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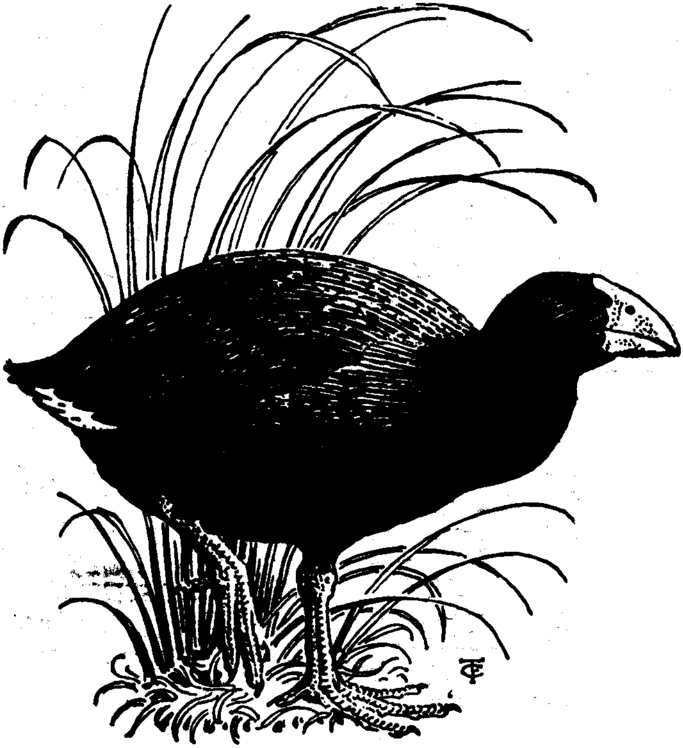

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BIRD COUNTS IN REGENERATED URBAN FOREST AT AUCKLAND DOMAIN

By B. J. GILL

ABSTRACT

From April 1987 to April 1988 (inclusive) I completed 195 5-min stationary bird counts at two forested sites in the Auckland City Domain. Auckland Domain has 22 species of passerines and near-passerines, more than half of them introduced. The mean annual counts – the first published for the North Island – showed a very high incidence of Silvereyes, Blackbirds and Fantails compared with beech-podocarp forests and conifer plantations of the northern South Island, and a low incidence of Grey Warblers and Shining Cuckoos. Whether these are general characteristics of northern or urban forests awaits further study.

INTRODUCTION

The simple technique of 5-min bird counts described by Dawson & Bull (1975) has been applied widely in New Zealand (Crook *et al.* 1977, Dawson *et al.* 1978, Gill 1980, Onley 1980, Bellingham *et al.* 1982, Gill 1983, Onley 1983, Clout & Gaze 1984), providing a wealth of data that allow indices of abundance to be compared species by species between areas. Counts have been undertaken in native forests and pine plantations, but no results have previously been published for urban parks.

Auckland Domain, including the forested parts, is a man-induced habitat entirely surrounded by urban and commercial areas. I undertook bird counts in two forested sections of the Domain to obtain indices of abundance of native and introduced birds there that could be compared with data from other parts of New Zealand, particularly native forests.

It is well known that several native song-birds – notably Fantail *(Rhipidura fuliginosa)*, Grey Warbler *(Gerygone igata)* and Silvereye *(Zosterops lateralis)* – flourish in greatly modified habitats, and that a few introduced song-birds – notably Blackbird *(Turdus merula)* and Chaffinch *(Fringilla coelebs)* – do well in native bush (e.g. Turbott 1957). I knew that all these species occurred in the Domain forest, but as for their precise abundance, I had no reason to suppose that they would occur in anything other than average numbers compared with other forested sites, both native and exotic.

STUDY AREA

The Domain (c. 275 ha) is the oldest park in Auckland (174°50'E, 36°55'S) and was set aside in 1845. Much of it is open, but there are about 70 ha of forest, mainly in gullies. The forest is a curious mixture of native and exotic species, many planted in historical times, others self-sown. A true forest structure has developed in many areas, with canopy, understorey layers and ground cover. Gardner (1981) reported a flora of 53 naturally occurring native species. The closest large, unbroken block of native forest is on the Waitakere Ranges,13 km away. (Rangitoto Island, 6 km away, has highly specialised forest.)

I established two sites 600 m apart at which I was surrounded by forest for at least 100 m in all directions. Only two such sites were possible given the distribution of forest. One site was at the centre of the bushy area south of Lower Domain Drive (NZMS260 R11 686 814); the other was between Domain Drive and the railway line (688 813). The altitude of both was about 50 m a.s.l. Both sites had a canopy about 15 m high dominated by exotic species, particularly large-leaved privet *(Ligustrum lucidum)*, oaks *(Quercus* spp.*)*, poplars *(Populus* spp.*)* and gymnosperms (e.g. *Cryptomeria, Araucaria).* The understorey was dense and included privet and numerous native shrubs and small trees. The ground cover was predominantly stinking iris *(Iris foetidissima)* and wild ginger *(Hedychium gardnerianum).* The exotic deciduous trees began to shed their leaves abundantly in May and were bare from July to September. This improved visibility at both sites.

METHODS

In general I followed the counting procedure laid down by Dawson & Bull (1975). I made 15 counts per month from April 1987 to April 1988 inclusive (13 months). On each counting day I made up to 4 counts (usually 3), which meant doubling back once or twice to count the previous station again. When a station was counted twice in one day the starting times were separated by about 25 minutes. I counted in fine weather (not wet or windy) and the counts for a month were spread between 0920h and 1530h (NZ Standard Time). I counted to a radius of 200 m. In some directions this distance went beyond the forest edge but I believe it made little difference. In practice most birds were seen within 50 m and very few were heard beyond 100-150 m.

Other noises during the counts were cicadas (stridulating in April 1987 and from November 1987 to April 1988), car traffic, trains, aircraft, ships' horns, sirens, naval gunfire, men working with machinery, human voices, barking dogs and running water in a stream. These noises were not significant, except that cicadas in February were so loud as to affect counting seriously. However, I recall a similar problem with counts at Kowhai Bush (Gill 1980) and suspect it happens in other studies.

Counts from this study were compared statistically with others by chi-squared tests on total numbers counted.

RESULTS

During the counts I recorded 17 species of birds – 7 native and 10 introduced – all of them passerines or near-passerines. The data (total numbers seen and heard) are summarised by month in Appendix 1. Table 1 shows the number of birds per 5-min count averaged over one year (May 1987 to April 1988 inclusive) for 11 of the most counted species.

TABLE 1 — Mean annual bird counts at Auckland Domain and two South Island beech-podocarp sites (Dawson *et al.* 1978, Clout & Gaze 1984). The Fletcher Creek counts were bimonthly. Counts were significantly different between areas ($P < 0.001$) for all species except Chaffinch

Locality Months n(counts)	Domain May 87-Apr 88 180	Camp Bush Nov 77-Oct 79 480	Fletcher Ck Apr 74-Feb 75 480
Silvereye	3.22	2.60	3.08
Blackbird	1.59	0.36	0.69
Fantail	1.40	0.28	1.17
Grey Warbler	0.52	1.25	1.25
Chaffinch	0.49	0.63	0.57
Song Thrush	0.31	0.10	0.23
Greenfinch	0.29	-	0.07
Tui	0.24	0.25	0.78
Kingfisher	0.19	0.02	0.01
Goldfinch	0.10	0.40	0.01
NZ Pigeon	0.02	0.31	0.59

No annual 5-minute counts were available for other North Island sites. Only Dawson *et al.* (1978), Gill (1980) and Clout & Gaze (1984) have published annual means – all for the South Island. For a particular comparison of the Domain annual means with data from native forest (Table 1) I chose two low-altitude beech-podocarp sites – Camp Bush (300 m a.s.l.) near Nelson (Clout & Gaze) and Fletcher Creek (230 m a.s.l.) near Reefton (Dawson *et al.*).

TABLE 2 — Mean April bird counts at Auckland Domain and Ohau Gorge, near Levin (Gill 1983). Counts were significantly different between areas ($P < 0.001$) for all species except Grey Warbler

Locality Years n(counts)	Domain 1987+1988 30	Ohau Gorge 1982 82
Silvereye	3.67	1.79
Fantail	1.47	0.68
Blackbird	1.47	0.27
Grey Warbler	0.57	0.70

Table 2 compares April counts of 4 species at Auckland Domain (April 1987 plus April 1988) with April counts for mixed podocarp-hardwood forest at Ohau Gorge near Levin (200 m a.s.l.; Gill 1983). Table 3 sets the only data available for another northern North Island site (Rakitu or Arid Island east of Great Barrier Island, December-January only; Bellingham *et al.* 1982) against comparable data for Auckland Domain for 8 species.

TABLE 3 — Mean December-January bird counts at Auckland Domain and Rakitu Island, off Great Barrier Island (Bellingham *et al.* 1982). Counts were significantly different between areas ($P < 0.005$) for all species except Fantail. (Song Thrush was not tested because one expected value was less than 5.)

Locality Months n(counts)	Domain Dec 87+Jan 88 30	Rakitu I. Dec 80+Jan 81 47
Silvereye	3.60	1.70
Blackbird	1.80	0.06
Fantail	0.80	0.47
Tui	0.43	1.28
Grey Warbler	0.33	0.98
Song Thrush	0.27	0.02
Kingfisher	0.20	0.89
NZ Pigeon	0	0.36

Species recorded in the counts

Silvereyes were more abundant in the Domain than at any other site (Tables 1-3). The annual mean (3.22) is exceeded in the literature only by 3.78 at Reefton Saddle (Dawson *et al.*). In the native and exotic forests studied by Clout & Gaze the greatest annual mean for Silvereye was 2.60 at Camp Bush. Flocking of Silvereyes diminished in August at the Domain, and resumed in December. I heard the first full song in September.

Fantails were more abundant in the Domain than at any site except Rakitu Island, where the difference was not significant (Tables 1-3). The Domain result (1.40) is the highest annual mean yet reported for Fantail.

Grey Warblers were less common in the Domain than at any other site except Ohau Gorge, where the difference was not significant (Tables 1-3). All four areas studied by Dawson *et al.* and 10 of the 12 native and exotic forests studied by Clout & Gaze had annual means for Grey Warbler greatly above 0.52.

The annual mean count for Blackbirds at Auckland Domain (1.59; Table 1) is the highest on record, the next largest being Fletcher Creek (0.69). The conifer plantations and native bush studied by Clout & Gaze had means for Blackbird of 0.16-0.38. In the Domain, sustained singing by Blackbirds was rare during the counting hours. I saw Blackbirds eating large-leaved privet berries.

Song Thrushes *(Turdus philomelos)* were more abundant in the Domain than in native forests (Tables 1 and 3). Clout & Gaze obtained annual means of 0.04-0.33, the latter in a mature conifer plantation. In the Domain I first heard full song in June, but it was seldom persistent during the hours of counting.

Mean annual counts of Chaffinches were not significantly different between areas (Table 1). The Domain mean (0.49) was low compared with means of up to 1.52 in native forest and up to 2.02 in conifer plantations obtained by Clout & Gaze. Chaffinches sang from July to December and were present, but seldom noticed, in other months (Appendix 1). I disregarded the Rakitu Island counts of Chaffinch because December-January is a time of sudden change in conspicuousness.

Greenfinches *(Carduelis chloris)* were significantly more abundant in the Domain than at Fletcher Creek (Table 1). The highest annual mean of the 10 given by Clout & Gaze was only 0.13. I counted Greenfinches most often in winter when flocks frequented the canopy and subcanopy eating large-leaved privet berries and foraging in *Cryptomeria japonica.*

Goldfinches *(Carduelis carduelis)* were a minor species in the Domain. They passed through the canopy and I saw them foraging in *Cryptomeria japonica.* Clout & Gaze recorded annual means up to 0.94 in bush and up to 0.66 in conifers.

Tuis *(Prosthemadera novaeseelandiae)* were a minor species in the Domain, compared with their incidence at Fletcher Creek and Rakitu Island (Tables 1 and 3), though I recorded them nearly every month (Appendix 1).

Kingfishers *(Halcyon sancta)* were quite common in the Domain counts, especially from August to December (Appendix 1). In August I saw noisy mating displays within the forest. Kingfishers were merely incidental in the studies by Dawson *et al.* and Clout & Gaze, but were abundant on Rakitu Island (Table 3).

I only once heard a Shining Cuckoo *(Chrysococcyx lucidus)* during the 60 counts from October to January (mean = 0.02) when cuckoos were about. This compares with means of 0.11 at Kowhai Bush, Kaikoura (Gill 1980) and 0.23 at Fletcher Creek (Dawson *et al.).*

During the counts I occasionally saw Starlings *(Sturnus vulgaris)* in the canopy and subcanopy. Mynas *(Acridotheres tristis)*, House Sparrows *(Passer domesticus)* and Feral Pigeons *(Columba livia)* were incidental species usually heard out towards the forest edge. One day I counted two Eastern Rosellas *(Platycercus eximius)* feeding in *Cryptomeria* and *Ligustrum.* New Zealand Pigeons *(Hemiphaga novaeseelandiae)* were similarly vagrant species.

Notes on other species

Five other passerines or near-passerines present in the Domain were not recorded in the counts – Morepork (*Ninox novaeseelandiae*) (nocturnal), Welcome Swallow (*Hirundo tahitica*), Yellowhammer *(Emberiza citrinella)*, Mapgie (*Gymnorhina tibicen*) and Malay Spotted Dove (*Streptopelia chinensis*). I saw the last occasionally – in grassy areas at the forest edge – as I walked between counting stations. Swallows, Magpies and Yellowhammers were common in open areas, the last seasonally. The avifauna of the Domain thus comprises 15 passerines and 7 near-passerines – a total of 22 species, 10 of them (46%) native.

Hedgesparrows (*Prunella modularis*) are absent from the Domain or very rare. In the early 1960s, Skylarks (*Alauda arvensis*) occurred in rough, open, grassy areas near the museum (E. G. Turbott, pers. comm.) but they disappeared, presumably as these areas were converted to mown grass.

DISCUSSION

There was no reason to predict that the native and introduced birds common in bush throughout New Zealand would occur in anything other that average numbers at the Domain compared with other forested areas, both native and exotic. It was therefore surprising to find Silvereyes, Fantails and Blackbirds in such abundance and Grey Warblers so poorly represented. Blackbirds appear to do well in the open parts of the Domain and the large number there spill over to produce high numbers in the forest. But it may be that northern or urban forests in general support high densities of these common song-birds. The Rakitu Island counts (Table 3) do not suggest this, but more studies in the north are needed.

The Domain counts were derived from only two counting stations. This increases the chance of bias from local "site effects" that are minimised in a study with many stations. However, it is a factor that cannot be helped if studies are to be made in small urban forests. It was gratifying to find a low incidence of Grey Warblers because it shows that the counts were not in some way consistently over-indicating the common species. I cannot account for the low numbers of Grey Warblers. Interestingly, the brood-parasite of this species (the Shining Cuckoo) was also poorly represented.

Some species are more conspicuous than others and so it is not strictly valid to compare the counts for different species. However, it does seem that Song Thrushes were less abundant in the Domain bush than Blackbirds. The same was generally the case in the studies by Dawson *et al.* (1978) and Clout & Gaze (1984). In whatever other ways the ecological niches of the two turdids may be alike or different in New Zealand, these results confirm the common belief that the Blackbird is the more successful in dense forest.

Kingfishers were most often counted from August to December. They may be more conspicuous then or they may use the forest for breeding and move away between times.

Eastern Rosellas are rare in the Domain, though they have been present for at least 60 years. In the late 1920s R. A. Falla saw them near the Robbie Burns Statue in the Domain (E. G. Turbott, pers. comm.). It seems strange that Hedgesparrows, so numerous in parks in Dunedin and Christchurch, for example, should shun the Domain. They prefer low, dense cover (Clout & Gaze 1984), but the Domain provides this in many places. E. G. Turbott (pers. comm.) has noted them only intermittently in his garden in Parnell, 0.6 km from the museum.

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APPENDIX 1 — Monthly summary of birds counted at Auckland Domain, April 1987 to April 1988. Year total is for May 1987 to April 1988 inclusive

	APR 87	MAY 87	JUN 87	JUL 87	AUG 87	SEP 87	OCT 87	NOV 87	DEC 87	JAN 88	FEB 88	MAR 88	APR 88	YEAR Total
n(counts)	15	15	15	15	15	15	15	15	15	15	15	15	15	180
Silvereye	43	43	67	65	47	22	42	39	46	62	26	53	67	579
Blackbird	18	19	17	27	16	29	27	43	37	17	11	17	26	286
Fantail	24	20	25	19	22	26	25	30	12	12	17	24	20	252
Grey Warbler	7	8	7	9	13	19	7	5	6	4	3	3	10	94
Chaffinch	9	4	1	1	11	9	7	13	29	4	0	2	7	88
Song Thrush	0	2	8	8	10	6	4	7	6	2	0	1	1	55
Greenfinch	0	7	11	18	6	0	2	4	4	1	0	0	0	53
Tui	3	2	2	7	3	6	3	2	4	9	2	3	0	43
Kingfisher	1	0	0	1	5	4	7	9	6	0	1	2	0	35
Goldfinch	0	3	4	0	0	4	4	1	0	1	0	0	1	16
Starling	3	3	0	5	4	1	0	1	0	0	0	0	0	14
House Sparrow	1	0	1	1	3	3	0	2	0	0	0	0	0	10
Myna	1	0	2	0	0	0	0	0	1	0	0	0	0	3
NZ Pigeon	0	0	2	1	0	0	0	0	0	0	0	0	0	3
Eastern Rosella	0	2	0	0	0	0	0	0	0	0	0	0	0	2
Rock Pigeon	0	0	0	0	0	0	0	0	0	0	1	0	0	1
Shining Cuckoo	0	0	0	0	0	0	1	0	0	0	0	0	0	1
UNIDENTIFIED	7	9	9	9	3	6	1	13	8	5	10	8	8	89

SHORT NOTE

A second Grey Phalarope at Lake Wainono

On 21 June 1987, RM found a Grey Phalarope *(Phalaropus fulicarius)* swimming among a group of Pied Stilts *(Himantopus himantopus)* in a shallow muddy pool at the northern end of Lake Wainono, South Canterbury.

As the phalarope was indifferent to our approach, we were able to watch it closely from 5 m away for an hour. On three occasions Pied Stilts, flying low and noisily overhead, caused the phalarope to fly. Each time, after a brief circular flight, it landed on the mud before dashing into the water to resume feeding. It fed very actively by turning buoyantly and constantly submerging its head in search of food. Pirouetting was not seen.

It was slightly larger than a Banded Dotterel *(Charadrius bicinctus)* seen nearby but with an unusually pot-bellied appearance. On land its proportionately short legs were noticeable.

The phalarope was last seen on 22 June by J. and J. Fennell.

Plumage: Black hindcrown, white forecrown, grey nape and hindneck, black "phalarope-mark" through eye, white lores and underparts, except for grey sides to breast and thickly streaked grey flanks. Small white patch beside carpal joint (cf. Brown & Latham 1978, p.201), pure grey mantle, grey scapulars and lesser coverts with small black centres, other coverts black with grey fringing, rusty orange tertials, black primaries, broad white wingbar conspicuous in flight, grey rump and tail.

Bare parts: Bill straight, sturdy and broad, the width especially noticeable from above. Basal half reddish orange, tip black. Legs brownish, short.

Voice: A sharp high-pitched *wit.*

Cramp & Simmons (1983, p.651), referring to post-juvenile moult in oceanic winter quarters, noted the " . . . partial replacement of first non-breeding by first breeding May-August and non-breeding on part of body directly replaced by second non-breeding; moult of flight feathers apparently also May-August. These birds probably do not visit the breeding grounds".

On this basis our bird was probably a first-year non-breeder in moult, as shown by its mixture of worn and fresh plumage. The bicoloured bill, being typical of adults in breeding plumage, also indicated changes in the moult cycle.

All four Grey Phalaropes previously recorded in New Zealand were in breeding plumage (Brown & Latham 1978). The first New Zealand record of a Grey Phalarope was also from Lake Wainono (= Waimate Lagoon) in June 1883 (Haast 1883).

We thank Ian McLean for criticising this note.

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THE BEHAVIOUR OF BITTERNS AND THEIR USE OF HABITAT

By ANDREW J. WHITESIDE

ABSTRACT

Australasian Bitterns *(Botaurus stellaris poiciloptilus)* were studied in the Whangamarino wetlands in the autumn and winter of 1986. A seasonal difference in the time of feeding was noted, as well as a local movement to feeding grounds. A decrease in the number of birds seen in the study area in winter seemed to be related to the duck hunting season and high water levels. A mixture of water purslane and willow weed on a wet substrate was the preferred habitat. "Surveillance posture" seems a better description of the traditional "freeze" behaviour. The birds gave this response even when there was no apparent danger.

INTRODUCTION

The Whangamarino wetlands, in the lower Waikato Basin, have been described as the second-largest (7100 ha) swamp and bog complex remaining in the North Island, supporting the largest bittern population known in New Zealand (Ogle & Cheyne 1981). Ogle & Cheyne suggested that these wetlands may be an important breeding ground for bitterns in the Waikato region and perhaps beyond. They reported an average density of bitterns of one per 49 ha, with the highest density over a 100 ha sample being one per 8.3 ha. Studies of *Botaurus stellaris stellaris* in Europe have reported densities from one per 2 ha to one per 50 ha (Cramp & Simmons 1977).

In the Whangamarino wetlands, Ogle & Cheyne (1981) saw 55% of the birds in mineralised swamps. These swamps contained willows (*Salix* spp.), bamboo sedges *(Eleocharis sphacelata* or *Baumea articulata)*, cutty crass (*Carex* spp.), water purslane *(Ludwigia palustris)* and willow weeds (*Polygonum* spp.). The other 45% of the bitterns were distributed throughout acid bog, semimineralised swamp and miscellaneous sites. Ogle & Cheyne also suggested that the dispersal of bitterns during the summer could be due to a decrease in surface water.

My aim in this study was to examine and describe the behaviour of bitterns and their habitat use in the Kopuku Arm of the Whangamarino wetlands.

METHODS

I made 90 hours of observations from the permanent hide from April to August 1986. After an initial three days of observation, I made fortnightly half-day (6 hour) observations, alternating dawn to midday and midday to dusk. A total of 97 sightings of bitterns were made in the Whangamarino wetlands, 59 by Wildlife Service staff and 38 by me. I made my observations from a hide on the southwestern margin of the Kopuku Arm, and a total of six Wildlife Service Officers and contract researchers provided data from sightings made during their routine work in the general Whangamarino

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wetland area. We all recorded the observations on prepared standard data sheets. I used a stopwatch to time behaviour and tried, unsuccessfully, to distinguish individual birds from photographs.

On 2 July I took five sweep-net samples around the edges of the main waterways of the Kopuku Arm to find potential prey of bitterns. One regurgitation sample was collected by a contract researcher when a bittern was accidentally disturbed. By calculating the viewing range from the hide I could estimate bittern densities.

Wildlife Service staff recorded their observations on cards, using the following behaviour descriptions:

Feeding – any behaviour associated with feeding.
Walking – wading in water or walking across vegetation.
Comfort behaviour – self-maintenance behaviour e.g. preening, wing flapping or roosting.
Flying – a bird flying overhead, but not flushed into flight.
Alarm flying – a bird flushed into flight.

RESULTS

Observations made in this study allowed me to expand the standard descriptions of bittern behaviour.

Feeding behaviour: I watched individual birds feeding in autumn for an average of 30 minutes (range 7-60 min) and in winter for an average of 23 minutes (range 3-63 min). All these birds fed on or near edges of ponds or waterways.

Figure 1 represents bittern feeding behaviour. In maximum concentration, a bird held its neck and back parallel to the substrate. It would then sway its head from side to side, creating S-waves down its neck, or keep absolutely still for up to 10 minutes. A lunge sometimes followed. To lunge, the bird pivoted its body (with neck and back straight) on its legs, sometimes completely submerging its head. It shook and bit the larger food, raising its head skyward to swallow the food.

Drinking sometimes followed swallowing. After taking food, the bird sometimes walked rapidly to another feeding site. At times, birds fed with their legs fully under water.

Surveillance: The bill was held erect with neck fully stretched. This lasted from a few seconds to 10 minutes. In this posture the plumage of the bird takes on a reed-like appearance. Typically the bird would rapidly scan the area and if it saw a threat, would lower itself slowly into the vegetation by retracting its head and crouching down. Surveillance postures were seen in all forms of the birds' terrestrial behaviour.

Walking: A bird would raise each foot high and then slowly lower it, with its head either retracted close to the body or extended.

Preening: In preening (seen seven times), birds appeared to use the uropygial gland at the base of the tail, repeatedly spreading the secretion through the plumage, particularly on the front of the throat and breast.

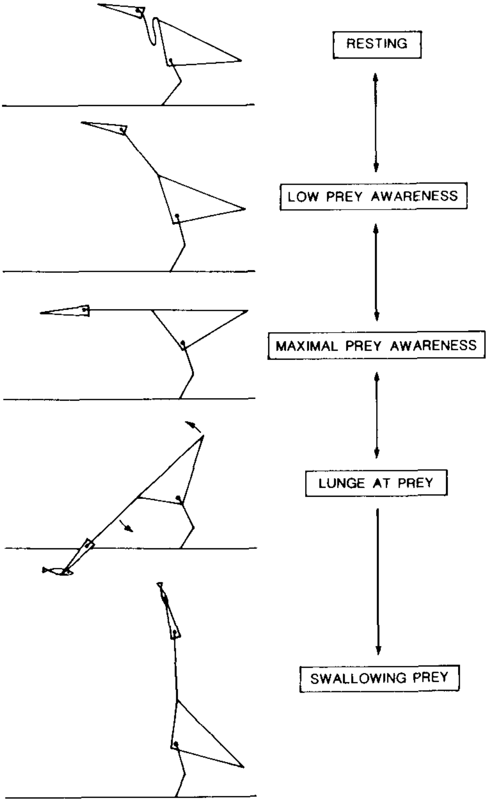

FIGURE 1 — Feeding behaviour of the Bittern

General: As I saw only solitary birds, I saw no interactive behaviour. I could not recognise individual birds, although some differences in plumage were noted. Figure 2 charts the number of birds I saw in each observation period. I found no birds in the last three observation periods (13 and 27 July and 8 August). Estimated densities of bitterns were calculated to range from 2/ha to 30/ha.

In autumn (1 March to 30 April) I saw birds feeding throughout the day. In winter (1 June to 31 August), most feeding was from early morning to mid or late afternoon, with a peak around midday. Observations by Wildlife Service staff showed similar trends. Differences were found between autumn and winter also for walking, which presumably is associated with feeding. Bitterns walked 10 to 500 metres during any observation period.

The regurgitation sample, collected from Kopuku Arm, consisted of five eels up to 200 mm long, two nursery web spiders *(Dolomedes minor)* and a common black field cricket *(Teleogryllus commodus)*. Birds were seen

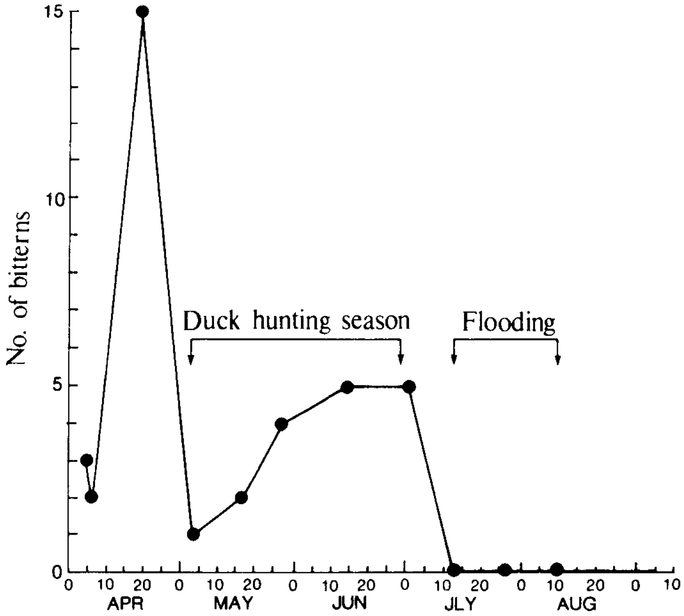

FIGURE 2 — Numbers of bittern seen per observation period in 1986 from the permanent hide, Kopuku Arm, Whangamarino Swamp

to feed on eels (the largest 50 cm long) on four occasions. Of the range of animals taken in the sweep-net samples on 2 July, only dragonfly larvae (Order Odonata) and mosquito fish *(Gambusia affinis)* were of suitable size to be bittern food. Mosquito fish were abundant in the samples taken. I did not do terrestrial sampling.

Comfort behaviour (e.g. preening) was observed in early morning and late afternoon in autum, but not in winter. In autumn, birds seem to fly before and after feeding. Only twice were flying birds seen in winter. It was noted that the direction of the flight was to and from the southwest (a similar direction as the Kopuku Arm waterway runs). The birds seen flying by the Wildlife Service staff (n = 8) were flying south or west from Kopuku Arm.

Of the Wildlife Service staff sightings, 97% (n = 57) were in the northeastern part of the Whangamarino wetlands, over 76% (n = 45) from the Kopuku Arm. Wildlife staff saw fewer birds walking and less comfort behaviour than I did from the hide (Table 1), but they saw more alarm flying (n = 24) than I did (n = 5). Of the five times I saw from the hide a bird flying in alarm, only once had it been disturbed by me.

From the habitat descriptions summarised in Table 2, all but two birds were in an area of mixed water purslane *(Ludwigia)* and willow weed *(Polygonum)* on a wet substrate.

TABLE 1 — Summary of bittern sightings, April-August 1986, in Whangamarino Swamp

		BEHAVIOUR OF BITTERNS				
		Walking	Feeding	Comfort Behaviour	Flying	Alarm Flying
TOTAL NUMBER OF BITTERN SIGHTINGS	Permanent Hide	19	15	9	14	5
	Wildlife Staff	8	16	3	8	24

TABLE 2 — Bittern habitat use, April-August 1986, in Whangamarino Swamp

				BITTERN HABITAT FEATURES							
				Dominant Plant Species						Substrate Dampness	
		Behaviour	n	Ludwigia	Polygonum	Ludwigia & Polygonum	Juncus	Cyperaceae	Other	Wet	Dry
Observers	Permanent Hide	Feeding	16	0	0	14	1	0	1	16	0
		Walking	8	1	0	7	0	0	0	8	0
		Comfort behaviour	3	0	0	3	0	0	0	3	0
	Wildlife Staff	Feeding	15	0	0	15	0	0	0	15	0
		Walking	19	0	0	19	0	0	0	19	0
		Comfort behaviour	11	0	0	11	0	0	0	11	0

DISCUSSION

Feeding: The small amount of time (less than 1 hour) bitterns spent feeding in autumn and winter and the long distances walked (up to 500 metres) suggest that the bitterns concentrated on finding larger food items. The presence of larger food items in the one reguritated sample supports this suggestion. I was unable to verify Soper's (1984) view that bitterns feed at night.

Quiet stalking was the main method of feeding. Birds could spend up to 10 minutes motionless, presumably using their well-known ability to swivel their eyes to look below the bill while the head is held horizontal (Figure 1).

All birds fed at the edges of ponds and waterways, which confirms the expected preference for aquatic food. Most of the animals regurgitated were aquatic, and birds were seen capturing eels. The regurgitated material was covered in mucus. The animals in it showed signs of digestion, but some were damaged (e.g. lost limbs), probably by the bittern's capture methods. Crop contents, which the birds seem to regurgitate when disturbed during or straight after feeding (also observed by Ogle & Cheyne 1981), may provide a useful method of assessing bittern diet.

Sweep-net samples showed an abundance of mosquito fish and dragonfly larvae, both likely foods. However, sweep-net samples may not have truly represented the potential prey animals present. More sampling (including terrestrial sampling) is needed throughout the year in places where bitterns have been feeding. The observed difference in peak feeding activity between seasons may have been associated with seasonal changes in the abundance of fish and insects.

Surveillance posture: This is, I believe, a suitable term to describe the well-known "freeze" behaviour of bitterns. The traditional interpretation makes it seem to be an involuntary action of the bird in the presence of danger. In my experience, however, it is primarily an awareness behaviour by which the bird investigates its surroundings, whether or not there is danger. When deep in vegetation a bittern, by raising its head, gets a clearer view of its surroundings. In this surveillance posture, the bird's plumage takes on a reed-like appearance, thus camouflaging the bird.

Local movements: The density of birds in the Kopuku Arm (30/ha) was higher than the range observed by Ogle & Cheyne (1981). In autumn birds were seen flying before and after feeding. This behaviour along with the bird densities suggested to me a local movement to and from the feeding grounds of the Kopuku Arm. The idea that birds fly into good feeding places is in contrast with the view of Williams (1985) that bitterns live in established feeding territories and rarely fly. My observations, however, were not made in spring and summer, when the birds are more likely to be resident and territorial.

As individual identification was difficult, I may have counted some birds twice. Although this would have made me overestimate the density of bitterns, the overestimate is unlikely to be significant because on 20 April, when I recorded the highest density, I saw three bird simultaneously, and later a further six flew into the area.

The decrease in the number of birds observed in winter (Figure 2) suggests that the Kopuku Arm was a less important feeding ground in winter. Note, however, that the duck hunting season (3 May to 29 June) may also have reduced the numbers seen in late autumn and early winter. Ogle & Cheyne (1981) suggested that drying out of the wetlands in summer forces the birds to move elsewhere. Deepening water in winter may change the birds' habits also because they prefer shallow standing water that does not fluctuate much. In any future study of bitterns movements, colour banding and radio telemetry would be useful.

Habitat: The bitterns seemed to prefer a mixture of water purslane and willow weed on a wet substrate. Ogle & Cheyne (1981) also found this. This habitat was still preferred in winter, even though the water purslane and willow weed had died down. Sedges (*Baumea* spp.) and rushes (*Juncus* spp.) are an alternative source of cover at this time.

Concern over the decrease in wetlands and a corresponding decrease in bittern numbers has been repeatedly expressed (Falla 1975, Moon 1979, Ogle & Cheyne 1981, Williams 1985). Accurate population estimates are difficult. Unless suitable habitat is preserved for this species, the numbers will continue to decrease to dangerously low levels, as has occurred with bitterns in Britain (Whitlock 1981, Moore 1980).

ACKNOWLEDGEMENTS

I thank Ron Kilgour and Alan Saunders for their help and advice during this study. Thanks also to staff of the former NZ Wildlife Service and Ian Boothroyd for their assistance. Financial assistance and use of equipment from both the Wildlife Service and the University of Waikato are gratefully acknowledged.

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SHORT NOTES

Morepork hunting House Sparrows

At dusk on 12/11/61 I watched a Morepork *(Ninox novaeseelandiae)* as it made a straight silent glide from the top of a tall deodar in my Remuera garden. Its objective across the road was a couple of large Italian cypresses where many House Sparrows both nested and roosted. The owl first alighted on the leader of one of the cypresses. Then it fluttered around the dense foliage like a moth round a lamp or a Barn Owl *(Tyto alba)* winnowing the ivy on an old building. A squeak was heard and one sparrow was seen fleeing.

The Morepork found a gap in the foliage, thrust in its head and shoulders and, after withdrawing, paused briefly before resuming its evening hunt. I could not be sure that the raid on the cypress had been successful.

When a pair of suburban Moreporks raised young in a specially designed and sited nesting box at King's College, Otahuhu, in 1960 (*Notornis* 9: 133-134), House Sparrows were a significant item in the owlets' diet, especially after they had become feathered.

R. B. SIBSON

Notes on the nesting, parental care, and taxonomy of the Silktail (*Lamprolia victoriae*) of Fiji

The Silktail is a 13 cm long, fine-billed, sexually monomorphic, insectivorous passerine. It has velvety black plumage, silky-white rump, upper tail-coverts and upper tail, and irridescent-tipped scale-like feathers about head, neck, throat and breast, which may appear blue, green or violet. It is found in coastal and upland mature forests on the Fijian islands of Taveuni and Vanua Levu but on the latter is confined to the Natewa Peninsula (opposite Taveuni) where birds are sparser and smaller and represent the distinct subspecies *L. v. kleinschmidti* (Heather 1977, Watling 1982, Frith 1985).

The affinities of monotypic *Lamprolia* have, since its description in 1873, remained the subject of considerable and largely inconclusive debate (Cottrell 1966, Heather 1977, Olsen 1980, Frith 1985). The bird is thus of considerable systematic interest, and any information on its little-known biology beyond that reviewed by Cottrell and Heather is important.

We did some brief field work at 100 m a.s.l. on Taveuni in forest directly above the Tutu Catholic Seminary on 21-22 August 1987. At 1030 on 21 August, two adult Silktails hit a mist net as it was being erected. After being photographed and released, they remained, to our surprise, in the immediate vicinity. From 1445 onwards we observed these adults feeding a recently flying (1-2 days) young on low ($<$ 2 m) forest vegetation.

On 21 August DW found a Silktail nest, containing a single well-developed nestling, 2 m above ground and suspended by its rim in the horizontal fork of a broad-leaved sapling well sheltered by several leaves directly above, as described and illustrated by Heather (1977). Heather noted two distinctly different forms of Silktail nest, one constructed of dry fibres and shredded dead leaves without external decoration and with few feathers lining the egg cup and another much decorated outside with green moss-like liverwort and completely lined inside with numerous feathers. The nest we observed was of the second kind.

On 22 August CF took photographs from a hide while DF and DW observed activity with field glasses from a distance of c.25 m. Two adults made very brief feeding visits to the nest, feeding insects to the young bird and carrying its faecal sacs off in the bill, always leaving the nest by dropping conspicuously downward. Only one adult visited the nest at a time, but several times one left the nest as the other arrived. After much wing flapping and stretching exercises on the nest rim, the nestling flew to the ground, but CF put it back in the nest (to obtain photographs), where it stayed to preen its plumage, which had become sodden in wet forest-floor foliage. Doubtless the nestling flew on 23 August.

On 22 August DW saw another newly fledged Silktail, definitely not the one seen on 21 August. All three observers repeatedly saw several adults foraging for insects on the leaf litter of the forest floor (reported by Heather as common on Taveuni), over rocks, and in the forest foliage up to c.7m above ground.

Heather (1977) reviewed Silktail breeding data. On Taveuni a nest was under construction 9-11 September; a nest with the single-egg clutch was recorded for May (DW), four or five nests in early June (Clunie *in* Heather 1977) and a nest with egg some time in "July/August" (Layard 1876), 22-26 August, 11 December, and three on 11-17 December. Near-fledged and recently fledged young are recorded for "late July/early August" (Layard 1876) and 9-13 September, and Holyoak (1979) found fledged young plentiful between 12 and 21 July. On Vanua Levu a nest with egg and a juvenile were seen on 4-7 September (Heather 1977).

Our observations of three fledged young and several recently vacated nests during 21-22 August suggest that there was local synchronised breeding by *Lamprolia* on Taveuni in 1987. Present data suggest nesting is predominantly during June to September. Records of clutches in December, and an apparent lack of breeding activity between 25 August and 10 September 1970 (Blackburn 1971), indicate that the breeding season may vary, as climate and/or food resources dictate. Silktail nesting appears to be seasonal as there are no nesting records for January to April inclusive, contrary to Heather's suggestion that it may breed at any time of the year.

Observations reviewed by Heather suggest that only one bird nest-builds and incubates. We once saw a second bird promptly appear in the immediate nest area when the sitting bird gave a scolding call. Holyoak (1979) wrote of the Taveuni Silktail "groups of three usually including a fledged juvenile", and of young begging food from "adults accompanying them", clearly suggesting that two adults feed the nestling/fledgling; as observed by P. Child on Vanua Levu (*in* Heather 1977) and by Heather on Taveuni. Our observations confirm that two adults feed the nestling.

Cottrell's (1966) excellent review of the systematic history of *Lamprolia* makes it clear that, although earlier authors expressed the view that the Silktail is morphologically very similar to some birds of paradise, particularly members of the genera *Manucodia* and *Ptiloris*, none of them formally placed it in the Paradisaeidae. Beecher (1953), having dissected a *Lamprolia* specimen, emphatically stated that is not related to birds of paradise. Bock (1963) compared *Lamprolia* and Paradisaeidae skull morphology and found several distinctive bird of paradise characters lacking in the former, and agreed with Beecher (1953). Cottrell (1966) and Heather (1977) speculatively reverted, however, to the notion that *Lamprolia* should be considered a possibly close relative, if not member, of the Paradisaeidae. Olsen (1980) forcefully and convincingly argued against this view and concluded that *Lamprolia* is part of the South Pacific monarchine flycatcher radiation (Monarchidae) closest to the genera *Clytorhynchus*, *Metabolus* and *Monarcha*. Olsen did not consider the nest and egg and general behavioural characteristics of the Silktail. As CF has experience of 29 of the 43 (Beehler *et al.* 1986) bird of paradise species in the wild or in captivity and of the nests and eggs of many of them (Harrison & Frith 1970, Frith 1970, 1971, Bishop & Frith 1979 & pers. obs.) we make the following observations.

The Silktail nest is unlike that of any known bird of paradise nest (Cooper & Forshaw 1977 & pers. obs. of CF) in almost every character, including the basic materials, the nest lining and the nest site. All known typical paradisaeid nests are a bulky cup or bowl of coarse materials built upon a substantial stick foundation, placed atop a fork, on palm frond bases, or in a crevice, and lack feather lining. Some atypical paradisaeid nests are domed structures built on tree stumps or against tree trunks (Cooper & Forshaw 1977, Frith 1985 & pers. obs.). No known bird of paradise nest is suspended from a sapling or tree fork by its rim. The egg of the Silktail is not typical of a paradisaeid. In materials, decoration, site, shape and colour the nest and eggs of *Lamprolia* are much more like those of some of the monarchine flycatchers, supporting the classification based on plumage, external morphology and zoogeography of Olsen (1980).

The Silktail is unlike birds of paradise in general character and behaviour. It has, however, been seen to hold a food item beneath a foot in order to tear it apart, behaviour characteristic of most birds of paradise (pers. obs. of CF & DF) but also typical of the monarch flycatchers, Monarchidae (Parker 1985 & pers. obs.).

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★ – The authors have agreed that I take this opportunity to correct a serious error on page 177 of my 1977 paper. The egg of *L. v. kleinschmidti* measured 19.6 x 14.8, not 16.6 as printed. I am grateful to Prof. V. Meise of Hamburg for pointing this out several years ago – Ed.

FEEDING BEHAVIOUR OF THE FANTAIL
(*Rhipidura fuliginosa*)

By IAN G. McLEAN

ABSTRACT

Three feeding methods are described for Fantails: hawking, flushing, and feeding associations. Hawking Fantails cover large distances, use any available perch, and often feed above the forest canopy. Flushing Fantails cover small distances, perch on twigs and small branches, and feed mostly within the canopy or on the ground. Fantails in feeding associations feed where the species being followed feeds. Changes in the proportion of use of each feeding method in relation to breeding stage are described; the sexes did not differ in feeding methods during breeding. By using several feeding methods, Fantails forage in a wider range of microhabitats and so may obtain a wider range of prey than they would by only one method.

INTRODUCTION

Although many studies have dealt with the feeding ecology of insectivorous New Zealand passerines (Clout & Gaze 1984, and references therein), most have emphasised habitat selection and few have concentrated on the details of feeding by each species. Available data indicate that there is considerable variation in feeding behaviour and/or habitat use through the year (*Petroica australis*, R. Powlesland 1980, 1981; *Bowdleria punctata*, Best 1979; *Gerygone igata, Zosterops lateralis, Mohoua novaeseelandiae*, Gill 1980). Several unpublished theses support these results. In general, insectivorous forest passerines in New Zealand spend most of their time feeding, each species using a range of feeding methods. Any seasonal variation is in habitat use and the proportions of use of each feeding method, rather than in overall time spent foraging.

The Fantail (*Rhipidura fuliginosa*) takes flying prey by hawking from a perch, flushes prey by disturbing vegetation, and may form feeding associations with other species (McLean 1984, Cameron 1985, McLean *et al.* 1987, Read 1987). Prey are rarely taken directly from the substrate (Cameron 1985, pers. obs.). Here, I describe the feeding behaviour of Fantails in relation to season, forest structure, breeding status and sex. The three feeding methods are described and compared and predictions are developed allowing discrimination between them.

METHODS

Feeding behaviour in relation to habitat use was studied on Cuvier Island during two weeks in May 1981. Each time I encountered a Fantail I recorded up to five samples of height, perch used, and feeding method, at 30 s intervals (details of the sampling procedure and statistical analysis are in McLean 1984). Due to lack of independence in the data, statistical significance was set at $P<0.01$.

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Feeding behaviour in relation to stage of the breeding cycle, and sex, was studied on Tiritiri Island during the summer of 1981/82 by the same methods as on Cuvier Island. Most birds were individually colour-banded and all nests were found. Thus each bird's breeding status was known on the day samples were taken. Breeding stages distinguished were: not breeding (including between nests), building/laying, incubating, feeding nestlings, and feeding fledglings.

Behavioural details of the differences between feeding methods were gathered on Little Barrier Island during one week in July 1985. Thus details of behaviour of Fantails in feeding associations were for birds following Whitehead *(Mohoua albicilla)* flocks.

About 40 and 24 Fantails made up the study populations on Cuvier and Tiritiri Islands respectively. Different numbers of samples were taken from each individual.

Perch size was defined in terms of vegetation that a hopping Fantail could disturb. Only twigs (<0.5 cm diameter) and leaves shook when a Fantail hopped on them. Small branches (0.5-2.5 cm), large branches (>2.5 cm), and trunks were also distinguished during data collection.

To distinguish between the two feeding methods used by Fantails feeding alone, I made two predictions: 1) flight lengths of birds feeding alone would show a bimodal distribution; and 2) perches from which short flights were made would be significantly smaller (i.e. twigs) than perches from which longer flights were made.

My aim was to use descriptive data gathered independently of subjective assignments of feeding method to show that Fantails used two distinct feeding methods when alone. I had previously observed that flushing Fantails made short flights whereas hawking Fantails made long flights (hence prediction 1). Flushing Fantails should use only small perches because an 8 g bird is not likely to disturb larger perches. In contrast, hawking Fantails should use any available perch (hence prediction 2). If the predictions were not supported, it is unlikely that my subjective assignments of feeding methods in data presented in other sections would reflect real differences in feeding behaviour by Fantails.

The lengths of flights and time spent perching were compared for Fantails using all three feeding methods on Little Barrier Island. I predicted that flushing Fantails would make short flights and have short perch times, hawking Fantails would make long flights (I made no prediction about perch time), and Fantails in an association would make short flights (i.e. similar to flushing) but would perch for long periods (because movement rate depends on prey items being disturbed by the host).

Forest types in each of the study areas were broadly similar. An upper canopy of pohutukawa *(Metrosideros excelsa)* and/or kanuka *(Kunzia ericoides)* reached to 20 m. Below this, a dense canopy of mixed broadleaf forest ranged from 3 to 6 m. The amount of ground cover varied from little to dense, depending on light intensities, but usually consisted of a variety of seedlings, shrubs and ferns.

RESULTS

Feeding methods

Almost all prey taken by Fantails were in the air when taken. Three main feeding methods were used: *hawking* (termed 'static searching and pursuit' by Cameron 1985), *flushing* (Cameron's 'progressive searching and pursuit'), and *feeding associations.* Each method was identifiable by characteristic behaviour. Birds switched quickly between methods.

When *hawking*, a Fantail captured flying prey it had seen from a perch. The Fantail either flew to a new perch or returned to the same perch after a hawking flight. Fantails often hawked through swarms of small insects in calm sunlit clearings, over the forest canopy, or along forest margins; that is, where the vegetation was open or patchy and the bird could see long distances. More than one prey item could be taken during a hawking flight (indicated by several bill snaps). In contrast to the other feeding methods, availability of prey did not depend on movements by the Fantail or any other species.

When *flushing*, moving Fantails disturbed resting prey and captured them in flight. Only one item seemed to be taken per flight. Flushing often occurred in dense vegetation, where visibility was limited.

When in a *feeding association* Fantails followed another bird (or occasionally a mammal such as a human or a large ungulate). The Fantail made short hawking flights to capture prey disturbed by the host. Feeding sites and prey availability for Fantails in feeding associations depended mainly on the habits of the species being followed. The only choice was whether to follow. Fantails formed short-term associations with most forest birds, but these rarely lasted for more than a few seconds, unless the bird was a messy or clumsy feeder (e.g. Saddleback, McLean 1984) or a member of a flock. Within a flock, the Fantail rarely stayed with the same individual for long.

Distinguishing feeding methods

Foraging associations were easily distinguished because the Fantail perched close to, scanned the air around, and moved at the same pace as, the host.

For Fantails feeding alone, I recorded a large number of very short flights, and a relatively large number of very long flights, supporting prediction 1 (Fig. 1).

Variation in length of flights in relation to perch size was significant (Fig. 2; $X^2_2 = 10.02$, Yates correction applied, $P<0.01$). Most flights from twigs were short, whereas flights from larger perches varied in length and were often long (supporting prediction 2).

These results indicate that my subjective assignment of foraging type in the following sections reflect real differences in the foraging behaviour of Fantails.

Feeding methods and microhabitat use

When flushing and hawking, Fantails used significantly different perch types (Fig. 3; $X^2_5 = 56.1$, $P<0.001$) and fed at significantly different heights (Fig. 4; $X^2_8 = 29.6$, $P<0.01$). While flushing, Fantails fed primarily from

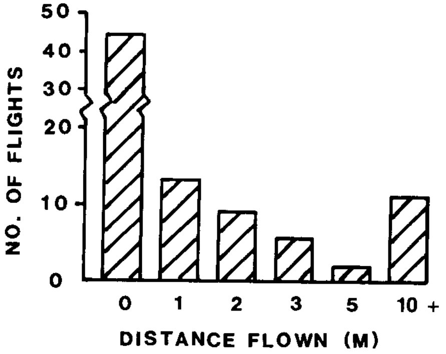

FIGURE 1 — Distances flown by Fantails feeding alone on Little Barrier Island in July. Includes flights from ground

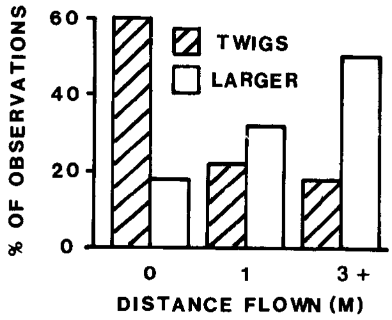

FIGURE 2 — Distances flown by Fantails feeding alone in July on Little Barrier Island in relation to perch used (twigs, N = 50; larger, N = 22)

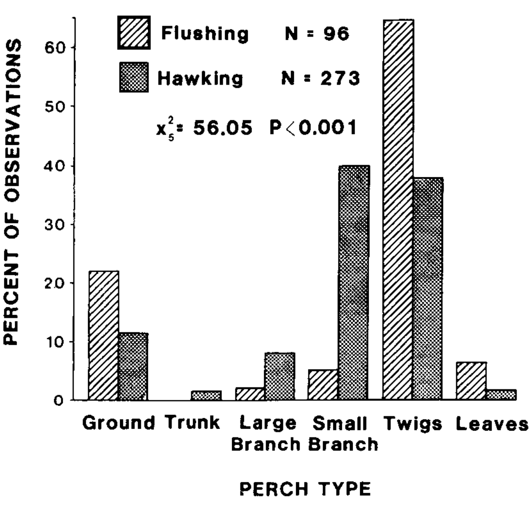

FIGURE 3 — Perches used by Fantails feeding alone on Cuvier Island in May

small perches in the thicker vegetation of the lower canopy, or on the ground. Hawking Fantails fed from all perches between the ground and the top of the lower canopy, or in the open canopy above the broadleaf forest.

The heights used by Fantails feeding in an association were intermediate between those for flushing and those for hawking (Fig. 2 in McLean 1984). Perches used by Fantails in an association probably depend on the behaviour of the host.

Feeding methods and behaviour

There was significant variation among all three feeding methods for flight lengths (X^2_8 = 49.7, $P<0.001$) and perch time (X^2_6 = 73.8, $P<0.001$) (Table 1). In accordance with predictions, flushing Fantails made short flights and perched for short times; hawking Fantails made long flights (they also perched for fairly short periods); and Fantails in an association made mostly short flights and spent long periods perching.

Feeding behaviour, breeding status, and sex

Most Fantails fed from small branches and twigs during all stages of breeding, and no significant variation was found in either perches used or feeding heights (data not presented). Significant variation in the feeding methods used during each breeding stage was found (X^2_8 = 70.2, $P<0.001$, Fig. 5), with most of the significance attributable to differences between non-breeding and breeding birds. As Fantails advanced through the breeding cycle, the proportion of hawking increased, reaching >80% when fledglings were being fed. Feeding associations were rarely formed by breeding Fantails (see also McLean 1984).

No differences were found between male and female Fantails in feeding methods used, perches used, or heights at which feeding occurred (Table 2). I used birds in this analysis only if they had a nest on the day I took the sample.

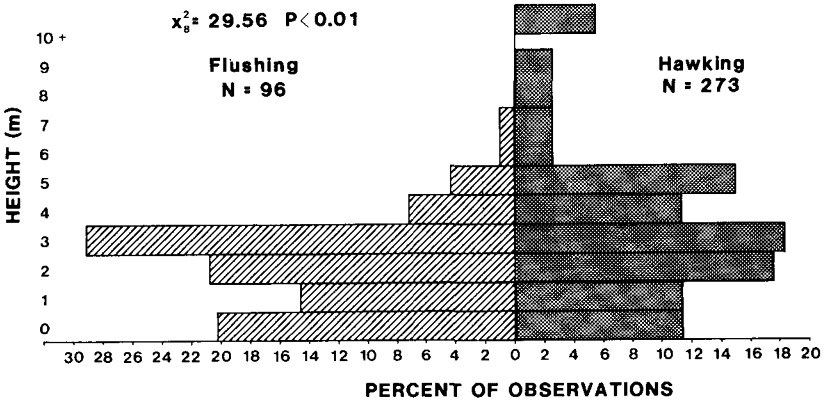

FIGURE 4 — Heights at which Fantails feeding alone perched on Cuvier Island in May

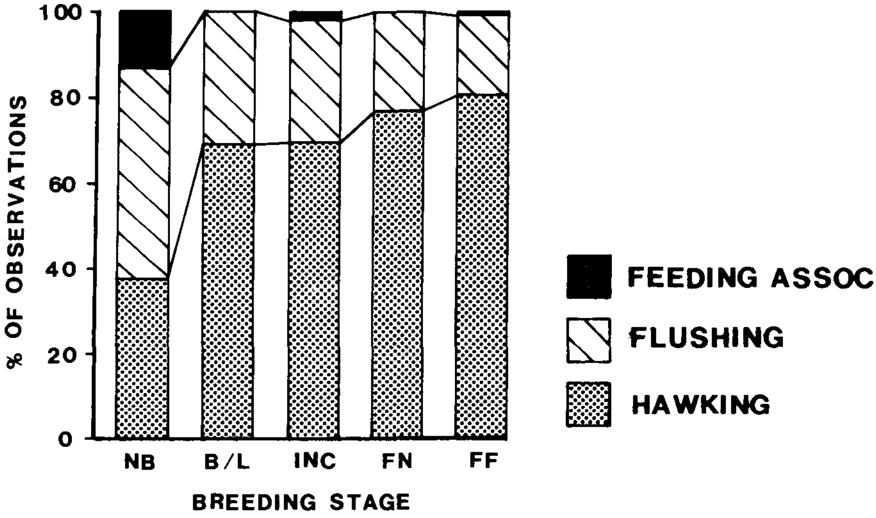

FIGURE 5 — Proportion of each feeding method used by Fantails at each stage of breeding on Tiritiri Island. NB = Not Breeding (88 observations); B/L = Building/Laying (29); INC = Incubation (59); FN = Feeding Nestlings (91); FF = Feeding Fledglings (145). Overall X^2_8 = 70.2, P<0.001

TABLE 1 — Distances flown and length of time perched by Fantails using three feeding methods on Little Barrier Island in July

Distance flown (m)	Flushing	Hawking	Association
0-0.9	51	6	24
1-1.9	13	4	15
2-4.9	3	16	14
5+	0	14	2
Total	67	40	55
Time perched (s)			
0-0.9	31	15	4
1-1.9	14	10	10
2-2.9	5	4	6
3-4.9	0	5	12
5+	0	6	16
Total	50	40	48

DISCUSSION

Fantails used three feeding methods and obtained food from different parts of the forest by each method. The main difference between methods was in how prey were detected. Fantails feeding alone detected their prey either by scanning a large airspace (hawking) or by disturbing vegetation to expose prey (flushing). In feeding associations, Fantails gained the advantages of

TABLE 2 — Feeding behaviour of breeding female and male Fantails on Tiritiri Island

Feeding method	Females (N = 61)	Males (N = 141)
hawking	50	118
flushing	11	23
$X^2 = 0.1$, $P > 0.1$		
Perch used		
ground	1	3
trunk	4	9
large branch	6	15
small branch	26	66
twig	23	47
leaf	1	1
$X^2_4 = 0.5$, $P > 0.1$ (not including leaf)		
Height (m)		
0-1.9	19	45
2-3.9	25	49
4-5.9	10	34
6+	7	13
$X^2_3 = 1.8$, $P > 0.1$		

short capture flights (as with flushing) and long perching periods. By using different methods, the birds used more parts of the habitat for feeding than they could by using one method only.

Each feeding method presumably represents a tradeoff between energetics, the kinds of prey obtained, the rate at which prey are captured, and the needs of the moment (Rudolph 1982). Fantails feeding young must catch prey quickly, and having to carry the prey, probably prefer large items. Hence, by hawking when breeding, they can scan large amounts of airspace and detect large prey more often than they would by the other feeding methods. Birds flushing or in feeding associations move more slowly (and so may conserve energy) but scan smaller areas. Fantails rarely form feeding associations during breeding, presumably in part because of having to keep finding the host again after feeding chicks (McLean 1984).

No differences between the sexes in feeding behaviour or microhabitat use were found in this study. As female and male Fantails provide approximately equal amounts of parental care (Powlesland 1982), it is not surprising that they feed in similar ways during the breeding period. However, differences between the sexes have been found in some small, insectivorous forest passerines (Holmes 1986), and they may occur in New Zealand species in which there is division of labour. Suggestions of sexual differences have been found for the Robin (proportions of time spent foraging during the breeding period differ between males and females, Powlesland 1980) and the Rifleman (*Acanthisitta chloris*); males gather most or all of the food required for manufacturing eggs and courtship-feed it to the female, Sherley 1985).

Other feeding methods reported for Fantails include 'tumble-chase' (birds use aerobatic manoeuvres to chase prey, Ude Shankar 1977, Crome 1978), which I include in hawking, 'spinning' (birds spin back and forth through a 180° arc as they move, Diamond 1972, in Cameron 1985), and 'flitting' (birds move rapidly through vegetation, Crome 1978). I include the last two in flushing.

Flushing is rarely recognised as a distinct foraging mode of small flycatchers (e.g. Powlesland 1981, Robinson & Holmes 1982, Cameron 1985). Whether this is because few birds use this method, or because researchers have not recognised the method as distinct, is not clear. Observations of flushing by Fantails may lead to understanding the function of the unusually large tail in this species. Ude Shanker (1977) rejected flushing as a specific function of the Fantail's tail. Here, I argue that the bird uses its entire body for flushing by disturbing twigs and leaves as it moves, enhanced by wing and tail motions. Fantails also flush while on the ground, a substrate which they cannot disturb except by generating air currents. The wings seem to be used for this function, and I suggest that the tail is also used.

ACKNOWLEDGEMENTS

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FEEDING BEHAVIOUR OF NEW ZEALAND KINGFISHERS AT AN ESTUARY IN WINTER

By LYNLEY MARIE HAYES

ABSTRACT

The feeding behaviour of New Zealand Kingfishers *(Halcyon sancta vagans)* overwintering at Brooklands Lagoon, a coastal North Canterbury estuary, is described. Kingfishers watched for crabs from perches on or near the mudflats and caught crabs on 96% of dives. Kingfishers then battered them against a perch; parts of the crabs such as the chelae were knocked off in the process. Fallen chelae (n = 225) provided information about species, size and sex of crabs taken. Crabs were collected in mud samples from 10 sites to compare the size, sex and species of crabs present on the mudflats with those taken by Kingfishers. Kingfishers fed only on the mud crab *Helice crassa,* which was the most abundant crab species on the mudflats. Male crabs and large crabs were taken more often proportionally than they were in the mud samples.

INTRODUCTION

New Zealand Kingfishers are throughout New Zealand and on most offshore islands, in forests and open country, on lake shores, along rivers and streams and on the coast. Kingfishers change their distribution seasonally, increasing in number on the coast and on estuaries in winter (Taylor 1966, Ralph & Ralph 1977). This change in distribution is probably due to scarcity of prey in the high country in winter. Kingfishers take a wide variety of prey, including mice, small birds, lizards, fish, freshwater crayfish, tadpoles, crabs, shellfish, earthworms, spiders and insects (O'Donnell 1981, Heather 1985, Fitzgerald *et al.* 1986). Foods such as tadpoles, lizards and cicadas, which are abundant in the high country in spring and summer, become less available in winter. Fish, crabs and other marine prey remain active and abundant throughout the year in coastal areas (Taylor 1966).

The aim of my research was to describe the feeding behaviour of Kingfishers on a coastal estuary. The main questions asked were:

1. What prey species, sexes and sizes were taken ?
2. How did the prey items taken relate to the prey available? That is, were Kingfishers selective foragers ?
3. What was the success rate of foraging Kingfishers ?
4. Were Kingfishers aggressive towards one another when feeding ?

STUDY AREA

Kingfishers were observed at Brooklands Lagoon, 15 km north-north east of Christchurch, during March to August 1987. Large areas of mudflat were exposed for 4-6 hours at low tide. In comparison with other New Zealand estuaries, Brooklands Lagoon has a very dense fauna, suggesting high biological productivity in the area (Knox & Bolton 1978).

NOTORNIS 36: 107-113 (1989)

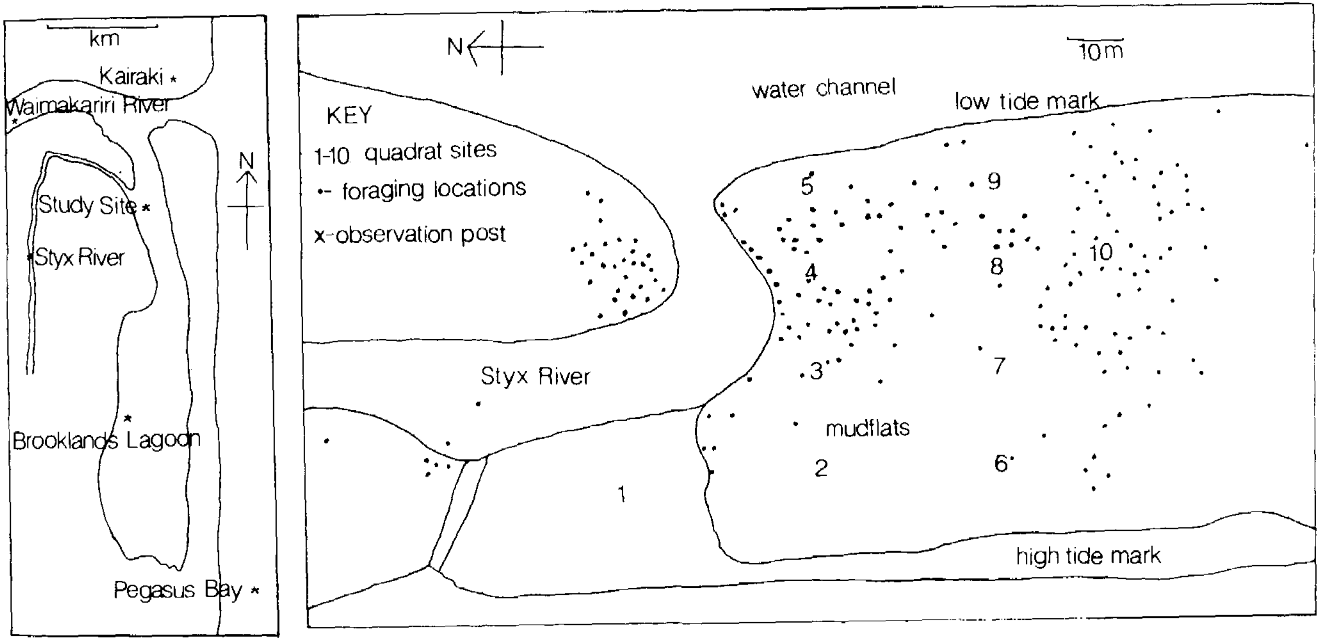

FIGURE 1 — *Left:* Brooklands Lagoon and the study site. *Right:* Prey capture locations for Kingfishers feeding at Brooklands Lagoon. Each dot represents where a crab was captured. Numbers show the ten sites where crabs were sampled

METHODS

To observe Kingfishers foraging I used a 25x spotting scope or 12x50 binoculars from distances of 20-250 m. I recorded feeding success, the height of feeding dives, the distance travelled to catch prey, whether prey was taken on the mudflats or underwater, handling time, whether the bird returned to the same perch, and any aggressive behaviour. To estimate height and distance of feeding dives, I used reference marks of known separation distance on the mudflats. Handling time was recorded to the nearest second with a stopwatch.

To divide the mudflat into areas of different feeding intensity, I plotted 200 sites where Kingfishers captured crabs (Fig. 1). Selecting 10 sites ranging from areas of little or no feeding to areas of heavy feeding, I sampled the crabs at low tide on 7 July 1987, using 0.25 m^2 quadrats at each site. I dug the samples to the depth of the deepest burrow (> 20 cm), extracted the mud and sorted for crabs by hand. Crabs were preserved in 70% alcohol and later blotted dry and weighed to the nearest 0.01 g on a Mettler balance. Chelae length and depth and carapace width were measured to 0.1 mm with vernier calipers, and the sex of each crab was recorded.

Kingfishers knocked parts off crabs before swallowing them. Each time I collected crab remains, I first removed old crab remains from beneath regular Kingfisher perches, or if possible, moved the perch several metres. After 2 hours, I collected from around the perches all the chelae and pellets the Kingfishers had dropped. I measured chelae lengths and depths with vernier calipers and sexed crab remains by the characteristic size and shape of the chelae (Hayes, unpub.).

To determine how often Kingfishers discarded or removed chelae during feeding, I recorded whether one, both or no chelae were dropped in each of 50 instances of a Kingfisher handling a crab.

RESULTS

The number of Kingfishers at Brooklands Lagoon ranged from three in March to ten in May and declined to five in August. The Kingfishers were tolerant of one another, often perching side by side. During 40 hours of watching I did not see any aggression or attempts to steal one another's prey.

Kingfishers at Brooklands Lagoon fed only at low tide, when *Helice crassa* were exposed feeding on the mudflats. Kingfishers used driftwood, rocks, wire and the goal post on the mudflats as perches (Fig. 2). Occasionally birds sat directly on the mud, but only when preferred perches were occupied. Kingfishers flew 2-60 m from perches and scooped up crabs in their beaks without touching the mud.

The success rate of Kingfishers at catching crabs was 96% (97 out of 101 attempts). The vertical drop of foraging dives depended largely on the height of perches available. The higher the perch, the further Kingfishers tended to fly to catch crabs (Fig. 3). Kingfishers with prey returned to the perch which they had flown from on 20 out of the 44 occasions recorded (46%). On very windy days the birds often carried the crabs back to the shelter of trees.

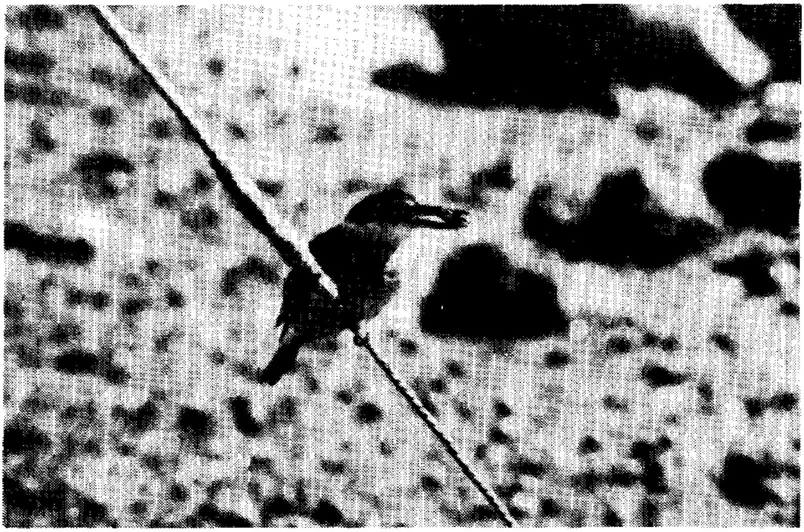

FIGURE 2 — Juvenile Kingfisher holding a mud crab *(Helice crassa)*

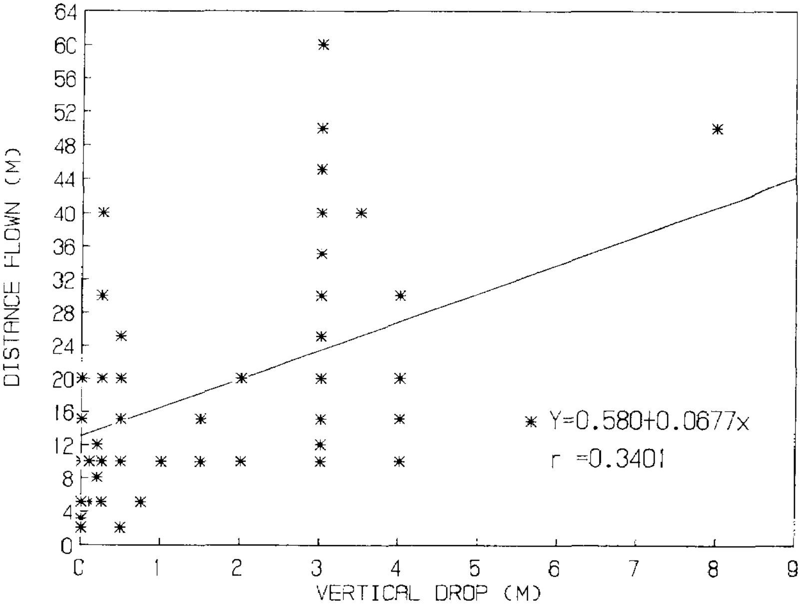

FIGURE 3 — The relationship between vertical drop and distance flown for Kingfisher feeding dives

Back at a perch, Kingfishers battered crabs against the perch to prepare them for swallowing. Birds attempting to eat crabs while sitting on the mud often flew to a solid perch to batter the crab against. Dealing with a crab before swallowing took on average 11.0 s ± SD 5.98 (range 3-30 s, n = 77), larger crabs seeming to take longest. After eating several crabs, birds regurgitated a pellet of indigestible chitinous material.

H. crassa was the only crab found in the ten quadrats (n = 50 crabs), although low numbers of *Halicarcinus whitei*, *Hemigrapsus crenulatus* and *Macrophthalmus hirtipes* are also at Brooklands Lagoon (Knox & Bolton 1978).

The chelae dropped by the Kingfishers were all of *H. crassa* (n = 225). When Kingfishers bashed the crabs against perches (n = 50), both chelae were removed 45.2% of the times, one chela was removed 19.1% and no chela was removed 35.7% of the times. Smaller crabs were swallowed with less bashing than larger crabs, and so most crabs with no chela removed were probably small. The samples of discarded chelae probably contained more than one chela from some large crabs and lacked the chelae of some small crabs because they had not been knocked off. However, the occasions where two chelae were removed were about equal in number to the occasions where no chelae were removed. I did a chi-square test to see whether right chelae were discarded more often than left chelae. The ratio of right to left chelae was 1:1.05 and therefore neither side was preferred. Swallowed chelae were regurgitated whole in a pellet of indigestible remains, and therefore were included in calculations of sex ratios and size of crabs taken by Kingfishers. The chelae sample is likely to be only slightly biased towards crabs from which two chelae were removed.

The crab samples contained mostly small and medium-sized individuals ranging in carapace width from 3 mm to 15 mm, with a mean 9.1 mm ± 3.07 (Table 1). Kingfishers dropped around the perches chelae significantly larger than those of crabs in the quadrat samples (females, $t = 4.06$, $p < 0.05$; males, $t = 11.30$, $p < 0.05$; Fig. 4), indicating that the Kingfishers did not take crab sizes randomly. As no chelae from crabs with a carapace width smaller than 10 mm were collected from around the perches, only crabs larger than 10 mm were important to the Kingfishers.

TABLE 1 — Sex ratio and numbers of crabs in 10 0.25 m^2 mud samples taken in areas in which Kingfishers fed at Brooklands Lagoon. Sex ratio (F:M) 1:1.77 ($X^2 = 3.92$, $p < 0.05$)

	Males (n=32)		Females (n=18)	
	x	SD	x	SD
Weight (g)	0.46	0.84	0.64	0.36
Carapace width (mm)	8.2	3.2	10.6	2.1
Chelae length R (mm)	5.4	2.9	5.7	1.5
Chelae length L (mm)	5.3	2.9	5.7	1.5
Chelae depth (mm)	3.3	2.0	2.6	0.6

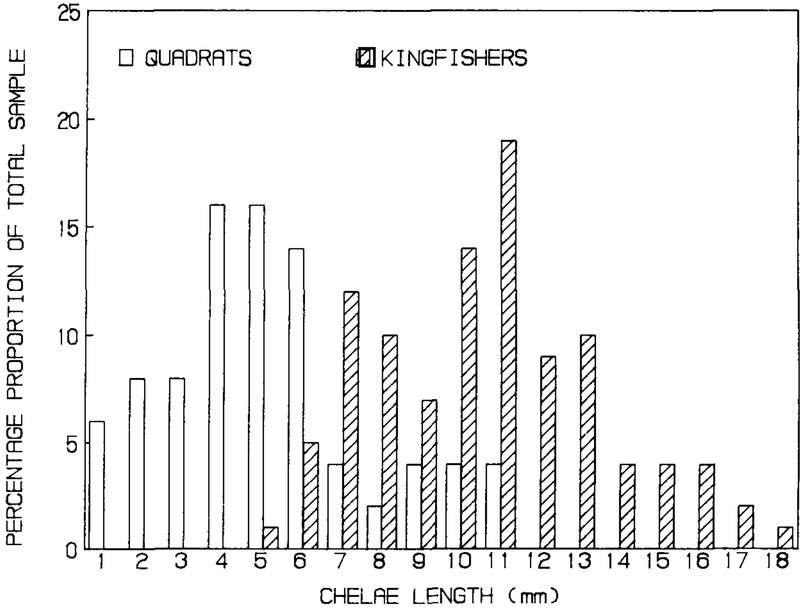

FIGURE 4 — The distribution of chelae lengths from *Helice crassa* found in the sampling quadrats (n = 50) compared with those discarded by Kingfishers (n = 225)

The sex ratio of the crabs in the sample was 1:1.77 (F:M), which is significantly biased towards males ($X^2 = 3.92$, $p < 0.05$). The sex ratio of the dropped chelae was 1:5.6 (F:M), which is significantly different from 1:1. The sex ratio of crabs in the sample is significantly different from the sex ratio of dropped chelae ($X^2 = 11.64$, $p < 0.005$). When only crabs larger than 10 mm from the quadrat samples were considered, the sex ratio was 1.2:1 (F:M), slightly biased towards females. Despite this bias, the Kingfishers took large male crabs significantly more often than large female crabs ($X^2 = 18.47$, $p < 0.05$; Table 1).

DISCUSSION

The Kingfishers preferred to feed on the mudflats, although they commonly dived in the nearby Styx River to wash. Although many species of fish were in the Styx River and Brooklands Lagoon (Knox & Bolton 1978), Kingfishers did not take fish, concentrating on mud crabs at low tide. They did not feed at high tide because the water on the mudflats was discoloured.

The Kingfishers generally used perches, although occasionally they sat on the mud. They needed something solid for bashing the crabs against, and perches presumably gave an elevated and extended view of the mudflats. In spite of the better view and larger attack area from high perches, the Kingfishers did not seem to prefer them on an open mudflat where the birds are more obvious to aerial predators such as the Harrier *(Circus approximans)*.

If Kingfishers fly further to catch crabs from higher perches, using a high perch may cost Kingfishers more energy than the greater catch would justify. Choice of perch may depend also on what perches are available near patches of high prey density.

Boag (1982) suggested that European Kingfishers *(Alcedo althis)* were less territorial and less aggressive in coastal areas than elsewhere because territories were poorly defined and the birds were flexible in their choice of feeding area. In these respects the Kingfishers at Brooklands appeared to behave like coastal kingfishers in Britain.

Kingfishers took large crabs and male crabs proportionally more frequently than they were on the mudflats. More large crabs may have been taken because large crabs were more obvious, offered a larger meal, or behaved more conspicuously than smaller crabs. Male crabs may be preferred for the same reasons. Beer (1959) suggested that female *H. crassa* are more timid and so may move underground at a hint of danger more quickly than male crabs.

Arkell (1978) studied the Giant Kingfisher *(Megaceryle maxima)*, which fed on Cape River crabs *(Potamon perlatus)* in South Africa. Arkell compared discarded chelae and carapaces with the sizes of live crabs available. Giant Kingfishers also seemed to select larger Cape River crabs, or perhaps swallowed small crabs whole (since no regurgitated pellets were examined).

The Kingfishers at Brooklands Lagoon fed only on the mud crab *Helice crassa* during the winter. This was a very restricted diet compared with the large number of prey types taken by Kingfishers in other habitats. However, crabs are active and abundant on the mudflats all year round and are a reliable source of food for Kingfishers in winter.

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METHODS

Between October 1980 and December 1982 I visited most of the saltmarshes and coastal freshwater wetlands in Nelson, the Marlborough Sounds, and Buller at least twice and searched them for Banded Rails, Marsh Crakes and Spotless Crakes (*Porzana tabuensis*).

I used three methods for detecting their presence: sightings, calls and sign such as footprints.

1. *Sightings:* All three species are very secretive, and in the thick vegetation of their habitats I saw few birds.
2. *Sound:* Apart from normal calling, Banded Rails often respond to tape-recorded calls by calling or by moving towards the tape recorder. However, their response is unreliable and I saw Banded Rails in places where there had been no response to taped calls.

   Both crakes are notorious for their unpredictable response to taped calls.

   I played taped calls of Banded Rails, Marsh Crakes and Spotless Crakes at most of the saltmarshes and swamps I visited, but because this method is not reliable, I did not take a lack of response to be conclusive evidence that a species was not present.
3. *Sign:* Banded Rails leave conspicuous and distinctive footprints in the mud of saltmarshes. Their footprints are 36-47 mm long, as are those of oystercatchers, Spur-winged Plovers, Pied Stilts, crakes and young wekas. However, the footprints of the waders are asymmetrical whereas those of rails are symmetrical; crakes have thinner toes and, being lighter, leave fainter impressions in the mud than Banded Rails; and wekas small enough to cause confusion are always with their large-footed parents.

   Other indicators of Banded Rails were their distinctive feathers and faeces and sometimes dead birds.

With the light impressions made by crakes in the mud, their very shy nature, and their small inconspicuous droppings, my attempts to define their distribution were far less reliable than for Banded Rails.

As rain and tides obliterate footprints, which proved the most reliable method of detecting rails, I did not try searching after rain or high tides.

RESULTS AND DISCUSSION

Banded Rails

Distribution: The places where I found Banded Rails are shown in Figure 1. The population of Banded Rails in Nelson and Marlborough seems to be an isolated one. I found no Banded Rails in the saltmarshes just south-east of the Marlborough Sounds, or in Buller. The most recent record of Banded Rails in Buller was of one found in 1978 (Morse 1981), and there have been no other recent reports of Banded Rails in the South Island outside Nelson and Marlborough. In the North Island they are rarely seen south of a line between Kawhia and Opotiki (Bull *et al.* 1985).

I found no Banded Rails in freshwater wetlands and, with one exception, all the Banded Rail sign I found was in saltmarshes. The one exception was sign found in rush-covered pasture adjacent to a very small saltmarsh.

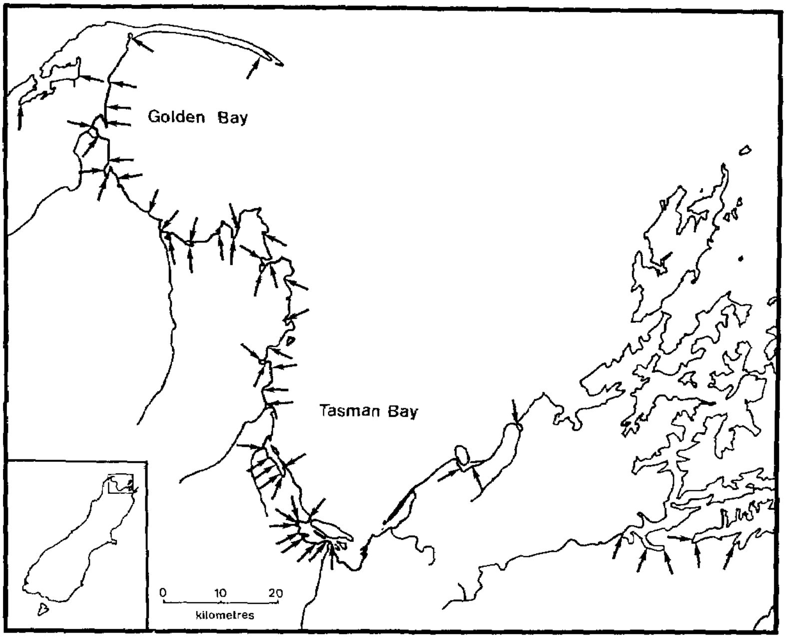

FIGURE 1 — Places where Banded Rails were found in Nelson and Marlborough

Elsewhere in New Zealand Banded Rails are found in freshwater wetlands, although never as commonly as in saltmarshes and mangroves. The Wildlife Service's Fauna Survey Unit recorded Banded Rails from many freshwater wetlands in the King Country, but most of the records were in wet, rush-covered pasture and scrubland, rather than in unmodified, raupo-dominated wetlands (Colin O'Donnell, pers, comm.). Few freshwater wetlands are left in Nelson and the Marlborough Sounds, and all of those that I checked for Banded Rails were raupo dominated. Furthermore, I found no Banded Rail sign in raupo adjacent to saltmarshes.

The lack of Banded Rails in raupo-dominated wetlands is consisitent with my conclusions in my study of the patterns of habitat use (Elliott 1987). I found that Banded Rails prefer vegetation which offers cover but does not hinder foraging movements (raupo is very tangled and dense at ground level).

Vegetation relationships: I found Banded Rails only in saltmarshes with stands of sea rush (*Juncus maritimus*) and mixed stands of jointed rush (*Leptocarpus similis*) and marsh ribbonwood (*Plagianthus divaricatus*). A requirement for sea rush is consistent with my observations (Elliott 1987) that Banded Rails are most active in vegetation dominated by sea rush, and though they are not active in stands of jointed rush and marsh ribbonwood, Banded Rails nest and roost there.

Freshwater supply: I found Banded Rails only in saltmarshes with a regular freshwater supply. Most saltmarshes have streams or rivers flowing through them, but those on the landward side of Rabbit Island, on Farewell Spit, and on the spits at the mouths of the Moutere, Motueka, and Aorere Rivers do not, and these saltmarshes have no Banded Rails. The vegetation of most of these saltmarshes differs from other saltmarshes in that it is dominated by the low-growing glasswort (*Salicornia australis*) and sparse sea rush, which alone could account for the lack of Banded Rails. However, the vegetation of the extensive area of saltmarsh on the inside of Farewell Spit is apparently the same as that of other saltmarshes with Banded Rails, and yet Banded Rails are in only a very small area near the seaward end of the spit where there is fresh water.

Two possible reasons for the Banded Rail's needing fresh water are that

1. It has a metabolic requirement for fresh water, or
2. It needs the snail *Potamopyrgus estuarinus* in its diet.

I frequently saw both wild and captive Banded Rails drinking fresh water, and a container of fresh water left on a lawn adjacent to a saltmarsh near my house was used by wild Banded Rails for bathing and drinking every day for a month. In parts of the Pacific, Banded Rails are on islands without fresh water (Warham 1961, Dunlop 1970, Blackburn 1971), and yet Carpenter & Stafford (1970) found that the Banded Rail's close relative, the Guam Rail (*Rallus owstoni*), needed to drink fresh or at least brackish water to maintain its salt and water balance. The case for a metabolic dependence on fresh water is inconclusive.

The small snail *Potamopyrgus estuarinus* is an important element in the winter diet of Banded Rails (pers. obs.), and Winterbourn (1970) wrote "*Potamopyrgus estuarinus* has a clearly circumscribed habitat, and is confined to brackish water." Clearly *Potamopyrgus* is only in saltmarshes with some freshwater input, and so lack of Banded Rails may be linked to lack of *Potamopyrgus*.

Banded Rails and domestic stock: I did not find any Banded Rails in saltmarshes or parts of saltmarshes that were extensively grazed by cattle. Cattle eat rushes, particularly the jointed rush, and the upper reaches of cattle-grazed saltmarshes had few, if any, mixed stands of jointed rush and marsh ribbonwood. Furthermore, trampling by cattle often reduced the amount of cover.

Density of Banded Rails: I was unable to estimate the number of Banded Rails at most saltmarshes, but at 11 saltmarshes I could tell the number of pairs of birds with fair accuracy. At eight saltmarshes, I estimated numbers from a 6-month trapping and breeding study. At one small saltmarsh I found little Banded Rail sign, and the number of nests I found was consistent with there being only one pair of birds. In two small saltmarshes, I found even less Banded Rail sign and no nests. I assumed that only one bird was at each of these saltmarshes.

Table 1 gives the areas of saltmarsh per pair or single Banded Rail at these 11 saltmarshes.

Size of the Nelson-Marlborough population: Having regard for the approximate density of breeding pairs of Banded Rails, the size of the saltmarshes, and the factors that affect the distribution of rails I estimate that about 100 pairs of breeding Banded Rails are in Nelson and Marlborough. In addition there is an unknown number of non-breeding birds.

TABLE 1 — Areas of saltmarsh vegetation in saltmarshes with known numbers of Banded Rails

Saltmarsh	Number of Pairs of Banded Rails	Area (ha) of Saltmarsh Vegetation per pair
Ngaio	<1	1.6
Milnthorpe	1	1.2
Hoddy	<1	1.4
Tasman	2	3.0
Dominion Road	1	0.6
Harley Road	1	0.8
Old Bridge	1	2.0
Trafalgar Road	2	0.8
Stringer's Creek	3	1.2
Kina	1	1.9
Moana	<1	1.5
Mean		1.5

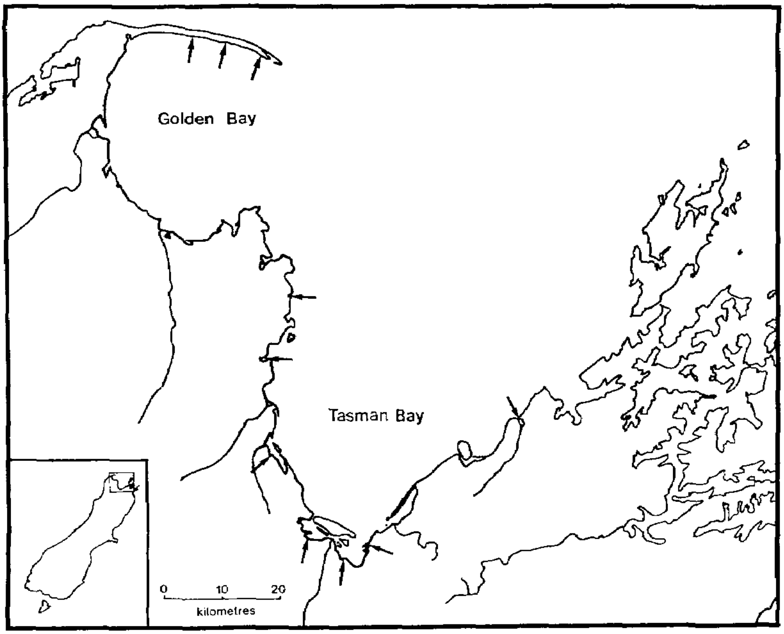

FIGURE 2 — Places where Marsh Crakes were found in Nelson and Marlborough

Crakes

Figure 2 shows the places where I found crakes. The three crakes I saw were Marsh Crakes, and all the sign I found was in saltmarsh. As Spotless Crakes rarely occur outside raupo-dominated freshwater wetlands, I assume that all were Marsh Crakes.

Marsh Crakes apparently have different habitat requirements from those of Banded Rails because

1. They were found in some of the saltmarshes that were apparently too small for Banded Rails
2. They were quite common in the Farewell Spit saltmarshes despite the lack of fresh water.
3. They were in some saltmarshes that had no stands of sea rush.

CONCLUSION

The Nelson - Marlborough Banded Rail population is vulnerable because it is small, dependent on unmodified saltmarshes, and scattered along the coastline. Many saltmarshes have only one resident pair of rails, and the long-term presence of Banded Rails is probably dependent on occasional colonisation from neighbouring saltmarshes. The disappearance of Banded Rails from only a few saltmarshes along the coast increases the isolation of parts of the population and thus makes the whole population even more vulnerable. Of particular concern are the Banded Rails in Marlborough Sounds. I estimate that only about 13 pairs of Banded Rails are east of Nelson City, and these birds and those west of Nelson are already separated by 35 km of unsuitable coast.

The only saltmarshes in the region with legal protection are those in Abel Tasman National Park and in the Farewell Spit Flora and Fauna Reserve, but probably too few Banded Rails are in these saltmarshes alone to sustain a population. There is clearly a need for more saltmarsh reserves in the region. A series of saltmarsh reserves equally spaced along the Nelson - Marlborough coast would keep the population from becoming unduly fragmented, but only the reservation of all saltmarshes could guarantee its long-term survival.

ACKNOWLEDGEMENTS

Thanks to Rod Hitchmough, who criticised a draft of this paper; Ben Bell, who supervised the MSc study of which this was a part; Kath Walker for all sorts of help; and the Department of Lands and Survey, who helped finance the study.

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SHORT NOTE

Grey-backed Storm Petrel at Doubtful Sound, Fiordland

On the night of 2/11/88 a Grey-backed Storm Petrel *(Garrodia nereis)* flew aboard RV Munida moored in Deep Cove, Doubtful Sound. The bird was presumably attracted by the lit-up vessel. The weather was overcast with rain. Moderate westerly winds had predominated for some days. The bird was given to me next morning by the crew, A. Heineman and P. Meredith. It was released on 4/11/88.

The lack of plankton-feeding birds plus very low surface salinity at the time suggested low available zooplankton. It is therefore unlikely that the storm petrel had been feeding in Doubtful Sound. Potential food abundance in Doubtful Sound would have been even lower in August, when Cooper (1980) recovered two *G. nereis* under similar circumstances. Breeding grounds are not known in the Fiordland region.

Similar recoveries were reported by Wright (1973), Esler (1978), Cooper (1980), and Morrison (1981, 1983). All were from the southern South Island remote from food sources. Seventeen birds have been recovered by beach patrols since 1953, mostly on the North Island west coast and all between May and December.

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REVIEW

Where to find birds in Australia by John Bransbury. 1987. Century Hutchinson. 539pp.; many maps and colour photographs.

This book is a successor to the late Roy Wheeler's works, *Birds and where to find them – New South Wales* (1974) and *The birds of Victoria and where to find them* (1979). Whereas Wheeler's books contained illustrations of the bulk of the species to be found, Bransbury has chosen to concentrate on where to find birds and leave their identification to the field guides. Although this book covers all of Australia, including offshore islands, the descriptions of the good birdwatching areas have been done in far greater detail than in its forerunners.

The book is divided into eight chapters, one for each state and one each for the Australian Capital Territory and the Northern Territory. A number of large areas, considered worthy of coverage, have been chosen in each state, and then the places of greatest interest in each of these have been picked out for further description. For example, eight areas are dealt with in Victoria, one of which is East Gippsland. This is then separated into two, Croajingalong National Park and Lind and Alfred National Parks. These are, in turn, divided into subsections, Croajingalong into three and Lind and Alfred into two. One of the subsections of Croajingalong, Mallacoota, is further divided into five. The East Gippsland area, and in particular Croajingalong, which is an exceedingly good birding area, is patently covered in some detail. The end result is that one is given very specific information on where to go to see what – the purpose of the book.

Throughout there is good information on access roads, accommodation and/or camping facilities and, of course, habitat types and the species of birds to be seen. The simple, easy to read maps, coupled with the concise directions given in the text, should see anyone to their desired destination. A list of useful addresses is provided at the beginning of each chapter.

Most of my birdwatching experience in Australia has been in the south-east and, in my opinion, the areas chosen for discussion, in this part of the country, are well chosen and thoroughly covered. Obviously all the good birdwatching places cannot be included in a book of this size but I was sorry to find that the entire south coast of Victoria, from Geelong to the South Australian border, was omitted. Anyone relying solely on this book would miss some grand birding and scenic areas. Three national parks, a game reserve and a forest park are there.

Nonetheless, I believe that this book is a must for any birder in Australia, resident or visitor. At $A35 it is within the price range of most. It may be obtained direct from Alan Davidson, Marketing Manager, Century Hutchinson, P.O. Box 496, Hawthorn, Victoria 3122, Australia.

P. C. M. Latham

SEABIRDS FOUND DEAD ON NEW ZEALAND BEACHES IN 1986 AND A REVIEW OF *Pachyptila* SPECIES RECOVERIES SINCE 1960

By R. G. POWLESLAND

ABSTRACT

In 1986, 4594 kilometres of coast were patrolled and 14 462 dead seabirds were found. Three new species for the Beach Patrol Scheme were the White-naped Petrel (*Pterodroma cervicalis*), the White-capped Noddy (*Anous minutus*) and the White Tern (*Gygis alba*). Four species found in greater numbers in 1986 than previously were the Yellow-nosed Mollymawk (*Diomedea chlororhynchus*), Narrow-billed Prion (*Pachyptila belcheri*), Short-tailed Shearwater (*Puffinus tenuirostris*) and Stewart Island Shag (*Leucocarbo carunculatus chalconotus*).

A summary is given of the coastal and monthly distributions for each species of *Pachyptila* found between 1960 and 1986. The Fairy Prion (*P. turtur*), a New Zealand resident, was found most frequently mainly in February and between July and November. By comparison, the other five species, all migrants to New Zealand, were picked up mainly during July-August.

INTRODUCTION

This paper records the results of the Ornithological Society of New Zealand's (OSNZ) Beach Patrol Scheme for 1986 and reviews *Pachyptila* species recovered since 1960. All sections of coast were patrolled (see Powlesland & Imber 1988), except Fiordland. In total, 664 Beach Patrol Cards and five Specimen Record Cards were submitted in 1986.

Kilometres "travelled" are the total lengths of coast actually patrolled, whereas kilometres "covered" are the lengths of coast patrolled monthly. Hence, if 1 km of beach is patrolled twice in one month, 2 km have been travelled but only 1 km covered per month.

The taxonomic nomenclature is that of Kinsky (1970, 1980), except that I have followed Imber (1985) for the White-naped Petrel and the Kerguelen Petrel (*Lugensa brevirostris*).

RESULTS AND DISCUSSION

In 1986, the total length of coast travelled was 4594 km along which 14 462 seabirds were found dead by 286 OSNZ members and their friends. The average number of birds per kilometre of coast covered was 3.45 (Table 1). Both the total distance travelled and the number of birds found were greater than the respective averages of 3994 km and 10 747 birds per year recorded over the previous 15 years 1971-1985). Further, the average number of birds per kilometre (3.45) was greater than that for the previous 15 years (3.15). A summary of the number of birds per kilometre covered per coast for each month is presented in Table 1. Coastal and monthly totals of uncommon species (less than 12 specimens) are given in Table 2, while for more common species (at least 12 specimens), coastal totals are presented in Table 3 and monthly totals in Table 4.

NOTORNIS 36: 125-140 (1989)

TABLE 1 — Numbers of dead seabirds recovered and kilometres covered on each coast in 1986

COAST	CODE		MONTH												TOTAL		BIRDS/KM /COAST
			JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	KM	BIRDS	
AUCKLAND WEST	AW	KM	213	245	180	214	219	192	189	268	203	186	199	186	2494		
		BIRDS	493	278	114	122	574	96	240	5699	315	322	455	380		9088	3.64
TARANAKI	TA	KM	6	22	2	23	8	22	16	2	5	36	13	4	159		
		BIRDS	25	4	2	10	12	15	6	2	3	27	12	4		122	0.77
WELLINGTON WEST	WW	KM	6	47	11	33	38	22	24	82	58	41	29	9	400		
		BIRDS	12	600	34	83	249	17	76	736	112	100	120	16		2155	5.39
AUCKLAND EAST	AE	KM	96	26	24	31	21	54	34	76	14	25	52	23	476		
		BIRDS	484	22	45	40	21	93	18	347	28	31	71	103		1303	2.74
BAY OF PLENTY	BP	KM	17	26	9	8	8	2	3	58	13	6	18	22	190		
		BIRDS	63	31	8	8	6	2	1	878	33	6	43	36		1115	5.89
EAST COAST NI	EC	KM	8	6	8	8	3	15	8	8	13	15	12	12	116		
		BIRDS	9	15	9	12	0	8	1	2	8	26	20	7		117	1.01
WAIRARAPA	WA	KM	-	1	3	6	-	6	-	-	-	-	-	-	16		
		BIRDS	-	3	3	3	-	3	-	-	-	-	-	-		12	1.33
WELLINGTON SOUTH	WS	KM		-	-	1	22	9	33	26	7	1	13	1	113		
		BIRDS	-		-	0	27	13	85	105	14	6	19	2		271	2.40
NORTH COAST SI	NC	KM	-	-	-	-	1	23	-	1	1	5	5	-	36		
		BIRDS	-	-	-	-	2	8	-	0	1	3	5	-		19	1.89
WESTLAND	WD	KM	-	4		-	5	4	2	4	-	4	1	-	24		
		BIRDS	-	0	-	-	0	0	4	1	-	0	1	-		6	0.25
CANTERBURY NORTH	CN	KM	6	6	1	-	-	6	6	6	2	6	11	6	56		
		BIRDS	8	12	2	-	-	2	6	7	7	10	15	13		82	1.46
CANTERBURY SOUTH	CS	KM	-	-	-	-	1	1	-	-	2	-	-	-	4		
		BIRDS	-	-	-	-	3	2	-	-	9	-	-	-		14	3.50
OTAGO	OT	KM	7	6	3	10	14	13	11	7	7	6	10	14	108		
		BIRDS	17	9	19	17	18	12	6	2	12	5	16	18		151	1.40
SOUTHLAND	SD	KM	-	1	-	-	1	-	-	-	-	-	-	-	2		
		BIRDS	-	3	-	-	4	-	-	-	-	-	-	-		7	3.50
TOTAL KILOMETRES TRAVELLED			394	434	281	346	384	373	348	634	354	357	396	293	4594		
TOTAL KILOMETRES COVERED			359	390	241	334	341	369	326	538	325	331	363	277	4194		
TOTAL BIRDS RECOVERED			1111	977	236	295	916	271	443	7779	542	536	777	579		14462	
BIRDS/KM COVERED/MONTH			3.09	2.51	0.98	0.88	2.69	1.73	1.36	14.46	1.67	1.62	2.14	2.09			3.45

TABLE 2 — Seabirds of which 1 to 11 specimens were found in 1986

SPECIES OR SUBSPECIES	NUMBER FOUND	COAST(S)	MONTH(S)
Megadyptes antipodes	11	OT(10),SD.	MAR(3),APR,MAY(6),DEC.
Eudyptula minor albosignata	9	BP,CN(7),CS.	MAR,JUN,JUL(2),AUG,SEP,NOV(2),DEC.
Eudyptes spp.*	1	OT.	JUN.
pachyrhynchus	1	OT.	DEC.
Diomedia exulans	9	AW(8),WS.	APR(3),MAY(2),JUN,JUL,AUG,NOV.
epomophora	5	AW(4),OT.	MAY,SEP(2),OCT,NOV.
melanophrys	3	AW(3).	JUL(2),DEC.
chlororhynchos	5	AW(2),AE(3).	APR,JUN,AUG(2),SEP.
bulleri	8	AW(4),AE,EC,WS(2).	MAY,JUN,JUL(2),AUG(2),SEP(2).
cauta subspp.*	6	AW(4),WS,OT.	JAN,APR(3),JUL,DEC.
salvini	2	AW(2).	OCT(2).
Pterodroma inexpectata	10	AW(9),WW.	FEB,MAR(2),APR,JUN,NOV(3),DEC(2).
neglecta	1	AW.	MAR.
pycrofti	1	BP.	AUG.
nigripennis	10	AW(4),WW,AE(3),BP(2).	JAN(6),FEB(2),MAR,APR.
cervicalis	1	AE.	JAN.
Procellaria cinerea	6	AW(3),AE,BP(2).	JAN,JUL,AUG(2),SEP,NOV.
parkinsoni	7	AW,AE(2),BP(4).	JAN(4),FEB(2),AUG.
westlandica	3	AW(2),WS.	JAN,JUL,DEC.
aequinoctialis	3	AW(2),AE.	JAN,FEB,OCT.
Puffinus gavia/huttoni	3	WW(2),WS.	MAY,AUG.SEP.
Garrodia nereis	1	WS.	AUG.
Phaethon lepturus	2	AE(2).	JAN(2).
Phalacrocorax spp.*	4	AW(2),AE,CN.	JAN,FEB,JUN,SEP.
carbo	11	AW(3),WW(2),AE,EC(3),OT(2).	APR,MAY(3),JUN,JUL,AUG(2),SEP(2),NOV.
sulcirostris	5	AW,BP(3),WS.	FEB(2),JUN,AUG,DEC.
brevirostris	9	AW(3),WW,WS,OT(4).	JAN,FEB,APR,JUN(2),JUL,AUG,SEP,NOV.
Stercorarius skua lonnbergi	2	AW,BP.	MAR,AUG.
parasiticus	1	AW.	AUG.
Larus bulleri	9	WW,EC(3),OT(5).	JAN(3),FEB(3),APR(2),JUL.
Hydroprogne caspia	5	AW(2),WW(2),AE.	JAN(2),APR,MAY,JUL.
Sterna spp.*	3	AW(2),OT.	FEB,OCT,NOV.
albifrons sinensis	1	AE.	FEB.
fuscata	4	AW(3),WW.	JAN(4).
Anous minutus	2	AW,AE.	JAN(2).
Gygis alba	1	WW.	MAY.
Procelsterna cerulea	1	AW.	DEC.
TOTAL	166		

* species or subspecies was not identified by the patroller.

Unusual finds

Despite the operation of the Beach Patrol Scheme since 1939, new species are recorded in most years. Three new species were found in 1986, one from the family Procellariidae and two from the family Sternidae. A White-naped Petrel was picked up at Karikari Bay, Northland (AE) in January. Dowding (1987) provided a description and measurements of this specimen.

Two White-capped Noddies were found in January, one on Muriwai Beach (AW) and the other on Karikari Bay (AE). Six live White-capped Noddies have previously been seen around New Zealand: two at Kaipara Harbour (AW), one in October 1953 (Sibson 1955) and the other in August 1964 (Sibson 1965); one at Farewell Spit (NC) in January 1961 (Edgar 1962); one at Spirits Bay (AE) in January 1965 (MacDonald 1965); one at Whangarei Heads (AE) in February 1965 (Robb & Robb 1965); and one at the Taieri River mouth (OT) in April 1977 (Westerskov 1977). In addition, one dead bird was found at Houhora Harbour (AE) in March 1975 (Edgar 1975). At least four of these birds were seen after gale force northerly winds.

The White-capped Noddy is distributed throughout the tropical and subtropical Atlantic and Pacific Oceans, breeding on islands throughout this range. In the New Zealand region it breeds on some of the Kermadec Islands. On the Meyer Islets laying occurs from October to January (Soper 1969), with the young leaving the nest in January-April. During the non-breeding season, the noddies return at dusk to roost at or near their nesting sites (Harrison 1983).

TABLE 3 — Coastal distribution of dead seabirds more commonly found in 1986

SPECIES OR	COASTS														TOTAL
SUBSPECIES	AW	TA	WW	AE	BP	EC	WA	WS	NC	WD	CN	CS	OT	SD	BIRDS
Eudyptula minor subspp.*	328	12	60	244	30	3	4	7	5		8	1	14	3	719
Diomedea spp.*	11	-	4	-	-	-	-	3	-	-	-	1	-	-	19
chrysostoma	39	-	-	-	1	-	-	-	-	-	-	-	-	-	40
cauta cauta	18	5	1	1	-	-	-	1	1	-	-	-	-	-	27
Phoebetria palpebrata	12	-	1	-	-	-	-	-	-	-	-	-	-	-	13
Macronectes spp.*	18	1	6	-	-	-	-	2	1	1	-	-	-	-	29
Fulmarus glacialoides	31	-	1	1	1	-	-	-	-	-	-	-	-	-	34
Daption capense	26	-	5	14	11	-	-	8	-	1	1	-	1	-	67
Lugensa brevirostris	100	1	32	3	2	-	-	-	-	-	-	-	-	-	138
Pterodroma spp.*	3	-	-	2	17	-	-	-	-	-	-	-	-	-	22
macroptera	31	1		15	14	-	-	-	-	-	-	-	-	-	61
lessonii	58	1	1	-	3	-	-	1	-	-	-	-	-	-	64
cookii	5	-	-	27	1	-	-	-	-	-	-	-	-	-	33
Halobaena caerulea	38	-	6	1	12	-	-	-	-	-	-	-	-	-	57
Pachyptila spp.*	653	11	391	28	7	-	-	15	-	-	1	1	1	-	1108
vittata	173	-	31	1	-	-	-	1	-	-	-	-	-	-	206
salvini	272	-	30	6	9	-	-	1	-	2	-	-	-	-	320
desolata	946	-	25	46	3	2	-	3	-	-	-	-	1	-	1026
belcheri	1269	2	123	6	8	-	-	2	-	-	-	-	-	-	1410
turtur	2880	12	662	210	198	5	-	35	-	-	1	-	2	-	4005
crassirostris	7	-	1	-	7	-	-	1	-	-	-	-	-	-	16
Puffinus spp.*	21	-	11	2	1	-	-	2	-	-	-	3	-	-	40
carneipes	34	1	-	42	15	1	-		-	-	-	-	-	-	93
bulleri	75	3	19	39	9	4	2	1	-	-	-	-	-	-	152
griseus	434	15	71	166	34	40	1	17	-	-	1	2	16	2	799
tenuirostris	490	19	187	61	2	3	-	1	-	-	-	-	-	-	763
gavia	333	6	70	122	137	9	2	4	1	-	-	-	5	-	689
huttoni	4	1	7	2	3	-	-	3	-		8	-	-	-	28
assimilis	18	-	-	16	4	-	-	-	-	-	-	-	-	-	38
Pelagodroma marina	8	1	-	2	5	-	-	-	-	-	-	-	-	-	16
Pelecanoides urinatrix	170	-	307	82	500	1	-	103	5	2	-	-	-	-	1170
Sula bassana	240	10	12	61	16	9	1	2	1	-	-	-	-	-	352
Phalacrocorax varius	16	-	1	11	8	-	-	-	-	-	2	-	-	-	38
Leucocarbo carunculatus chalconotus	-	-	-	-	-	-	-	-	-	-	-	-	25	1	26
Stictocarbo punctatus	2	-	1	1	-	-	-	3	2	-	8	5	28	-	50
Larus dominicanus	184	11	58	45	18	25	2	31	2	-	7	-	19	-	402
novaehollandiae	44	6	9	21	25	3	-	14	1	-	32	-	12	-	167
Sterna striata	27	3	10	7	-	5	-	1	-	-	5	-	1	-	59
TOTALS	9018	122	2143	1285	1101	110	12	262	19	6	74	13	125	6	14296

* Species or subspecies was not identified by the patroller.

TABLE 4 — Monthly distribution of dead seabirds more commonly found in 1986

SPECIES OR SUBSPECIES	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL BIRDS
Eudyptula minor subspp.*	311	66	33	46	23	51	21	45	29	28	31	35	719
Diomedea spp.*	-	-	-	5	4	1	1	3	1	2	1	1	19
chrysostoma	1	1	1	1	-	3	4	10	9	8	1	1	40
cauta cauta	-	1	-	5	-	3	4	5	1	2	2	4	27
Phoebetria palpebrata	-		-	1	1	1	1	1	-	4	2	2	13
Macronectes spp.*	-	1	1	-	-	4	4	7	-	3	7	2	29
Fulmarus glacialoides	3	1		-	-	1	1	1	7	15	3	2	34
Daption capense	-	-	-	-	-	-	7	26	9	6	9	10	67
Lugensa brevirostris	1	1	-	-	1	-	2	42	58	25	7	1	138
Pterodroma spp.*	1	-	1	-	1	-	-	13	1	1	2	2	22
macroptera	14	1	2	2	5	7	1	10	5	7	1	6	61
lessonii	2	2	1	1	7	5	5	11	6	9	9	6	64
cookii	10	-	2	3	-	-	-	-	-	-	4	14	33
Halobaena caerulea	4	1	-	-	-	1	2	41	2	5	1	-	57
Pachyptila spp.*	14	217	9	20	27	14	19	528	92	80	71	17	1108
vittata	-	-	-	-	-	-	1	188	5	11	1	-	206
salvini	-	-	-	-	-	2	5	298	9	6	-	-	320
desolata	1	-	-	-	16	10	24	950	21	3	1	-	1026
belcheri	-	-	-	-	3	3	21	1351	21	7	4	-	1410
turtur	41	330	12	16	9	8	81	3026	127	108	181	66	4005
crassirostris	-	-	-		-	-	1	9	-	6	-	-	16
Puffinus spp.*	8	7	1	1	6	1	9	4	3	-	-	-	40
carneipes	25	7	13	10	3	5	3	1	-	-	8	18	93
bulleri	36	28	12	6	8	4	1	1	3	14	24	15	152
griseus	190	47	10	17	86	26	8	1	6	48	192	168	799
tenuirostris	94	5	1	3	587	24	1	1	-	1	27	19	763
gavia	114	83	27	28	25	13	28	220	19	37	46	49	689
huttoni	3	2	-	1	1	2	2	5	2	5	3	2	28
assimilis	8	-	-	2	-		2	5	1	-	9	11	38
Pelagodroma marina	2	2	-	-	-	-	-	-	-	2	4	6	16
Pelecanoides urinatrix	51	9	3	6	12	20	133	810	50	15	31	30	1170
Sula bassana	44	38	16	27	16	6	15	73	17	36	33	31	352
Phalacrocorax varius	8	2	4	3	3	2	2	5	2	4	2	1	38
Leucocarbo carunculatus chalconotus	7	4	2	1	4	3	2	-	1	1	1	-	26
Stictocarbo *punctatus*	1	3	8	5	2	2	-	6	11	3	3	6	50
Larus dominicanus	37	66	53	47	42	31	14	43	9	16	25	19	402
novaehollandiae	39	22	7	16	8	4	4	17	3	8	17	22	167
Sterna striata	11	15	8	7	-	3	-	4	-	5	3	3	59
TOTALS	1081	962	227	280	900	260	429	7761	530	531	766	569	14296

* Species or subspecies was not identified by the patroller.

A White Tern was found on Otaki Beach (WW) in May. There are records of five other White Terns on the New Zealand mainland; Waipu (AE) in 1883, Ettrick (OT) in March 1945, Bethell's Beach (AW) in May 1960, inland Pakotai (Northland) in May 1964, and Palmerston North in June 1972, (Sibson 1978). These stragglers were probably blown south by northerly gales.

The White Tern breeds on many islands throughtout the tropical and subtropcial regions of the Indian and Pacfic Oceans. It breeds from October to March on the Kermadec Islands in the New Zealand region (Serventy *et al.* 1971). Outside the breeding season it disperses to pelagic waters (Harrison 1983).

A Kermadec Petrel (*Pterodroma neglecta*) which came ashore between Maunganui Bluff and Glink's Gully (AW) in March is the second recorded for the Beach Patrol Scheme. The first was picked up on Muriwai Beach (AW) in April 1981 (Powlesland 1983). This species' nearest breeding localities are at the Kermadec Islands on Macauley Island (B.D. Bell pers. comm.) and the Herald Islets (Falla *et al.* 1979). Considering that breeding occurs throughout the year on the Herald Islets (Falla *et al.* 1979), it is interesting that only two birds have been found on New Zealand beaches. Presumably it takes exceptionally strong north-easterly winds to blow these birds as far south as new Zealand.

Two White-tailed Tropicbirds (*Phaethon lepturus*) were found in January 1986, one on Waikuku Beach (AE) and the other at Great Exhibition Bay (AE). Previously, eight specimens have been found by patrollers: 1973, BP, January: 1979 (3), TA and AW (2), February (2) and June; 1983 (3), AW (3), March, April and May; 1985, AE, December. This species breeds on islands in the tropical Atlantic, Indian and Pacific Oceans, with New Caledonia being the nearest breeding locality to New Zealand (Serventy *et al.* 1971, Harrison 1983). It is a regular though rare visitor to the eastern coasts of Australia, with the stragglers that reach New Zealand possibly being blown south by cyclones.

A Little Tern (*Sterna albifrons*) was found on Access Bay, Firth of Thames (AE) in February 1986, the fifth specimen to be found by patrollers. The records for the other specimens are: 1975, CS, October; 1978, AW, November; 1980, AW, December and 1982, AE, April. This tern is a regular summer migrant to New Zealand. Details about the numbers of Little Terns seen annually and their seasonal and geographical distribution in the country have been provided by Powlesland (1984).

Species found in greater numbers in 1986 than in any previous years were Yellow-nosed Mollymawk, Narrow-billed Prion, Short-tailed Shearwater and Stewart Island Shag. Five Yellow-nosed Mollymawks were found on Auckland West (2) and Auckland East (3) beaches in April, June, August (2) and September. Although Yellow-nosed Mollymawks were occasionally seen at sea about northern New Zealand in the 1970s, it was not until 1980 that the first beach-wrecked specimen was found (Veitch 1982). Three Yellow-nosed Mollymawks were found in 1981 and one in most subsequent years.

All six *Pachyptila* species were found in large numbers in 1986 (Table 3). The recovery of 1410 Narrow-billed Prions (*P. belcheri*) is the highest annual total for this species, 1326 in 1974 being the previous highest total. Generally, fewer than 100 specimens are found each year. The 1986 totals for the other *Pachyptila* species are their second (*desolata* and *crassirostris*) or third (*vittata, salvini* and *turtur*) highest annual totals. Most of the 1986 prions were picked up from Auckland West and Wellington West beaches (Table 3) in August (Table 4). Wrecks of prions are relatively frequent along the North Island west coast in winter and these are discussed in the prion review section.

The 1986 total of Short-tailed Shearwaters was 763, just surpassing the previous highest annual total of 755 in 1968. Usually 100-200 specimens of this shearwater are found each year. Most of the 1986 Short-tailed Shearwaters were recovered from North Island west coast beaches (91%) (Table 3) in May (77%) (Table 4). This shearwater winters in the northern Pacific Ocean, returning in late September to its many breeding islands about south-eastern Australia, in Bass Strait and around Tasmania (Serventy *et al.* 1971). Like other migrant shearwaters, Short-tailed Shearwaters have a short laying period, from about 19 November to 2 December for this species. The eggs hatch in late January and the chicks leave from about mid-April to early May (Serventy *et al.* 1971). Thus, the wreck of Short-tailed Shearwaters on New Zealand beaches in 1986 coincided with the departure of the birds to their Northern Hemisphere wintering grounds. As young birds, particularly recent fledglings, would be most prone to starvation or exhaustion, it was probably mainly these inexperienced foragers which were beach-wrecked.

In most years fewer than ten Stewart Island Shags are found. However, 26 were picked up in 1986; the previous highest annual total was 19 in 1979. All but one of the 1986 birds were found on Otago beaches (Table 3). Birds were recovered in most months, with the greatest numbers being in summer and early winter (Table 4). The cause of this apparently increased mortality is unknown. However, it occurred over several months and therefore was probably not caused by storms. Scarcity of food is a more likely explanation.

Miscellaneous birds

Birds other than seabirds recovered in 1986 totalled 176. There were 34 magpies, 20 Rock Pigeon, 15 Black Swan, 10 Starling, nine each of Cattle Egret and unidentified passerine species, seven each of Mallard and Kingfisher, six Tui, five each of White-faced Heron and Australasian Harrier, four each of Pukeko, Pied Stilt, Blackbird and Indian Myna, three each of domestic geese, duck species, Variable Oystercatcher and Silvereye, two each of Grey Duck, domestic turkeys, South Island Pied Oystercatcher and Song Thrush, and one each of White Heron, Australasian Bittern, Canada Goose, Western Weka, oystercatcher species, New Zealand Dotterel, Banded Dotterel, Bar-tailed Godwit, Turnstone, Knot, Red-necked Stint, Morepork and Skylark.

REVIEW OF *Pachyptila* RECOVERIES 1960-1986

The following is a summary of the coastal and monthly distributions of the *Pachyptila* species found by patrollers during the past 27 years. In total, 74 505 prions (*Pachyptila* spp.) were found, of which 13 504 were not identified to species. The remaining 61 001 birds comprised six species (Table 5).

The Kolmogorov-Smirnov one-sample test (Siegel 1956, p. 47) was used to test whether the pattern of recovery for each species (Figures 1 & 2) differed from the theoretical situation whereby an equal number of birds were found each month.

BROAD-BILLED PRION *P. vittata*

The Broad-billed Prion is confined to the subtropical convergence zone and nests mainly on islands situated in or adjacent to it (Harper 1980). In the New Zealand region it is a common prion, nesting in vast numbers at the Chatham Islands, on islets in Foveaux Strait and at The Snares. Elsewhere, it nests on Gough and Tristan da Cunha Islands in the South Atlantic Ocean and St Paul Island in the Southern Indian Ocean (Harper 1980).

TABLE 5 — Rate of recovery (number of prions found per 100 km of beach covered) of six species of *Pachyptila* on each coast in 1960-1986

SPECIES	AW	TA	WW	AE	BP	EC	WA	WS	NC	WD	CN	CS	OT	SD	OI	Total
P. vittata	4.8	1.1	19.5	0.5	0.1	0.3	1.5	1.2	1.0	1.4	1.5	8.7	0.4	19.4	3.5	5.8
P. salvini	21.3	1.8	16.3	0.3	0.3	0.7	-	0.7	0.3	1.6	0.3	0.3	0.1	1.7	-	12.0
P. desolata	17.8	1.0	3.8	1.2	0.9	1.9	-	0.5	-	2.3	0.2	0.6	0.1	0.3	0.4	6.7
P. belcheri	13.9	2.5	6.1	0.6	1.4	0.6	0.3	1.0	0.3	0.9	0.6	3.5	0.1	1.1	0.2	7.4
P. turtur	85.1	14.6	84.6	16.2	15.7	19.0	16.3	22.4	19.6	3.1	9.1	6.4	2.6	7.1	8.4	55.5
P. crassirostris	0.1	0.1	0.1	0.1	0.3	0.2	0.6	0.9	-	-	0.2	0.3	-	-	0.2	0.2

Richdale (1965) studied the breeding biology of the Broad-billed Prion at Whero Island in Foveaux Strait. Large numbers of birds return to the island in July to dig or clean out burrows. After mating they remain at sea for several weeks while the female forms an egg. Laying occurs between late August and mid-September, and hatching about mid-October. Most nestlings have left the breeding islands by the end of December. The species is sedentary, birds being present about the breeding islands throughout the year, but noticeably fewer are evident for the first two months after breeding (Richdale 1965).

During 1960-1986 patrollers found 3979 Broad-billed Prions. Fewer than 100 were picked up during most years, but 1385 were found in 1961 and 1175 in 1974. Overall, the average rate of recovery was 3.45 birds per 100 km of coast covered. Of the coastal regions, Wellington West had the greatest rate of recovery (19.5 birds/100 km of coast covered), followed by Southland (19.4) and Canterbury South (8.7) (Table 5). The Southland result is to be expected, given the large numbers breeding on Foveaux Strait islands. The high rate of recovery from Wellington West beaches results largely from a wreck in 1974. Of the 1175 Broad-bills picked up during that year, 80% were found on Wellington West beaches. Why only seven Broad-bills have been found on Otago beaches (0.4 birds/100 km), when further north 137 have been found on Canterbury South beaches (8.7 birds/100 km) is not known.

The recovery of so many Broad-bills wrecked on North Island west coast beaches suggests that large numbers disperse from their nesting islands into

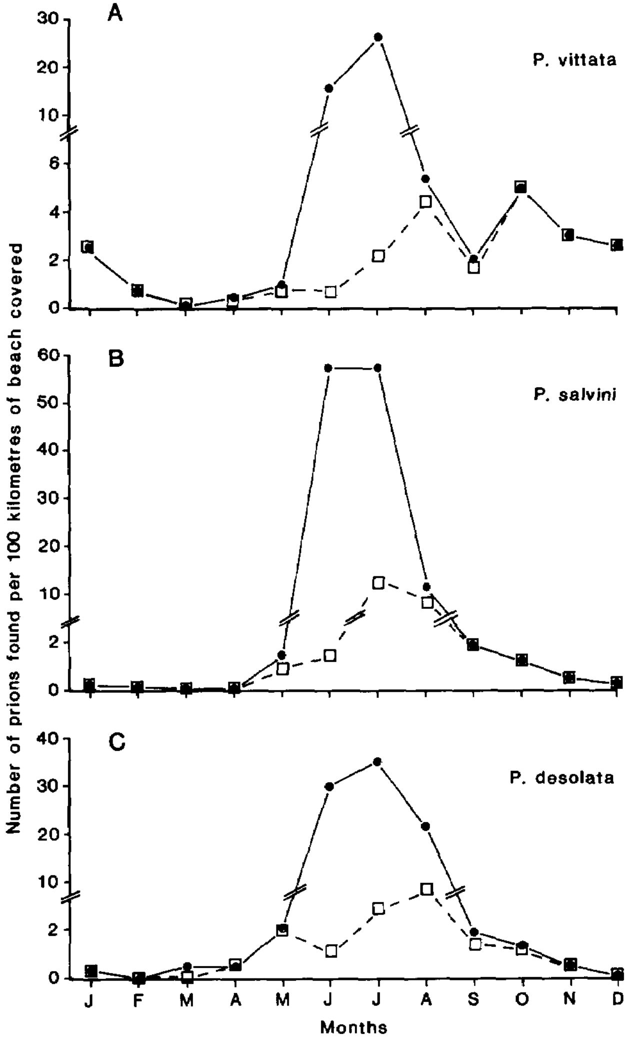

FIGURE 1 — Monthly rate of recovery (number found dead per 100 km of beach covered) of *Pachyptila vittata*, *P. salvini* and *P. desolata* during 1960-1986 (circles) and durig all but wreck years (squares).

the Tasman Sea after the breeding season (Harper 1980). Alternatively, southwest gales may force Broad-bills into the Tasman Sea from the subtropical convergence zone to the south of the Tasman Sea, as apparently happened in 1961 (M. J. Imber, pers. comm.)

The monthly rate of recovery of Broad-billed Prions changed significantly during the year ($p<0.01$; Figure 1A), being greatest in winter and least in late summer-autumn. When the data for 1961 and 1974 were deleted (years in which 500 or more *vittata* were found in any month), the monthly rate of recovery of Broad-bills still changed significantly during the year ($p<0.01$; Figure 1A). However, the period of peak mortality was then in late-winter-spring. The main cause of the wrecks in 1961 and 1974 was considered to be food shortages which left the birds with bodily reserves too low to sustain them during a subsequent period of persistent westerly winds (Bull & Boeson 1963, Veitch 1976).

SALVIN'S PRION *P. salvini*

This prion's breeding range is restricted to islands in the Southern Indian Ocean, where it nests on Marion Island and Prince Edward Island, and on East, Hog, Possession, Penguin and Apostle Islands of the Crozet Archipelago (Harper 1980, 1985; Jouventin *et al.* 1984). Salvin's Prions first return to the Crozet Islands in mid-September, laying between mid-November and early December. The young hatch in January and leave their nests after about 60 days (Jouventin *et al.* 1985). After the breeding season, this prion deserts the Crozet Islands (Jouventin *et al.* 1985), but it returns occasionally to its colonies on Marion Island (Mendelsohn 1981).

Patrollers usually find fewer than 100 Salvin's Prions annually. However, 1307 birds were recovered in 1970 and 5228 in 1974. During 1960-1986, 8148 Salvin's Prions were found at an average rate of 12.0 birds per 100 km of beach covered. The species has been found on all coasts except Wairarapa. Most Salvin's Prions were found on Auckland West beaches (21.3 birds per 100 km of coast covered) and Wellington West beaches (16.3) (Table 5). These high rates of recovery resulted from wrecks in July 1970 and June-July 1974, when 6459 (79% of the total found) were recovered.

The monthly rate of recovery of Salvin's Prion changes significantly through the year ($p<0.01$; Figure 1B). Most were found in winter. Even when the data for years in which wrecks of *salvini* occurred were deleted from the analysis (years in which 500 or more prions were found in any month: 1970, 1974), the monthly rate of recovery of Salvin's Prions changed significantly ($p<0.01$) and the period of peak mortality was still in winter (Figure 1B). Most of the *P. salvini* found on New Zealand beaches have been emaciated fledglings which had left their nests 3-4 months previously (Harper 1980)

ANTARCTIC PRION *P. desolata*

The Antarctic Prion is abundant in subantarctic waters, breeding on at least nine widely distributed archipelagoes about Antarctica (Harper 1980). In the South Atlantic Ocean it nests on the South Orkneys, South Georgia, South Sandwich Islands and Bouvet Island, and in the South Indian Ocean on Kerguelen and Heard Islands. In the New Zealand region (Southern Ocean) it nests on Macquarie Island, the Auckland Islands and Scott Island. Although these nesting islands are widely separated, their populations of Antarctic Prions have similar breeding schedules (Harper 1980). The birds at Signy Island, South Orkneys, return in late October (Tickell 1962). Eggs are laid there mainly from mid to late December, and the young leave the burrows from mid-March to early April (Tickell 1962). The birds then disperse throughout the cooler waters of the Southern Ocean, except for the central South Pacific Ocean, where food is scarce (Harper 1985).

Generally, fewer than 50 Antarctic Prions have been found annually during the past 17 years. However, the two highest annual totals of 3186 in 1974 and 1026 in 1986 are in marked contrast to this pattern. From 1960 to 1986, 5896 prions were picked up at a rate of 8.7 birds per 100 km of beach covered. Nearly 90% of all Antarctic Prions have been found on Auckland West beaches, giving a rate of 17.8 birds found per 100 km of beach covered (Table 5).

The monthly rate of recovery of the Antarctic Prion varies significantly ($p<0.01$) and is much the same as that for Salvin's Prion, most birds being found in winter (Figure 1C). When the data for years in which wrecks of *desolata* occurred (years in which 500 or more were found in any month: 1974, 1975, 1986) were deleted from the analysis, the monthly rate of recovery still changed significantly ($p<0.01$). However, the period of peak mortality changed slightly, from June-July to August (Figure 1C).

Harper (1980) considered that most of the Antarctic Prions beach-wrecked here came from Macquarie Island and the Auckland Islands. Although the earliest records of fledgling *P. desolata* on New Zealand beaches are in mid-March (Harper 1980), very soon after leaving their burrows, most birds have been found in winter after persistent westerly winds. This suggests that the birds came from the subantarctic zone and were driven north into the Tasman Sea and on to our beaches by south or southwest gales.

NARROW-BILLED PRION *P. belcheri*

Although a few Narrow-billed Prions nest on East Islands of the Crozet Islands (Jouventin *et al.* 1984), most nest at Kerguelen Island in the Southern Indian Ocean (Harper 1985), on the Falkland Islands in the South Atlantic Ocean (Strange 1980) and on Isla Noir off southern Chile in the South Pacific Ocean (Clark *et al.* 1984). After an absence of six months, the birds return to New Island, in the Falklands, in early September and lay during the first three weeks of November. The young leave the colonies from mid-February to early March (Strange 1980). Narrow-billed Prions from southern South America disperse westward into the South Pacific, but do not reach New Zealand (Harper 1980). However, those from Kerguelen Island migrate eastward, adults being found on West Australian beaches from May to September. The younger birds travel further east and are commonly found on New Zealand beaches (Harper 1980).

In total, 5044 Narrow-billed Prions have been found by patrollers from 1960 to 1986, giving an overall rate of 7.4 birds per 100 km of beach covered. From 1970 to 1986, about 50 birds were found each year, with as few as eight in 1971 and 14 in 1977. Wrecks of Narrow-billed Prions occurred in 1974 (1326) and 1986 (1410), these being the highest annual totals. As for *P. desolata*, the majority of *P. belcheri* (82%) have been picked up from Auckland West beaches, the average being 13.9 birds per 100 km of beach covered (Table 5).

As for *P. salvini* and *P. desolata*, the majority of *P. belcheri* (92%) have been found on New Zealand beaches in winter (Figure 2A), their monthly rate of recovery varying significantly ($p<0.01$). Similarly, when the data for years in which wrecks of *belcheri* were deleted from the analysis (years in which 500 or more *belcheri* were found in any month: 1974, 1984, 1986), the period of peak mortality still occurred in winter ($p<0.01$, Figure 2A).

FAIRY PRION *P. turtur*

The Fairy Prion has a circumpolar distribution. It breeds on Marion Island, Roche Quille near St Paul Island, the Crozet Islands, Prince Edward Island and Kerguelen Island in the South Indian Ocean, on Beauchene Island (Falklands) and Bird Island (South Georgia) in the South Atlantic Ocean, and on Tasmania and the Bass Strait Islands in the South Pacific Ocean

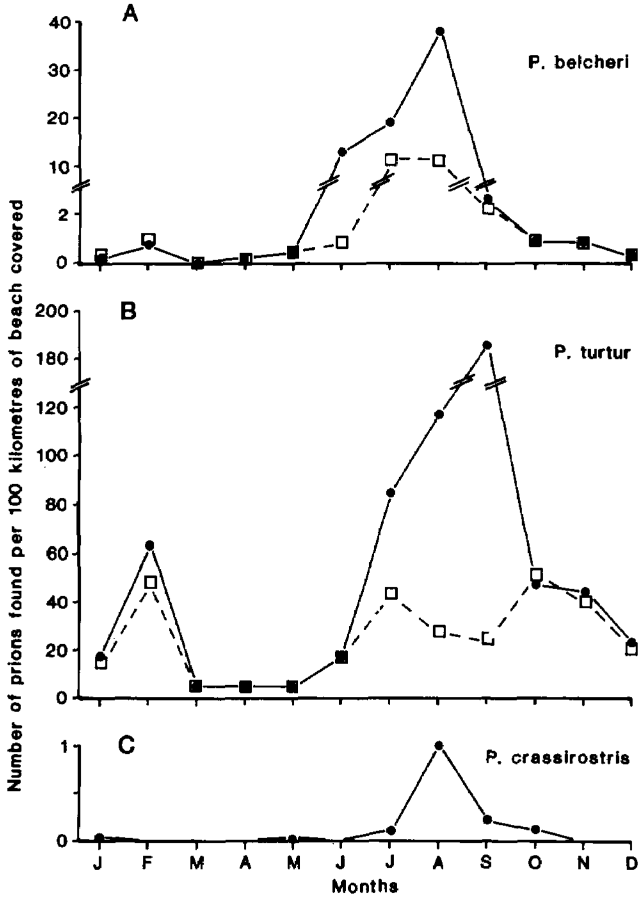

FIGURE 2 — Monthly rate of recovery (number found dead per 100 km of beach covered) of *Pachyptila belcheri, P. turtur* and *P. crassirostris* during 1960-86 (circles) and during all but wreck years (squares).

(Harper 1980, Prince & Croxall 1983, Jouventin *et al.* 1984, Williams 1984, J.- C. Stahl pers. comm.). In the New Zealand region it is particularly numerous, nesting on the Antipodes Islands, islets off Macquarie Island, the Snares, Chatham Islands, Poor Knights Islands, Trio Islands, Stephens Island, Brothers Islands, Motunau Island, Open Bay Island, and islets off Stewart Island, Akaroa and Otago (Harper 1985). The timing of the breeding cycle alters with latitude. For example, those on the Poor Knights Islands (35° 28'S) off Whangarei lay a fortnight earlier than those further south on Whero Island (46° 55'S) in Foveaux Strait (Harper 1980). Fledglings from the Poor Knights leave their nests in early January, whereas those from Whero Island do so in February and early March. During the non-breeding season (March-August), these birds generally remain within the New Zealand region, the largest concentrations being east of Northland and in the Cook Strait-South Taranaki Bight and Foveaux Strait areas (Harper 1985, J. A. F. Jenkins, pers. comm.).

During 1960-1986, patrollers found 37 833 Fairy Prions. Usually 500-1000 prions were picked up annually from 1970 to 1983, but in the last three years 3912, 10 929 and 4005 were found. The two highest annual totals of Fairy Prions were 10 929 in 1985 and 5118 in 1975. Nearly 90% of the Fairy Prions were picked up from Auckland West and Wellington West beaches. Overall, the average rate of recovery was 55.5 birds per 100 km of coast covered. Of the coastal regions, Auckland West (85.1 birds/100 km of coast covered) and Wellington West (84.6) had the greatest rates of recovery (Table 5).

The monthly rate of recovery of the Fairy Prion changed markedly during the year ($p<0.01$), large numbers being found in February and from July to November (Figure 2B). Even when the data for years in which wrecks of Fairy Prions occurred were deleted from the analysis (years in which 1000 or more *turtur* were found in any month: 1975, 1976, 1984, 1985, 1986), the monthly rate of recovery changed significantly through the year ($p<0.01$) and the periods of peak mortality remained the same. The February peak in recoveries coincides with the dispersal of fledglings to sea. Strong winds in late January and February kill many young prions before they can develop foraging skills and accumulate fat reserves (Harper 1985). Although many nestlings from southern localities apparently fledge after February, few beach-wrecked Fairy Prions were found in autumn (Figure 2B).

The second and greater peak in recoveries occurred over winter and spring. Rough seas and poor food supplies at this time and the depletion of fat reserves when battling persistent westerly winds probably contribute to these deaths (Harper 1985). Occasionally, such conditions result in wrecks numbering thousands of birds on North Island west coast beaches. Most of these beach-wrecked Fairy Prions are probably immatures, as has been established for a few other seabird species (Imber 1984, Harper & Fowler 1987). This is to be expected considering that only about 6% of Fairy Prion fledglings survive to adulthood (Harper 1985).

FULMAR PRION *P. crassirostris*

The Fulmar Prion is the rarest of the prion species. Populations occur at the Chatham Islands, on the Western Chain of The Snares and on the Bounty and Auckland Islands in the New Zealand region. The only other population is on Heard Island in the South Indian Ocean (Harper 1980). The population associated with each island is not large, and the birds do not seem to disperse far from their breeding sites (Harper 1980). Information about the breeding schedule of the Fulmar Prion is sparse, but it apparently lays in mid-November and the nestlings go to sea between mid-February and mid-March (Harper 1985).

Fulmar Prions were first reported by patrollers in 1970. Since then 101 have been found, 79 of them in the last two years. Overall, the average rate of recovery has been 0.2 birds per 100 km of coast covered. The sedentary habit and rarity of this species are probably the main reasons why so few have been found. Of the coastal regions, Wellington South has had the greatest rate of recovery (0.9 birds per 100 km of coast covered) (Table 5). This recovery rate is due to 21 Fulmar Prions being found there in 1985 after two days of gale-force winds over an area extending from the Chatham Islands to much of New Zealand's east coast (Powlesland 1987).

Almost all the Fulmar Prions were recovered in the period July-October (Figure 2C), the monthly recovery rate changing significantly ($p<0.01$). Presumably, this pattern relates to the incidence of severe storms forcing some birds on to New Zealand shores.

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OBITUARY

C. F. PARKIN

1903-1988

Many who were lucky enough to stay on Little Barrier Island between 1943 and 1958 will remember with affection Charlie Parkin and his wife, May.

A Geordie from Sunderland, Charlie left England as a seaman-boy and fell in love with New Zealand, where he could always be near the sea. In 1932 he and May were married. During many adventures together, they rode pushbikes from Auckland to Wellington and back. (Just imagine the state of the roads at that time.) They also lived for 5 years on an old oil hulk in the Hauraki Gulf.

On Little Barrier Island Charlie and May were dedicated custodians for 15 years, waging war on the cats as best they could and steadily amassing a wealth of information about their unique island.

One of Charlie's most notable contributions to ornithology was the study of a pair of Stitchbirds at a nest which K. V. Bigwood had found. The nest was 7 metres above ground in a position awkward for photography. With the skill of a sailor-bushman, Charlie erected scaffolding without causing undue interference and built a hide on top. One of Bigwood's resulting colour photographs may be seen as plate 47 in Gordon Williams's *Birds of New Zealand* (Reed 1963). When Bigwood had to depart, Charlie carried on with the observation of the nest. Some of the photographs which he took appeared in *Notornis* 6 pp. 233-236.

King's College boys who took part in trips of exploration to Little Barrier in 1946, 1947, 1948 and 1952 happily recall the warmth of the welcome they received from the Parkins, and especially May's sumptous cooking as a change from their Spartan camp-tucker.

The Ornithological Society extends sympathy to May, who now lives at Hector, near Westport. Our precious offshore islands need resident guardians such as Charles and May Parkin.

R. B. Sibson

INCUBATION AND EARLY CHICK-REARING IN THE GREY-BACKED STORM PETREL *(Garrodia nereis)*

By ADRIAN R. PLANT

ABSTRACT

The breeding of the Grey-backed Storm Petrel at Houruakopara Island in the Chatham Islands (44°06'S, 176°31'W) was investigated and the nest site, egg, and chick are described. Both parents incubated the egg in poorly synchronised shifts averaging 1.9 days, generally followed by a desertion period of 2.7 days. Eggs hatched from mid-November, and the chick was brooded by either parent for up to 4 days after hatching. Chicks were fed on average every 1.6 days and the size of each feeding increased with age. The average daily increase in body weight was 12.6%, and by 17 days the weight of the chicks equalled that of the adults.

Evidence of competition for nest sites within the species and with Broad-billed Prions *(Pachyptila vittata)* and Little Blue Penguins *(Eudyptula minor)* is discussed and a list of food items taken from regurgitations is presented.

INTRODUCTION

The Grey-backed Storm Petrel *(Garrodia nereis)* has a circumpolar, subantarctic distribution, breeding at Tristan da Cunha, Gough, Marion, Prince Edward, Crozet, Kerguelen, South Georgia, and the Falkland Islands (Croxall 1984). In the New Zealand region, it is known to breed on the Chatham, Antipodes and Auckland Islands and is suspected to breed on islets off Campbell Island (Imber 1985). Imber gave an outline of breeding in New Zealand, and some information on aspects of the breeding cycle at the Crozet Islands was reported by Despin *et al.*(1985), but it remains one of the less studied subantarctic storm petrels.

During the late spring and summer of 1987 I visited the Chatham Islands with the Department of Conservation's Taiko research team. This paper reports the results of observations of breeding Grey-backed Storm Petrels on Houruakopara Island between 14 November and 6 December, particularly incubation and the growth and development of the chick.

STUDY AREA AND METHODS

Houruakopara Island is about 400 m south of Chatham Island at 44° 06' S, 176° 31' W. It is a small island rising to 37 m. About half the land area of c. 5 ha is a low promontory of bare rock on which a colony of 130 pairs of White-fronted Terns *(Sterna striata)* nest; the rest has a low forest of *Dracophyllum arboreum*, *Olearia* sp. and *Hebe* sp. with an understorey of *Astelia* sp. and other low shrubs. A narrow dense belt of New Zealand flax *(Phormium tenax)* rings the forested area and also grows in scattered pockets

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on the rock promontory. Most of the colony of about 300 pairs of Grey-backed Storm Petrels nests in the flax along with similar numbers of Broad-billed Prions *(Pachyptila vittata)*, Little Blue Penguins *(Eudyptula minor)* and a few Sooty Shearwaters *(Puffinus griseus)*.

I marked nests with plastic tape and marked attending birds with numbered metal bands. I did not try to sex the birds. I examined nests daily until I realised that some incubating birds were likely to abandon their egg as a result of frequent handling. Thereafter I inspected most nests every 2-5 days. Adults did not abandon nests with chicks, and I examined and weighed the chicks daily.

RESULTS AND DISCUSSION

Nest site and egg

Unlike other storm petrels, which usually nest in burrows or rock crevices, *G. nereis* lays its egg in cavities formed at the base of dense vegetation (Carrick & Ingham 1967). On Houruakopara Island the nest chamber generally occupied spaces underneath sheaves of dead flax leaves or in "fissures" between the bases of living flax leaves and rhizomes. The nest chamber had no real lining, although shredded flax leaves were often present.

The usual clutch was one egg, but 3 (8%) of the 37 nests I found held two eggs. I found no three-egg clutches as reported by Imber (1985). Of 41 eggs examined, 39 were elongate ellipsoid but 2 (5%) were pyriform. Their ground colour was white with a light scattering of reddish-brown spots more or less restricted to one end but occasionally extending more sparsely over the whole egg.

Eggs on Houruakopara Island were slightly smaller and less heavy (Table 1) than the eggs of birds breeding at the Crozet Islands (Jouventin *et al.* 1985). The ratio of egg weight to adult weight was 25.9%, compared with 28.1% at the Crozet Islands, although Imber (pers. com.) found a ratio of 29.2% for freshly laid eggs at the Chatham Islands. The adult birds of both populations were of similar weight. I did not record the dimensions of live birds on Houruakopara Island, but Table 2 compares the dimensions of Crozet Island birds (Jouventin *et al.* 1985) with those of 48 study skins in the National Museum of New Zealand, which were collected in the New Zealand region (7 from Chatham, 15 from Antipodes, 9 from Campbell and 17 from the Auckland Islands). Birds from both areas were of similar size, and the small differences in the length of the culmen and tarsus probably arose from shrinkage of dried museum material. In the New Zealand region, females had longer wings than males.

TABLE 1 — Weights (g) and dimensions (mm) of *Garrodia nereis* eggs

	This study	Jouventin *et al.* (1985)
Weight (g)		
Mean S.D.,range (n)	8.4 ± 0.9, 6.8 – 9.9 (18)	9.0 ± 0.7, 8.5 – 10.0 (8)
Length (mm)		
Mean S.D.,range (n)	31.2 ± 1.0, 29.2 – 33.0 (9)	33.2 ± 1.9, 31.6 – 37.5 (8)
Breadth (mm)		
Mean S.D.,range (n)	23.2 ± 0.6, 22.0 – 23.9 (9)	24.3 ± 1.1, 22.7 – 25.7 (8)

TABLE 2 — Weights (g) and dimensions (mm) of *Garrodia nereis* adult birds

	This Study	Jouventin *et al.* (1985)
Weight (g): mean S.D.,range (n)		
males and females	*32.5 ± 2.3, 29.0 - 37.0 (9)*	*32 ± 5, 25 - 42 (16)*
Culmen (mm): mean S.D.,range (n)		
males	*12.8 ± 0.5, 12.0 - 13.8 (23)*	
females	13.0 ± 0.4, 12.4 - 13.8 (23)	
males and females	12.9 ± *0.5, 12.0 - 13.8 (46)*	*13.6 ± 0.7, 12.5 - 15.0 (18)*
Tarsus (mm): mean S.D.,range (n)		
males	31.4 ± 1.4, 28.3 - 35.2 (23)	
females	32.6 ± 1.3, 30.3 - 35.3 (24)	
males and females	*32.0 ± 1.4, 28.3 - 35.3 (47)*	*32.6 ± 1.4, 30.0 - 34.0 (18)*
Wing (mm): mean S.D.,range (n)		
males	*126 ± 4, 116 - 137 (24)*	
females	132 ± 3, 127 - 139 (24)	
males and females	*129 ± 5, 116 - 139 (48)*	*127 ± 6, 116 - 134 (18)*

Incubation

I followed nest attendance and incubation at nine nests containing one egg. Both partners incubated, alternating between shifts averaging 1.9 ± 1.1 days (range 1-5 days, n = 30). On all but one occasion, shifts were followed by a desertion period lasting 2.7 ± 1.2 days (range 1-7 days, n = 26). Jouventin *et al.* (1985) followed four incubation shifts at one nest and found that the shift length varied from 1-3 days (mean 1.5 days) and that each of three shifts at another nest was followed by a desertion lasting 3.0 ± 2.0 days (range 1-5 days). In the present study the egg was left unattended for a total of 70 (55.6%) of 126 egg-observation days, and using the data of Jouventin *et al.* (1985), I calculated that the eggs of *G. nereis* at the Crozet Islands were deserted for about 50% of the egg period, compared with about 36% for the Black-bellied Storm Petrel *(Fregetta tropica)* and 28.2% for Wilson's Storm Petrel *(Oceanites oceanicus)* at the same localities. In contrast, the eggs of the White-faced Storm Petrel *(Pelagodroma marina)* on Whero Island, New Zealand, were deserted for only 12.9% of the total egg period (Richdale 1965).

Three days is the longest desertion period I know of for an egg that later hatched, but I do not know how the cumulative length of desertions or their timing during incubation influences hatching sucess.

Temporary egg desertion during incubation, a common feature in Procellariiformes, is probably an adaptive mechanism by which the egg can survive long periods of chilling when adverse climatic or feeding conditions prevent the parents returning to the nest (Boersma & Wheelwright 1979). However, my quantitative data should be treated with caution as repeated handling of incubating birds may sometimes have caused premature desertion. Indeed Richdale (1965) commented that the span of incubation in *P. marina* was hard to observe accurately because the birds readily deserted the nest after being handled. Without observer interference (assuming good weather and feeding conditions) the incubation shifts might become longer (and the desertions shorter) and could approach the figure of 5 days reported by Imber (1985). In future work, incubating birds should be handled only to mark them, for example, with paint rather than metal bands, so that individuals can be recognised without being removed from the nest.

One nest containing a single egg was incubated by three birds. If the three incubating birds are called A, B, and C, and a period of desertion O, the daily sequence of nest attendance over 20 days was ABOCCAOBBBOAOCBBBCCC. I do not know whether this was co-operative breeding (Emlen 1984) or a frustrated breeder showing inappropriate parenting behaviour as a result of competition for nest sites (McLean *et al.* 1987).

Nests with two eggs

Although storm petrels usually lay only one egg (Crossin 1974), I found three nests with two eggs. Two such clutches were being incubated when first found but were permanently abandoned early in the study. The third nest had only one cold egg when first examined on 18 November and was incubated for only 2 days (20 & 21 November) and then deserted until 30 November, when two eggs were present. The eggs were left unincubated until 4 December, when a new bird was sitting on one remaining egg. Imber (1985) has reported that competition for nest sites frequently results in two or even three eggs being laid in the same nest, and two-egg clutches of *P. marina* (Richdale 1965) and the White-throated Storm Petrel *Nesofregetta albigularis* (Crossin 1974) were also attributed to two females. In such circumstances they reported that the extra egg was often infertile or abandoned from an earlier nesting and, almost invariably, none survived to hatching.

Birds may have been unable to recognise their own egg, or at least did not reject those laid by other birds because, on one occasion, when I replaced a damaged egg from one nest with one that had been abandoned and had rolled out of another nest, it was readily incubated by both foster parents.

Hatching

The hatching period was protracted. When I arrived on the island on 14 November, hatching was just beginning. During the next 22 days only 9 (22%) of 34 single-egg clutches hatched. Imber (1985) implied that, in the New Zealand region, eggs hatch from mid-November to the end of January, whereas at the Crozet Islands hatching was confined to the first two weeks of February (Jouventin *et al.* 1985). The laying period in storm petrels, other than those breeding at high latitudes, is usually protracted (Imber 1983) and the differences in timing and length of the hatching period between the two regions are probably caused by the influence of climate on the laying period or other factors such as seasonal availability of food (Croxall 1984).

The empty egg shells were not expelled from the nest chamber and were gradually pulverised by the activities of the birds.

Description of the chick

At one day old the chicks were covered with smoky-grey down about 2.0 cm long. On the ventral surface two bands of paler down, whitish-grey but sometimes almost white, run forward from the base of each leg, gradually broadening and uniting on the breast. The throat, cheek and face from the base of the bill to just behind the eye were bare, as in *F. tropica* (Beck & Brown 1971). The crown of the head was covered in down, as in *Oceanites oceanicus* (Roberts 1940) and Leach's Storm Petrel *Oceanodroma leucorhoa* (Ainslee & Atkinson 1937) and there was no bald patch as in the British Storm Petrel *Hydrobates pelagicus* (Lockley 1932) or *Pelagodroma marina* (Richdale 1965).

The eye was fully open by the second day. The bill and claws were black but the legs, toes and webs were whitish flesh, becoming greyer from 8 days onwards, until by 14 days they were wholly black, as in the adult. The first quills to emerge were those of the scapulars (9 days), followed by the secondaries and their coverts (10-11 days) and then the primaries and their coverts (12-13 days). At 12-14 days old and thereafter, feather tracts were clearly discernible on the back and the breast.

Chick rearing and food

I followed brooding shifts of the newly hatched chicks in five nests, at which the patterns of attendance at the nest were AAOO (2 nests), AAAO,AAOB and AOOB (one nest each). I did not find adults at the nest by day later than 4 days after the chick hatched. An initial brooding period is common to many storm petrels, including the Madeiran Storm Petrel *Oceanodroma castro* (Allan 1962), *Oceanites oceanicus* (Beck & Brown 1972) and *Hydrobates pelagicus* (Davis 1957a & 1957b), but is absent in others such as *Fregetta tropica* (Beck & Brown 1971).

Chicks grew rapidly (Figure 1) and by 17 days their weight equalled that of the adults. The maximum weight reached was not determined. From the data in Figure 1, I calculated the average daily rate of growth during this period to be 1.74 g per day, the daily increase in body weight being 12.6%, which agrees closely with the 13.0% derived from the data of Despin *et al.* (1972). Chicks were fed on average every 1.6 ± 0.6 days (range 1-3 days, n = 23) and the size of each feeding increased with the age of the chick (Figure 2).

Storm petrels often regurgitated food when handled during the chick brooding period, and the lag period shown in Figure 1 over the first few days of growth may have been a result of chicks not getting this food. I found that regurgitation samples of nesting birds contained remains of crustaceans. M.J. Imber examined the samples and confirmed his earlier observation (Imber 1981) that the major food items were planktonic larvae of the cirriped *Lepas australis*, but euphausiids *(Nematoscelis megalops, Nyctiphanes australis)* and two species of amphipod, one of which was *Parathemisto gaudichaudii*, were also present.

Interference by other species

I found four nests with damaged eggs and one with a badly mauled chick as well as two eggs and one chick (2-3 days old) which had been expelled from the nest chamber. Broad-billed Prions and Little Blue Penguins, which were both common on Houruakopara Island, nesting in burrows under the flax, were the most likely cause of interference at the nest. By trampling the ground adjacent to their burrows, prions and penguins left large areas

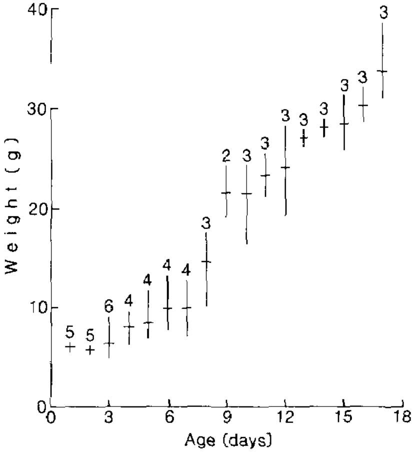

FIGURE 1 — Weight increase in *Garrodia nereis* chicks. Mean, range and sample size

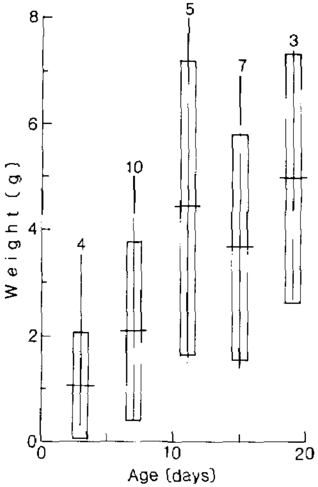

FIGURE 2 — Weight of food given to *Garrodia nereis* chicks during four-day periods. Mean ± standard deviation, range and sample size

of bare earth under the flax, making it unsuitable for storm petrels, which were more abundant where the flax grew on soil too shallow for prions and penguins to burrow. If storm petrels tried to nest in the denser parts of the prion and penguin colonies, the trampling by the larger birds would probably displace or damage their eggs and chicks.

In Tasmania, Gillham (1963) amd Brothers (1981) reported that Short-tailed Shearwaters *(Puffinus tenuirostris)* displaced *Pelagodroma marina* from mutually favoured burrowing areas. Similarly, Richdale (1965) found evidence of competition between *P. marina* and prions on Whero Island. The storm petrels suffered not so much from aggression by the prions, but from the fact that their nests just happened to be in the prions' way.

ACKNOWLEDGEMENTS

I thank Mike Imber for the opportunity to work on Houruakopara Island, for examining regurgitation samples and providing data on egg weights; Kina Scollay and George Watola for help in the field, Gerry Clark for transportation on *Totorore*, and Sandy Bartle for access to study skins in the National Museum of New Zealand. Frank Bailey drew the figures.

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SHORT NOTES

Possum in a kiwi burrow

Both possums and kiwis use natural dens or excavated burrows. Only kiwis excavate their own burrows. Possums occupy already dug burrows or natural dens, modifying them for their needs.

The little information available on kiwi/possum burrow occupancy relates mainly to the Little Spotted Kiwi *(Apteryx owenii)* on Kapiti Island, where possums were found occupying previously used kiwi burrows (Reid, Jolly, pers. comm.). Even less is known of possums using burrows of Brown Kiwis *(A. australis)* (Reid, McLennan, pers. comm.).

On Stewart Island some Brown Kiwi burrows are short and open. A burrow I found at Mason Bay in 1985 measured c. 60 cm deep and c. 25 cm wide at the entrance, sloping slightly down to an enlarged nest chamber c. 30 x 30 cm. Guthrie-Smith (1914, *Mutton Birds and Other Birds*) described four Stewart Island Brown Kiwi burrows as "quite shallow with their entrance tunnels short." Lengths given were three nests 2ft. 6ins. (75 cm) deep and one 1ft. 9 ins. (52 cm) deep.

In June 1984 at Mason Bay I was shown a burrow by Tim Te Aika which was c. 55 cm deep and c. 25 cm wide at the entrance, sloping down to an enlarged area occupied by a female Brown Kiwi. This burrow was 200 m distant from the 1985 breeding burrow and probably in an adjacent territory. After a wait of four days while I set up photographic equipment, I kept an evening watch on the burrow. I photographed the kiwi as it left the burrow and found it paid little attention to my hide, camera or flashlight. Exit times were 7 p.m. on 18 June, 6.25 p.m. on the 19th, 6.30 p.m. on the 20th and 6.30 p.m. on the 21st. Dusk was at about 5.45 p.m. The time the kiwi spent at the burrow entrance after emerging varied from four minutes' preening on a warm still night to leaving immediately on a night with sleet falling. I stopped watching the burrow 15-20 minutes after the kiwi had left.

On 22 June the kiwi left the burrow at 6 p.m., and by 8 p.m. a heavy frost had set in. Some of the other kiwis in the area started calling at 5 p.m. half an hour earlier than usual. All calling ceased at 7 p.m. On a torch search from 9.30 to 11.30 p.m. I saw no kiwis, which was unusual. Slight frosts at Mason Bay are common in winter but not heavy frosts. On checking the burrow at 11 p.m., I found a half-grown male possum in residence. Next morning the possum was still there and no kiwi. I evicted and killed the possum. No kiwi was in the burrow by day until the 27th, when a female was curled up asleep. After I left on the 27th, the burrow was checked periodically by Tim Te Aika, who found a male and a female in residence. A preliminary nest was started, but the burrow was abandoned in December without as egg being laid. This burrow had been used by kiwis for breeding in the past.

During further visits in October 1985 and February 1986, I found no kiwis or possums in the burrow but it did not appear totally disused. During the four weeks I have spent at Mason Bay I saw only two other possums.

Natural dens for possums are plentiful, especially in the red tussock *(Chionochloa rubra)* and flax *(Phormium tenax)* in the pasture area where this burrow was located.

My thanks to Tim & Ngaire Te Aika for their help and showing me the burrow and checking it after I left.

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* * *

A Tahiti Petrel *(Pseudobulweria rostrata)* from Gau Island, Fiji

The bird fauna of Gau Island, which is roughly at the centre of the Fiji archipelago at 18° 00′ S, 179° 16′ E, is reasonably well known (Watling 1985). It includes two species of petrel, the Collared Petrel *Pterodroma (leucoptera) brevipes*, which breeds, in large numbers, and the Fiji Petrel *Pseudobulweria macgillivrayi*, which is apparently endemic to Gau and has recently been rediscovered, having been presumed "lost" since 1855 (Watling & Lewanavanua 1985). We noe report the presence of a third species, the Tahiti Petrel *Pseudobulweria rostrata* on the island.

On 29 September 1987 we found the cat-killed remains of an adult *P. rostrata* at 620 m a.s.l. on a track following the steep-sided NW ridge of Qilai (a subsidiary peak of the island's main summit, Delaco; see Watling (1985) for a general description of the island's topography). The remains were estimated to be 2-3 weeks old and hard to measure, being in an advanced state of decomposition. The folowing measurements were noted, however: culmen 32 mm, tarsus 45.5 mm, mid-toe and claw 55.4 mm, wing 285 mm. These measurements are in reasonable agreement with the measurements quoted by Murphy & Pennoyer (1952). The blunt ends to the latericorn plates of the bill, which usefully distinguish *Pseudobulweria* from *Pterodroma* (Imber 1985), were distinctly obvious.

Previously the only record of *P. rostrata* on land in the Fiji group is of an immature female which flew into a light on Taveuni island on 9 October 1972 and considered by Bourne (1981) to have been reared locally. Jenkins (1986) has reviewed records of *P. rostrata* in Fijian waters, to which we can add the following:

10 May 1986	1 bird 2 miles S of Rewa delta, Viti Levu.
Aug 1986	I. Watkins found a bird dying in Suva harbour, Viti Levu. The bird is preserved as a formalin-mummified specimen in the Fiji Museum, Suva.
21 Nov 1986	4 birds 5 miles E of Taveuni.
10 Sep 1987	1 bird, probably this sp., S of Fiji at 21° S, 177° E.
9 Oct 1987	1 bird, probably this sp., 10 miles W of Gau.

All Fijian records have been between April and November, and it now seems possible that *P. rostrata* is a winter breeder on Gau, Taveuni and perhaps other islands of the group. We made an intensive search of the area where remains were found but found no evidence of breeding. We also spent a total of 114 hours between 15 September and 9 October 1987 operating floodlights and spotlights at night from several site on the island, including the NW ridge of Qilai, but saw no Tahiti Petrels. In 1984 and 1985, spotlighting during February, April, May and July was equally unproductive (Watling & Lewanavanua 1985, Imber 1986). If *P. rostrata* does indeed breed on Gau it probably does so in low numbers, although large areas have still to be explored for breeding petrels.

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DIET OF THE FIORDLAND CRESTED PENGUIN DURING THE POST-GUARD PHASE OF CHICK GROWTH

By Y. M. van HEEZIK

ABSTRACT

The stomach contents of 50 adult Fiordland Crested Penguins were collected during the post-guard phase of chick growth. Twenty-two food species were identified from 19 families. The composition of the diet, expressed as percentages of calculated weight, was 85% cephalopods, 13% crustaceans and 2% fish. The sexes did not differ in their diets. The cephalopods and fish were juvenile and larval forms, indicating that the penguins were feeding on pelagic macro-zooplankton and micro-nekton. The main cephalopod taken was *Nototodarus* sp., and so the penguins were foraging mainly over the continental shelf, which extends no more than 10-15 km from the shore.

INTRODUCTION

Eudyptid penguins characteristically feed offshore on small shoaling species of euphausiids, cephalopods and small fish. The proportions of these three groups in the penguin diet vary between localities, but crustaceans and cephalopods usually make up at least 85% of the diet (Duroselle & Tollu 1977, Croxall & Furse 1980, Croxall & Prince 1980, Williams & Siegfried 1980, Williams & Laycock 1981, Croxall *et al.* 1985, Brown & Klages 1987).

The Fiordland Crested Penguin *(Eudyptes pachyrhynchus)* breeds on the south-west coast of the South Island. Its distribution extends southwards to include Stewart Island, the Solander Islands, and Codfish Island. General features of their growth, breeding cycle, moult and display behaviour have been described by Warham (1974), but very little is known about their diet. In this study I examined the diet of adult Fiordland Crested Penguins during the post-guard phase of chick growth.

METHODS

I visited two colonies in Fiordland: Jackson's Bay on 9-11 October 1984 and Martin's Bay on 4-7 November 1984. At dusk I captured penguins returning from foraging as they made their way up the beach, measured them to sex them (Warham 1974) and weighed them. I was not able to differentiate between breeders and non-breeders.

By water-offloading (Wilson 1984) I collected nine vomits at Jackson's Bay and 41 at Martin's Bay. I decanted off excess fluid and preserved the rest in alcohol in sealed plastic bags.

The vomits were sorted for otoliths, cephalopod beaks, and crustacean remains. I weighed the crustaceans after blotting off surface moisture. Very few fish were entire, and so I sorted, identified and weighed the otoliths and applied allometric equations of Lalas (1983) to calculate both fish length (total length) and weight. Cephalopod beaks were identified as far as possible. I measured upper rostral lengths on squid beaks and upper hood lengths on

TABLE 1 — Species composition of the diet of 50 Fiordland Crested Penguins in Fiordland, South Island

SPECIES		FAMILY	%WT	%OCCUR (n=50)
Cephalopods				
Arrow Squid	*Nototodarus sloanii*	Ommastrephidae		
Warty Squid	*Moroteuthopsis ingens*	Onychoteuthidae	71	94
Octopus	*Ocythoe tuberculata*	Octopodidae		
Octopus	*Octopus maorum*	Octopodidae	14	52
Crustaceans				
Krill	*Nyctiphanes australis*	Euphausiidae		
Squillid shrimp		Stomatopoda	13	94
Crab megalopa	*Ommatocarcinus macgillveryi*	Goneplacidae		
Fish				
Hoki	*Macruronus novaezelandiae*	Merlucciidae	<1	74
Sprat	*Sprattus antipodum*	Clupeidae	<1	30
Red cod	*Pseudophycis bachus*	Moridae	<1	82
Long-snouted pipefish	*Stigmatophora macropterygia*	Syngnathidae	<1	16
Warehou	*Seriolella brama*	Centrolophidae	<1	4
Ahuru	*Auchenoceros punctatus*	Moridae	<1	28
Tarakihi	*Nemadactylus macropterus*	Cheilodactylidae	<1	2
Monkfish	*Kathestoma giganteum*	Uranoscopidae	<1	6
Lantern fishes		Myctophidae	<1	8
Common roughy	*Paratrachichthys traillii*	Trachichthyidae	<1	16
Cockabully	*Trypterygion* spp.	Trypterygidae	<1	2
Grenadier cod	*Tripterphycis gilchristi*	Moridae	<1	4
Sole	*Peltorhamphus tenuis*	Pleuronectidae	<1	10
Maori chief /Black cod	*Notothenia angustata*	Nototheniidae	<1	2
Silversides	*Argentina elongata*	Argentinidae	<1	2

beaks and then calculated weight estimates of the animals (Lalas 1983). Because appropriate allometric equations are not available for all of the cephalopod species encountered, I used the equation for *Nototodarus* also for *Moroteuthopsis*, both of which belong to the order Decembrachiata, and I used the equation for *Robsonella australis* (Lalas 1983) also for *Octopus maorum* and *Ocythoe tuberculata*, all three belonging to the family Octopodidae. As they were all small juveniles, any error was probably small. For dorsal mantle lengths I measured only intact mantles. However, I could not weigh entire animals because the tentacle mass and the mantle appear to separate very quickly after ingestion, and were seldom intact. Finally, I calculated the total weights for each species in each stomach sample and the length-frequency distributions for the two most common species of fish.

RESULTS

Number of species

Altogether, 22 species from 19 families were identified from the 50 vomits collected (Table 1). Two vomits contained nothing and were stained green from bile. All stomachs with more than about seven pairs of squid beaks contained both *Nototodarus* and *Moroteuthopsis*. In those stomachs, an average of 61% by number of these two cephalopod species were *Nototodarus* and 39% *Moroteuthopsis*. Of the Octopodidae, 94% of all individuals were *Ocythoe*.

Relative importance of species

Of the 22 species recorded, cephalopods and crustaceans contributed 98% of the total weight of food ingested. Of the cephalopods, squid *(Nototodarus* and *Moroteuthopsis)* constituted 71% and Octopodidae 14% of the total (Table 1).

The bulk of the weight of crustaceans was made up of the euphausiid *Nyctiphanes australis*, but occasionally crab megalopa *(Ommatocarcinus macgillveryi)* and squillid shrimps were also present. The remaining 2% by weight was made up of 15 species of fish belonging to 13 families. Red cod *(Pseudophycis bachus)*, hoki *(Macruronus novaezelandiae)*, sprat *(Sprattus antipodum)* and ahuru *(Auchenoceros punctatus)* were in many of the stomachs, whereas the remaining species were in few stomachs.

Percentage frequency of occurrence

In general, frequently occurring species also contributed largely to the bulk of the diet. However, red cod and ahuru were present in 82% and 28% of the stomachs respectively, but they were too small to be significant in terms of weight. Being small, they are digested rapidly, which introduces a potential error in reconstructing the penguin's diet. Both the flesh and otoliths of larval fish consumed early in a foraging trip may well have disappeared by the end of the foraging trip, reducing the apparent contribution of fish in the diet. However, even when such errors are compensated for by multiplying the fish component in the diet by a factor of, say, three, its percentage contribution increases only from 2% to 9%. To get a more accurate correction factor I would need to know the duration of the foraging trip as well as the rate of digestion of larval fish.

Size

The measurements of mantle lengths indicated that only juvenile squid were being taken (Fig. 1). Calculations of fish lengths and weights indicated that the penguins were taking only small larval and post-larval fish which contributed very little to the bulk of the diet. Mean total lengths of hoki and red cod were 35.2 mm (SD = 5.5) and 28.0 mm (SD = 7.3) respectively (Fig. 1).

Sexual differences in diet

Of the 50 penguins captured, 35 were females and 15 males. Their diets were almost identical, cephalopods and crustaceans comprising 98% and 97% respectively of their intake. Patterns of intake of the fish species were essentially similar ($X^2 = 0.56$, d = 2, $X^2 = 0.82$, df = 2, $p > 0.05$, grouping crustaceans, cephalopods and fish together, for % weight and % occurrence respectively).

Stomach content weights

The mean calculated weight of all stomach contents except the empty ones was 348 g (n = 48, SD = 330, range = 46 - 1608 g). The mean body weight of the penguins was 3.05 kg (n = 48, SD = 0.40, range = 2.1 - 3.9 kg). Total calculated stomach weights were < 10% body weight in 32 birds, < 20% in 13 birds, and 23, 25, 42, 50 and 62% in the remaining birds.

DISCUSSION

With their diet being mainly cephalopods, small crustaceans and post-larval fish, adult Fiordland Crested Penguins in Fiordland in 1984, both male and female, were probably feeding on the macro-zooplankton.

In samples of spilt food and stomach contents from dissected chicks collected between 1966 and 1971, Warham (1974) also found that the identifiable prey

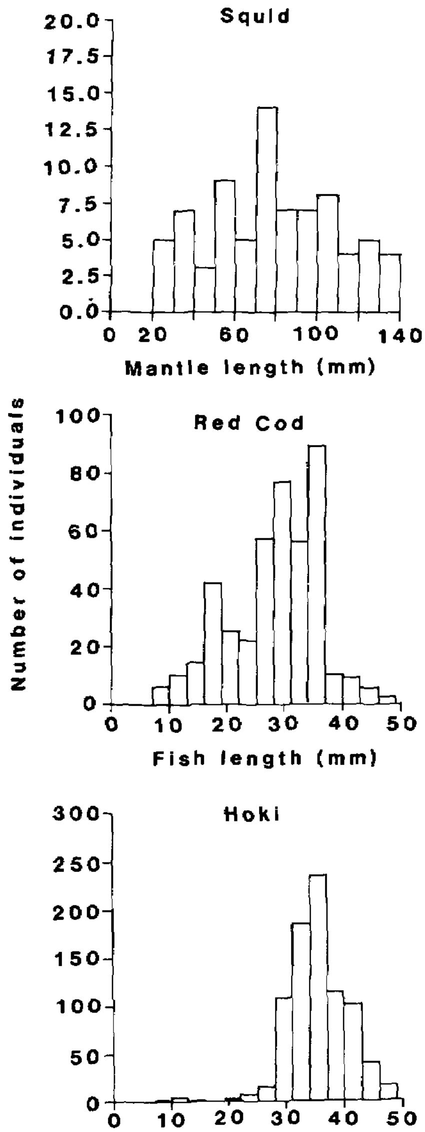

FIGURE 1 — Size-frequency distributions of squid, red cod and hoki found in the stomachs of Fiordland Crested Penguins

of Fiordland Crested Penguins were predominantly cephalopods and sometimes small euphausiids described as being probably *Nyctiphanes australis*. Warham (1974) also found squid beaks up to 10 mm long, far larger than any in this study. Warham (1974) found no identifiable fish remains, but Reischek (1884) claimed young blue cod *(Parapercis colias)* to be the main prey species. I found no blue cod in this study, or in the diet of Fiordland Crested Penguins at another locality (van Heezik 1988) where blue cod were known to be abundant at the time of sampling.

The proportion of cephalopods in the diet compared with crustaceans and fish may be exaggerated by the more rapid digestion of flesh and diagnostic remains (Blake *et al.* 1985, Gaston & Noble 1985, Jackson & Ryan 1986, Adams & Klages 1987). Chitinous cephalopods beaks are likely to remain in the stomach much longer than crustacean remains and fish otoliths. The fish remains in this study were mainly tiny larval fish and hence were rapidly digested. If these fish are totally digested within two hours after ingestion (van Heezik & Seddon, in press), if we assume a foraging trip to last 12 hours, and if fish are taken as much at the beginning as at the end of a trip, and we multiply the weight of the fish by even a factor of 6, the precentage contribution of fish would increase only to 16% of the total weight, compared with 61% squid, 12% octopods and 11% crustaceans.

A further possible bias is that the squid and octopus beaks in the stomach contents had accumulated over more than one day, resulting in an overestimation of cephalopods in the diet. However, the calculated values for weights of squid in individual stomachs are not very high (n = 46, $\bar{x}$ = 254 g, SD = 265 g, range = 5 - 1436 g), 43 of these values being less than 600 g. These values are not an unrealistic meal size for an adult which is also feeding a chick (i.e. 8% adult body weight). Meals of King Penguins *(Aptenodytes patagonicus)* varied between 8.5% and 12% of adult body weight, depending on how meal mass was calculated (Adams & Klages 1987). Moreover adults regurgitate loose beaks along with food to their chicks and so regularly pass loose beaks from their stomachs to those of their chicks, as also observed in the King Penguin (Adams & Klages 1987). Almost all the beaks I recovered in each stomach were small and unstained, apparently at the same stage of digestion, i.e. wings intact with little or no sign of abrasion or wear. Therefore it seems likely that most of the beaks in the stomachs of adults feeding chicks had been accumulated during a single foraging trip.

When comparing feeding ranges of Macaroni and Gentoo Penguins, Croxall & Prince (1980) suggested that certain features of the breeding biology of Macaroni Penguins comply with those characteristics described for offshore feeders: only one chick raised per clutch, long incubation stints rather than daily changeovers, fewer and longer foraging trips, and breeding in vast colonies. They made a rough estimate of foraging ranges, based on length of foraging trip and assumed swimming speed. However, when actual foraging ranges are determined by radio telemetry, for several species of penguin they turn out to be smaller than theoretical ranges calculated on the basis of time at sea and average swimming speed (Wilson 1985, Trivelpiece *et al.* 1986). Although the Fiordland Crested Penguin raises only one chick and spends more than one day at sea at a time during incubation (Warham 1974), and possibly throughout fledging also, the relatively large numbers of *Nototodarus* in the diet indicate that foraging is confined to a distance no further than the width of the contenental shelf (Mattlin *et al.*

1985), which extends only about 10 km off the coast near the study sites. This short foraging range implies a distributionally predictable prey (Frost *et al.* 1976). Although little is known about squid and fish off the coast of Fiordland, the diet of the Fiordland Crested Penguin shows that squid and crustacea are abundant and predictable foods during the post-guard chick-feeding phase of the breeding cycle.

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SHORT NOTES

Surveys of South Georgian Diving Petrels *(Pelecanoides georgicus)* on Codfish Island

In 1978, Imber & Nilsson (1980) found that South Georgian Diving Petrels breed on Codfish Island (46°46'S, 167°39'E). In November 1980, December 1981 and December 1983 counts of their burrows were made by officers of the New Zealand Wildlife Service working there on management projects. In October 1985, JW visited the island to investigate the status of these diving petrels.

South Georgian Diving Petrels burrow in the sand dunes behind the only sandy beach on the island, the habitat described by Imber & Nilsson (1980). The unstable sand made study burrows risky to prepare and so all information was gathered by observing burrow entrances. Initially, JW found that many of the burrow marker tags placed by previous workers still remained but their numbers were not legible; 26 still had a burrow nearby but eight did not. Between 1 and 10 October 1985 all burrows found, including 18 new ones, were monitored daily and all were numbered.

Each burrow entrance was fenced with leaves or twigs so that any petrel entering or leaving the burrow would be detected, giving evidence of occupation. Three adult birds were captured at night (two from one burrow), and their identity was confirmed by the criteria described by Payne & Prince (1979). Particular note was taken of the posterior black line on the tarsus, present in these three.

At that time, these diving petrels were cleaning out their burrows in preparation for laying. Newly opened burrows were found almost daily as digging and prelaying activity increased. Many of these burrows had not been visible because of sand accumulated in the entrances but, once opened, they remained clear as long as regular visits continued.

TABLE 1. The status of burrows of South Georgian Diving Petrels counted on Codfish Island from 1978 to 1985

	Number of burrows				
Month/Year	Active	Inactive	Uncertain	Not Found (marked 1978)	Total
Oct. 1978 (1)	35	10	–	–	45
Dec. 1978 (1)	28	11	2	4	41
Nov. 1980 (2)	32	3	0	9	35
Dec. 1981 (2)	33	9	0	3	42
Dec. 1983 (3)	38	–	–	–	38
Oct. 1985	41	0	3	8	44

1 Imber & Nilsson (1978)
2 Count by J. West and E. Kennedy (Wildlife Service)
3 Includes burrows higher on the dunes at the SE end of the beach, probably of Common Diving Petrels *(P. urinatrix)* (A. Cox pers. comm.)

Table 1 gives the numbers of burrows found on this and earlier counts. Thirty-six burrows were visited nightly, or nearly so; three were visited on less than 50% of nights; two were not visited during the observation period; one was opened on the night before final observations. Two were found only two days before observations ceased.

The population of South Georgian Diving Petrels on Codfish Island may be over 120 birds: 80-90 breeders and 40 + non-breeders.

DISCUSSION

This colony seems to have been stable between 1978 and 1985. Apparently the distribution of burrows gradually changes, some burrows being abandoned and others newly dug from time to time. When these birds arrive over their colony, they land and enter their burrows without delay (pers. obs.), making them unlikely prey for Stewart Island Wekas *(Gallirallus australis scotti)*. This was borne out of the lack of corpses of diving petrels when the large weka population was killing other species of petrel (R.J. Nilsson, pers. comm.), although wekas may well have taken a few fledglings. All wekas had been removed or killed or had died by 1986. Sealers Bay has about 1 km of beach and, as the burrows are scattered along the entire length of the dunes, space for burrows is not likely to be limiting the number of birds. Kiore *(Rattus exulans)* are in the dunes. Whether they are affecting the diving petrels is not known.

This small population does not seem under threat of extinction but it must be watched regularly to see that it remains secure.

We thank E. Kennedy and A. Cox, who helped with field work.

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Grey Ternlets in the Andaman Sea

The Grey Ternlet *(Procelsterna cerulea)* is a sedentary noddy tern of the tropical and subtropical Pacific Ocean (Fig. 1). Its known breeding range extends from Isla San Ambrosio in the east to Lord Howe Island in the west and north to Nihoa and Necker Islands in the Hawaiian Is (Harrison 1983, Schlatter 1984, Harrison *et al.* 1984). The westernmost records of non-breeding Grey Ternlets are from the east coast of Australia (Holmes 1976, Blakers *et al.* 1984). Here, I report a sighting of a flock of Grey Ternlets in the Andaman Sea, c.6000 km from the nearest known breeding island (Fig. 1).

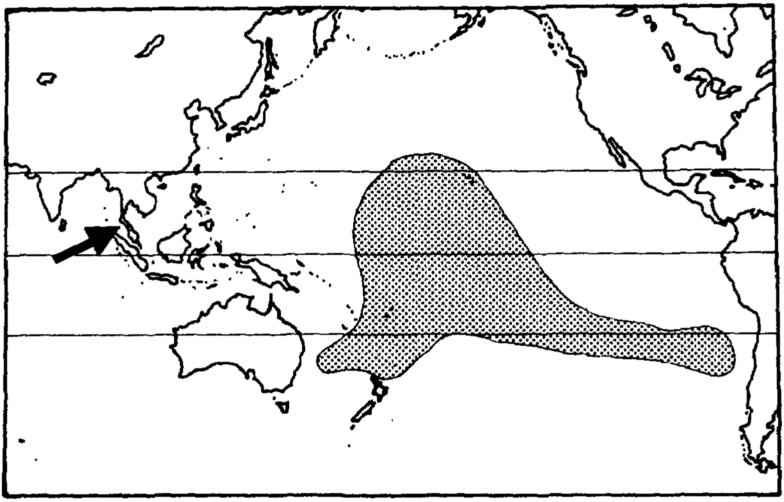

FIGURE 1 — Distribution of Grey Ternlet. Stippled area shows previously known breeding and non-breeding range. Black arrow indicates the 1988 sighting in the Andaman Sea

On 9 May 1988, I visited the twin islands of Koh Phi Phi (7°45′N 98°46′E) off the west coast of southern Thailand, which are about 50 km east of the southern tip of Phuket Island, a popular tourist resort. Phi Phi Don, the larger of the two, has in recent years been opened up to tourists. The smaller island, Phi Phi Le, which is uninhabited, is fringed by sheer limestone cliffs, with several caves. The largest cave contains hundreds of swiftlet nests, which are collected each year for use in soups. For this reason no one is allowed to live or stay on the island. Tourists are taken over to the cave on boats from Phi Phi Don, shown nests, and then taken around the rest of the island. It was during this trip that I saw the ternlets.

While off the western end of Phi Phi Le I was surprised to see small grey terns among the numerous Black-naped Terns *(Sterna sumatrana).* Although the heavy swell made binoculars hard to use, the weather was fine and clear with excellent visibility and the birds came to within 12 m of the boat. The birds were noticeably smaller than the Black-naped Terns and were pale grey with darker primaries and black bills. In all aspects of appearance and behaviour they were identical to the Grey Ternlets that I have seen off the Kermadec and Poor Knights Islands in New Zealand.

About 30 ternlets were around the perpendicular cliffs. Some were flying over the water with their typically buoyant flight, and some flew up and alighted on ledges on the cliff face, where others were already perched.

The *Bird Guide of Thailand* (Lekagul & Cronin 1974) does not mention Grey Ternlets. However, as the Koh Phi Phi islands have been opened to tourists only recently, the birds may have been present for some time.

I thank Colin Miskelly for suggesting changes to an earlier draft of this note, locating some of the references and drawing the map.

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Unusual nesting site for Little Shag

Little Shags are nesting on a rock in a water-level cave at the foot of sheer cliffs in the north-west part of Lake Taupo. The cave entrance is about 2 m wide at the waterline and tapers to a point about 2 m above water level. Height increases inside the cave. The nesting rock is about 6 m from the entrance. Water depth is 2-3 m.

In November 1988 there were 4 or 5 nests. One bird had three naked chicks and another had at least one chick. Adults remained on their nests during my visit. The only access to the nesting rock is by swimming.

I have been aware of this cave and its occupants since about 1972 and have seen the nesting birds in most years. The cave and its residents are not at all obvious to a casual observer.

A nearby waterfall on the Tutaewaeroa Stream is called "The Falls Of The White-breasted Shag" on a map that I have had since the early sixties, and so they may have been nesting there for many years. The main nesting areas on the lake are Motutaiko and Motuwhara Islands.

The site is doubly unusual in that the Little Shags are nesting on a rock in a cave, rather than in trees and shrubs, which is usual for the species (Falla, Sibson & Turbott, 1979, the *New Guide to the Birds of New Zealand).*

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