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by

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ABSTRACT

Kukupa, or New Zealand pigeons (*Hemiphaga novaeseelandiae*), were studied in the Whangarei area of Northland and the Chickens Islands in 1991-1993. Near Whangarei the annual survival rate of 11 adult kukupa (6.2 bird-years) was 0.20, giving a crude estimate of mean life expectancy of 1.25 years. None of the five recorded "deaths" was natural: one bird crashed into a window and four birds disappeared, possibly to poachers. Six radio-tagged birds had minimum annual home ranges of 80-402 ha (average 242 ha), and home range lengths of 2.52-4.62 km (average 3.47 km). In winter and spring, the diet of Whangarei birds was dominated by ripe berries of taraire, with puriri increasing in importance in spring and especially summer. In autumn, a variety of native and especially exotic berries were eaten and the longest flights were recorded at that time of year. Foliage was rarely eaten, mostly in spring. On the Chickens Islands a variety of native berries were consumed. Egg-laying began in July, peaking in September-October and continued to January. On the mainland, 19% of nests were successful to the late-fledging period, but on the Chickens Islands 63% were successful. Most failures were assigned to predators, including at least two instances of possum (*Trichosurus vulpecula*) predation in rural gardens.

1. INTRODUCTION

The NZ pigeon (*Hemiphaga novaeseelandiae*), usually known as kukupa or kereru to Taitokerau Maori, is widespread in Northland, occurring in most forests, forest remnants, residential areas, and on the Hen and Chickens Islands. Low numbers occur at Te Paki but they are absent from the rest of Aupouri Peninsula, Three Kings Islands and, until 1995, the Poor Knights Islands.

Despite their being widespread, a survey of six Northland forests in 1993 revealed significantly fewer NZ pigeons compared with their numbers in 1979 (Pierce *et al.* 1993). A survey of the opinions of landowners surrounding Raetea Forest and smaller forest remnants in 1993-94 revealed a similar pattern: 42 landowners (72%) considered that kukupa had declined over the past 1-30 years (average 8.2 years), five (8%) of farmers considered that the birds had held their own or increased, and 12 (20%) were not sure if numbers had changed (W Sporle pers. comm.). Factors implicated in their decline include severe hunting pressure by people (Atkinson 1993, W. Sporle pers. comm.), nest predators (Clout *et al* in press) and competition for food from possums and other species (W. Sporle pers. comm.).

The objectives of this study were to describe the home range, diet and aspects of breeding and mortality of a sample of Northland kukupa in order to identify vulnerable aspects of their ecology. These data are compared with data collected on the Chickens (Marotere) Islands which possessed few species of vertebrate predators and competitors.

2. STUDY AREAS AND METHODS

2.1 Study Areas

2.1.1 Maungatapere The main study area was centred on Maungatapere, 10 km west of Whangarei (Fig. 1). The rich volcanic soils of this area supported remnants of the formerly extensive taraire (*Beilschmiedia tarairi*) forest that occurred on these lowlands. Other dominant fruiting species were tawa (*B. tawa*), puriri (*Vitex lucens*), kahikatea (*Dacrycarpus dacrydioides*), nikau (*Rhopalostylis sapida*), kohekohe (*Dysoxylum spectabile*), karaka (*Corynocarpus laevigatus*), kawakawa (*Macropiper excelsum*), pigeonwood (*Hedycarya arborea*), totara (*Podocarpus totara*), *Coprosma* spp. and pate (*Schefflera digitata*). Miro (*Prumnopitys ferruginea*) was scarce. Common exotic fruiting plants in the area included golden privet (*Ligustrum ovalifolium*), guava (*Psidium cattleianum*), loquat (*Eriobotrya japonica*), monkey apple (*Acmena smithii*) and Jerusalem cherry (*Solanum pseudocapsicum*), the latter of which grew beneath ungrazed or lightly grazed forest remnants. In the southern part of the area, an extensive exotic pine (*Pinus*) forest contained remnants of native forest, particularly along stream edges. Willows fringed a few of the streams in the study area. The study area was typical of much of rural Northland in that scattered mostly small (<5 ha) forest remnants and individual trees (mostly native) dotted the landscape. Kukupa were common in this area, but as with most of Northland, local residents have noted a substantial decline in numbers over the past 10-20 years (pers. comm.).

Predatory mammals present in the forest remnants included brush-tailed possums (*Trichosurus vulpecula*), feral cats (*Felis catus*), ferrets (*Mustela furo*), stoats (*M. erminea*) and ship rats (*Rattus rattus*). Predatory birds present were harriers (*Circus approximans*), moreporks (*Ninox novaeseelandiae*), kingfishers (*Halcyon sancta*), kookaburra (*Dacelo gigas*) which were rare, white-backed magpies (*Gymnorhina hypoleuca*) and mynas (*Acridotheres tristis*).

2.1.2 Chickens Islands The secondary study area was on the Chickens Islands, namely Lady Alice (140 ha) and Coppermine Islands (80 ha). Both islands supported a cover of mature and regenerating forest diverse in composition, but lacking podocarp species. Dominant fruiting trees were puriri, tawa, taraire, nikau, kohekohe, pigeonwood, *Coprosma* spp., fivefinger (*Pseudopanax arboreus*), tawapou (*Planchonella costata*), karaka, kawakawa, and the climber supplejack (*Rhipogonum scandens*) was also common. No permanent streams were present, except on Lady Alice Island. The islands have been uninhabited since farming ceased on Lady Alice Island in the early 20th century.

The only predatory mammal present on the Chickens Islands was the kiore or Pacific rat (*Rattus exulans*). Predatory birds present were harriers, moreporks, kingfishers and small numbers of mynas, the latter species restricted largely to the western end of Lady Alice Island. During this study an attempted kiore eradication took place on Coppermine Island. Poison bait stations were operated from 14 September 1992 to March 1993 during which time kiore were reduced to very low densities. They had, however, recovered in numbers by spring 1993.

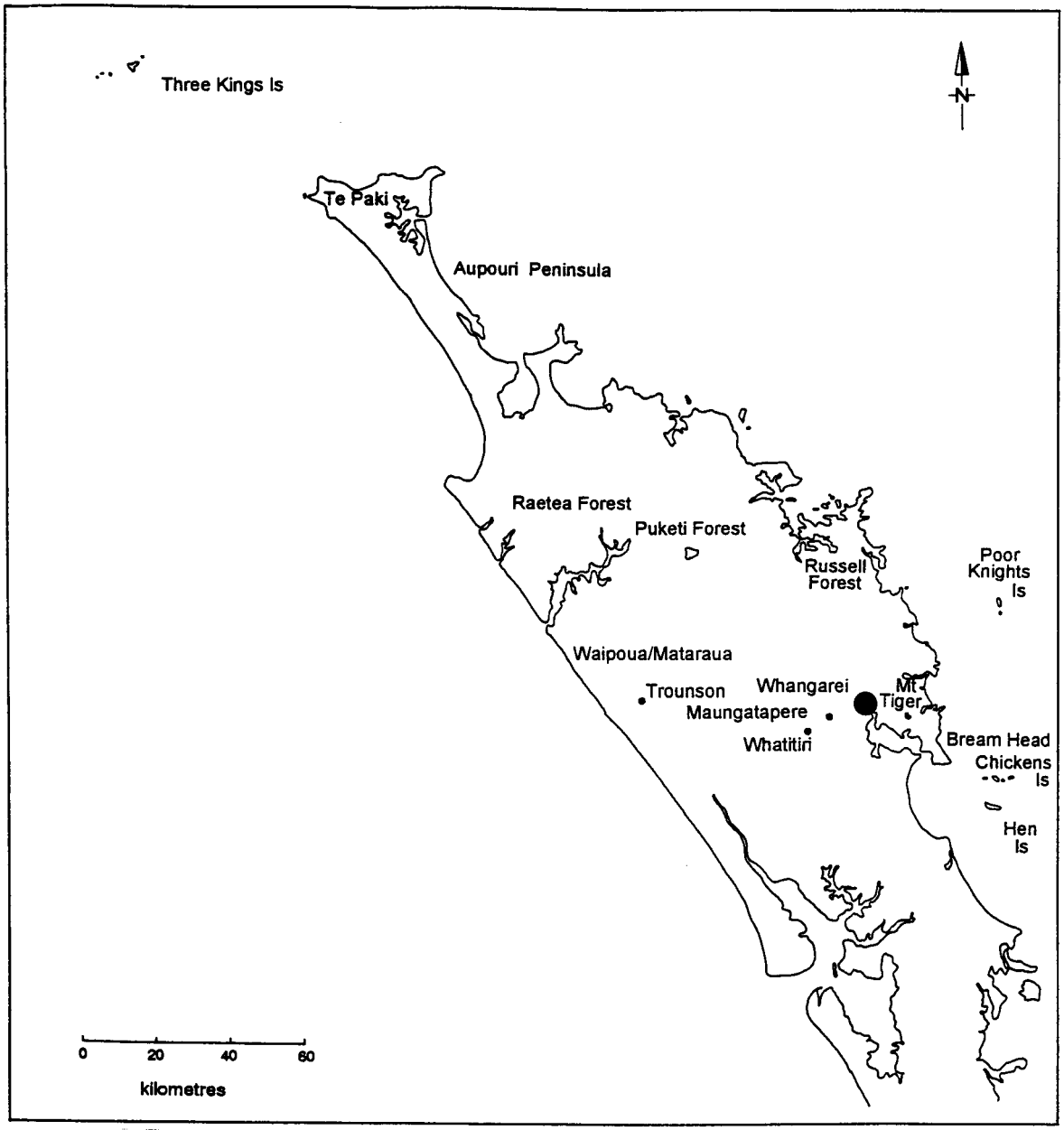


Figure 1 Localities mentioned in the text.

2.2 Capture of Birds

Eleven kukupa were radio-tagged at Maungatapere. Birds were captured in 10 m long mist nets (10 cm mesh size) located on flight paths beside food trees. Each bird was weighed and aged, and fitted with a 17-25 g radio transmitter on its back (Karl and Clout 1987). The radio-transmitters were "Sirtrack" two-stage units which emitted a pulsed signal in the 160 MHz range for up to 15 months. Each bird was also fitted with a coloured leg jess enabling individual recognition should the transmitter fail.

2.3 Radio Tracking

At Maungatapere, radio-tagged kukupa were monitored weekly from May 1992 to February 1993 and every 2-3 weeks thereafter until August 1993. The birds on the Chickens Islands were checked less frequently as the opportunity arose. Transmitters giving erratic signals were interpreted as being on active birds and their approximate position was established (to within 100 m). Those transmitters giving constant signals were interpreted as being on inactive birds and these birds were located visually in order to determine whether they were nesting or not. At Maungatapere, monitoring occurred over a 4-6 h period from about 0800 h to 1400 h which allowed for detection of either sex on the nest; the first of two daily nest changeovers usually occurred between 0930 and 1200 h (pers. obs.).

The annual home range of each radio-tagged kukupa was determined by calculating the area containing all locations.

2.4 Nests

Active nests were observed from the ground only. On subsequent visits, at weekly intervals, the nest tree was approached via a circular route in order to reduce the chances of leaving a scent trail to the site which predators might follow. Nest heights were estimated to the nearest metre for heights over 4 m and to the nearest 0.1 m for heights less than 4 m, and the tree species recorded. Failed nests were checked for cause of failure, including inspection of some nest bowls for animal droppings and examination of egg shell remains for sign of predator marks.

2.5 Feeding

All feeding observations of kukupa in the Whangarei-Maungatapere area from July 1991 to June 1993 were recorded and analysed by month. Food types distinguished were ripe fruit, unripe fruit, flowers and foliage for each species. A feeding observation was defined as one bird feeding on one food type (but possibly more than one food item) in one tree. As soon as the bird moved to and fed in a different tree, the event constituted a new feeding observation. Fruiting phenology was carried out for taraire and puriri monthly. Total fruit was scored on a 0-10 scale with ten being the highest possible score for a tree. Green and ripe berries were given separate scores, and data for ripe berries were subsequently analysed.

Feeding observations on the Chickens Islands were less frequent, taking place primarily in March, August, October and December 1991-93.

3. RESULTS

3.1 Study Birds

At Maungatapere, 10 kukupa were radio-tagged and jessed during 1-13 May 1992, and another bird at nearby Cemetery Road in August 1992. Two further birds were jessed at Maungatapere on 13 May 1992. The mean weight of the 12 Maungatapere birds was 694 g and ranged from 585 g to 745 g (Appendix 1). Two of these birds displayed juvenile features including greyish-brown underparts and brownish-red bills. At 585 g and 610 g, these juveniles were the lightest of the sample.

3.2 Adult Survival

Of the 11 birds radio-tagged in May-August 1992, five had died or disappeared within three months. For these birds the total time elapsed from the month of radio-tagging to the month of last sighting was 6.2 "bird-years". The five deaths represent a crude mortality rate of 0.80 deaths per bird-year, or an annual survival rate of 0.20. This mortality rate equates to a mean life expectancy of 1.25 years. The other six birds all survived until at least May 1993.

One of the five deaths occurred when 2/5 crashed into a large window which, from the outside, reflected images of the forest remnants behind. The remaining four birds, however, were never recovered. Three of these disappeared in May and one in July. Transmitters were recovered from two of these (2/8 and 2/11) and each showed signs of human interference. Hunters were seen by local residents in the area at approximately the times the birds disappeared.

During the course of the privet fruiting season, at least two untagged kukupa were killed by vehicles along the privet-lined Otaika Valley Road and State Highway 14. No evidence was found of birds dying from nutritional-related causes.

3.3 Home Range and Movements

In early May 1992, the 10 radio-tagged kukupa at Maungatapere were spending most of each day on the outskirts of Maungatapere village, where they fed almost entirely on ripe berries of privet. Up to 60 birds (including six radio-tagged birds) were feeding there at any one time. Late in the day nearly all of these birds moved to native forest remnants located up to 3 km from the privet hedges and returned in the morning. By early June, each of the surviving birds had settled in relatively small areas of 50-200 ha in which they remained, for the most part, throughout winter, spring and summer (Fig. 2, Appendix 2). The area of annual home ranges recorded averaged 242 ha and ranged from 80 to 402 ha (n = 6). After the autumn fruiting of privet, however, most birds settled back into core ranges of 50-200 ha (Appendix 2). Maximum home range lengths averaged 3.47 km and ranged from 2.52 to 4.62 km (n = 6).

2/2: This bird was radio-tagged on 5 May 1992 and seen feeding on privet during all subsequent visits to Maungatapere up to 13 May 1992, but no signal was received after this date.

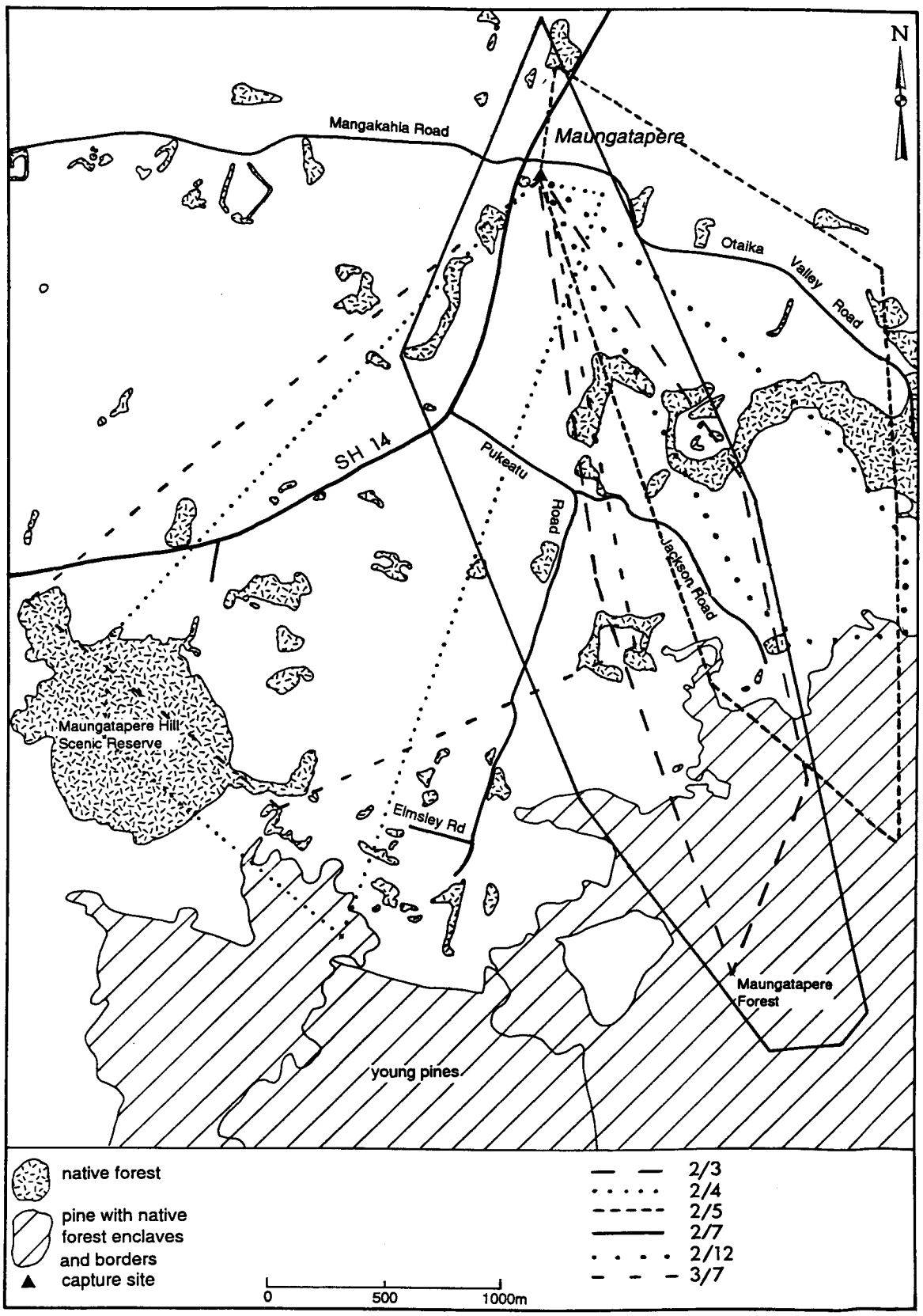


Figure 2 Home ranges of six Maungatapere kukupa from May 1992 to May 1993

2/3: This bird, a male, had an annual range of 140 ha. After the privet fruiting season it favoured a small area south of Jackson Road comprising dense secondary growth (native) on steep gully margins and a mature pocket of taraire and puriri on flatter terrain. It was often seen with a mate in July-December 1992 and it nested in the core part of its range in August-September 1992.

2/4: This bird had an annual range of 293 ha, favouring the northern and eastern slopes of Maungatapere Hill where the canopy was dominated by taraire and puriri. In August-December 1992 it was usually seen paired, but no nest was found.

2/5: This bird had an annual range of 286 ha. Its range spanned the northern part of Maungatapere Forest, frequenting enclaves of mature and regenerating native trees including the important food trees of taraire, tawa, puriri and pate, but also pockets of mature taraire on flatter terrain. In July-August 1992 it was usually seen paired and nesting was strongly suspected in September 1992 (constant signal in dense canopy of Maungatapere Forest), but the site had been abandoned by the following week.

2/6: This bird also favoured the northern part of Maungatapere Hill. On 2 June 1992 it crashed into a house window and split its crop. After veterinary attention and subsequent care by the Whangarei Bird Rescue Group, this bird was released on 19 June 1992 and continued to frequent the northern end of Maungatapere Hill until 1 August 1992. It was found dead (cause unknown) near Pukeatua Road in September 1992. In the three months of monitoring it ranged over 251 ha.

2/7: This bird had an annual range of 402 ha. It was the most mobile of all the radio-tagged birds, ranging across native enclaves in Maungatapere Forest and into mature stands of taraire and puriri north of the Maungatapere village area. In July-October 1992 it was usually seen paired but no nest was found.

2/8: In May-June 1992 this bird frequented small stands of mature taraire near Mangakahia Road, centred 1.5 km west of Maungatapere. It was last recorded on 7 July 1992 and its radio-transmitter with severed aerial was found in this area by a farm worker on 25 August 1992.

2/10: In May 1992 this bird frequented small stands of mature taraire near Otaika Valley Road, centred 1 km south-east of Maungatapere. The last signal from this radio-tagged bird was received on 26 May 1992.

2/11: This bird frequented "Church Bush", a small stand of mature taraire and puriri on the edge of Maungatapere, up until 26 May 1992. On 2 June 1992 its radio-transmitter was found with intact harness (kukupa cannot shed a harness naturally without breaking the weak link) in a dense bush beside the main road of Maungatapere.

2/12: This bird, a male, was aged as a juvenile when first captured, and had an annual range of 80 ha. It favoured areas with scattered puriri and kahikatea trees near the eastern end of Jackson Road and a tongue of mature taraire and puriri north of Jackson

Road. From July to December 1992 it was often seen with a partner and it nested in September 1992.

3/7: This bird was captured in a garage 5 km north of the study area on 25 August 1992. Over the following six months it ranged over an area of about 50 ha comprising forest remnants dominated by mature taraire and puriri. In August 1992 to January 1993 it was usually seen paired, but no nest was found.

3.4 Diet

Of 940 feeding observations in the Maungatapere-Whangarei area over two years, 99% were of ripe or nearly ripe berries swallowed whole. In winter, spring and summer the diet was dominated by berries of taraire and/or puriri (Fig. 3). In winter, taraire was the preferred food, averaging 79% of all feeding observations. In spring, taraire (37%) and puriri (41%) fruit were eaten approximately equally, with taraire decreasing and puriri increasing in the monthly diet during this season, but in summer puriri dominated, averaging 78% of feeding observations.

In autumn, puriri became increasingly rare in the diet and taraire had not yet ripened. A variety of other native species, including podocarps and particularly exotic species (61%) were important as autumn foods (Fig. 3, Appendix 3). The changed abundance of taraire and puriri in the diet closely coincided with the availability of the ripe fruits (Fig. 4).

The only non-fruit food seen being eaten were kowhai (*Sophora microphylla*) flowers and foliage (4 observations), houhere (*Hoheria populnea*) foliage (3), and willow foliage (2), all recorded during spring (Appendix 3).

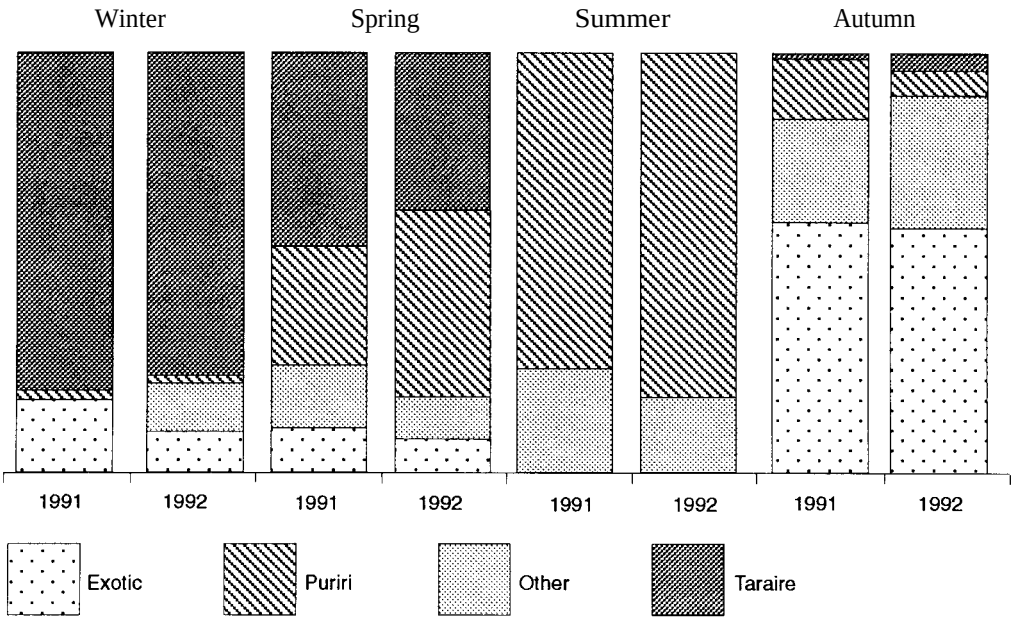


Figure 3 Seasonal diet of Kukupa in the Maungatapere-Whangarei area 1991-1993.

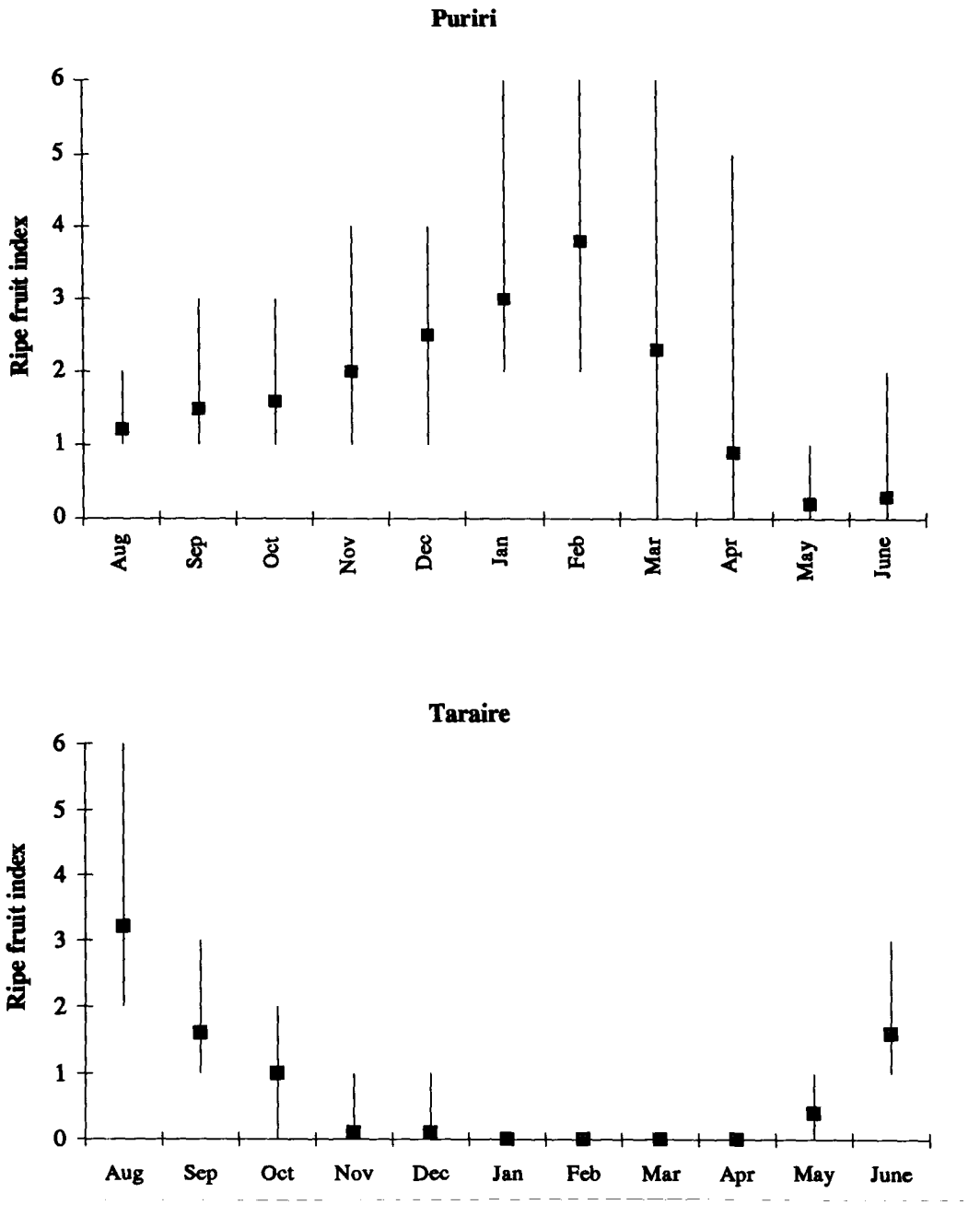
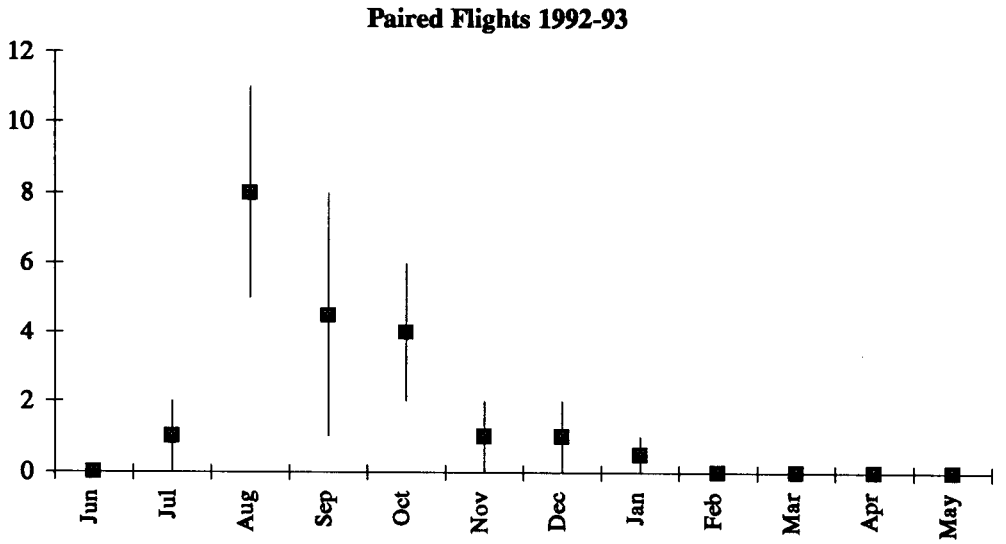


Figure 4 **Fruiting phenology of puriri and taraire at Maungatapere 1992-1993. Mean and range of ripe fruit scores.**

Fewer observations were made on diet on the Chickens Islands. In October 1992, the diet on Lady Alice Island comprised almost entirely ripe pigeonwood berries (n=32), which were abundant, and puriri berries (n=3). In December 1992, ripe berries of pigeonwood (10), puriri (15), supplejack (7), karaka (4) and kawakawa (3) were being eaten. In March 1993, ripe berries of kohekohe (14), tawapou (3), puriri (7) and kowhai foliage (1) were recorded in the diet. In July-August 1993, taraire (3), pate (4) and kowhai foliage (2) were recorded.



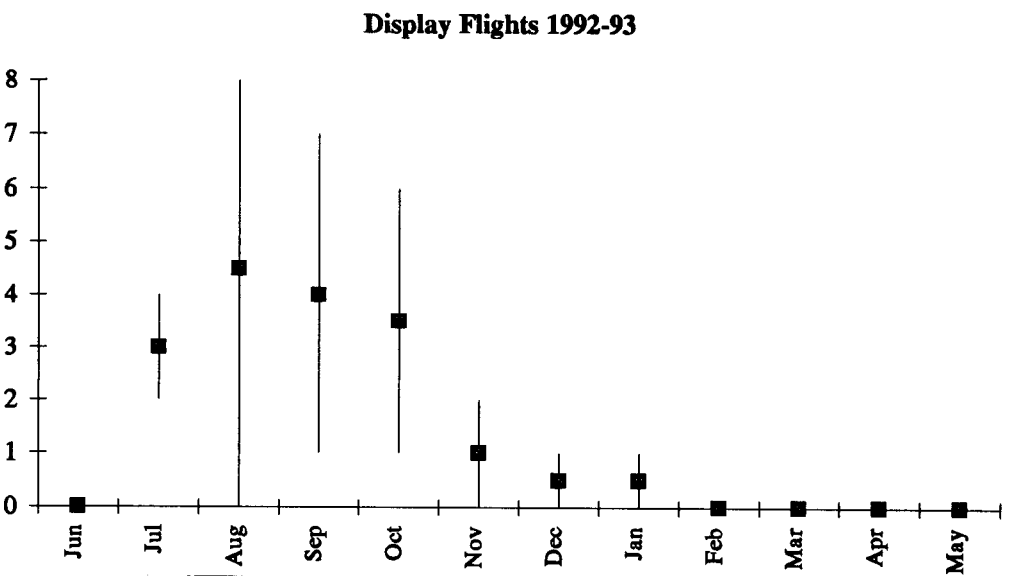


Figure 5 Mean and range of number of paired flights and display flights seen per visit at Maungatapere 1992-1993.

3.5 Nesting

3.5.1 Timing In the 1992-93 season the first indication of breeding behaviour occurred in mid July 1992 when there was a change from flying singly or in loose flocks to flying closely with another bird for varying distances ("paired flights"). Display flights or "display diving" (Clout 1990, Pierce 1993) was initiated at about the same time. Paired flights and display flights peaked in August-September but continued at a lower frequency until January 1993 (Fig. 5). In the winters of 1993 and 1994, the onset of display flights in the Whangarei area was also in July (pers. obs.).

At mainland sites in 1991 and 1992, (n=33) 73% of eggs found were laid in September-November (Fig. 6). Earliest nests were found in July (all in 1991) and latest nests in January. Of six radio-tagged birds monitored weekly during spring and summer, only

three were found attempting breeding (all once only), and none were successful. One of the birds to attempt nesting was less than one year of age. Although no visits were made to the Chickens Islands in August-September and November 1992, it was clear that most nests (n=16) were initiated in September-October of that year.

3.5.2 Nest Sites Mainland nests were placed at heights of 1.7 m to 12 m (average 6.1 m) compared with 0.5 m to 4.0 m (average 2.1 m) on the Chickens Islands. Mainland nests were usually placed in the upper understory or higher with only 7 of 29 nests (24%) being in the lower understorey, whereas the trend for the 16 Chickens Islands' nests was for them to be in the lower understorey (62% of the 16 nests) (χ^2 = 3.71, l.d.f.).

On the mainland the 33 nests were found in a total of 13 tree species, of which totara (42%) and karaka (15%) were the most commonly used (Appendix 4). On the Chickens Islands the 16 nests were found in six tree or shrub species of which kanuka (50%) was the most commonly used. Three of the eight kanuka nests were in fallen dead kanuka.

3.5.3 Success Of 31 unprotected mainland nests, six (19%) succeeded to the late fledgling stage. Of 16 Chickens Islands nests found, 10 (63%) succeeded to the late fledgling stage, a significantly higher productivity (χ^2 = 4.45, P <0.05) than for mainland nests. Host trees of a further two mainland nests were banded by the property owners to deter predators. Both nests succeeded in fledging a chick, one chick of which was subsequently seen killed by a stoat. The predation occurred at a height of c.2 m in an unbanded totara tree (D. Bridge pers. comm.).

The low number (8) of successful nests on the mainland precludes any statistical analysis of safe features. The six "unprotected" nests that succeeded were initiated approximately evenly over August December, at varying heights from 2.5 m to 12 m

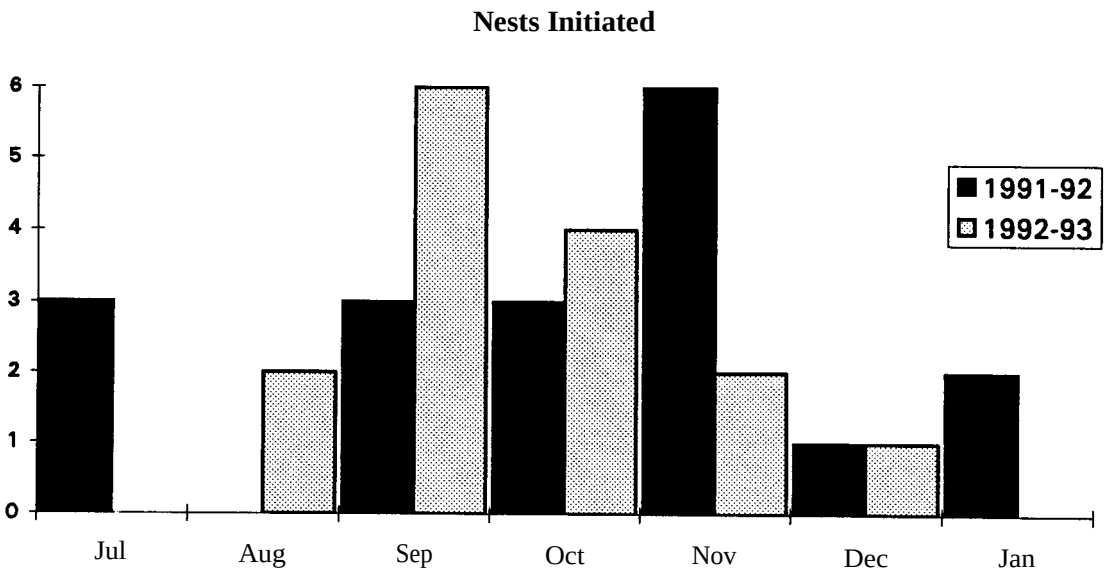


Figure 6 Month of initiation of nests found in Northland in 1991-1992 and in Maungatapere-Whangarei area in 1992-1993.

inadvertently protected from predators: W8 was sited at 12 m in a suburban titoki which had a Weimaraner dog tied up at its base, and W25 was sited at 6 m in a taraire grove which had traps set for possums throughout. One other nest (W30) also experienced significant protection in the form of local possum control, but it failed.

3.5.4 Causes of Nesting Failure No actual events causing failure of nesting were witnessed at Maungatapere, but in several instances weather and/or sign left at the nest site were analysed to help determine probable fate. Natural causes of mortality included single instances of egg infertility, and a chick apparently dying of exposure, whilst single instances of a broken egg and a chick falling out of nest may also have been natural (Table 1).

Two instances of possum predation occurred in rural gardens; possum hair was found stuck to the drying insides of squashed eggs and the broken edges of the shells were crushed inward. In both cases the property owners had seen a kukupa on the nest the previous afternoon, so it is most likely that possums were responsible, rather than arriving after the primary event. Two other nests were partially destroyed and probably involved large animals the size of possum, cat or harrier. One of these had a broken uneaten egg on the ground with feathers of an adult kukupa scattered about.

Table 1 Sign left and probable fate of failed kukupa nests

Sign	Probable Fate	Nest No. (Appendix 2)
Egg abandoned, infertile.	Egg infertile	C3
Dead chick on ground.	Chick fell out of nest	C8
Dead chick 1 week old. Had rained heavily for 48 h.	Chick died of exposure	W19
Rotting egg.	Egg broken in nest	C5
Nest largely destroyed, egg on ground directly below, not eaten.	Large animal disturbance	W9, W21
Eggs squashed, contents mostly eaten, possum fur on egg shell.	Possum predation of egg	Wll, W20
Egg removed whole from nest, one hole covering half of length of egg, inside of shell "clean".	Small animal predation	W7, W12, W18, W27, W30, C6
Egg eaten in nest, large numbers of mainly shell fragments, one accompanied by rat droppings.	Small animal predation	W23, W24, C7, W26
Egg or chick missing, no sign.	Unknown	W3, W10, W13, W14, W15, W16, W17, W22, W29, W31, W32, C1
Remains of chick in nest.	Unknown	W2

Six instances were found of eggs being removed intact from the nest and left on the ground nearby with a single hole approximatley 20 x 20 mm but with many small jagged indentations and projections and scratches to the egg shell. In all cases the contents of the eggs had been eaten and the inside of the egg shell was clean. Three instances were found of many small scattered shell fragments being left in the nest, one of which included rat droppings. Most failures, however, involved the egg or chick being removed with no sign left at the nest.

4. DISCUSSION

4.1 Adult Mortality

The window casualty was one of 22 window casualties dealt with by the Whangarei Bird Rescue Group in 1992 and 1993. These 22 casualties represent about 30% of the 73 kukupa needing attention in those years (R. Webb pers. comm.). The frequency of such accidents can be effectively reduced by the strategic placement of window hangings or by hanging coarse netting across potentially lethal flight paths (R. Webb, L. Winch pers. comm.; pers. obs.).

The four birds which disappeared are also considered to have died. In two of these cases, transmitters that the birds were wearing were recovered in circumstances that revealed clear signs of foul play and, because of the technical reliability of these transmitters (D. Ward pers. comm.), it seems likely that the other two birds which disappeared could have done so as a result of human predators who operate in the area.

Although 11 birds are a small sample from which to draw conclusions, the loss of nearly half of these birds within three months of radio-tagging is cause for concern. In a long-term study of NZ pigeons in Marlborough, Clout *et al.* (1995) recorded a crude mortality rate of 0.19 deaths per bird-year, considerably lower than the present study of 0.80 deaths per bird-year.

If the four birds which died from suspicious causes are excluded from the sample, the one (window) death recorded over 5.9 bird-years corresponds to a crude mortality rate of 0.17 deaths per bird-year. This figure is very similar to that for the unhunted Marlborough population (Clout *et al.* 1995), but higher than that (0.04) for the Chatham Island pigeon parea *H. novaeseelandiae chathamensis* (Powlesland *et al.* 1995).

4.2 Home Range, Movements and Diet

The home range lengths of Maungatapere kukupa were similar to range lengths recorded at Wenderholm, 50 km north of Auckland (pers. obs.), but smaller than that recorded in Marlborough where Clout *et al.* (1991) recorded about one third of their study birds travelling distances of 5-18 km from the capture site. In the present study, no birds were found more than 4 km from the capture site, and most had core home ranges spanning 1-2 km in length.

The relatively small home ranges of the Maungatapere kukupa reflect the year round availability of ripe fruit in the local area. Unlike the southern half of the North Island and South Island where birds are dependent on foliage for most of the year (Clout *et al.* 1986, H. Robertson pers. comm.), Northland kukupa take little foliage, primarily in spring. The only significant departures from core home ranges at Maungatapere took place in autumn when many birds travelled up to 4 km to privet hedges. This temporal dependence on privet occurred when puriri and kahikatea had finished fruiting and taraire fruit was just beginning to ripen. Moreover, the local scarcity of miro and the poor fruiting of kohekohe and other species (much of it possum-induced) would have

increased the dependence on privet fruit in April-May. In the larger forests of Northland, kukupa were often seen flying at least a few kilometres to or from concentrations of miro trees (pers. obs.).

Taraire and puriri are pivotal species for kukupa in this and other parts of Northland. The two species collectively contributed to over 75% of the observed diet of Maungatapere NZ pigeons in winter (taraire), spring (both) and summer (puriri). Fruiting failure of either of these species could have serious consequences for kukupa, and there is some evidence to suggest that nutritional problems sometimes occur in spring. Numerous emaciated, weak or dead birds have been found in several Northland areas in spring (P Anderson, W Sporle, B. Waddell, R. Webb pers. comm.) and unconfirmed reports have been received of "die-offs" in other areas of Northland in the 1980s and in 1991 and 1992. Additionally, some spring reports of non-emaciated birds dying have also been made. No evidence of nutritional stress was found in the Maungatapere-Whangarei area, although deaths have been reported in this area in previous years (J. Hawken pers. comm.).

Privet and especially Jerusalem cherry have both been thought potentially toxic to birds, including kukupa, and kukupa recorded recently feeding on Jerusalem cherry have been found dead (J. Hawken pers. comm.). However, all of the study birds ate privet and most of them also ate Jerusalem cherry (including 2/7 at the time of its window accident), with no evidence of nutritional or physiological (e.g. infertility) problems being detected. Only one egg was found to be infertile, but because most eggs were preyed upon, it was not possible to calculate percentage of egg infertility. There is, however, a clear need to assess the effects of these and other potentially toxic plants on kukupa and the relative nutritional values of different native fruits.

Another time of year when emaciated and weak birds are frequently found is in autumn, when many birds (mostly juveniles) are handed in to the Department of Conservaton and Whangarei Bird Rescue Group. These birds normally recuperate when provided with artificial foods and are subsequently released, and several of them have been resighted later in the wild.

4.3 Nesting

The onset of breeding occurs much earlier (July, peaking in September-October) in Northland than it does in Marlborough (November, peaking in January) (Clout *et al.* 1995), and the season continues for longer. This difference in chronology coincides with differences in fruit availability which in the south does not begin until December, and where in poor fruiting years breeding may not be attempted at all (Clout *et al.* 1995). In Northland, where fruit is available year round, nests have been reported in all months from June to February, but not in autumn, which is the moulting season.

In spite of the long northern breeding season, kukupa may be coming under increased pressure through competition for fruit from possums. This may be accentuated by localised clearance of key food species, e.g., podocarps, and the poor regeneration of puriri, taraire and other pivotal species in areas which are grazed. Only large scale

possum control in extensive forests and intensive possum control in smaller, potentially very productive reserves, e.g., the puriri-taraire forests, will alleviate competition from possums. In the Maungatapere-Whatitiri area in September-October 1993, flocks of up to 50 kukupa were seen (and bigger flocks reported) in taraire groves where possums were being controlled to low levels. These birds had abandoned feeding (and possibly breeding) in other groves and reserves where berries had been depleted to low levels. This, together with the few breeding attempts initiated by radio-tagged birds, suggests that the birds may sometimes be under nutritional stress as a result of competition with possums (and perhaps rats) for berries. Because we do not know what levels of possum density are acceptable for kukupa (and other threatened plants and animals) to maintain viable populations, there is a need to monitor the abundance of pigeons in different forests under different possum control regimes and corresponding possum densities. The dietary change of stoats following depletion of their staple rodent prey during 1080 operations (Murphy and Bradfield 1992) could also place kukupa at risk. There is a need to identify the benefits and risks of such operations to kukupa and implement appropriate management.

The low breeding success (19%) of mainland nests is consistent with earlier studies at Pelorus (Marlborough), Mohi (Hawkes Bay) and Wenderholm (Auckland) (Clout *et al.* 1995). The present study has added possum to the list of nest predators. This is in addition to its role as a competitor for food. Management programmes aimed at increasing breeding productivity of kukupa should therefore consider sustained possum control as well as mustelid and rodent control.

The relatively high breeding success (63%) of kukupa on the Chickens Islands is consistent with those islands being free of possums, mustelids, cats and ship rats. It is not known to what extent mainland birds are recruited from the Hen and Chickens Islands or whether there is seasonal movement between the islands and mainland. One bird was seen flying between Lady Alice Island and Bream Head in March 1993 (pers. obs.), but further work is needed to ascertain the significance of that observation.

5. RECOMMENDATIONS

1. Undertake sustained possum control over extensive broadleaf-podocarp forest habitats in Northland, particularly Waipoua-Mataraua, and compare the benefits to kukupa and other threatened species of reducing possum densities to different levels.

2. Undertake sustained year-round possum and predator control (to low densities) at potentially productive breeding sites containing extensive broadleaf-podocarp (especially taraire/puriri) habitat, e.g., Maungatapere, Bream Head, Trounson. Some of these could be incorporated into other threatened species protection programmes, e.g., for kiwi, kokako, snails.

3. Continue annual or biennial monitoring of kukupa and other bird populations in key forests (e.g., Waipoua-Mataraua, Puketi, Russell) in conjunction with the wild animal control monitoring programme, and in intensively managed sites in 2 above.

4. Implement research to assess the need to undertake cat/stoat/weasel control following extensive 1080 operations.

5. Advocate for the protection, fencing and weed control (especially *Tradescantia*) of taraire-puriri forest remnants on private land and encourage landowners to undertake possum and predator-control programmes. Assess responses of taraire and puriri to possum control and stock exclusion, and evaluate other causes of dieback of these species.

6. Encourage the planting and/or protection from browsers of native trees which form an important part of the annual diet of kukupa (e.g., taraire, puriri, kohekohe), and which may be scarce locally (e.g., miro in Maungatapere area). This will reduce, in the long term, the dependence of kukupa on exotic species, some of which are plant pests.

7. Assess the causes of death of emaciated and non-emaciated kukupa dying in spring.

8. Assess the relative nutritional value to kukupa of different native fruits and the effects of potentially toxic berries (Jerusalem cherry and privet) on captive kukupa.

9. Explore options with iwi for managing kukupa and develop a management plan for this species in Taitokerau.

10. Assess whether significant numbers of Hen and Chickens kukupa are recruited into the mainland population.

11. Advocate the placement of window ornaments and netting to reduce the frequency of window accidents. Support initiatives of Whangarei Bird Rescue Group in rehabilitating injured/weak kukupa.

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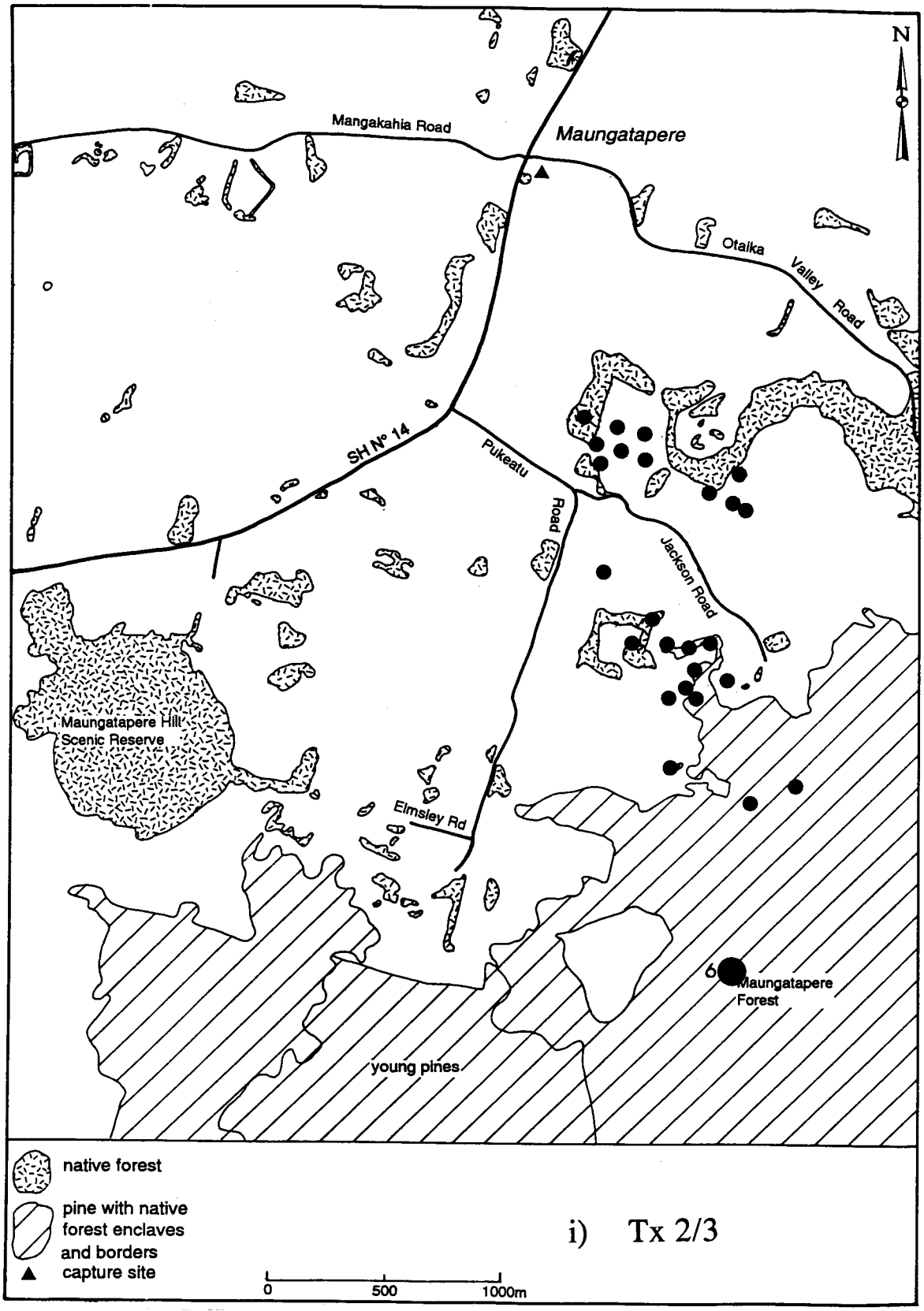
APPENDIX 1: Study Birds

Jess	Tx	Date	Age	Weight(g)
Red R	2/2	5.5.92	Ad	655
Green R	2/3	6.5.92	Ad	745
Pink R	2/4	4.5.92	Ad	650
Orange R	2/5	4.5.92	Ad	745
Lime R	2/6	5.5.92	Ad	705
Lime L	2/7	13.5.92	Ad	715
Orange L	2/8	13.5.92	Ad	675
Blue R	2/10	1.5.92	Juv	585
Yellow R	2/11	5.5.92	Ad	610
Lt Blue R	2/12	5.5.92	Juv	610
Yellow L		13.5.92	Ad	705
Lt Blue L		13.5.92	Ad	705
	3/7	Aug 92	Ad	

APPENDIX 2: **Location of fixes of radio-tagged birds. A small dot represents one "fix", a large dot 2 or more "fixes", with actual number given.**



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