The process could take up to two days, so there was considerable incentive to select the best possible site within a given area. The best sites were usually those under forest with an even canopy and few emergents, a relatively open understory and on a slope. The end result was, hopefully, a site where kaka would feel secure enough to descend below the canopy (and below the top of the mist net) in response to unfamiliar calls. A relatively open understory does not impede flight at this level and the slope tends to focus movement downhill toward the net (which are always set across the slope) at much greater speeds making entanglement more likely.

Kaka calls recorded previously within the Waihaha area by B. Lloyd in 1991 were used to lure birds into the net sites using a Sony MiniDisc MZ-1 Walkman. The use of calls recorded from kaka populations elsewhere in the North Island (Little Barrier and Kapiti Islands) was not successful, and in several instances appeared to be responsible for chasing birds from the area. Also counter-productive was persistent repetitive playing of calls, especially if the birds themselves were silent at the time. A more restrained approach using only brief snatches of recorded calls and using only a single speaker on either side of the net (particularly if a bird was heard calling in the vicinity) was far more effective. Kaka also appear to ignore recorded calls on return visits to specific locations even if these visits are several months apart.

As predicted, kaka were considerably easier to catch during the summer, with 14 of the 21 kaka captured in January and February. The subsequent decline in catch rate may be attributed to a number of factors, such as the overall deterioration in the weather, the marked seasonal fluctuations in the conspicuousness (kaka were considerably less conspicuous in winter), changes in habitat preferences and an overall decline in response to recorded calls during colder weather.

Following removal from the net, all kaka were weighed, measured, banded (with both metal and colour bands) and fitted with radio transmitters. Measurements taken included bill length, width and depth from which sex was determined (Moorhouse *et al*. in press) as well as tarsal, wing and tail measurements. The date and location of capture was also recorded. Metal bands (L size) were then fitted to left or right legs depending on sex (male right and female left) and a unique combination of three colour bands (Darvic wrap-around) fitted to the remaining leg. A yellow band at the top of all combinations marked these birds as having been caught in the Waihaha area. Because of the short tarsus length of kaka (which is typical of all parrots) and the requirement for sufficient unique combinations, each colour band was made 4.0–4.5 mm high.

All transmitters fitted to kaka were provided by Sirtrack Ltd. Standard two stage transmitters were fitted to the first 17 kaka captured. These transmitters weighed 20 g (excluding harness) and with a pulse rate of 40 pulses/minute have a battery life of 9.6 months. The last four kaka captured were fitted with 'mortality' transmitters. When there is no movement for 22 hours from an individual carrying one of these transmitters the pulse rate doubles from the standard 40 pulses/minute to 80 pulses/minute. This allows the rapid detection of mortality and reduces the amount of monitoring effort required by allowing the rapid recovery of the bird. The cost-effectiveness of this system is significant and far out-weighs the slight increase in weight (from 20 g to 21 g) and reduction in battery life (from 9.6 months to 8.8 months).

The harness used to attach the transmitter to kaka was, with some slight modifications, essentially the same as that developed by Karl and Clout (1987) and used successfully on kaka elsewhere by Moorhouse (pers. comm.). The harness incorporated a biodegradable linen weak link designed to let the transmitter fall off freely once the weak link rots. The weak link was encased within a 20 mm section of tough, rigid plastic tubing to prevent the bird chewing through the linen. As kaka are very active and strong fliers considerable care was taken to ensure a good fit for the harness by positioning the weak link directly over the sternum. The overall weight of the package was further reduced by melting the ends of the braided nylon harness cords back into the attachment tubes of the transmitter itself thereby eliminating the need for metal bands as a means of securing the harness.

Data showing the date and location of capture, measurements, band combinations and transmitter frequencies for each kaka caught is shown in Appendix 2.

Blue Duck

Compared with kaka, the capture of blue ducks was relatively straightforward. By the middle of May a total of 24 ducks had been captured (20 adults and 4 juveniles) 19 of which were fitted with radio transmitters (Appendix 3 and Fig. 3). Of these, 6 pairs from a project target of 10 pairs were captured.

The Waihaha River was the primary study site for this species. Other streams and tributaries (e.g., the Mangatu Stream) were ignored even if known to hold blue ducks, thereby streamlining the monitoring process. The standard technique of erecting nets downstream of the ducks then herding them into the net was highly successful. All ducks targeted for capture in this way were caught.

Once removed from the net, all adult blue ducks were weighed, banded (with both metal and colour bands) and fitted with radio transmitters. Juveniles (easily identified by dull grey bill and dull yellow iris) were sexed and banded with a single metal band. The date and the location of capture on the river was also recorded. Metal bands (S size) were fitted to left or right legs depending on the sex of the bird (male on the right and female on the left). On adult birds a unique combination of two colour bands was fitted to the other leg.

The transmitters fitted to blue ducks were almost identical to those used for kaka (weight 20 g; pulse rate 40 pulses/minute; battery life 9.6 months) the only difference being the smaller diameter of the external aerial. The harness used to attach the transmitter was much simpler in design to that used for kaka. The most significant difference was the absence of an integrated weak link. All birds therefore had to be recaptured and the harness/transmitter removed at the conclusion of the study. Unlike kaka, the harness was secured by crimping the cords using two small aluminium bird bands.

Although there were few difficulties in capturing individual ducks, the capture of known pairs proved more difficult. In 1994, the post breeding moult for birds in the Waihaha River was extremely late, especially for females

(D. Cunningham pers. comm.). Most birds were very secretive and hard to locate, especially between March and May. As single male ducks were the only birds commonly seen on the river during this period, an assumption was made that they had a mate and were therefore captured and radio-tagged in the hope that later inspection would reveal the missing female. This strategy was fairly successful. However, eight males, almost all of which inhabit the lower section of the Waihaha River, are now known not to have mates. Only one of these males (YW-M) could be captured and his transmitter removed prior to the start of the poisoning operation.

The delayed period of moult also resulted in itinerant male ducks occasionally usurping the female of a pair if the original male was moulting off the main river (i.e., up small side creeks). This usually resulted in a great deal of confusion, especially if the interloper was then removed by the female's original mate! On two occasions what were assumed to be adult pairs were identified (cloacal inspection and vocalisations) as males, further adding to an already often confused picture.

3.2.2 Other non-target species

Other species also defined as at risk by Spurr (1979) have been difficult to monitor in a rigorous fashion largely due to the time involved in trying to achieve the original aims of this project. However, observations were noted for a number of other species, the most notable being bats, New Zealand falcon and kakariki (yellow-crowned parakeets). A list of bird and animal species recorded within the study area can be found in Appendix 1.

To determine which species of bat (if any) were present within the Waihaha Ecological Area and how common they might be, bat detectors and automatic bat recorders were used. As long-tailed bats (*Chalinolobus tuberculatus*) are aerial insectivores there is little possibility of their being poisoned during control operations and therefore little reason to monitor this species, even if it is present. However, if short-tailed bats were detected (especially their roosts), observations on the effect of 1080 operations on them would be attempted as they are considered more vulnerable than the long-tailed species (B. Lloyd pers. comm.). Abundance and distribution would dictate the means by which they can be monitored but potential methods included counts at roost sites or indices of abundance derived from automatic bat recorders.

The effect of 1080 on New Zealand falcon is unknown although there would appear to be potential for secondary poisoning. All falcon observed within the study area were recorded and these birds looked for after poisoning operations.

Previous measurements of kakariki numbers before and after 1080 operations have been inconclusive largely because of the high levels of count variance resulting from this species behaviour. For the purposes of this study only subjective comparisons of numbers before and after control operations were made.

3.2.3 Invertebrates

Discussions between the Department of Conservation and Massey University have resulted in the invertebrate component of the study being adopted as part of a student's MSc. thesis topic. Detailed methodologies for this part of the project can be found in the proposal (Asplin 1994) submitted by the student concerned. The results for this part of the study will be written up as a separate report with a summary of the initial findings to be made available as soon as possible.

3.3 BAIT PREPARATION AND APPLICATION

To improve the kill rate of possums in operations using 1080 and carrot baits, non-toxic carrot baits are often broadcast over the area to be poisoned as prefeed (Spurr 1993). For this operation, chopped and screened non-toxic carrot baits were broadcast at rates of 10 kg/ha over the entire operational area (24 600 ha.) from North to South in late June and early July.

Toxic carrot baits were prepared at five sites within the operational area as required. Baits were processed in the standard manner described in the draft Department of Conservation Pesticide Manual. Carrots were cut in a 'Reliance' type carrot cutter then passed over a 16 mm screen to remove the 'chaff' or small fragments. Baits were then surface coated with a solution of Special Green V200A dye (0.02 %wt/wt), vegetable (Soya Bean) oil (0.1% vol./wt), cinnamon oil (0.1% vol./wt) and Compound 1080 (0.08% wt/wt). Baits were broadcast at a rate of 15 kg/ha from rotary spreaders beneath helicopters (Bell Jet Ranger, Hughes 500 and Robinson R22). Helicopter position was determined using a Global Positioning System (GPS).

Unfortunately, the weather conditions remained wet and unsettled throughout July and into August. Ideally three fine nights (i.e., no significant rain) following the application of toxic baits are considered necessary to prevent both the dye/lure mix and the toxin from being leached out and the baits being rendered useless. This requirement often resulted in significant delays in the application of toxic baits to adjacent sections of the core study area containing radio-tagged birds. The area south of the Mangatu Stream (i.e., the core study area) was poisoned from July 21 in three distinct stages with up to a week occurring between each. The broadcasting of toxic baits was finally completed within the Waihaha Ecological Area on 12 August. Subsequent rainfall of 80–100 mm over the following seven days was assumed to have rendered the majority of baits non-toxic.

3.4 PRE-POISON MONITORING OF KAKA AND BLUE DUCK

Because of the large number of radio-tagged birds (40 in total), the area over which they were scattered (approximately 60 km^2) and the densely forested and predominantly featureless terrain within the study area, radio-tagged birds were monitored from the air prior to the poison drop as well as from the ground. Although observers on the ground could accurately locate individuals, this method was laborious and often only effective within the highly localised area that radio signals could be received (only 500 m in some instances). A light aircraft fitted with two wing-strut mounted aerials could quickly and effectively cover the whole study area and accurately locate often widely dispersed and highly mobile birds.

Prior to the application of toxic baits, monitoring of radio-tagged kaka and blue duck within the study area was limited to three flights. These flights served a number of purposes:

- aerial familiarisation of the study area and the ability to precisely locate specific points on a map.
- development of the aerial survey technique to be used to accurately locate birds following the poison drop.
- familiarisation with equipment to be used.
- to carry out periodic 'roll calls' of all radio-tagged birds to identify which were still within the study area and whether the mortality transmitters were still functioning properly (40 pulses/minute).

3.5 POST-POISON MONITORING OF KAKA AND BLUE DUCK

During the period immediately following the application of toxic baits, most effort was directed toward monitoring kaka. Kaka were considered more likely to be killed immediately following the poison drop as a direct result of eating baits while they were still toxic. Blue duck, on the other hand, were thought to be at a far greater risk from increased predation pressure over a much longer period following a potentially large scale reduction in the populations of small rodents (Murphy and Bradfield 1992) which are a major food source for predators such as stoats and cats. Two complimentary techniques were used to intensively monitor radio-tagged kaka and blue duck for 1080 induced mortality following the application of toxic baits.

3.5.1 Ground based monitoring

Despite some of the shortcomings of monitoring birds from the ground (reduced reception of signals, difficulties of moving about over long distances), the ability to accurately plot movement and visually check on the status of individual birds (dead or alive) was considered crucial.

As each section of the core study area was poisoned, observers used Telonics TR-4 and TR-2 receivers and folding handheld three element Yagi type aerials to determine whether or not birds were moving, and therefore alive.

For kaka, bearings were taken on individual transmitter signals from fixed points (usually prominent spurs, ridges or hills, see Fig. 4) in the area. These points were situated some distance from one another in an attempt to minimise misleading movements caused by the error arcs of the bearings.

Using VHF radios, three synchronised 'sweeps' of all kaka transmitter frequencies were made at 30 minute intervals during the early morning. When a signal was received, the arc representing the area of peak signal strength was recorded using a compass. The direction of the bird was determined using the mid-point of this arc. The strength of each signal was also recorded as either