in any given breeding season should be monitored using miniature video camera equipment.

# 3. South Island kaka research by management — Experimental design

## 3.1 INTRODUCTION

There are three study sites for South Island kaka research, Lake Rotoiti and Lake Rotoroa in Nelson Lakes National Park, and the Windbag Valley in South Westland (see section 1.). Research at Lake Rotoiti, the site of a mainland island restoration project, will focus on monitoring changes in kaka mortality and nesting success in an area where predators and competitors are intensively managed. Lake Rotoroa is the unmanaged control site for this study. Research in the Windbag Valley has a broader focus since little is known of the ecology of kaka in mixed beech/podocarp forest. Research here will attempt to determine which food resources are required for breeding, and the status of the population.

Because the proposed Lake Rotoiti/Rotoroa study is unreplicated it is impossible to exclude the possibility that any significant improvement in kaka breeding success was due to factors other than predator management. Since the costs of predator control prohibit replication this problem is insoluble. Nonetheless, since eleven years of baseline data on kaka productivity in the Nelson Lakes region indicate that this population is declining due to predation (Beggs and Wilson 1991; Wilson *et al.* in press) a reversal in this trend following pest control would strongly suggest that the latter has been effective. Rigorous experimental confirmation of the value of predator control with respect to kaka will require replication in other mainland areas.

A fundamental problem in the Lake Rotoiti/Rotoroa study is that the sex ratio of birds radio-tagged so far is so male biased (14 males to 1 female) that we are unlikely to locate sufficient nests to be scientifically useful. It is possible that male birds will lead us to additional nests but it is also possible that the density of female kaka in the Nelson Lakes region is insufficient for our purposes. Since it would take many years for sufficient female chicks to be recruited from a few protected nests (and an additional three to four years for these to reach sexual maturity), the only solution to this problem is the translocation of additional females to the mainland island site.

## 3.2 METHODS

### 3.2.1 Lake Rotoiti/Rotoroa

Densities of stoats, rats, possums and wasps will be reduced at Lake Rotoiti through intensive poisoning. The abundance of these species will be index monitored at Lake Rotoiti and at the unmanaged Rotoroa control site. The mortality and nesting success of radio-tagged kaka will be monitored intensively (monthly) at both sites. Should we fail to find sufficient (5) nests, the following autumn we will attempt to translocate ten adult female kaka from Codfish Island into the Lake Rotoiti Mainland Island site. We will attempt to keep these birds within the mainland island by providing them with supplementary food. It is hoped that these females, being new to a beech forest environment, will rely predominantly on the food we provide for them and consequently breed every year rather than every three to four years as is typical of resident females. If the translocation of adult females is unsuccessful, translocation of captive-bred juvenile birds (as has been achieved at Mt Bruce) will be attempted.

### 3.2.2 The Windbag Valley

In the Windbag Valley the foraging and breeding activity of radio-tagged kaka, and plant phenology (the temporal availability and abundance of plant foods) will be monitored monthly over a five year period.

## 3.3 OUTPUTS

- An indication of whether predator control can benefit kaka populations in terms of reducing female mortality and increasing breeding success.
- Determination of whether adult female kaka can be successfully translocated into a new habitat type and maintained on site by the provision of supplementary food.
- An indication of the effectiveness of such translocations as a management technique for kaka populations suffering the cumulative effects of decades of stoat predation on females.
- Identification of the breeding frequency of kaka in the Windbag Valley and the plant foods required for breeding.
- Evaluation of the conservation status of the Windbag Valley population and, if in decline, the likely causal factors.

## 3.4 RECOMMENDATIONS

- If less than five nests are located in the Lake Rotoiti Mainland Island this summer (1997/98) all should be protected from stoats by banding with sheet-metal.
- A translocation of female kaka from Codfish Island to the Lake Rotoiti Mainland Island should be undertaken in April–May 1998.
- If the first translocation is successful, then a second translocation should be undertaken at Lake Rotoroa.
- A foundation breeding stock of captive South Island kaka should be established to provide birds for future translocations if required (see section 17.).

# 4. Marking/tagging systems

## 4.1 INTRODUCTION

Recognition of a sufficient number of individuals is central to any investigation of an animal's behaviour and social organisation over time. Unfortunately few species display consistent natural differences that can be recognised reliably. For the majority of species a system of artificial markings must therefore be devised so that an individual can be recognised at a distance without having to regularly recapture it (Rowley and Saunders 1980).

The use of coloured leg bands is the most common method of individually marking birds but the usefulness of this method is often compromised for parrots because of their very short tarsi, and ability to remove bands with their powerful beaks.

Previous studies of kaka have all used coloured leg bands of some sort. These were usually coloured plastic (Darvic®) wrap-around bands of varying heights depending on the number of combinations required. Painted metal bands have also been used to prevent removal. However, plastic bands (providing they are fitted correctly) appear to remain attached to the majority of birds for long periods.

As kaka (like all other parrots) have very short tarsi, it is difficult to identify individuals using colour bands. Accurate sightings of band combinations are rare (particularly within mainland forests) and usually only occur at close quarters. By far the most effective and efficient means of identifying individuals has been radio transmitters where each individual is identified by a unique frequency. The major drawback of this method is the limited battery life of the transmitter; currently 11 months for North Island kaka and 15 months for South Island kaka. Studies which exceed this period necessitate the recapture of birds – not an easy task.

A marking method is therefore required that combines the durability over time of colour bands with the "visibility" and/or the ease of identification of radio-transmitters.

## 4.2 METHODS

Several options for marking kaka exist but all of them have inherent problems (technological or ethical) which are not easily overcome. Field trials are probably also the only effective means of testing the utility of these ideas.

### 4.2.1 Colour bands

This is the standard technique currently used to individually mark kaka and can be considered the minimum requirement for individual identification. Plastic bands and/or painted/anodised metal bands are adequate and provide numerous unique combinations.

### 4.2.2 Radio-transmitters

A highly effective means of identifying individuals but currently limited by battery life (particularly for North Island. kaka which are smaller than their South Island relatives) which determines the effective life of the unit. Once the battery fails identification of individuals is impossible unless a secondary method (e.g., leg-bands) is employed. Current performance of transmitters can be improved by reducing the pulse rate and/or controlling the period during which the transmitter is operating (e.g., daylight hours only). Transmitters which can be turned on only when required are also being developed.

### 4.2.3 Transmitter aerial tags

This method utilizes the aerial of the transmitter to carry a unique identifying tag. Two tag types have been recently trialed. The first type of tag consists of a coloured anodised aluminium disc (approx. 29 mm diameter) with an engraved letter(s) on the upper surface. The second type comprises of a tube (approx. 45 mm long) with combinations of three different colours. Both tags are affixed to the end of the transmitter aerial which protrudes over the bird's tail. Feedback on the visibility of each tag type on kaka in a field situation is currently being collected.

The significant advantage with this method of identification is that individuals are still able to be identified (with a great deal more ease than leg bands) past the point at which the transmitter ceases to work. The period that this tag is useful for is, however, dependent on the time the transmitter remains on the bird before the weak link parts and the harness falls off. This period is unknown and is likely to be variable.

To date trials of these two types of tags suggest that they are robust, have no effect on the transmitter signal, do not appear to impede the birds in any way and are significantly more visible than coloured leg bands (R. Berry pers. comm., H. Aikman pers. comm.).

### 4.2.4 Patagial tags

Patagial tags are rigid wing-tags which are permanently fixed to the wing using a piece of stainless steel wire passed through the patagium (the web of flesh in front of the ulna or forearm of the wing) and twisted closed between the third and fourth secondary feathers (Rowley and Saunders 1980). This method has been used extensively in Australia on a number of parrot species (particularly cockatoos) and is the only method robust enough and offering sufficient variations to rival leg-bands as a means marking large numbers of individuals (Rowley and Saunders 1980).

These tags are both durable and exceptionally visible. Anodised aluminium disks in a variety of colours can be used for the tags and can be engraved with combinations of letters. Little pain or discomfort is apparently felt by birds fitted with these tags as musculature, enervation and blood vessels are minimal within the patagium (Rowley and Saunders 1980).

Despite the advantages of this method drawbacks have been reported. In particular, some concern has been expressed about the relatively poor rate of return of patagial tagged Carnaby's cockatoos (*Calyptorhynchus funereus* *latirostris*) to their traditional breeding areas compared to colour leg-banded birds (Saunders 1988). This, however, has been linked to increased predation by birds of prey due to the greater conspicuousness of wing-tagged birds (Smith and Rowley 1995). This is unlikely to be a significant problem in New Zealand.

A more recent study on other smaller cockatoos (Western Long-billed Corella (*Cacatua pastinator*) and Major Mitchell Cockatoo (*C. leadbeateri*) concluded "that patagial tags had no significant effect on the survival of adults and were unlikely to have had a significant effect on immature birds of these two species" (Smith and Rowley 1995). A trial of this technique on kaka would, therefore, seem worthwhile.

## 4.3 OUTPUTS

- The development of a practical method for marking kaka over the medium to long term. Such a method would require that individual birds are able to be clearly identifiable (i.e., tags/transmitters are highly visible/long-lasting) and support an adequate number of individual colours, combinations and/or frequencies.

## 4.4 RECOMMENDATIONS

- Ethics committee approval should be sought to conduct trials using patagial wing tags on kaka in a field situation. If successful, this means of marking should then be applied to all kaka caught during field studies.
- Urgent work should be undertaken to develop the best specifications for kaka transmitters, particularly those to be fitted to North Island kaka.
- Development of transmitter aerial tags should continue.
- Other potential marking techniques should be researched and their potential for application to kaka examined.

# 5. Productivity

## 5.1 INTRODUCTION

Finding nests and recording the outcome of breeding attempts is the most direct way to monitor the effectiveness of our management. Unfortunately, in kaka there is evidence to suggest that years in which most breeding takes place are relatively infrequent (Beggs and Wilson 1991; Moorhouse 1991). This means that we may be able to measure the effectiveness of management only **in a good breeding year**. In Nelson, where kaka appear dependent on beech mast for breeding, this could be as infrequent as one in every four years. If such a relationship between breeding and mast seeding events is typical of kaka populations, determining what triggers breeding in various habitats is a primary objective as this will allow us to predict the years in which most production will occur, and thus when control of predators and competitors will have the most benefit. In addition to monitoring the usual avian reproductive parameters (clutch/brood size, fledgling survival), we should also attempt to record data on adult and nestling body weight as this may provide clues to variation in breeding success between sites or years. Physical parameters of nest sites should also be recorded so that we can assess whether these are likely to be limiting for kaka.

## 5.2 METHODS

Since kaka nests are hard to find and we won't know in advance in which year most breeding will occur we need to radio-tag a sample of birds (20) each year until we encounter a good breeding year. This would be defined as one in which the majority of radio-tagged birds attempt to breed. By monitoring the foraging activity of these birds and annual variation in plant food abundance we should be able to identify the foods that promote and sustain breeding. Provided control populations are in the same habitat types as managed populations we should be able to evaluate the benefit to kaka of our management techniques.

The following data should be collected from nests wherever possible:

- Clutch size
- Brood size
- Number of chicks fledged
- Fledgling survival
- Nestling weights

This will require regular inspection of nests and radio-tagging of a sample of nestlings prior to fledging. Extracting kaka nestlings for weighing will rarely be possible without causing excessive disturbance. It may, however, be possible to modify some nest sites during the non-breeding season so that subsequent nestlings can be extracted unobtrusively. It may also be possible to weigh breeding adults with a weighing perch. Such a device has been used successfully by Doug Armstrong and Isobel Castro (Massey University) to weigh free-living stitchbirds.

All nest sites should be measured (maximum dimensions of the entrance, distance from entrance to nest chamber, circumference of nest chamber, height above ground) and the species, crown health and DBH of the nest tree recorded.

An annual survey of fledglings should also be conducted within nominated habitats particularly those in which intensive nest monitoring is not possible or necessarily desirable. Following fledging, kaka chicks give distinctive begging calls which are often audible over considerable distances. A simple count of number of fledglings over a given distance (recorded in a standard format) may provide a useful and comparable index of productivity over time.

## 5.3 OUTPUTS

- Monitoring the number of radio-tagged birds that attempt to breed each year combined with concurrent quantification of their foraging activity and food abundance will enable us to identify foods that are limiting on breeding.
- Comparison of the productivity of radio-tagged birds in managed and unmanaged areas will indicate the effectiveness of our management techniques.
- Productivity data will enable us to assess whether production is sufficient to sustain populations, and nestling and adult weight data may shed light on variation in productivity between sites or years.
- Data on nest site dimensions will enable us to assess whether such sites are likely to be limiting for kaka in various habitat types.

## 5.4 RECOMMENDATIONS

- As many nests as possible should be monitored within the managed and unmanaged study sites in any given breeding year.
- The reproductive output from populations other than those being studied intensively should also be measured (directly by counting number of eggs, chicks and fledglings produced and/or indirectly by annual fledgling census), particularly if their pest regimes differ from those in the primary study areas.

# 6. Predators and competitors

## 6.1 INTRODUCTION

The fact that kaka have become rare, or virtually extinct, within some large remnants of native forest strongly suggests that introduced predators and competitors are major factors in the species' decline. Population viability analysis (Seal *et al*. 1993) suggests that predation of nesting females by stoats (*Mustela erminea*) poses the greatest threat to the survival of remaining mainland populations. In addition to stoats, Norway rats (*Rattus norvegicus*) are known predators of eggs and nestlings (Moorhouse 1991). Ship rats (*R. rattus*) are also likely nest predators, while cats (*Felis catus*), weasels (*M. nivalis*) and ferrets (*M. furo*) may prey on eggs, nestlings, fledglings or nesting females. Wasps (*Vespula* spp.) and possums (*Trichosurus vulpecula*) compete with kaka for food (Beggs and Wilson 1991), while possums, deer (*Cervus* spp.) and goats (*Capra hircus*) may modify vegetation to the extent that it becomes unsuitable for kaka. There has been a 50% increase in the index abundance of kaka on Kapiti Island (assessed by five minute counts) since the eradication of possums in 1980 (H. Robertson and A.J. Beauchamp pers. comm.).

There is information which suggests that control of introduced predators and competitors will benefit kaka populations. By integrating kaka research with planned mainland restoration projects we will have the opportunity to test this hypothesis.

## 6.2 METHODS

The experimental design is simple, an experimental area in which pest species are intensively controlled, and an area (same habitat) in which they are not. We compare the productivity of a sample of radio-tagged kaka and the relative abundance of pest species in each area. By comparing the incidence of predation by specific predators, the abundance of specific plant foods and the breeding success of kaka in the unmanaged and managed experimental areas we can quantify the effectiveness of our pest control measures.

Regular index monitoring of pest abundance is required in the experimental and control areas. We will need to develop (in association with Landcare) effective methods of trapping mustelids and indexing their abundance. Time-lapse video or infra-red triggered still cameras should be used at kaka nest sites to identify nest predators. Our phenology monitoring programme (see section 7.) will allow comparison of plant food abundance between experimental and unmanaged areas.

The most difficult aspect of this work will be indexing the abundance of mustelids and determining whether we have achieved a sufficient level of control. Stoats are notoriously difficult to catch and there is presently no reliable method of indexing their abundance (E.J. Murphy pers. comm.). Landcare–Manaaki Whenua Research are presently working on developing improved lures for mustelids. As we are presently working "blind" with respect to the efficacy of control measures for mustelids, we have no alternative but to implement the most intensive control regime that is sustainable for the duration of the study. The sole performance measure can only be "significantly reduced impact" of the pest in question in experimental (managed) relative to control (unmanaged) areas. In the case of stoats we would measure our success in terms of the difference in predation rate on kaka in experimental *vs* control areas. In the case of possums, we would compare the abundance of plant foods eaten by this species (and kaka) between managed and unmanaged areas.

## 6.3 OUTPUTS

- Information on the relative abundance of introduced pests, the incidence and timing of predation and plant food abundance in the experimental and control areas will allow us to estimate the impacts of various introduced predators and competitors on kaka and the benefits of controlling these species.

## 6.4 RECOMMENDATIONS

- The effectiveness of control efforts should be assessed in terms of increases in kaka productivity rather than in the number of pest species killed.
- Landcare and/or DOC staff should be assisted in the development of more effective trapping and indexing methods for mustelids.
- We should investigate/develop camera systems suitable for identifying predators at kaka nests.

# 7. Species specific protection

## 7.1 INTRODUCTION

It is generally acknowledged that predation by introduced mammals has had a significant and highly detrimental effect on kaka populations (O'Donnell and Rasch 1991; see section 6.). Control of these pests is largely dependent on trapping and poisoning. However, the efficacy of these methods for controlling and monitoring the large numbers of potential predators, particularly stoats, is uncertain (E.J. Murphy pers. comm.). Protection of species such as kaka using such methods has, not surprisingly, proved difficult (P. Wilson pers. comm.).

The protection of specific nest sites or the provision of artificial nest sites, safe from climbing predators, also warrants consideration. Previous attempts at providing artificial nest boxes for kaka (Beggs *et al*. 1984) and "banding" nest trees (P. Wilson pers. comm.) have had either little, or equivocal, success.

## 7.2 METHODS

Apart from developing more effective means of pest control using different methods of trapping and toxin use (see section on predators and competitors), development of physical barriers preventing access of predators to kaka nests and nesting females is desirable. Several methods could be suitable for kaka.

### 7.2.1 Protection of natural nest cavities

This is obviously dependent on locating active nest sites. The most obvious and practical means of protecting nests is by "banding" the trunk of the tree in which the nest occurs with a strip of slippery material (usually a piece of sheet metal) below the nest entrance hole. In view of the arboreal habit of many predator species it is probably necessary to band the trunk above the hole also, particularly if there is an interlocking canopy. Considerable caution must be exercised if banding nest trees while nests are in use.

### 7.2.2 Modification of natural nest cavities

Banding of nest trees is unlikely to be a suitable method of nest protection for all nests. For example, those with trunk irregularities or in lateral branches. Alternative techniques include the construction of barriers, baffles or tunnels preventing access to either the nest entrance or nest chamber. These techniques have been used with some success for the Norfolk Island parakeet (*Cyanoramphus novaezelandiae cookii*) (Hicks and Greenwood 1989) and the Puerto Rican parrot (*Amazona vittata*) (Snyder *et al*. 1987). Apart from preventing the entry of predators, nest site modifications may make some sites, or potential sites, more habitable and weatherproof (e.g., Echo parakeets (*Psittacula echo*) T.G. Lovegrove pers. comm. and Snyder *et al*. 1987).

### 7.2.3 Artificial nest sites

The potential for artificial nest sites to provide safe breeding refuges for kaka is high (particularly if natural nest cavities are scarce, Snyder *et al*. 1987). This, however, requires a design that can keep predators out as well as being acceptable to kaka. A previous trial of wooden nest boxes for kaka was hampered by the relatively small numbers produced and the unwieldy nature of the boxes themselves (Beggs *et al*. 1984). Nest "boxes" manufactured from pieces of lightweight PVC pipe could, however, provide a serviceable alternative. Studies in South America have shown that this type of "box" is readily accepted by several parrot species particularly where suitable nest sites are scarce (S. Beissenger pers. comm. and C. Munn pers. comm.). A significant advantage of this type of nest-box design is the very smooth outer surface typical of PVC pipes which may be sufficient to keep predators from entering.

## 7.3 OUTPUTS

- The development of effective measures to protect natural nest sites and females nesting within them from predators.
- The assessment of nest boxes as predator safe artificial nest sites.

## 7.4 RECOMMENDATIONS

- Further work is required on the development of effective predator trapping and poisoning strategies.
- Investigate the utility of structures designed to prevent predator access into nests.
- Examine design options for artificial nest sites suitable for kaka.

# 8. Feeding ecology

## 8.1 INTRODUCTION

Knowing what kaka eat is essential to understanding their competitive overlap with introduced species. If breeding is universally linked to mast seeding events (Beggs and Wilson 1991, Moorhouse 1991) it will be possible to predict years in which most breeding attempts will occur. Since kaka can nest infrequently (Beggs and Wilson 1991) the ability to predict when breeding will occur will greatly facilitate both research and management. While it is relatively easy to obtain qualitative information on diet, it is much harder to obtain the statistically robust data we need to identify which foods trigger breeding in a specific habitat. Although qualitative data is better than none, we should attempt to quantify kaka foraging activity and nutritional intake wherever we are able to do so.

## 8.2 METHODS

Qualitative observations (e.g., 12 observations of kaka feeding on fruits of species A in January) of foraging activity can be made opportunistically whenever birds are seen feeding. It is important to note the location, date, time of day and the identity of the bird, if marked.

Quantification of foraging activity will, however, require a regular commitment of field-time over at least half the year (the breeding season). The standard way of quantifying animal activity budgets is by instantaneous behavioural sampling. As the name suggests, this involves recording the activity of an individual bird at specified time intervals (for kaka a one minute interval is suitable). In practice this means locating a kaka and following it (usually only possible if the bird is radio-tagged) until a predetermined minimum number of foraging observations have been obtained. A timer set to "beep" at the set time interval provides the cue to record the bird's behaviour. Although our focus is primarily on foraging behaviour, general activity budgets (i.e., the amount of time spent foraging, sleeping, etc.) will also be obtained in the course of this work.

The value of activity budget data depends primarily on the number of different individuals observed rather than the number of observations on individual birds. It is much better to have 50 observations on twenty different birds than 1000 observations on one bird. It is therefore important to try to obtain the same minimum number of foraging observations from **as many different individuals as possible** each month. The feasibility of this work will be determined by the logistics of moving about the study sites (terrain, weather, etc.) and the mobility of the kaka themselves. Depending on what birds are doing, it can be very easy or virtually impossible to watch kaka foraging. Fifty foraging observations from each of at least 10 birds in a month is probably the minimum amount of data that would be statistically credible. Activity budget work will not be worthwhile where we cannot achieve this.

Observations need to be made within a standard "time window" during daylight hours New Zealand Standard Time. We can't watch kaka 24 hours a day so we have to make the assumption that foraging behaviour within such an interval is representative of overall foraging activity. Standardised record sheets for activity budget sampling will be provided.

We can estimate the nutritional intake of kaka by counting the number of discrete food particles (seeds or fruits) they eat within a set time interval. We should attempt to do this whenever we suspect foods are important, as would be suggested if all or most of the radio-tagged birds are spending the majority of their foraging time feeding on the same food. Ten counts on individual birds would provide an average ingestion rate per bird and an overall mean for all radio-tagged birds. The foods in question would need to be collected for weighing and nutrient analysis.

Opportunistic feeding observations of unmarked birds within all kaka habitats (including those in which intensive research is being undertaken) are also useful providing that only the first foraging observation seen is recorded. Standardised record sheets will be provided.

## 8.3 OUTPUTS

- Activity budget data will tell us what kaka spend their time feeding on at different times of the year and in different years (e.g., 20 kaka spent an average of 50% of observed foraging activity feeding on food A in January 1997 but 80% in January 1998) — potentially important foods can, therefore, be identified.
- Combined with quantitative data on plant food abundance, activity budget data should allow us to identify important kaka foods in different habitats.
- Information on the nutritional value of different foods (e.g., 20 radio-tagged kaka ingested an average of 2 fruits of species A per minute in January which would provide them with an average $x$ kilojoules of energy for each hour of foraging) will indicate the importance of specific foods.

## 8.4 RECOMMENDATIONS

- Intensive monitoring of kaka foraging activity should be undertaken.
- Nutrient analyses of important foods should be budgeted for and undertaken.
- Opportunistic feeding observations should be collected in a standardised format.

# 9. Phenology

## 9.1 INTRODUCTION

Obtaining statistically robust phenology data is vital to identifying plant foods that limit kaka productivity. We need to know if plant foods eaten in breeding years are measurably more abundant in a breeding year than in other years in which no, or relatively few, birds breed. Similarly, we can only ascertain food preferences and determine which foods might act as cues for nesting if we know when various plant foods are available. Thus we need a phenology monitoring system that will both quantify differences in plant food abundance between years, and indicate when various plant foods are available.

## 9.2 METHODS

Fruit/seed abundance can be quantified using seed-fall traps. Although these have limitations — they only collect the fruit that falls to the ground, not what is eaten by birds — they should perform well for mast seeding species (e.g., beech and podocarp species). The number of seedfall traps we set out will be determined by the number of species we attempt to monitor, but a minimum of ten individual plants per species is probably the smallest number we can monitor (A. Djikgraaf pers. comm.). An alternative (superior?) method to seedfall traps is to count individual fruits or flowers (or in the case of compound flowers racemes or panicles). Astrid Djikgraaf suggests counting the number of flowers within a cubic metre in a representative part of each tree. This could, however, be difficult in the case of tall emergent species. An alternative may be photographing a representative portion of the canopy with a telephoto lens from a fixed (marked) spot on the ground and later counting the fruit visible in the resultant photo (magnified if required).

The timing of fruiting, flowering, etc., can be monitored using a transect of individually marked trees run once a month. All we need to record is the presence/absence of flower buds, flowers, green/ripe fruit and which are the most abundant on individual trees (e.g., green fruit > ripe fruit). This will be sufficient to identify peaks of flowering and fruiting in different species.

## 9.3 OUTPUTS

- Seed-fall traps or direct counts will give us hard numbers of fruits/flowers which we can use in statistical comparisons of plant food abundance between different years.
- Monthly phenology transects recording the presence/absence of flowers, fruits, etc., will indicate the temporal availability of food plants.

## 9.4 RECOMMENDATIONS

- We should separate quantification of plant food abundance from monitoring the temporal availability of plant foods.
- A method that will give us truly quantitative abundance data should be used.
- Our phenology monitoring should be integrated as much as possible with the national monitoring programme co-ordinated by Astrid Djikgraaf (University of Auckland) as we will then be able to gain access to the resultant national database.

# 10. Home-range and dispersal

## 10.1 INTRODUCTION

Home-range is one of those things that is often measured for no obvious purpose other than because it's measurable. There is, however, a good reason to obtain accurate home-range estimates for kaka. Knowing how far individuals range and the degree of overlap between individual home-ranges will greatly increase the accuracy of density estimates derived from a modified mark-recapture sampling technique. Knowledge of bird movements will also indicate habitat preferences and/or population boundaries. For example, dispersal of juveniles from Little Barrier to Great Barrier, and adults from Hen Island to Little Barrier strongly suggests that the kaka of the forested northern islands are effectively one population. Dispersal has also been recorded from Little Barrier Island to the adjacent mainland and even as far as Gisborne.

## 10.2 METHODS

Sophisticated software packages are available for home-range analysis. These are, of course, only as reliable as the data we put into them. Getting accurate location fixes on birds in tall forest is not easy — satellite navigation devices don't work well (if at all) under the forest canopy. Nonetheless, with good map reading and radio-tracking skills we should be able to obtain location fixes of sufficient reliability to be useful. The important thing is to be able to reliably estimate the error on each fix. Location fixes need to be recorded using grid references, ideally the bird's location should be fixed and recorded at standard half hour time intervals while we are observing its foraging behaviour.

## 10.3 OUTPUTS

- Maps of kaka home-ranges can be superimposed on vegetation maps to look at habitat preferences.
- Mean home-range sizes will allow us to estimate the geographic boundaries for population estimates based on modified mark/recapture techniques, in other words, to estimate the actual density of populations.
- Home-range size will also assist in the planning of the extent of pest control programmes in areas inhabited by kaka.

## 10.4 RECOMMENDATIONS

- We should integrate regular fixing of the locations of radio-tagged birds within our activity budget monitoring programme (see Section 8.).
- We should investigate GPS units that are the most suitable for fixing kaka locations in forested areas.

# 11. Sex ratio of kaka populations

## 11.1 INTRODUCTION

Recent observations and captures of kaka on the mainland suggest a significant bias in the sex ratio toward males in the order of three males to every female (Greene and Fraser unpubl. data, C.F.J. O'Donnell pers. comm., P.R. Wilson pers. comm.). In comparison, examination of the sex of kaka captured on relatively pest free Little Barrier Island and Kapiti Island gave a ratio of almost one to one (Greene and Fraser unpubl. data).

An imbalance in the sex ratio of this magnitude suggests disproportionate predation of breeding females. If allowed to continue such predation will reduce the number of breeding females to the point that recruitment will no longer compensate for mortality. A dramatic decline in kaka numbers would then be expected when surviving adults reach the end of their life-span.

If the sex ratio of kaka populations on offshore islands with few/no pests/ predators is considered representative of a healthy population (i.e., close to 1:1), sex-ratio assessment may provide a useful measure of the success of mainland pest management programmes. Regular surveys might indicate whether current management regimes are effectively protecting incubating females and their offspring. An increase in the proportion of breeding females encountered in the population would suggest the impact of management was successful.

## 11.2 METHODS

Reliable assessment of a species' sex ratio depends on the ability of observers to accurately identify males and females. Characteristics, such as overall size, plumage colour, song, behaviours or combinations of these, may be used. Although North Island kaka are sexually dimorphic in size (culmen length, depth and overall size are greater in male kaka, Moorhouse *et al*. in press) these differences are not obvious from a distance. There is no significant variation in plumage colouration between the sexes and no readily detectable sexual differences in calls.

The peak egg-laying period for North Island kaka appears to occur during December (R.J. Moorhouse, pers. obs.). Behaviours exhibited during a 1–2 month period prior to this are often related to pair formation (allo-preening, allo-feeding and copulation) and nest site prospecting (R.J. Moorhouse pers. obs.). During this time, breeding displays and copulations can be readily observed and the birds sexed behaviourally, providing that it is a year in which kaka breed (kaka do not breed every year; Moorhouse 1991).

Annual assessment of the sex ratio of kaka should, therefore, be attempted in the month prior to the peak of egg laying. In the North Island the best time would seem to be between October (when mated pairs and breeding behaviours become obvious) and December (when most eggs are laid and incubation commences). Other populations of kaka (particularly those in the South Island) appear to lay much later (e.g., February in South Westland) and the optimal period for assessing population sex ratio should be adjusted accordingly.

To allow a direct comparison of bill size and a means of interpreting behaviours, only birds occurring in groups of two or more should be sexed. This **should** significantly reduce the chances of assigning the wrong sex to any bird, but will reduce the size of the sample.

Assessment of the sex ratio would be greatly assisted by the presence of radio-tagged and/or other individually marked birds of known sex in the area during the spring and summer. As kaka are particularly gregarious during this period (Moorhouse, pers. obs.), radio-tagged kaka (particularly males) will often lead observers to other groups/pairs of birds, the sex of which can then be determined by observation.

## 11.3 OUTPUTS

- An assessment of the utility of population sex-ratio as a long-term method of evaluating the status of kaka populations.

### 11.4 Recommendations

- Methods used for assessing the sex ratio of kaka populations as outlined above, should be further developed to improve accuracy.
- Surveys of sex ratio for kaka populations should be undertaken in a number of locations (including habitats, such as islands, with few/no predators/ competitors) to determine a baseline for future comparison.
- Further research is urgently required to determine the reason(s) for the disproportionate loss of adult females from mainland kaka populations.

# 12. Assessment of kaka population size

## 12.1 INTRODUCTION

An accurate understanding of the population status of kaka is essential to the species' conservation and management. Precise assessment of population size for kaka is, however, difficult due to the comparative rarity and extreme variability in diurnal and seasonal conspicuousness of the species. Traditional survey methods (such as 5-minute counts) are particularly sensitive to such variations and have only been used in the past to derive relatively crude indices of kaka abundance.

The development and application of a robust and sensitive census method is seen as a priority if the effectiveness of management programmes, such as pest control, are to be accurately measured. In view of the limited resources available for monitoring the size of the remaining kaka populations, it is important that a robust, relatively simple and standardised method of data collection and analysis be devised. Trials of alternative methods have been completed but have only reinforced the need for further investigation (Greene and Fraser unpubl. data). A number of methods do, however, show potential providing violations of inherent assumptions can be addressed.

## 12.2 METHODS

Methods worth further investigation can be summarised as follows;

### 12.2.1 Mark/recapture models

This group of models are well established techniques for estimating population size (e.g., Lincoln estimates). At the most basic level individuals are marked and returned to the wider population from which the ratio of marked to unmarked birds observed within a given period is assessed and used to estimate population size.

There are a number of problems when trying to apply these techniques to populations of kaka, the most significant of which is the identification of marked individuals. Colour leg-bands are extremely difficult to see in most instances and the marked population is usually small and often extremely mobile (especially on the mainland). Radio-tags using different frequencies have been used in an attempt to identify marked and unmarked individuals but considerable care is required when interpreting results obtained in this way. Providing improved identification could be developed (patagial tags?), the sample size increased and violations of assumptions implicit within the models addressed (e.g., definition of population as 'open' or 'closed', constant sampling effort, etc.) this method may be worth further consideration.

### 12.2.2 Multiple observer census or simultaneous counts

This is a relatively simple technique requiring little mathematical analysis. All that is required are simultaneous records of time and direction of all kaka seen and heard during a defined sampling period from fixed points of known location. Records can then be plotted on a map where the intersection of bearings at simultaneous times are assumed to represent the location of individual birds. An estimate of the minimum number of kaka within a defined area during the census period can then be derived.

Population densities of kaka have been calculated from three preliminary trials (Lake Waikaremoana and Mayor Island) by this census method. The estimates were derived from kaka populations which were at relatively low densities. This census technique was found to be unsuitable, however, for assessing density where kaka are relatively common (e.g., Waihaha Ecological Area). The large number of birds and high level of activity within such a population made it impossible for individual kaka to be resolved in terms of time, distance and direction by different observers.

### 12.2.3 Distance sampling

Distance sampling provides an objective means of analysing population sampling data (where distance between a random point and object/animal of interest has been measured) to estimate the density and abundance of a given population (Buckland *et al*. 1993). As detectability usually decreases with increasing distance from the random point, a large proportion of the objects of interest may go undetected. However, the theory allows accurate estimates of density to be made with only mild assumptions (Buckland *et al*. 1993). Data is analysed using the programme DISTANCE (Laake *et al*. 1994) which is capable of analysing distance sampling data derived from line transects, point counts and cue counts. A variety of estimation models are available within the programme and the 'best' model is selected for the data set.

This method has only been applied to kaka populations in a relatively rudimentary fashion to date. Considerable improvements in experimental design (choice between point counts, line transects, cue counts) and observer training (accurate estimation of distance) are required to rigorously test the suitability of this method for assessing the size of kaka populations. Future studies would therefore benefit from the advice of a statistician.

### 12.2.4 Cue counts

This method relies on the species of interest producing a cue that leads to its detection by an observer. For kaka this may be visual or the loud krarking calls heard frequently in the morning and evening. Considerable caution is required when using this method as cues may vary with the age or sex of the animal, time of day, or season. Counts of these cues can therefore vary for reasons unrelated to density (Buckland *et al*. 1993).

### 12.2.5 Five-minute counts

Further investigation of this method as it applies to kaka populations may be warranted. Despite the drawbacks to the method already mentioned, trials calibrated to a known number of marked/radio-tagged birds may be useful. Although seasonal variations may be high using this method most people are familiar with the technique which is therefore easily replicated with a minimum of training. Although the variations between counts of this type may be high they may be precise enough to indicate any gross trend in population dynamics. Significant increases in the abundance index derived from this type of count and significantly increased measures of productivity would be sufficient to demonstrate net population growth. Conversely, an abundance index much lower than Kapiti or Little Barrier Island's, combined with poor productivity and a male biased sex ratio is, perhaps, more compelling evidence of a population in trouble than a number/hectare value.

### 12.2.6 Encounter rates and population density

This method relies on prior robust estimates of density from a number of areas. Given a positive correlation between these population density estimates and the encounter rate (mean number of detections per observation site), estimates of population density using graphs of this relationship and independently measured encounter rates should be possible. The significant advantage of this approach is that there is no need to measure distance or use complicated analysis techniques. Relatively inexperienced observers could therefore use this method as an economic and relatively simple tool with which to monitor population trends providing they follow set procedures and can competently identify kaka by call as well as sight.

## 12.3 Outputs

- The development of a relatively simple and efficient census technique that allows for the rapid and accurate evaluation of kaka population size at a local level with a minimum of resources.

## 12.4 Recommendations

- Known numbers of radio-tagged and colour banded kaka should be used to further test the validity of methods with potential to estimate population size.
- The performance population estimation methods should be measured in the field under a variety of conditions and kaka densities. Little Barrier Island and/or Kapiti Island kaka populations should be used as baseline measures of abundance.
- Guidance should be sought from a statistician/biometrician familiar with the application of the above techniques and the analysis of the data derived from them.

# 13. Disease

## 13.1 INTRODUCTION

A recent review (Reed 1996) highlighted the need for information on the nature and prevalence of disease in wild populations of protected species. Without such information the role of disease in the decline of native species is unknown and the identification of new disease threats is unlikely. The kaka research project provides the opportunity to obtain baseline disease information on several populations of this threatened species in both the North and South Islands.

## 13.2 METHODS

Two cloacal swabs per bird are required to test for potential enteric pathogens (e.g., *Yersinia, Salmonella, Chlamydia*). The procedure, inserting a purpose designed swab into the cloaca, can be completed in minutes.

Two faecal samples per bird are required to test for *Coccidia* and worm eggs. Captured birds often defecate during handling and after they are placed in bags for weighing allowing relatively easy collection of faecal samples.

A smear of blood on a slide is required for detection of blood parasites while a blood sample collected in an haematocrit tube will allow the determination of baseline blood parameters. These samples can be taken at the same time as blood is collected for genetic analysis (see section 14.). The amount of blood required is small (a few drops will suffice) and so does not add appreciably to the total amount taken.

## 13.3 OUTPUTS

- A disease profile for individuals and populations.
- A useful contribution to a national protected species disease database.

## 13.4 RECOMMENDATIONS

- Cloacal swabs should be taken from all kaka captured for radio-tagging and faecal samples collected whenever possible.
- Blood samples (slide and haematocrit) should be taken whenever blood is taken for genetic analysis.
- Disease testing should be budgeted for, whenever kaka are captured at new locations. Once a reasonable baseline is established, sampling should be repeated at least biannually or sooner if mortality patterns in the population change.

# 14. Genetics

## 14.1 INTRODUCTION

Since kaka are highly mobile (juveniles from Little Barrier have gone as far as Gisborne) there is reason to doubt the biological reality of presently recognised "populations". The actual taxonomic status of North and South Island subspecies is also questionable given the mobility of the bird. Cook Strait may not be wide enough to be a geographic barrier for kaka. If this is so, the question remains as to why North and South Island birds differ significantly in size (Moorhouse *et al.* in press, P. R. Wilson unpubl. data). The possibility this size difference could reflect a cline between demes of a meta-population rather than a subspecies distinction, or, conversely that North Island and South Island kaka could in fact be different **species** remains untested. In view of this uncertainty we cannot be sure of what we are actually attempting to manage at either the population or sub-species (species?) level. Genetic research is the only way to resolve these questions.

## 14.2 METHODS

Analysis of genetic material will have to be contracted to external agencies (e.g., Universities). However, we need to obtain the samples — blood or feathers — for this. Blood sampling is an established technique that has been used on a variety of bird species, including kaka. Between 0.5 and 1.0 ml of blood is drawn from the brachial vein (underside of the wing at the "elbow" joint) with a needle and syringe. As a backup, a few small contour feathers are plucked from the breast and placed in a clean plastic bag (these contain sufficient DNA to be useful). In a recent (May 1996) capture operation on Kapiti Island, blood samples were obtained from 21 kaka, none of which suffered any ill effects apart from the occasional haematoma (blood blister under the skin). Once obtained, blood can be temporarily stored in liquid nitrogen before transfer to a minus 80°C freezer where it can be kept indefinitely.

## 14.3 OUTPUTS

- We may be lucky enough to detect a consistent difference between populations using allozyme electrophoresis although this is not a definitive technique. It is, nonetheless worth doing since it is cheap (could be done free), fast (result within a week) and could indicate whether more expensive methods of analysis are warranted.
- Mitochondrial DNA analysis would be able to reliably identify biological populations and the actual taxonomic status of North/South Island subspecies distinction. We will need to shop around for the best deal from the various labs that do this kind of work. The important thing is to get the

blood. Once we've got it we can store it indefinitely (free storage has been provided by the genetics laboratory at Victoria University and other institutions may also be agreeable).

- Providing that sufficient blood is able to be collected (not always possible), samples could also be used to establish health parameters of wild populations (see section 13.2).

## 14.4 RECOMMENDATIONS

- Blood and/or feather samples should be routinely collected from kaka whenever birds are captured, until sufficient samples have been obtained from each site.
- We should liase with several genetics laboratories to establish which can provide the expertise we require at the best price.
- Initially we should analyse samples from as broad a geographic range as possible (e.g., Little Barrier, Kapiti, Nelson, Codfish) as this is most likely to reveal any large differences.

# 15. Population modelling

## 15.1 INTRODUCTION

Computer modelling of populations is a useful tool for identifying the key factors affecting their survival. Such Population Viability Analysis (PVA) has already provided useful insights on the likely reasons for the decline of kaka populations (Seal *et al*. 1993). Depending on the reliability of the information we are able to provide, models can give a realistic projection of a population's future. A reliable population model for kaka should be an achievable goal within the six year time-frame.

## 15.2 METHODS

The first step is to obtain reliable estimates of the relevant population parameters (recruitment and mortality rates, adult survival and age of first breeding). These data should be readily obtainable from our samples of radio-tagged adults and fledglings. For the analysis itself there are existing software packages (such as VORTEX) available, or we may be able to develop our own programme specifically for kaka.

## 15.3 OUTPUTS

- The development of a reliable population model for kaka will enable us to assess whether any increase in productivity associated with our management is, in fact, sufficient to ensure the continued survival of managed populations. Working within a population modelling framework will also force us to think in population ecology terms rather than practice *ad hoc* management.

## 15.4 RECOMMENDATIONS

- The suitability of software for modelling kaka populations should be evaluated.
- We should ensure that we record the relevant data in a suitable format for population modelling.

# 16. Moult

## 16.1 INTRODUCTION

Moult generally imposes increased nutritional demands on birds such that it is usually impossible for birds to moult and breed at the same time. Knowing when the moult occurs and whether it is heavier in some years than in others may shed further light on the periodicity of breeding in kaka. Observation of moult can also provide useful additional information. The timing of the moult can distinguish juveniles from adults and sub-adults (Moorhouse and Greene 1995). Stress bars (gaps in the pigmentation) on feathers indicate periods of nutritional stress. It is possible that aspects of the moult may differ between breeding and non-breeding birds — allowing the two to be distinguished in the field.

## 16.2 METHODS

There is a standard method for recording moult using "moult cards" provided by the Ornithological Society of New Zealand.

## 16.3 OUTPUTS

- Systematic moult records may allow us to identify consistent differences between individuals of different sex, age or reproductive status.
- Recording of stress bars may allow us to identify populations that are subject to greater nutritional stress during this period than others.

## 16.4 RECOMMENDATIONS

- Observations of moult should be routinely made and recorded in a standardised fashion whenever kaka are captured.
- Recording moult should be practised using captive kaka (see section 17.).

# 17. Captive maintenance

## 17.1 INTRODUCTION

There are presently 51 kaka (39 North Island and 12 South Island, M. Bell pers. comm.) in captivity. Two institutions, Auckland Zoo and Mt Bruce, have breeding pairs. Because facilities for holding birds are limited nation-wide, eggs produced by captive birds are routinely destroyed unless there is a specific requirement for kaka nestlings — such as analogues for hand-rearing techniques intended for kakapo.

An attempt to reintroduce captive bred kaka to the wild is currently underway at Mt Bruce. The last progress report indicated that after 10 months of freedom 8 of the nine birds released still survive. All 4 captive bred birds and 2 of the 5 wild-bred juveniles (from Kapiti Island) still regularly visit the feeding station. A further 2 wild-bred juveniles inhabit the Mt Bruce Reserve and are essentially independent. Only one wild-bred bird has disappeared. Although it is too early to tell if captive-bred kaka can be successfully returned to the wild and establish a viable population, this experiment has proven that wild and captive reared juveniles can be successfully translocated (and held in captivity for several weeks prior to release).

On the basis of the available evidence it would seem easier to boost dwindling mainland populations with young birds (of suitable genetic provenance) from offshore islands (where kaka are numerous and from which some migration already seems to occur) rather than with captive-bred birds. The reintroduction of birds to the wild is, therefore, at least at present, not the primary justification for keeping kaka in captivity. A more appropriate use for captive-bred birds may be as demonstrators on the utilisation of supplementary foods to wild caught birds held in captivity prior to release and the prevention of rapid dispersal at the liberation site.

There are, however, other reasons for maintaining captive stock. The most obvious of these is advocacy; having kaka on display raises public awareness of the bird. Another reason is research. Because kaka are in demand as analogues for kakapo there is likely to be an ongoing requirement for eggs and nestlings. There are also some aspects of kaka biology which would be difficult, if not impossible, to investigate in wild birds. For example, daily energy expenditure (which requires repeated capture and blood sampling), experimental testing of various plant foods as cues for breeding, ageing of birds (using genetics and morphometrics), gut flora and population genetics (see section 11.). Captive birds are also useful for trialling new field techniques, such as methods of transmitter attachment and alternative marking systems (see section 2.) and testing prototype “predator-proof” nest boxes.

## 17.2 OUTPUTS

- A small captive population of North Island and South Island birds (minimum founder populations of 20 individuals) should be maintained for advocacy purposes and research.
- Eggs/chicks produced in captivity can be used as a source of analogues for the kakapo programme and as a potential source of birds for reintroduction to the wild.

## 17.3 RECOMMENDATIONS

- Permission to keep kaka in captivity should be conditional on institutions allowing access to the birds for approved research purposes.
- The number of kaka in captivity should be maintained at a level determined by the co-ordinator of the captive breeding programme.

# 18. Supplementary feeding

## 18.1 INTRODUCTION

As there is evidence to suggest that breeding in kaka is limited by food availability, supplementary feeding has the potential to boost productivity. Although the single supplementary feeding experiment that has been performed did not increase breeding **frequency**, it did increase the breeding **success** of birds. In addition, the supplementary feeding stations acted as a collecting place for kaka greatly facilitating their capture for banding and radio-telemetry (P.R. Wilson pers. comm.).

The provision of supplementary food is the most direct way of testing the food limitation hypothesis (i.e., that reproductive output of kaka is limited by the presence of pests such as wasps and possums) competing for limited high quality foods) and would appear to be a useful management technique for improving nesting success and the ease of capturing birds. The drawbacks are that it has proved time consuming (months) to train birds to take supplementary food sources and that once supplementary food is provided it confounds any effect of natural food sources on kaka productivity. Supplementary feeding stations are also expensive ($1000's?) and, although automated, require weekly servicing and maintenance. Another problem with supplementary feeding is that although juvenile birds readily learn to use feeding stations, adults are very slow to do so (P.R. Wilson pers. comm.). Thus unless populations are actually producing juveniles it may be very difficult to train birds to take supplementary food.

## 18.2 METHODS

Automated supplementary feeding stations should be established near some natural food concentration, such as a stand of trees which produce fruits or flowers preferred by kaka. Site selection should also take into account the appropriate capture technique to be used. The initial training period will probably be labour intensive so the chosen site should be reasonably accessible. The average number of birds feeding each month should be recorded so that the actual amount of food (calories, protein, etc.) provided to individual birds can be estimated.

As supplementary feeding stations result in the localised congregation of birds, an assessment of the disease risk (particularly of respiratory disease) at feeding stations is required. Basic hygiene guidelines designed to minimise this risk need to be prepared in association with appropriate expert advice.

## 18.3 OUTPUTS

- If we could provide kaka with a significant proportion of their nutritional requirements through supplementary feeding we could test the hypothesis that breeding is limited by food availability in a given habitat. If we find that birds breed more frequently or have improved breeding success when provided with supplementary food then we also have a valuable management technique for increasing productivity.

## 18.4 RECOMMENDATIONS

- Limited supplementary feeding/attraction should be investigated as a means of facilitating the capture/recapture of kaka throughout the duration of the study.
- The decision to implement **intensive** supplementary feeding should only be made at the conclusion of the study of each population, after the relationship between breeding and food abundance has been established.

# 19. Minimum data requirements

## 19.1 INTRODUCTION

The program of research outlined in this document is both comprehensive and ambitious. Although we are working within a six-year time frame, each year's data will build on the year preceding it. We therefore need to "get it right" from year one. Although we have tried to be clear on the data/information we require in the preceding sections it is worthwhile to summarise the minimum data requirements of each key research area as follows:

## 19.2 SUMMARY OF MINIMUM DATA REQUIREMENTS

### 19.2.1 Marking/tagging methods

Recognition of a sufficient number of individuals is central to the investigation of kaka ecology, behaviour and social organisation over time.

***Recommendations***

- All kaka captured should be marked using colour bands or, if radio-tagged, using aerial tags.

### 19.2.2 Productivity

This area of research is largely descriptive. The more nests we monitor the more reliable the results will be. Although obtaining clutch/brood sizes and fledging success for most nests shouldn't be too difficult, we will only be able to routinely weigh nestlings that are in unusually accessible nest sites.

***Recommendation***

- Clutch/brood size and fledging success should be recorded for all nest sites found, where practicable. Annual fledgling census be conducted in designated areas.

### 19.2.3 Predator/competitor interactions

The goal of this aspect of the research plan is to develop techniques that will ensure the continued survival of kaka populations. The single most critical experiment is the comparison of productivity between the unmanaged and managed areas (see section 2., 3., and 5.). The validity of this comparison depends on finding a sufficient number of nests in each area.

***Recommendations***

- Ten nests in each of the experimental and unmanaged areas should be located if possible and monitored. We can't conclude anything about the effectiveness of control until we locate and monitor a reasonable number of nests.

### 19.2.4 Species specific protection

One of several management techniques to be applied to kaka populations within managed areas within the study site. Dependent on the discovery of nest sites.

#### *Recommendations*

- All nest sites discovered should be modified (if possible) to prevent access by pests. Artificial nest boxes (20?) of appropriate design to be trialled in appropriate situations (height, orientation, habitat) within managed areas.

### 19.2.5 Feeding ecology

The primary goal is to identify plant foods (if any) that may limit (or conversely induce) breeding at each study site. The reliability of the data obtained depends on the number of individual birds observed at each study site.

#### *Recommendation*

- A minimum of 50 foraging observations should be obtained each month from ten different individuals at each study site (500 observations). This minimum sample size should include an equal number of males and females, if possible.

### 19.2.6 Phenology

Here we are attempting to monitor when various plant foods are available to kaka, and quantify the abundance of these foods.

#### *Recommendation*

- About 10 individuals of each food plant species should be monitored for both presence/absence and abundance (seed-fall traps or direct counts) of plant parts eaten by kaka in both managed and unmanaged sites.

### 19.2.7 Home-range/dispersal

There is no way of specifying how many fixes are required to describe the full extent of an animal's home-range without knowing how frequently it uses the boundaries of its range. Normal practice is to plot increments in home-range area against successive fixes until the graph plateaus, but sufficient information should be collected so that seasonal expansions and contractions in range can be identified. The minimum sample size would probably be 10 birds, preferably 5 of each sex.

#### *Recommendation*

- We should record and plot regular location fixes from at least 10 birds in each study site, preferably 5 of each sex.

### 19.2.8 Sex ratio

Regular surveys of kaka population sex ratio may indicate whether the management regimes are effectively protecting the kaka population from the effects of predation and competition.

***Recommendations***

- A random sample of no less than 10–20 unmarked kaka should be sexed by observation once a year (October–December) in all study areas.

### 19.2.9 Assessment of kaka population size

The development of a census technique sensitive enough to monitor changes in a population's status is seen as a priority.

***Recommendation***

- When the most appropriate census technique is finalised it should be applied to each study population of kaka at least twice a year (a pre-breeding and post-breeding census).

### 19.2.10 Genetics

As population differences should exceed those between individuals from the same population, we do not need to sample many birds from each population.

***Recommendation***

- A blood sample (1 ml) and a minimum of 4 contour feathers should be obtained from 5 birds in each putative population.

### 19.2.11 Population modelling

If we are to develop a reliable model we need reliable demographic information (adult survival, recruitment rate, juvenile survival, productivity per female, etc.). This will depend on the sample size, i.e., the number of birds we monitor (by radio-telemetry) each year over the full duration of the project.

***Recommendation***

- The survival and productivity of at least 20 adult kaka each year in each study area, and the survival of all eggs through to independence should be monitored. The sex ratio of the monitored adults should be as near to 50 : 50 as possible. Sightings of marked individuals should be recorded throughout the duration of the study.

### 19.2.12 Moult

A largely descriptive exercise requiring data collection from all captured wild birds

***Recommendation***

- Patterns of moult should be recorded in a standardised fashion for all birds captured/handled using O.S.N.Z. moult record cards.

### 19.2.13 Captive maintenance

A minimum number of kaka to be maintained in captivity for advocacy and research purposes.

### *Recommendations*

- Co-ordinator for captive kaka (BRU) should determine acceptable number of kaka to be kept in captivity and ensure access to them for appropriate research purposes.

## 19.2.14 Supplementary feeding

This is a potential management technique rather than a research proposal. Nonetheless, should the decision be made to attempt supplementary feeding there are some minimum data requirements. Obviously, the amount and nutritional composition of the food provided must be known, and also the average number of birds taking supplementary food per month.

### *Recommendation*

- If supplementary feeding is utilised the average number of kaka using supplementary feeding stations should be recorded each month. If the food provided is in discrete particles (pellets) we could also estimate the amount ingested per bird per day.

# 20. Kaka recovery plan

## 20.1 INTRODUCTION

A recovery plan (as defined by Department of Conservation guidelines for Recovery Plans) refers to the process by which “the decline of a threatened species is arrested or reversed by minimising the threats to its survival,” the long-term goal being the “maintenance of secure, self-sustaining populations of species with the minimum necessary intervention by managers”.

A species recovery plan should set out the goals, objectives and actions for the conservation of a threatened species or groups of species. The process calls for consultation with interested parties regarding planned initiatives and is therefore a useful advocacy tool. Recovery plans are concise statements of proposed management intentions and are a useful measure against which progress in species conservation can be measured.

## 20.2 KAKA RECOVERY PLAN

If considered necessary the preparation of a recovery plan for kaka will be overseen and co-ordinated by the Biodiversity Recovery Unit using a standardised format. The first part of this process requires that the major issues and scope of the proposed plan be discussed by the relevant staff.

It is particularly important that:
- Conservation goals are agreed to on a national scale
- Performance measures are agreed to
- The cost of attaining these conservation goals is realistically assessed
- A timetable is agreed upon in which the priority and timing of individual tasks and responsibility for their implementation are detailed.

It is hoped that the attached research plan will provide the basis for these discussions and the necessary first step in the development of a recovery plan for kaka if such a document is considered desirable.

## 20.3 OUTPUT

- If a recovery plan for North Island and South Island kaka is considered necessary it should be produced in consultation with all interested parties.

## 20.4 RECOMMENDATIONS

- Any recovery plan preparation and approval process should be initiated and co-ordinated by the Biodiversity Recovery Unit
- The attached research plan should be used as an initial discussion document outlining the relevant issues (Step 1. in the recovery plan process).

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