SCIENCE & RESEARCH SERIES NO.66

SOME ASPECTS OF THE ECOLOGY AND BREEDING BIOLOGY OF PAREA ON SOUTHERN CHATHAM ISLAND, JULY 1992 - APRIL 1993

SCIENCE & RESEARCH SERIES NO.66

SOME ASPECTS OF THE ECOLOGY AND BREEDING BIOLOGY OF PAREA ON SOUTHERN CHATHAM ISLAND, JULY 1992 - APRIL 1993

by

Ralph Powlesland, Andrew Grant,
Ian Flux and Peter Dilks

Published by
Head Office,
Department of Conservation,
P 0 Box 10-420,
Wellington,
New Zealand

ISSN 0113-3713
ISBN 0-478-01576-3

Cataloguing-in-Publication data

Some aspects of the ecology and breeding biology of parea on southern Chatham Island, July 1992 - April 1993 / by Ralph Powlesland . . . [et al.] Wellington, N.Z. : Dept. of Conservation, 1994.
1 v. ; 30 cm. (Science & Research series, 0113-3713 ; no. 66.)
Includes bibliographical references.
ISBN 0478015763
1. Chatham Island pigeon--Breeding. 2. Chatham Island pigeon--Counting. 3. Chatham Island pigeon--Feeding and feeds. 4. Chatham Island pigeon--Habitat. 5. Rare birds--New Zealand--Chatham Islands. I. Powlesland, Ralph G. (Ralph Graham), 1952- II. Series: Science & research series ; no. 66.
598.65099349 20NZ
zbn94-019347

Keywords: parea, *Hemiphaga novaeseelandiae chathamensis,* numbers, diet, breeding, conservation, Chatham Island

CONTENTS

SOME ASPECTS OF THE ECOLOGY AND BREEDING BIOLOGY OF PAREA ON SOUTHERN CHATHAM ISLAND, JULY 1992 - APRIL 1993

by
Ralph Powlesland[1], Andrew Grant[2], Ian Flux [1] and Peter Dilks[3]

[1]Science & Research Division, Department of Conservation,
PO Box 10-420, Wellington, New Zealand

[2]Canterbury Conservancy, Department of Conservation, Private Bag, Christchurch
[3]Science & Research Division, Department of Conservation,
Private Bag, Christchurch, New Zealand

ABSTRACT

This report describes the results from the second year of a research programme on parea or Chatham Island pigeon (*Hemiphaga novae-seelandiae chathamensis*) at southern Chatham Island. One of two marked adult females disappeared in 1992-93. However, at least five of six parea marked as nestlings in 1991 were alive in April 1993. Two of the five birds, both females, bred when less than a year old. Limited sightings of the other three birds suggest none of them paired during the 1992-93 breeding season. The total number of pigeons in the Awatotara and Tuku study areas increased by 36% from about 33 adults in 1991 to about 45 in 1992. The ready availability of ripe fruit from matipo (*Myrsine chathamicus*), supplejack (*Ripogonum scandens*) and hokataka (*Corokia macrocarpa*) in autumn and an abundance of hoho (*Pseudopanax chathamicus*) fruit that began ripening in winter were probably important factors in promoting the early start (June) to breeding in 1992. Once hoho fruit sources had been exhausted in the pairs' valley home ranges, the birds flew to tarahinau (*Dracophyllum arboreum*) forest on the tableland to feed on the later ripening hoho fruit there. The nesting efforts and success of 16 pairs were monitored. Nesting began in early June and most eggs were laid between then and November. All pairs nested at least once, and two pairs nested four times each. The most productive pair raised three fledglings. Overall, 24 fledglings were raised from 37 nesting attempts; 65% success and an average of 1.5 fledglings per pair. The contents of only two of the 13 failed nestings were obviously taken by predators. Other reasons for failures were abandonment (1), infertile egg (2), and insecure/inadequate nest (2). On at least 6 of 12 occasions that pairs fledged a chick and re-nested, females laid their next clutch 4-8 days **before** the nestling in their previous nest fledged.

1. INTRODUCTION

The parea, or Chatham Island pigeon, is a large (680-960 g) fruit pigeon, endemic to the Chatham Islands. Parea were common on Chatham, Pitt and Mangere Islands when the Chathams group was visited by early European naturalists in 1867 (Travers and Travers 1872). By 1938 there were few pigeons north of Waitangi, Chatham Island (Fig. 1), however they remained moderately plentiful in forested areas to the south (Fleming 1939). By 1975 there were only sporadic sightings of parea in the northern parts and it was considered rare in the southern forests of Chatham Island (Merton and Bell 1975). A survey during the summers of 1988 and 1989 of much of Chatham Island suggested a population of about 40 birds (Grant 1990). This rapid decline of parea following European colonisation had led to the subspecies becoming critically endangered. The reasons for the decline were considered to be forest clearance for farming, degradation of the remaining forest by browsing stock (cattle, sheep, pigs) and possums (*Trichosurus vulpecula*), predation by cats and rats (*Rattus* spp.), and hunting by people.

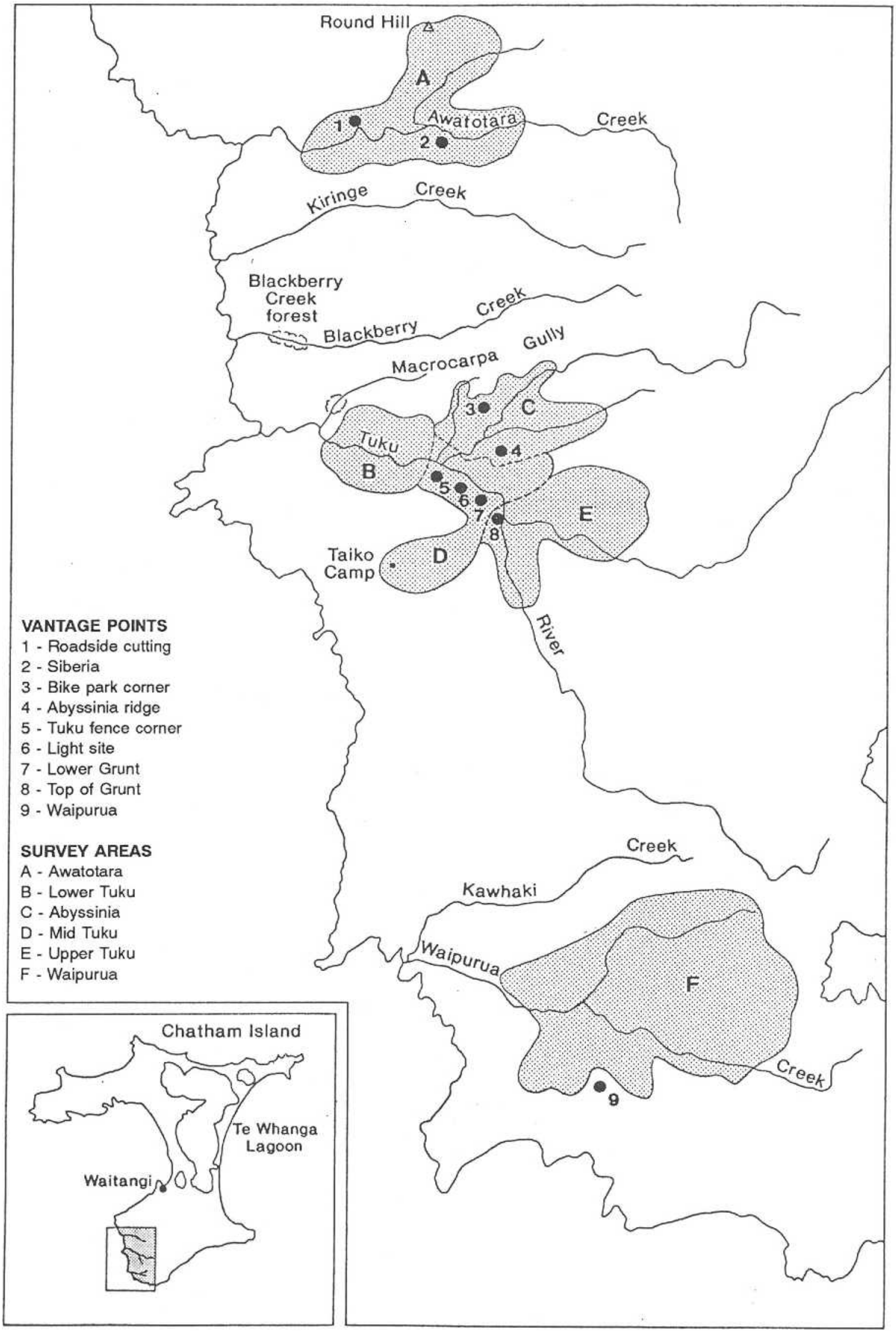
Since so few birds were evident during the 1988-89 survey and extinction of parea seemed imminent, a draft recovery plan was prepared. Actions considered necessary to reverse the decline of parea were listed (Grant 1990). One of the objectives of the plan was to gain as much information as possible about the ecology and biology of parea so that the most appropriate management actions could be undertaken. This report describes the results of the second year of a three-year intensive field programme to meet this objective, and makes recommendations for future research and management of parea.

2. METHODS

2.1 Study areas

The main study areas were the forested Awatotara and Tuku valleys (Fig. 1) and most of the fieldwork from July 1991 until January 1993 was carried out here. These areas contained the largest known numbers of parea; 35-40 birds in May 1991, two of which were radio-tagged (Clout and Robertson 1991). Here operations had been underway since 1989 to improve the forest for parea by trapping cats and possums, and controlling feral stock. In 1991, the lower portions of both valleys were covenanted under the Forest Heritage Fund scheme by landowners Bruce and Liz Tuanui. These blocks of open forest and pasture were fenced in 1992-93 with funding from the Forest Heritage Fund and the Department of Conservation. Index trapping of possums in the two covenanted blocks during August-September 1992 indicated densities of 1-3 possums/ha. Subsequently, sustained possum control was begun in November 1992 using poison pellets in permanent bait stations to keep possum densities as low as possible (Brown 1992).

In February 1993 it was decided to compare parea breeding effort and success in an area without mammal control with that in the areas described above. The Waipurua catchment



Reproduced from Powlesland *et al.* (1992).

Figure 1 Chatham Island, showing locations of Awatotara Valley, Macrocarpa Gully, and Tuku Valley study areas; survey vantage points (1-9); and boundaries of survey areas (A-F).

(Fig. 1), six kilometres to the south, and therefore well beyond the influence of the mammal control operation, was chosen for this purpose. In April 1993, four parea in the Waipurua were captured and marked with jesses (see 2.3); three of these were also radio-tagged (see 2.3).

2.2 Study periods

Field-trips by the authors were made during: 10-31 July 1992; 8 September - 16 October 1992, 9-13 November 1992, 3-22 January 1993, and 19 April - 7 May 1993. In addition, wage workers spent the following periods monitoring pairs of nesting parea: 16-29 August 1992 (L. Adams), 17 October - 7 November 1992 (C. Tisdall), and 14 November - 17 December 1992 (M. Bell).

2.3 Identity of parea

Parea were individually identified by coloured jesses fitted to their legs. Each nestling, when about a month old, was removed from its nest and jesses fitted to it. Jesses were attached to adults following their capture in mist-nets. Most adults were captured when they flew to ground near a net to feed on clover and were then flushed into the net. Each jess was a strip of PVC impregnated coloured cloth, 13 X 120 mm (obtained from a tarpaulin/tent repairer). It was fastened around the leg by a splice called a falconers' knot, with a 50 mm length hanging from the back of the leg. Parea had either a jess on one or both legs. Jesses made of heavy duty cloth (0.7 mm thickness) remain intact for at least two years. Appendix 1 lists the jess combinations for all banded parea. Some jessed birds were also fitted with transmitters. Two-stage transmitters of about 32 g (supplied by Sirtrack Electronics, Landcare Research NZ Ltd) were attached to birds' backs by harnesses of the kereru (*Hemiphaga n. novaeseelandiae*) design (Karl and Clout 1987). These incorporate a weak link which the parea could break by struggling if the harness ever became snagged. The transmitter signal could be detected from several kilometres away (depending on terrain) and enabled us to locate and monitor individuals regularly.

2.4 Phenology records

In July 1991, Christine Tisdall (University of Otago MSc student) individually marked plants of 11 species known or thought to be important parea foods; mainly fruiting trees and shrubs. The number of marked plants per species varied from 10 to 66, and totalled 327 plants. The marked plants are in the Awatotara, Tuku and Macrocarpa study areas. They were visited in January, April, July and October each year to record the availability (estimated density) of leaf buds, leaf shoots, young leaves, flower buds, flowers, immature fruit, green fruit, half ripe fruit and ripe fruit. Since Christine completed her field work in March 1992 (Tisdall 1992), RGP has continued seasonal phenology observations of these plants, and increased the sample sizes for matipo and karamu (*Coprosma chathamica*). Availability of each phenology stage was subjectively recorded on a scale from 0 (none seen) to 5 (heavily laden), with 0.1 indicating just a trace was seen.

2.5 Diet records

During each field-trip prior to January 1993 between one and three parea had functional radio-tags, and therefore most of the habitat use records (see section 2.5, in Powlesland *et al.* 1992) were obtained from a few birds. This could result in biased data being obtained on the foods and habitat requirements of parea. In an endeavour to overcome this problem, prior to the January 1993 trip we changed our procedure of recording parea diet. Instead of recording the activities and foods of parea for as long as a bird could be followed, we recorded the first feeding observation of a parea and then ignored its further feeding activities, unless it shifted to a different plant, a different food in the same plant or resumed feeding after a period of non-feeding activity, for example roosting or courtship. This procedure has resulted in a greater independence of feeding observations by increasing our sample of individual parea observed. At each 'observation' the following details were recorded:

1. **Observer:** initials
2. **Time:** of day (24-hour clock)
3. **Location:** name of study area and precise locality
4. **Habitat type:**
   description based on dominant canopy species and whether open or closed canopy:
   - tarahinau - open/closed
   - kopi - open/closed
   - mixed broadleaf forest - open/closed
   - tree fern - open/closed
   - scrub (pouteretere, bracken, tree fern associations) - open/closed
5. **Number of birds:** that were in view (but foods of only one bird recorded)
6. **Birds' identity:** indicated when individually identifiable, otherwise `unknown'
7. **Food species:** that the bird was eating
8. **Food type:** category of food being tasted, and/or picked and eaten (leaf bud, young leaf, mature leaf, gall, moss, lichen, pasture/herbs, flower bud, flower, immature fruit, green fruit, half ripe fruit, ripe fruit, water, unknown.

2.6 Census and hill-top watches

During the January 1993 field-trip a census of parea in all study areas was undertaken. Parea movements were recorded for the last three hours before dusk by observers (with two-way radios, to discuss bird movements) on the designated vantage points (Fig. 1). Each study area was observed during a different evening. Observers noted the time of each sighting, the number of birds in view, their location, and their direction of movement. Estimates of the number of birds seen in each catchment were made by comparing the sightings of all observers. In addition, during the breeding season (July 1992 - January 1993) observers watched from vantage points at regular intervals to determine whether particular pairs were nesting (see 2.7). These regular hill-top watches enabled us to estimate the number of pairs in the Awatotara and Tuku study areas.

2.7 Nest finding, protection and observations

Nests of parea were found using three methods:

1. When one member of a pair was radio-tagged, this pigeon was regularly located to determine if and where the pair was nesting.
2. Some nests were located when a parea being followed flew off with a twig to nest build or relieve its incubating partner.

3. Two or three people, each with a two-way radio, were stationed on different viewing points to watch for a changeover at a nest. A nest was searched for if a bird was seen to fly to a likely nest tree and then a bird leave the same site within two minutes. These observations were carried out from 0830 to 1130 and from 1600 to 1900 because previous observations indicated that incubating birds changed over once during each of these periods (Powlesland et al. 1992). This method was used when a pair was known to be resident in an area, but their nest had not been found.

An effort was made to prevent rat predation at half the nests. Six 'Ezeset' rat traps baited with cheese were placed under low vegetation at a 20-50 m radius about each nest tree. At one nest, which was on the ground, six gin traps baited with cat lures (salmon food pellets) were used to remove cats, possums and wekas.

Records of parea activities at nests during incubation and nestling phases were obtained by an observer sitting 20-30 m from the nest tree. A hide was not used, but often foliage hid the person to some degree. Most adults proved very tolerant of the presence and movements of an observer; no parea left its nest when approached, or gave the appearance of being alarmed. Similarly, when people were placing or checking traps about nest trees, adult birds showed no concern.

Nests were inspected only if the adults were absent. At readily accessible nests chicks were weighed at about 3-day intervals once they were left unattended (at c. 15 days of age). Weighing continued until they were 35-40 days of age when their wing-flapping and movements to avoid capture were likely to result in injury to themselves or in their falling from the nest. Jesses and a numbered metal band were put on each nestling when it was about 25 days old. A transmitter and harness (see section 2.3) were attached to each of three nestlings when about 35 days old. A feather sample was obtained from each nestling during handling and was stored for later genetic analyses (see Leeton and Christidis 1993).

2.8 Rat index trapping

Index trapping of rats (see Cunningham & Moors 1993) was carried out in July and October 1992, and January and April 1993. Trapping was conducted in the Awatotara Valley (22 sites), Macrocarpa Gully (21 sites) and Tuku Valley (50 sites) (Fig. 1), with the sites being about 50 m apart. At each trap site one Ezeset rat trap was placed under natural cover or in a tunnel of plastic-covered wire mesh. The traps, baited with cheese, were set for three consecutive nights. They were checked daily and any rats identified, sexed and weighed.

3. RESULTS

3.1 Numbers of parea

3.1.1 Survival of marked birds No dead parea were found, nor aggregations of feathers and bones indicating predation or scavenging. However, one breeding female (K-8153) which was first marked in July 1990, disappeared during 1992. She had been seen regularly during each field trip, but was last seen on 31 October 1992, three days after her fledgling had left the nest. Her partner subsequently reared the fledgling. K-8151 (jessed July 1990) was not seen during 1992-93, and K-8161 (jessed December 1991) was seen once in November 1992. Neither K-8151 nor K-8161 occupied home ranges in the study areas and so the lack of recent sightings of them does not necessarily indicate their demise.

Five of the six individually jessed fledglings of the 1991-92 nesting season were seen in April 1993. The sixth bird was last seen in January 1993. It was seen only occasionally after its transmitter fell off in early October 1992, and so its home range is likely to have been beyond the study areas.

3.1.2 Territorial pairs During the 1992-93 breeding season, regular watches were made from vantage points to determine the nesting status of each pair in the Awatotara and Tuku study areas. Although only three of the breeding birds were individually identifiable (jessed), we estimated the home range location of each pair by watching their movements and those of neighbouring birds. When an unmarked adult was seen within a home range we assumed it was a member of the resident pair. All nests found in a particular home range were assumed to be those of the resident pair. This was indicated in several cases by an unmarked adult observed feeding a well-developed nestling or jessed fledgling and later going to another nest in the home range and incubating, or vice versa.

As a result of our hill-top observations we determined how many pairs were present and the general location of the boundaries between the home ranges of neighbouring pairs, especially early in the breeding season when most pairs confined their activities to their home ranges. Unpaired adults were evident, but obtaining an accurate count of their numbers was not possible because of their irregular appearances. Three pairs and at least two unpaired birds were evident in the Awatotara, and 17 pairs and at least eight unpaired birds in the Tuku study area; at least 48 adults in total (Table 1).

3.1.3 Census As recommended in Powlesland et al. (1992), an effort was made to count the parea population in the study areas during the January 1993 field trip. However, it proved impossible to determine the number of individuals present for several reasons. As most pairs had finished nesting before January and were in moult, they were not roosting conspicuously, making display flights or evicting interlopers from their home ranges. Also there were many juveniles present that could not be distinguished from adults at a distance.

3.2 Movements and pairing of 1991 juveniles

3.2.1 K-8154 (radio-tagged): During February 1992 this juvenile was seen at several locations in the Tuku study area, including its natal home range, but in April it was fairly sedentary east of Taiko Camp (Fig. 2). In July it was in the lower Kawhaki Creek catchment, about three kilometres south of Taiko Camp, paired with an unjessed adult. It has been found in this area during each subsequent trip. From the timing of its stints on the nest (males incubate from mid-morning to late afternoon, females for the rest of the time), K-8154 is assumed to be a female.

Table 1 Number of adult parea during July-August 1992 in the Awatotara and Tuku study areas, southern Chatham Island.

Study area and territory names	Paired	Un-paired*
AWATOTARA		
Hadlee	2	
Siberians	2	
Eastenders	2	
Extras		2
Total	6	2
TUKU		
Lower Tuku		
Bumbag	2	
Lower Tuku	2	
Total	4	
Abyssinia		
Head Basin		1
Bike Park	2	
Punga	2	
Slip	2	?
Catch-22	2	
Pigeon Alley	2	
DSIR Plot		4
Upper Doubters	2	
Mid Doubters	2	
Total	14	5
Mid-Tuku		
Taiko Camp 2 ?		
Toyota Gully	2	1
Grunt	2	2
Snake Gully	2	
Greenpeace	2	
Waterfall	2	
Lower Doubters	2	
Total	14	3
TOTAL	**38**	**10**

* Minimum numbers

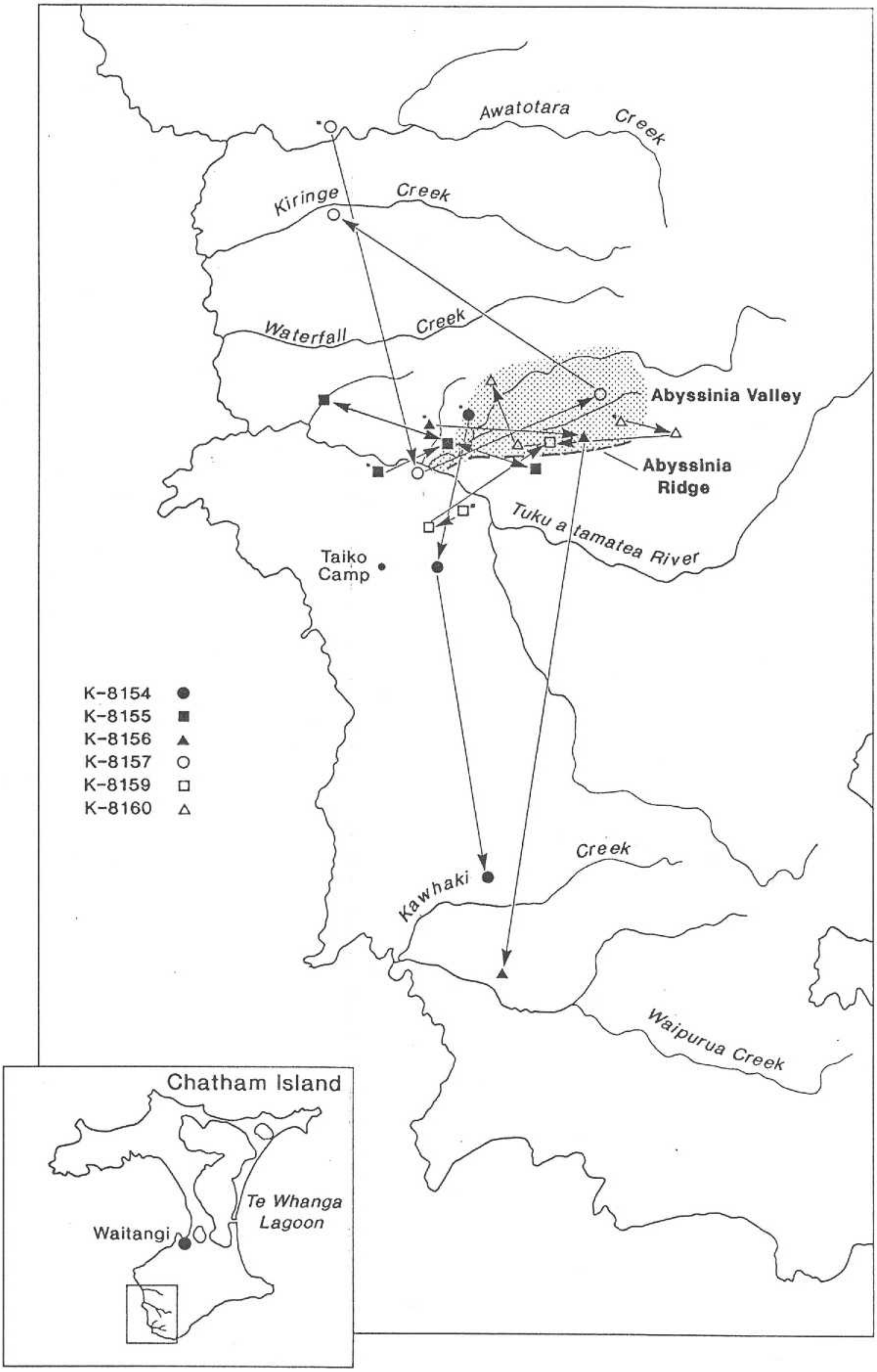


Figure 2 Nest sites (symbol with a dot beside) and subsequent general sightings of the six parea jessed and fledged in 1991.

3.2.2 K-8155 (radio-tagged): In February 1992 this bird moved between several sites in the Tuku catchment, and in April 1992 it was found mainly east of Abyssinia Ridge (Fig. 2). Initially during the July trip it remained in Macrocarpa Gully, but later fed mainly east of Abyssinia Ridge and roosted in southern Abyssinia Valley. Similarly, in September-October 1992 it fed east of Abyssinia Ridge and roosted in southern Abyssinia Valley, but also joined other birds to feed on clover in the lower Tuku Valley. In January 1993 it fed in Macrocarpa Gully and southern Abyssinia Valley, and was invariably found at the latter location in the early morning and evening. During April 1993, by which time its transmitter had fallen off, the bird was located once, in southern Abyssinia Valley. Although it associated with other parea, particularly in January 1993, it remained unpaired.

3.2.3 K-8156 (jessed): This bird was seen once in flight over Abyssinia Valley in February 1992, and was next seen in September 1992 in the Waipurua Valley (Fig. 2). The next sighting of it was during April 1993 in the same valley, in company with a juvenile raised in the lower Tuku Valley in 1992.

3.2.4 K-8157 (jessed): During February and late March 1992, K-8157 associated with its parents in the Awatotara Valley, but was not seen in April 1992. In July it was seen only twice at the southern end of Abyssinia Valley. The next sighting was in November near the head of Abyssinia Valley (Fig. 2). It was not seen in January 1993, but in April it was regularly found in a patch of forest beside Kiringe Creek opposite the Tuanui's home. Although still unpaired, a 1993 unjessed juvenile was often seen near K-8157 in Kiringe Bush.

3.2.5 K-8159 (jessed): In February and April 1992 this bird was seen in its natal home range near the Taiko Camp. During late July it was found nest building in mid Abyssinia Valley (Fig. 2) and has since remained there and bred successfully. The timing of its stints on the nest indicates that it is a female.

3.2.6 K-8160 (radio-tagged): During February, April and July 1992, K-8160 was located mainly in the northern portion of Abyssinia Valley (natal home range) and to the northeast (Fig. 2). Although its transmitter fell off in September, in October it was often seen along Abyssinia Ridge, and occasionally in the lower Tuku Valley feeding on clover with other parea. It seemed to be paired in October and was sometimes seen breaking off and carrying twigs, but it was not found nesting. The only subsequent sightings were in January 1993 when it was twice seen near the Bike Park feeding with other pigeons on pouteretere fruit (Fig. 2).

In summary, these birds became independent during December 1991 - April 1992. For the first few months after becoming independent they were fairly mobile and often returned to their respective natal home ranges. Two females (K-8154 & 8159) had paired by August 1992, one to four kilometres from their natal areas. The behaviour of K-8160 suggested it was also a female which may have paired, but subsequent sightings were too infrequent to confirm this. The three other birds were possibly males, but this can be confirmed only after they have paired and their mating or incubation behaviour observed.

3.3 Phenology

Research into the ecology of kereru has indicated that fruit availability is probably the main factor that induces and sustains breeding (Clout 1990, Langham 1991). Ripe fruit of all seven species were eaten by parea, plus green and half-ripe fruit of karamu and hoho. Therefore, phenology results are provided for ripe fruit availability of five food species, and a combined score for green, half-ripe and ripe fruit of karamu and hoho from April 1992 to April 1993 (Fig. 3).

Ripe matipo fruit was scarce during the 13-month period; just the remnants of an abundant crop were available during November 1991 to March 1992. Similarly, few ripe mahoe fruit were present. Most mahoe fruit ripened during January to April. It is highly sought after by parea and several species of introduced passerines, and was eaten almost as soon as it ripened. Supplejack and hokataka fruit ripened during late summer-autumn (Tisdall 1992), and was most abundant in autumn and winter 1992 (Fig. 3). Small amounts of green karamu fruit were available year round; no ripe fruit was seen. Hoho fruit reaches full size in autumn and ripens gradually in winter and spring (Tisdall 1992). In July 1992 several marked trees were laden with fruit (scores = 5). The availability of hoho fruit in April 1993 was much less than in April 1992 (Fig. 3). Ripe pouteretere fruit has been evident during each trip, but was most abundant in January 1993. This fruit crop gradually ripens during winter to summer.

3.4 Diet

During each three-week field trip much of the parea's diet consisted of two or three food-types from five or fewer species (Table 2). When parea ate pasture species we were often unable to determine the species. Pasture species eaten in October 1992 seemed to be mainly white clover (*Trifolium repens*) and some ryegrass (*Lolium* sp.) from what had recently been sheep pasture. However, during April 1993, as well as foraging at such sites, parea often fed on the ground under open kopi forest, feeding on clover, pennywort (*Hydrocotyle heteromeria*) and chickweed (*Stellaria decipiens*).

The diet of parea, as presented in Table 2, is considered, from more general observations, to be a good approximation of what the birds were eating during each field-trip, except in October 1992. During October only one parea in the Awatotara and Tuku study areas had a functional transmitter. All birds proved difficult to follow because most flew some distance from their home ranges to feed. They flew to the tarahinau (*Dracophyllum arboreum*) forest to feed mainly on hoho fruit, and to sheep pasture to feed on clover. While we readily located parea feeding on pasture, only the radio-tagged bird could be regularly found when parea sought food in tarahinau forest. From a casual analysis of at least 50 droppings, we are confident that in October the birds fed almost entirely on hoho fruit and pasture species. However, the proportion of feeding observations attributed to the eating of hoho fruit (22%) probably underestimates the importance of this food.

A feature of the parea diet during 1992-93 was the change from a largely fruit and pasture diet in April, July and October 1992, to one of mainly leaves in 1993 (Table 2). This difference is most evident when the April 1992 diet is compared with that of April 1993 (Fig. 4). In 1993, other than the pasture component, much of the rest was

Parea nesting season extended from June 1992 - February 1993.
Figures in brackets are sample sizes.

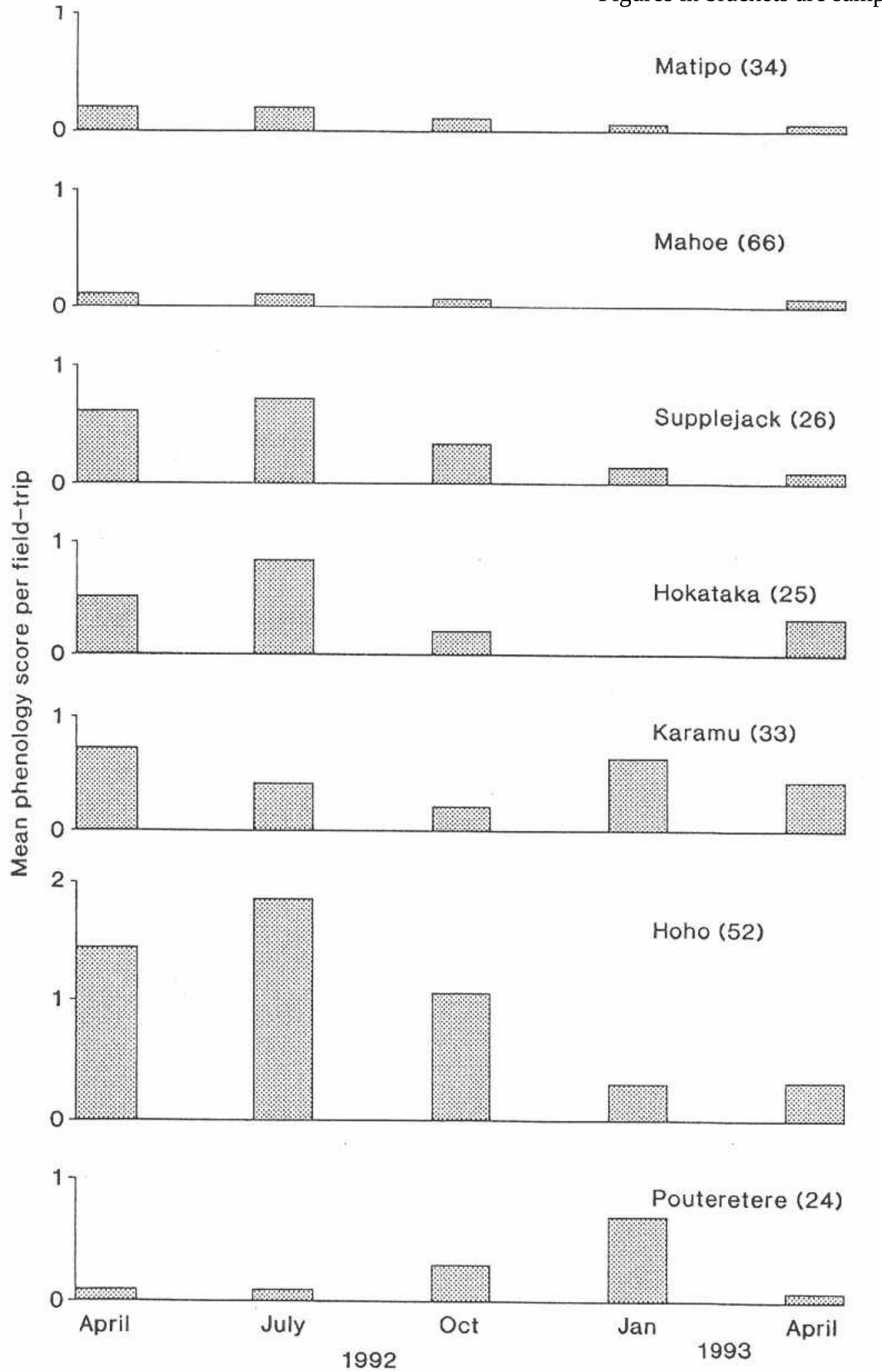


Figure 3 Phenology scores (max. of 5) for fruit availability on 7 parea food species, southern Chatham Island.

coarse, mature leaves that appeared little digested in the droppings. As well as these mature leaves, parea regularly ate the terminal 3-5 cm of mahoe (*Melicytus chathamicus*) and karamu twigs. Although only a minor component of the diet in April 1993 (2% of 419 feeding observations), parea were seen feeding on galls on the twigs of karamu. These galls were formed by gallmidges and each probably contained a 0.5 mm long maggot (J. Dugdale pers. comm.). A juvenile parea that ate a caterpillar from a mahoe is the first instance of a parea seen deliberately eating an invertebrate.

3.5 Foraging movements

Parea flew long distances over unsuitable habitat (extensive pasture-bracken, *Pteridium aquilinum*) to reach forest and shrub habitats, as was noted in 1991-92 (Powlesland *et al.* 1992). No doubt a small proportion of flights were made by wandering juveniles and unpaired adults, but the majority were by birds flying to food sources not available in their home ranges. Such foraging flights were particularly evident in October and January. By October very little hoho fruit remained in the home ranges of nesting pairs in the Awatotara and Tuku Valleys. Birds from Abyssinia and Awatotara Valleys (Fig. 1) flew up to about two kilometres east to reach hoho trees laden with ripening fruit in tarahinau forest. Most birds returned to their home ranges within an hour, but a radio-tagged unpaired bird often remained in the tarahinau forest for 3-4 hours at a time. It seems that the tarahinau tableland forest was not inhabited by territorial pairs.

Flights west from Abyssinia Valley and down the Tuku Valley in October were generally of birds flying for about half a kilometre to feed on pasture. Such sites were usually at the forest edge or where a small isolated forest patch was surrounded by pasture. Some sites were visited more than once each day by several individuals, and it was usual to find a parea feeding on the ground or roosting nearby at any time. On one occasion at least 14 birds were seen at such a site; this flock included breeding and non-breeding adults, as well as juveniles raised earlier in the season.

Table 2 Percentage of feeding observations (>5%) parea fed on a variety of food-types in southern Chatham Island.

Field-trip	N[1]	Food species and types										
		Matipo	Mahoe		Pasture[2]	Pouteretere	Hokataka	Hoho			Karamu	Other
		FRU[3]	FRU	LEA	LEA	FRU	FRU	FRU	LEA	FLB	LEA	
1992												
April	754	32.2	34.0	-	9.8	-	8.1	-	-	-	-	15.9
July	543	-	-	-	-	-	-	84.7	-	-	-	15.3
October	495	-	-	-	59.0	-	-	22.0	-	-	-	19.0
1993												
January	185	-	-	10.3	16.2	13.5	-	11.9	17.3	9.2	9.2	12.4
April	419	-	-	12.4	23.2	-	-	-	18.6	-	24.8	21.0

1 N = number of feeding observations.
2 Pasture foods were mainly white clover, grasses, pennywort and chickweed.
3 FRU = fruit; LEA = leaf; FLB = flower bud.

In January 1993, as in 1992, parea were seen flying from the valleys to eat hoho fruit and flower buds, and clover. Often the birds spent several hours at isolated forest patches, such as Macrocarpa Gully and Blackberry Creek forest (Fig. 1), feeding and roosting before returning to the main valleys. Parea flew two to three kilometres to reach sources of ripe pouteretere fruit during January, particularly in the Tuku study area. Flights to and from pouteretere scrub were most evident in the early morning and late evening. Flocks of up to seven parea were seen roosting together in isolated tarahinau trees in the semi-open pouteretere scrub, but generally the birds dispersed to feed on the fruit.

3.6 Breeding

3.6.1 Timing of breeding season During the 1992-93 breeding season, the nesting of 16 pairs of parea was monitored in detail; three pairs in the Awatotara Valley, 12 in the Tuku Valley and one in the Kawhaki Valley (Fig. 1). Because observers were not available every day to determine the breeding status of each pair and five nesting attempts failed early in incubation, a few nesting attempts may have gone undetected. When not known from direct observation, the egg laying date at a nest was estimated from chick age and/or fledging date. The earliest pair to nest began incubating in early

Figures above the colums are the number of feeding observations.

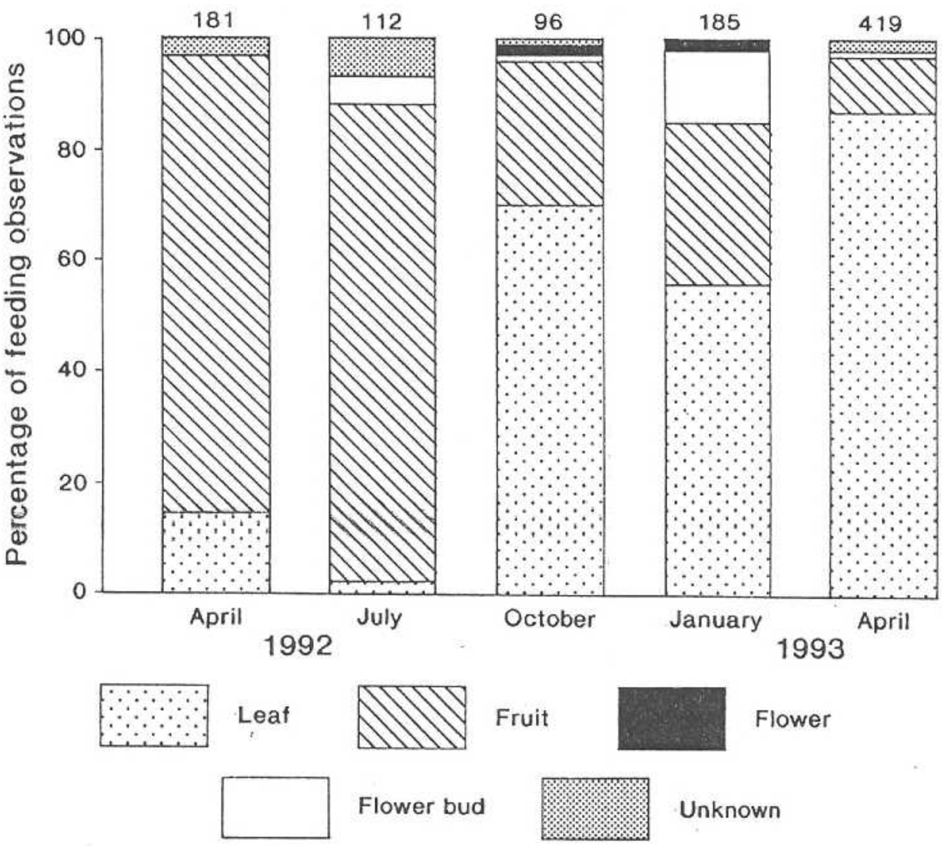


Figure 4 Feeding observations of parea during 5 field-trips in 1992-93, expressed as percentages, identifying the 4 food-types (plus unknown) on which the birds were feeding.

June. Thus, nesting in 1992-93 began two months earlier than in 1991-92 (Fig. 5). The last pairs to lay in 1992-93 probably did so in late January or early February because two pairs had young juveniles in April. Therefore, the nesting season extended over at least 10 months, with eight of the 16 pairs breeding continuously for at least six months (July-December 1992).

3.6.2 Nesting effort In total, 34 nests were found in 1992-93, and although not located, three other nests (one early and two late) were successful because the pairs were found with dependent fledglings or juveniles. Each of 16 pairs of parea nested at least once. Three pairs (two of which had jessed one-year old females) nested once each during the breeding season, seven pairs nested twice each, four pairs nested three times each and two pairs nested four times each. Of the two one-year old females, one began incubating in late July when only nine months old, and the other began incubating in early September when 11 months old.

On 12 occasions pairs fledged a chick and re-nested. At least six of these re-nestings involved females laying their next clutch 4-8 days **before** the nestling in their previous nest fledged. For example, one pair began nest-building when they had a 35-36 day-old chick. When this chick fledged 11 days later, its parents had already been

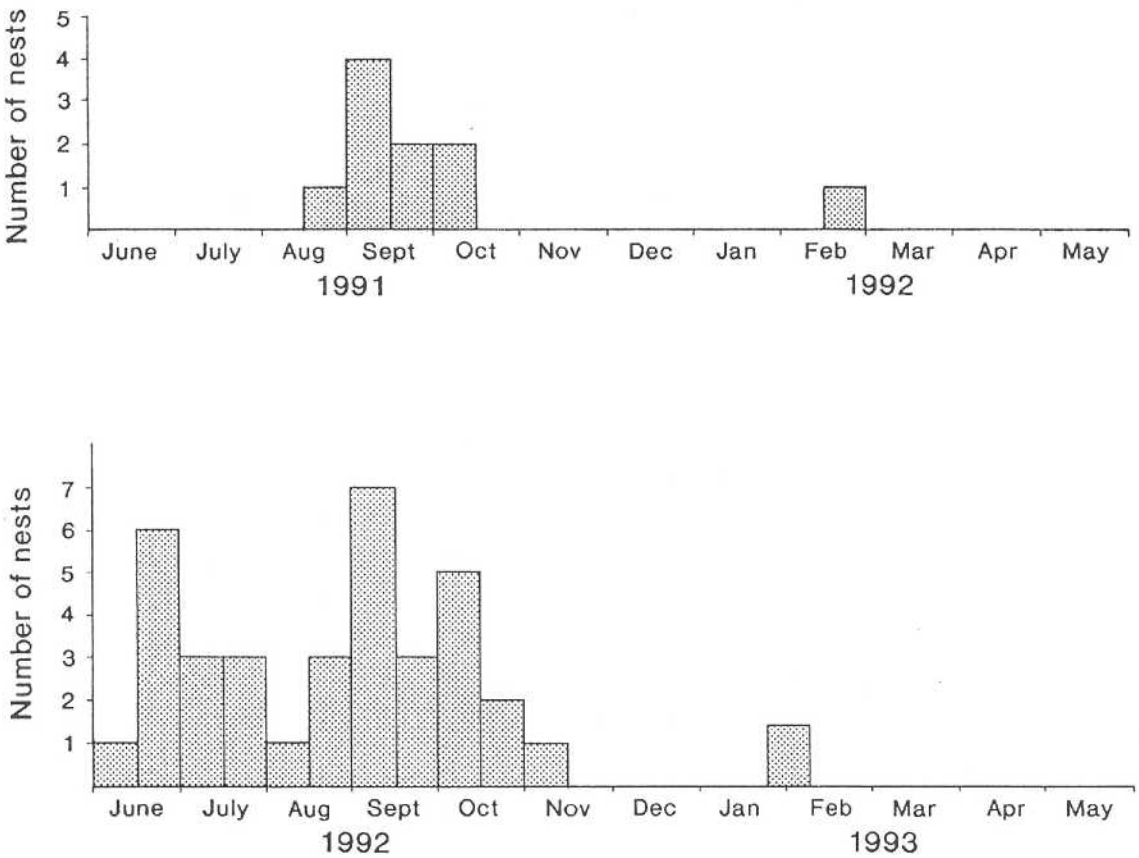


Figure 5 Monthly distribution of egg-laying dates for parea in the 1991-92 and 1992-93 nesting seasons, southern Chatham Island.

incubating for seven days. Thus, during the entire incubation period of the re-nesting, the pair were also feeding a nestling or fledgling.

3.6.3 Nesting success Only one of the 16 pairs failed to raise a fledgling. Seven pairs each produced two fledglings and one pair produced three. Thus, from the 37 nests, 24 nestlings fledged (1.5 fledglings/pair), a 65% success rate. The nesting success of the pairs differed markedly between their first and subsequent nests. From the 14 nests with eggs laid in before August, 13 (93%) produced fledglings. The one failure resulted when the egg presumably rolled out of the nest after it tilted during strong winds and rain. From the subsequent 23 nesting attempts only 11 fledglings were produced (48%). Of the 13 failed nesting attempts, one egg was abandoned early in incubation, one egg fell through its nest the day it was laid, one egg fell from a nest when the nest tilted during heavy rain and strong winds, two infertile eggs were abandoned after full-term incubation periods, the contents of two nests were preyed upon (an egg by an unknown predator and a late nestling by a harrier (*Circus approximans*), and the reasons for the other six failures were not obvious. The two infertile eggs found after being abandoned represent 7.1% of the 28 nesting attempts for which fertility was ascertained. Both infertile eggs were laid by pairs that had already raised fledglings.

An effort was made to minimise the risk of rat predation at half of the nests by setting six rat traps about the base of each nest tree. Of 14 nests laid in before 1 August 1992, only one of seven protected nests failed (nest tilted) and none of seven unprotected nests failed (Table 3). However, of 18 nests laid in after 1 August 1992, six (60%) of 10 protected nests failed as a result of predations or possible predation compared with five (62%) of eight unprotected nests (Table 3). This difference is not significant (Fisher Exact test, p>0.1). Two other nests were not included in this analysis because one was in the Kawhaki Creek catchment (no possum or cat control) and the other was on the ground in the Tuku Valley about which cats, wekas and possums, as well as rats, were controlled.

Table 3 Number of protected (six Ezeset rat traps baited with cheese at a 20-50 m radius about each nest tree) and unprotected parea nests that produced a fledgling or failed in 1992/93.

	Number of nests				
	Protected		Unprotected		Total
	Fledgling	Failed	Fledgling	Failed	
Nests found before 1 August	6	1	7	0	14
Nests found after 1 August	4	6	3	5	18
Total	10	7	10	5	32

1 Two other nests were found, but were not included in this analysis; one located in the Kawhaki Creek catchment (no possum and cat control) and the other was on the ground in the Tuku Valley about which cats, wekas and possums, as well as rats, were controlled.

3.6.4 Nests Although tall canopy trees suitable for nesting in were available to each pair, 32% of the 37 nests found were in upper understorey shrubs or lower vegetation. The average nest height was 4.2 m (range = 0.0-8.9, s.d. = 2.47) compared with 5.9 m (range = 2.0-10.1, s.d. = 2.30) for the canopy height directly above the nests. Several nests were in trees and shrubs with almost horizontal trunks; these nests were readily accessible to cats, and even some to wekas (*Callirallus australis*). Two nests were on the ground and two were at about a metre high on fern and bracken fronds. As well as a high proportion of nests being readily accessible to possums, cats and rats, some were flimsy structures or were built in insecure locations resulting in tilting during incubation and loss of the egg.

Although no nests were re-used in consecutive attempts, two pairs used sites they had successfully used in the past. In both cases nests were rebuilt as all material had disappeared before the second nesting attempt. Pair A used the same site in each of the 1991-92 and 1992-93 breeding seasons. Pair B used the same site for their first and third nests of the 1992-93 breeding season.

Of the 34 nests found, 11 were situated on branches and/or twigs, 2 on branches and fern (*Cyathea* and *Dicksonia* spp.) fronds, 4 on branches and supplejack vines, 6 on fern fronds and supplejack vines, 5 on fern and bracken fronds, 2 in tree fern crowns, 2 on broad horizontal fern trunks, and 2 on the ground. Twelve (35%) of the nests were in patches of dense tree ferns, a habitat type that parea rarely otherwise use.

Thirty-two of the nests were thick platforms of twigs with a slight depression at their centres. However, the other two were inadequate structures, being small with no obvious depressions to restrict egg movement. Of the 21 successful nests monitored, 11 (52.5%) remained reasonably intact, five (23.8%) consisted of little material after the chicks fledged, but the other five disintegrated completely before the chicks fledged. In the latter cases the chicks were old enough to perch at the nest sites by the time most material had fallen from each site.

3.6.5 Eggs Each parea clutch found during the 1992-93 breeding season (n = 29) consisted of one smooth, white, oval egg. Four eggs were measured after being abandoned (n = 3) or having fallen from an insecure nest. All four egg shells have been submitted to the Museum of New Zealand, Wellington. These four eggs and the three previously measured (Powlesland *et al.* 1992) had a mean length of 51.2 mm (s.d. = 1.38) and a mean maximum width of 34.5 mm (s.d. = 0.80) (Table 4).

3.6.6 Incubation On no occasion were we able to record the day an egg was laid and the day it hatched. Therefore, the following three cases can be used only as a guide to the duration of the incubation period. At Nest 1 a parea was first seen sitting on the nest on 26 October. On 21 November (day 26) the egg was seen during the morning changeover, and on 22 November the nest contents were obscured during the changeover and no egg shell fragments were found on the ground beneath the nest. However, the following day (day 28) a chick was seen and shell fragments were found under the nest. Shell fragments were first found under Nest 2 on 3 November, 29 days after a parea was first seen sitting on the nest. Similarly, at Nest 3 the interval between when a parea was first seen sitting and the first shell fragments were found (11 November) was 27 days.

Changeovers at the nest occurred twice each day. During July to November, 23 morning changeovers were seen between 0909 and 1135 hours, with a mean time of 1021 (s.d. = 37 minutes). The 25 afternoon changeovers observed occurred between 1554 and 1845, with a mean of 1709 (s.d. = 51 minutes). From observations of two nesting pairs each with an identifiable member (radio-tagged and jessed), it was evident that the males (gender determined during copulation) incubated from mid-morning to late afternoon, and that females incubated the rest of the time. During incubation the relieving bird often brought a twig to the nest at changeover. Of the occasions when it was determined, 79% of 14 birds at morning changeovers each had a twig, and 80% of 10 birds at afternoon changeovers each had a twig.

3.6.7 Nestlings Compared with information obtained about the nestling period in the 1991-92 breeding season (Powlesland et al. 1992), little detailed information was obtained during the past season. However, the information gained does concur with that from the previous season. The estimated ages of three nestlings when first seen unattended were 8-10 days old (October), 11-12 days old (November) and 16-17 days old (December). Weights of nestlings during the 1992-93 season were similar to those of nestlings at the same age in the 1991-92 season, except that four, when 25-29 days old, were heavier (Fig. 6). A nestling of unknown age weighed 242 g on 28 September 1992 and 580 g on 15 October, a mean weight gain of 20 g/day. During this 17-day period the weight gain varied inconsistently from one 2-day period to the next from 11 to 35 g/day, and was probably related to how recently the chick had been fed.

We were asked by staff at the National Wildlife Centre to regularly weigh one or two nestlings from hatching because this information is required for hand-rearing of injured

Table 4 Measurements (mm) and weights (g) of parea eggs.

Identity	Locality	Date collected	Length	Breadth	Weight	Comments
Siberia A	Awatotara	24-7-92	52.0	34.9	32	Nest tilted, embryo c.1 week old.
Toyota B	Tuku	5-10-92	51.6	34.7	29	Abandoned, infertile.
L. Doubters B	Tuku	6-10-92	52.9	33.5	27	Abandoned, infertile.
Slip	Tuku	18-10-92	52.6	33.7	–	Abandoned, embryo c.1 week old.
–	Chatham Islands	–	49.0	35.4	–	–
–	Cascade Gorge	17-10-85	49.6	35.5	–	–
Waterfall	Tuku	4-10-91	50.6	33.6	31	Found below nest, embryo c.1 week old.

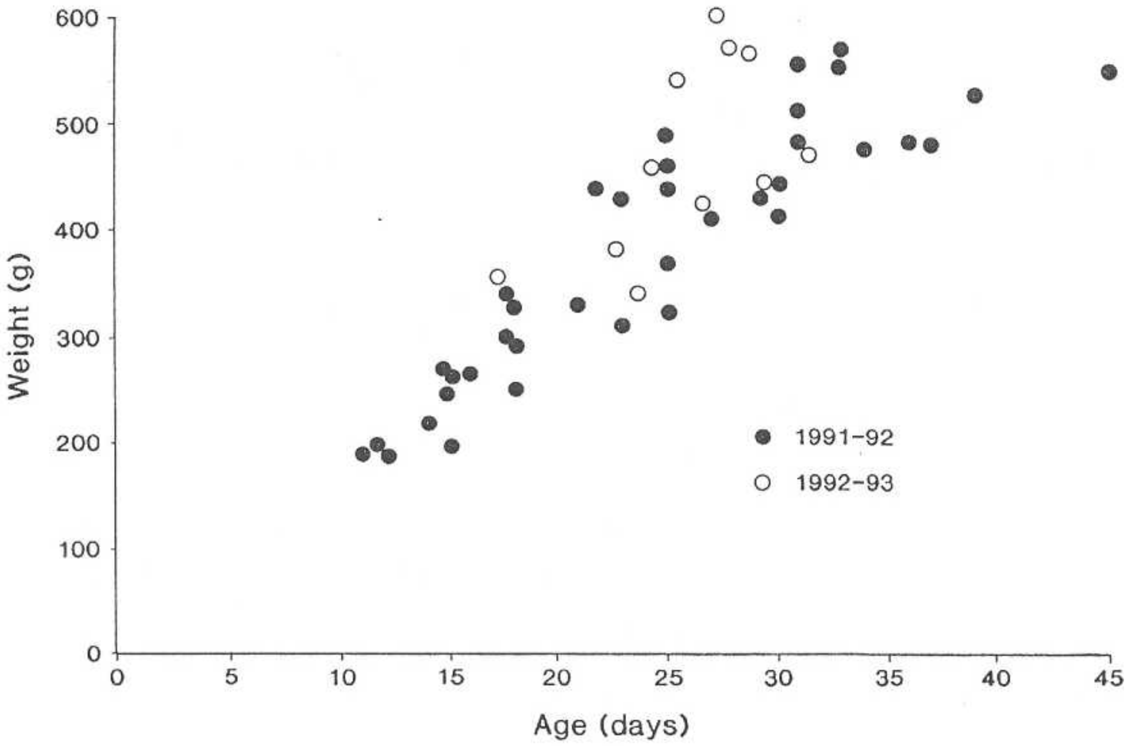


Figure 6 **Weights of parea nestlings at various ages, in the Awatotara and Tuku study areas during 1991-92 (n=7) and 1992-93 (n=10).**

or orphaned nestlings. The pair chosen for this investigation were nesting on the ground. After one weighing of the chick it was decided not to repeat the procedure for the following reasons:

1. The parent struck out at the observer with its wing so vigorously that there seemed a good chance of it injuring itself or the chick.
2. The parent flew to a roost nearby and so a young nestling would get chilled if its parent did not return promptly to brood it.
3. The defensive actions of a parent are likely to result in a nest in a tree tilting or collapsing.

On only one occasion was a live nestling found on the ground. This particular nestling was 30 days old (±1 day), about a fortnight from fledging. Its nest, sited 1.5 m up on bracken, had largely disintegrated. The nestling was placed near its nest and remained there until at least 29 September, when it appeared ready to fledge. One radio-tagged nestling, that seemed sufficiently developed to leave the nest, did so when approached and landed on the ground. It was unable to fly from the ground and so was caught and placed on a sloping trunk. Later the same day it flew across the Tuku River and subsequently was not found on the ground.

A nestling was considered to have fledged (flown from the nest) when it was found in a tree other than the nest tree. The estimated age at fledging of five nestlings was 43.4 days old (s.d. = 2.01, range = 40.5-46.5).

3.6.8 Fledglings In the 1991-92 breeding season we found that fledglings foraged little for themselves until they were about 70 days old (about 25 days after fledging) and then remained with their parents for a further 10 to 30 days (Powlesland *et al.* 1992). However, because some pairs in the 1992-93 season renested before their nestlings had fledged, this resulted in the first chicks receiving a reduced period of parental care. In one case for which we have accurate dates for nest building, egg laying and fledging, the fledgling had been away from the nest for only 20 days before the chick from the subsequent nesting attempt hatched. It seems unlikely that a pair is able to feed a fledgling and a recent hatching as each require different food. Studies of a variety of pigeon species have indicated that pigeon milk, a secretion of the adult crop, forms the complete diet of nestlings for the first few days, after which an increasing proportion of the diet offered is food items (Goodwin 1970, Robertson 1985). Whether the fledgling received any food from its parents once their next nestling hatched is unknown. However, all fledglings whose parents renested and successfully hatched their next clutch survived beyond independence. Thus, the age of independence in such circumstances may be as little as 65 days.

Once a fledgling no longer receives food from its parents we refer to it as a juvenile. In the cases where a pair raised a fledgling and either did not renest (Powlesland *et al.* 1992) or their next nesting failed prior to hatching (1992-93 season), their juvenile often remained with the pair long after it was able to feed itself. In addition, there were cases during the 1992-93 season when a juvenile was kept away by its parents from the vicinity of their subsequent nest, but was tolerated in their home range. Such juveniles moved and fed independently from their parents. However, once a pair stopped nesting, their juvenile often rejoined them. In one case where the parents had a juvenile and a fledgling, all four birds were occasionally seen in close proximity to each other in the pair's home range.

3.6.9 Juvenile colouration Several features of juvenile parea enable them to be distinguished from adults for up to eight months after becoming independent. At independence, juveniles have a reddish-brown beak with a dark brown tip. Skin at the base of the beak is bare or in pin, giving the bird a beaky appearance; feathers grow there two to three weeks after independence. Although the base of the beak gradually changes to red within about three months, the tip remains brown for six to eight months. The irises of juvenile parea are initially brown-black, and become red when the birds are about eight months old. Likewise, the eye lids change from brown at independence to red by the time the bird is eight months old. Initially the feet are pink or pink-brown, but gradually change to crimson/bright red when the bird is six to eight months old. Two plumage features can be helpful in distinguishing juvenile parea:

1. An area in front of, or around the eyes is sometimes fawn coloured, instead of the blue-green on adults.
2. Some juveniles have variable amounts of fawn-cinnamon coloured feathers at the top of the white breast. The fawn colouring can be a 10-15 mm band, as irregular narrow markings, or may be completely absent. The demarcation of the dark chest and white breast feathering is uneven on juveniles compared with the straight line of adults.

Most juveniles exhibit one of these characteristics, although some show neither. Observers should be aware that no one feature can be used to distinguish juveniles from adults, and that it is necessary to check for all juvenile features on a bird before deciding on its age.

3.7 Rat index trapping

Results of the index trapping indicate that, in general, rats in each study area were most abundant in autumn (April 1991, 1992, and 1993) (Table 5). They declined to low numbers from winter to summer 1992 in the Tuku Valley and Macrocarpa Gully, but numbers increased during the same period in the Awatotara Valley. A dead rat found by Graeme Taylor and Mike Imber in November 1992 on the track to the southern taiko burrows, Chatham Island was confirmed to be a kiore (*Rattus exulans*). Thus a careful check was made to determine the species of each rat caught during subsequent trapping sessions. Of the 16 rats captured in January 1992 and 37 identifiable rats captured in April 1993, one (6.3%) and 16 (43.2%) respectively were kiore, the rest being ship rats (*Rattus rattus*). Mice (*Mus musculus*) were also caught, and wekas (*Gallirallus australis*) occasionally sprung traps.

Table 5 Results of seasonal rat index trapping (captures per 100 trap nights) during 1991/93 in the Awatotara Valley, Tuku Valley and Macrocarpa Gully, southern Chatham Island.

Date	Awatotara Valley	Tuku Valley	Macrocarpa Gully
9-11 April 1991	–	14.6	19.6
29 July - 5 August 1991	14.0	18.0	5.3
26 September - 7 October 1991	1.6	13.5	11.4
3-8 February 1992	6.8	13.5	1.8
2-5 April 1992	7.1	22.0	25.2
12-18 July 1992	1.2	13.4	10.4
1-6 October 1992	5.3	11.5	3.6
6-11 January 1993	14.3	4.2	4.0
21-23 April 1993	6.9	18.8	19.0

4. DISCUSSION

4.1 Numbers of parea

Although no dead adult or juvenile parea were found, there was circumstantial evidence that at least one marked adult died. This female was marked in July 1990, remained quite sedentary, and disappeared in November 1992. Because so few adult parea were individually marked prior to the 1992-93 field season, the significance of the one bird's disappearance cannot be assessed yet. Now that parea marked as nestlings are maturing and becoming established on home ranges within the study areas, and six resident adults were jessed in April 1993, a reasonable number of birds are available to monitor their survival and longevity in future. To date there seems to have been a high survivorship of marked parea; five of the six 1991 fledglings were seen in April 1993.

There were three pairs in the Awatotara in both 1991-92 and 1992-93, but the population in the Tuku study area increased from 12-14 pairs to 16. In addition, there were unpaired birds in both study areas bringing the total to about 45 adults in 1992, compared with about 33-37 in 1991: a 22-36% increase. We expect that the adult population will increase further during 1993 because of the large number of fledglings produced in 1992 and there seems to be suitable unoccupied habitat in the study areas for at least some of them to occupy.

4.2 Fruit availability, diet and movements

From October 1991 until about December 1992 there was fruit of a variety of species available to parea. The fruits of the species ripened in succession (Fig. 3) such that the diet of parea consisted mainly of fruit or fruit and `pasture' species during the 15-month period (Fig. 4). The availability of fruit over an extended period was probably an important factor in promoting the early start to breeding in 1992 (Fig. 5) and for the continuation of nesting activities until February 1993. Research into the ecology of kereru at Pelorus Bridge, Marlborough, has shown that kereru also prefer a fruit diet and that the start of nesting coincides with a change from a mainly leaf to a fruit diet (Clout 1990).

The preference of parea for a fruit diet was evident during the first two years of this study. Whenever fruit has been scarce or unavailable in the pairs' home ranges but has been available elsewhere, such as in isolated small forest remnants or in tarahinau forest on the tablelands (both habitat types apparently unoccupied by territorial pairs but less than 1 km away), adults have briefly left their home ranges in the valleys to feed on fruit. One to four birds flying to and from the valleys was a regular sight during the October 1992 and January 1993 trips. The main fruit species fed on during the nesting seasons of 1991 and 1992 was hoho. It was noticeable that when hoho fruit was available in July 1992 that the fruits of supplejack, matipo and hokataka were ignored. Nutrient analyses of the pulp of the main fruits eaten may indicate why parea prefer hoho fruit and have bred when it has been available. Circumstantial evidence of the importance of hoho fruit for parea breeding is indicated by the early start to the 1992 breeding season and its extended duration when an abundant crop was available. Thus the continued conservation of hoho as a significant component of parea habitat seems vital for the conservation of parea. The mixed broadleaf forest in the valleys and tarahinau forest on the tablelands provide hoho fruit at different times of year ensuring a long period of availability. If breeding of parea is found to be largely dependent on hoho fruit, then the opportunity is available through phenology observations to predict good and poor parea breeding seasons and then take appropriate management actions (e.g., intensify predator control before a predicted good breeding season).

The importance to parea of fruit sources outside the breeding season is not clearly evident yet. However, because leaves of trees, in general, are a relatively 'low energy' food which can be difficult to digest (Clout 1990), and kereru do not breed when their diet consists mainly of leaves, it would seem that fruit is important for the breeding of *Hemiphaga* pigeons. Having a variety of habitats within a small area (2-3 km radius) is the best way to ensure parea have access to a variety of fruiting species and that fruit sources are available for as much of the year as possible. Maintaining the diversity of foods for parea can be promoted by: protecting large tracts of land containing a variety of habitats (e.g., Tuku Nature Reserve) by fencing-out farmed stock and eradicating, or controlling introduced herbivores like possums, feral sheep, and cattle; by protecting scarce habitats (e.g., Blackberry Creek forest); and by planting species that increase the variety of parea foods (Powlesland *et al.* 1992).

We suspect that the early start to parea nesting in 1992 was related to two factors. First, there was abundant hoho fruit that began ripening in winter. Second, the diet of parea from the end of the 1991 breeding season to the start of the next consisted mainly of fruit. We assume that as a result of the availability of this readily digestable and nutrient-rich food, compared with leaves, the birds were able to moult quickly and attain excellent body condition so that many pairs were ready to breed when hoho fruit began to ripen, even though it was winter. Since most pairs have completed a long breeding season, were eating mainly leaves and twigs in autumn 1993, and phenology observations indicate there will be little hoho fruit available in winter-spring 1993, the comparison of parea breeding efforts in 1993 with that of 1992 should enable us to learn much about the ecology of the subspecies.

4.3 Breeding

4.3.1 Timing and duration of breeding season That food supply is the primary factor controlling parea breeding is apparent because most pairs start nesting when other environmental factors are expected to make it an inappropriate time to nest; shortest daylengths and coldest temperatures of the year. Although kereru have been recorded nesting in winter, most nests have been found during spring and summer (Dunn & Morris 1985, Clout *et al.* 1988). Results from other studies indicate that food has a major impact on the timing and duration of pigeon and dove nesting. Pink pigeons (*Columba mayeri*) that fed on food supplements nested three months earlier than those that do not (Jones *et al.* 1992). Captive kereru at the National Wildlife Centre, Wairarapa, with *ad libitum* access to nutrient-rich foods frequently raised two or three chicks per annum (M. Bell pers. comm.). Similarly, the super-abundant and persistent availability of grain to collared doves (*Streptopelia decaocto*) in England was considered to be the main factor enabling some pairs to nest for nine months and to fledge up to five broods in a season (Robertson 1990). The long and productive parea breeding season in 1992 is likely to result in a significant increase in the number of birds, a very important result for an endangered population. Just how often such productive seasons occur will require long-term monitoring of the population.

4.3.2 Clutch overlap Clutch overlap, whereby a pair starts another clutch while continuing to attend the nestling from their previous clutch, has been recorded for several species of the family Columbidae (Robertson 1985), including the kereru (Clout *et al.* 1988). It is regarded as a means by which a species can increase its reproductive output when it cannot increase clutch size (one egg) and/or has a brief energetically-limiting phase in the nesting cycle (production of crop milk for the young chick from a herbivorous, low-protein diet) (Clout *et al.* 1988). Presumably, parea are able to produce overlapping clutches only when food is particularly nutritious and readily available. Certainly, clutch-overlap decreased the time taken for a pair of parea to complete two nesting cycles from about 240 days (nest-building - 3 days, prelay - 5, incubation - 27, nestling - 45, fledgling - 40) to about 185 days, a 23% reduction. To determine the exact timing of when pairs start re-nesting in relation to their first cycle and for how many days the first fledgling is fed, a more detailed study of parea nesting would be required. The incidence of clutch overlap by parea in 1992 was at least 50% of the 12 occasions that pairs fledged a chick and re-nested. This seems a high incidence given that of 43 occasions that collared doves (with access to super-abundant and persistent grain) fledged a chick and re-nested, only 3 (7%) instances of clutch overlap were recorded (Robertson 1990).

The first fledglings raised by parea pairs involved in clutch overlap seemed to be fed by their parents for only about 20 days, compared with the 40 days indicated in 1991 when pairs raised only one brood each (Powlesland *et al.* 1992). Similarly, pink pigeons with access to food supplements provided only 10-20 days of parental care to their fledglings, whereas those pairs without access to such food cared for their fledglings for 60-90 days (Jones *et al.* 1992).

4.3.3 Nesting success The fledging success of 65% from 37 nests in 1992 is much the same as 60% from 10 nests in 1991. The low success of the 1992 nests in which eggs were laid after 1 August (37% from 19 nests, Table 3) was caused by a variety of factors. Of the six nests that failed where there was definite or possible predation, at only one was the predator identified (a harrier). Trapping of rats about nests did not improve the fledging success at late nests (Table 3). Perhaps this was, in part, because all nests were accessible to possums, and some were to cats and wekas as well. One way of determining the identity of predators of parea eggs and nestlings would be to set up time-lapse video cameras at some nests, as has been done at kokako (*Callaeas cinerea*) nests in Rotoehu Forest (J. Innes pers. comm.). We hope to determine the value of possum and cat control operations in the Tuku and Awatotara study areas by comparing the nesting success of parea pairs in these study areas with that of pairs in the Kawhaki and Waipurua study areas, where there has been no mammal control. For this comparison to accurately reflect the difference between the treated and untreated areas, it is important that no rat control be carried out near any parea nests. A feature of the rat index trapping results for the Tuku Valley, where 10 of the 16 monitored pairs lived, is that rat numbers remained fairly constant (1991-92) or decreased

(1992-93) during the parea breeding season (July-January) rather than increased, as would be expected then (Table 5).

That parea can nest successfully without rat control being carried out around nests was evident from the production from unprotected nests, and by the number of unjessed juveniles we saw (progeny of unstudied pairs). During October to December 1992, one to two unjessed juveniles were seen for every jessed one. This result also indicates that there were probably at least 20 breeding pairs of parea beyond, but in the vicinity of, the Awatotara and Tuku study areas that contained the 16 pairs we studied. That parea bred more successfully than usual in 1992 is suggested by the reports of parea being seen elsewhere on Chatham Island (Owenga, Waitangi, Big Bush and Henga) where they had not been for a few years (Gilmour 1993).

5. RECOMMENDATIONS

1. A census of paired parea should be carried out in the Awatotara, Tuku, Kawhaki and Waipurua study areas just before or early in the nesting season (July-September) to provide comparative information about the number of parea present. To obtain the most accurate results, these censuses should be carried out by personnel familiar with the location of parea home ranges.

2. To determine whether parea nesting success needs to be bolstered by protecting eggs and nestlings from rat predation, all nests found during the 1993-94 season should be left unprotected. Occupancy of such nests should be determined from as far away as possible so as to reduce the likelihood of attracting predators to them. Any abandoned nest should be closely checked for any sign of predation.

3. Trapping and/or poisoning of cats and possums should be continued twice annually (March-April and September-October) in the Awatotara and Tuku conservation covenant areas and Abyssinia Valley.

6. ACKNOWLEDGEMENTS

We thank Lynn Adams, Michael Bell, Suzanne Clegg, David Cornick, Jan and Arnold Heine, Rachel Shorten, and Christine Tisdall for assistance with the field work; Allan Munn and Steve Soyer of the Chatham Island Field Centre for support assistance; Robert Holmes, Ron Seymour and Liz and Bruce Tuanui for access across their properties and interest in the project; Telecom through the World Wide Fund for Nature (New Zealand) for funds to purchase telemetry equipment; and to Duncan Cunningham, Peter Moore and Christine Tisdall for commenting on drafts of this report.

7. REFERENCES

Brown, K. 1992. Sustained possum control, Abyssinia (Tuku Nature Reserve), Lower Awatotara and Lower Tuku conservation covenant areas. Unpublished report, Department of Conservation, Christchurch.

Clout, M. 1990. The kereru and its forests. Birds *International* 2 (4): 11-19.

Clout, M.N., Gaze, P.D., and Ilay, J.R. 1988. Clutch overlap by a New Zealand pigeon. *Notornis* 35*:* 59-62.

Clout, M.N., and Robertson, H.A. 1991. Chatham Island pigeon recovery prospects: report on a visit to Chatham Island in July 1990. *Science & Research Internal Report No.95.* Department of Conservation, Wellington.

Cunningham, D.M. and Moors, P.J. 1993. Guide to the Identification and Collection of New Zealand Rodents. 2nd ed. Department of Conservation, Wellington.

Dunn, P. and Morris, R.B.M 1985. New Zealand pigeon. Pp. 238-239 *in* Reader's Digest Complete Book of New Zealand Birds. Reader's Digest Services Pty Ltd, Sydney.

Fleming, C.A. 1939. Birds of the Chatham Islands. Part II. *Emu* 38: 492-510.

Gilmour, C. 1993. Conservation Chathams style. *Forest and Bird* 269: 23-28.

Goodwin, I). 1970. Pigeons and Doves of the World. 2nd edn. Trustees of the British Museum (Natural History), London.

Grant, A. 1990. Chatham Island pigeon (kuku): recovery plan 1990-1996 (Draft 1). Unpublished report. Department of Conservation, Christchurch.

Jones, C.G.; Swinnerton, K.J.; Taylor, C.J. and Mungroo, Y. 1992. The release of captive-bred pink pigeons *Columba mayeri* in native forest on Mauritius. A progress report July 1987 - June 1992. *Dodo, Journal o.f the Jersey Wildlife Preservation Trust* 28: 92-125.

Karl, B.J., and Clout, M.N. 1987. An improved radio transmitter harness with a weak link to prevent snagging. *Journal of field ornithology* 58: 73-77.

Langham, N. 1991. The ecology of the kereru or New Zealand pigeon (*Ilemiphaga novaeseelandiae*). *DSIR Land Resources Contract Report No. 91/45*, DSIR Land Resources, Havelock North.

Leeton, P. and Christidis, L. 1993. Feathers from museum bird skins - a good source of DNA for phylogcnetic studies. *Condor* 95: 465-466.

Merton, D.V, and Bell, B.D. 1975. Endemic birds of the Chatham Islands. Unpublished report of N.Z. Wildlife Service, Department of Internal Affairs, Wellington.

Powlesland, R., Grant, A., Tisdall, C., Dilks, P. and Flux, I. 1992. Ecology and breeding biology of parea (Chatham Island pigeon) on southern Chatham Island, July 1991-April 1992. *Science & Research Internal Report No.134.* Department of Conservation, Wellington.

Robertson, 11. 1985. Pigeons. Pp 216-219 *in* C.M. Perrins and A.L.A. Middleton (Eds). The Encyclopaedia of Birds. G. Allen and Unwin, London.

Robertson, H. A. 1990. Breeding of collared doves *Streptopelia decaocto* in rural Oxfordshire, England. *Bird study* 37: 73-83.

Tisdall, C. 1992. Feeding ecology of parea (*Hemiphaga novaeseelandiae chathamensis*) and impacts of possums (*Trichosurus vulpecula*) on parea food plants. Unpublished M.Sc. thesis, University of Otago, Dunedin.

Travers, H.H., and Travers, W T L. 1872. On the birds of the Chatham Islands. *Transactions and Proceedings of the New Zealand Institute* 5: 212-222.

APPENDIX I
Details of all parea banded

Band No.	Name	Date Banded	Jess Colour		Age	Pair/Nest
			Left .	Right		Notes
K-8151	Floyd	10/07/90	Red	Red	A[1]	Awatotara (mn)[2]
K-8152	Hadlee	10/07/90	Dk blue	Dk blue	A	Awatotara (mn)
K-8153	Greenpeace	14/07/90	Green	Green	A	Generator Shed (mn)
K-8154	Puke	15/10/91		Yellow	N	Motupuke (Pigeon Alley?)
K-8155	Sporrin	15/10/91		Dk blue	N	Bumbag
K-8156	Tbomas	02/11/91	Lime		N	Doubters
K-8157	Metallica	18/10/91	Orange		N	Hadlee
K-8158	T.P.	28/11/91			N	Siberia DEAD
K-8159	Otago	28/11/91	Yellow	Dk blue	N	Toyota
K-8160	Vicky	03/12/91	Lime	Pink	N	Punga
K-8161	Dagg	12/12/91	Pink		A	Woolshed Bush (mn)
K-8162	Toni	07/04/92	Yellow	Lime	N	Catch-22
K-8163	Chris	30/07/92	Lime	Orange	N	Hadlee I
K-8164	Alle	21/08/92	Dk blue	Pink	N	Pigeon Alley I
K-8165	Pango	21/08/92	Lime	Dk blue	N	Punga I
K-8166	Kerry	21/08/92	Yellow	Pink	N	Bike Park I
K-8167	Ralph	21/08/92	Yellow	Orange	N	Bumbag I
K-8168	Greensleves	21/08/92	Red	Lime	N	Toyota I
K-8169	Littlepeacc	21/08/92	Yellow	Yellow	N	Greenpeace I
K-8170	Cascade	28/08/92		Red	N	Waterfall I
K-8171	Kadel	10/09/92	Pink	Orange	N	Eastenders I
K-8172	Tegal	13/09/92	Dk green	Yellow	N	Lower Tuku I
K-8173	Clockwork	18/09/92	Orange	Orange	N	Catch-221
K-8174	T.P.	22/09/92	Pink	Pink	N	Siberia II
K-8175	Breeze	15/10/92	Dk green		N	Greenpeace II
K-8176	Lynn	15/10/92	Pink	Red	N	Bike Park II
K-8177	Terra	15/10/92	Lime	Lime	N	Bumbag II
K-8178	Merk	27/10/92	Yellow	Red	N	Puke
K-8179	Sandy	03/11/92			N	Punga II DEAD
K-8180	Mike	10/11/92	Red	Orange	N	Pigeon Alley II
K-8181	Lou	28/11/92	Pink	Dk blue	N	Siberia III
K-8182	Tuku	08/12/92			N	Lower Doubters III DEAD

Band No.	Name	Date Banded	Jess Colour		Age	Pair/Nest
			Left	Right		Notes
K-8183	Satch	21/12/92	Orange	Dk green	N	Bumbag III
K-8184	Eddy	13/01/93	Orange	Dk blue	N	Waterfall IV
K-8185	Sib	15/01/93	Orange	Yellow	A	Siberia adult (mn)
K-8186	Tangles	28/04/93			J	Waipurua (mn) DEAD
K-8187	Spike	28/04/93			J	Waipurua (mn) DEAD
K-8188	Bruce	28/04/93	Yellow	Black	A	Waipurua (mn)(#1)[3]
K-8189	Liz	28/04/93	Lime	Black	A	Waipurua (mn)(#1)
K-8190	Shorn	02/05/93	Lime	White	A?	Woolshed (mn)(#2)
K-8191	Fadge	02/05/93	Orange	White	A	Woolshed (mn)(#2)
K-8192	Folly	03/05/93	Pink	White	J	Toyota (mn)(#3)
K-8193	Olly	03/05/93	Yellow	White	A	Toyota (mn)(#3)
K-8194	Molly	03/05/93	White	Blue	A	Toyota (mn)(#3)
K-8195	Abby	05/05/93	Red	White	J	Slip (mn)
K-8196	Wart	05/05/93	Dk Green	White	A	?? (mn)
K-8197	Briar	20/07/93	Red	Blue	A	Blackberry (mn)
K-8198	Col	21/07/93	Red	Dk Green	A	Bumbag (mn)
K-8199		26/07/93	Blue	Lime	A	(mn)
K-11303		27/07/93	Blue	Dk Green	A	(mn)
K-11304	Canterbury	27/07/93	Red	Black	A	Pigeon Alley (mn) (#4)
K-11305	Dumbo	27/07/93	Lime	Dk Green	A	Pigeon Alley (mn) (#4)

1 A= adult, N = nestling, J= juvenile
2 (mn) = mist netted
3 (#number) = family association, i.e., member of pair or offspring of pair