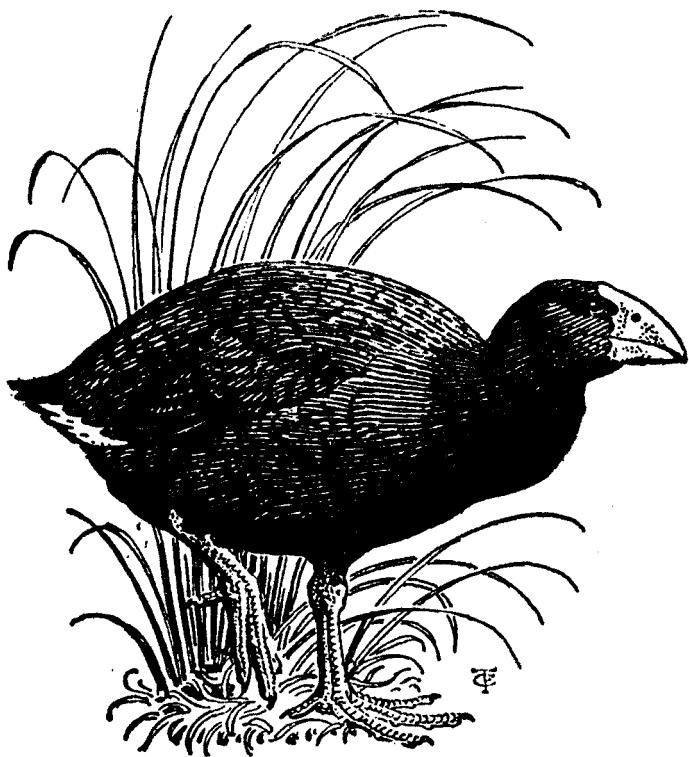


NOTORNIS

Journal of the Ornithological Society
of New Zealand



Volume 31 Part 3 September 1984

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NOTORNIS

is the journal of the Ornithological Society of New Zealand (Inc.)

Editor: B. D. Heather,
10 Jocelyn Crescent
SILVERSTREAM

VOLUME 31

PART 3

SEPTEMBER, 1984

BREEDING SUCCESS OF ISOLATED PAIRS OF CASPIAN TERNS IN CANTERBURY

By R. J. PIERCE

ABSTRACT

In Canterbury, Caspian Terns (*Hydroprogne caspia*) nest mainly as single pairs associated with colonies of Black-backed Gulls (*Larus dominicanus*) on shingle riverbeds. Of 37 nests studied, 28 (75%) hatched and 20 (54%) produced a total of 21 flying young, each pair raising an average of 0.6 young per season. The low productivity is attributed to reduced prey availability.

The Caspian Tern (*Hydroprogne caspia*) is primarily a colonial nester throughout its semicosmopolitan range (e.g. Ludwig 1965, Falla *et al.* 1970, Soikkel 1973), some colonies containing over 100 pairs. At least two colonies occurred in Canterbury until about the 1950s, one at Rakaia River and one at Washdyke Lagoon (Pennycook 1949, Oliver 1955, Sagar 1976). Since the 1950s there have been no reports of colonies of Caspian Terns in Canterbury. Apart from a few pairs nesting together on at least two islands in Lake Ellesmere (G. A. Tunnicliffe, C. F. J. O'Donnell, pers. comm.), the birds breed in solitary pairs scattered throughout the province. From 1970 to 1983 I recorded nest sites and breeding success of some of these pairs.

During the early 1970s in particular, I walked stretches of many riverbeds and lake shores, mainly in Mid and South Canterbury, and found many nesting pairs of Caspian Terns. Because the pairs appeared to have a high site fidelity, I could in later years reach the nesting places quite closely by vehicle. At all accessible nests I noted the substrate, the clutch or brood size, and the approximate number of nests in nearby colonies of gulls or terns. Except at the Cass River, I could not visit the nests often enough to assess accurately the young reared per nest, even by the "exposure method" of Mayfield (1975).

For example, I would have missed the start and loss of some nests. Instead, I used young reared per pair per season as a measure of breeding success. This I consider to be highly precise because there was no confusion with other pairs of Caspian Terns, and I was able to time my visits to critical periods, especially fledging.

Nesting localities were widespread in Canterbury (Fig. 1), but only five (four at Lake Ellesmere and one at Lake Wainono) were near the sea coast, where most nesting had occurred in the early 20th century (Stead 1927). All others were along braided shinglebed rivers, ranging in size from the Cass River (mean daily spring flow less than 10 cumecs) to the Rakaia and Waitaki Rivers (mean daily spring flow over 100 cumecs). Most of these rivers are partly snowfed and have highly variable flows, but two (the Tekapo and Waitaki Rivers) have artificially controlled flows. Breeding is likely to be more regular on the Waitaki River than indicated in Fig. 1, but nesting sites are difficult to visit there. I made no visits to the Waimakariri River where four birds have been seen recently (O'Donnell & Moore 1983).

All nesting pairs were over 8 km apart, but they were markedly associated with colonies of Black-backed Gulls (*Larus dominicanus*) and a few nests were at colonies of Black-billed Gulls (*L. bulleri*) or White-fronted Terns (*Sterna striata*). See Table 1. The distance from Caspian Tern nest to nearest gull nest ranged from 4.5 to 120 m ($\bar{x} = 16$ m, $n = 24$), apart from one nest c.800 m away. (In Table 1, the headings for gull colonies should read > 100 nests, < 50, 50-100, > 100 nests.)

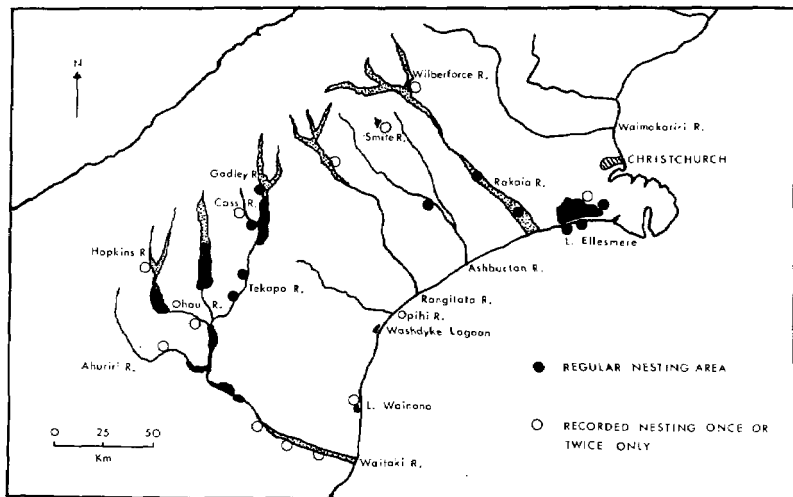


FIGURE 1 — Breeding distribution of Caspian Terns in Canterbury

TABLE 1 — Caspian Tern nest sites

Locality	Other larids present				Substrate and % cover of vegetation			
	None	<i>L. bulleri</i> 100 nests	<i>L. dominicanus</i> 50 50-100	100 nests	Dirt >50% veg	<50%	Shingle >50%	<50%
Godley River			5		1		3	1
Cass River	1		12		4	1	2	6
Tekapo River			2	4	4			2
Ohau River			1					1
Hopkins River		1					1	
Ahuriri River	1				1			
Waitaki River			1					1
Kangitata River			1				1	
Ashburton River			2		1			1
Rakaia River	1 ¹	2	1	1			4	1
Lake Wainono				1		1		
Lake Ellesmere			6		4	2		
Total	1	2	28	6	.15	4	11	13

Note: ¹ Also 100 nests of White-fronted Tern present

Most nests were on raised shinglebanks or riverbed terraces, where gulls nested also. Vegetation around the nest ranged from bare dirt or fine shingle to almost complete cover of prostrate plants such as *Raoulia*, *Muehlenbeckia axillaris*, *Coprosma*, and grasses such as *Trifolium*, *Agrostis*, *Myosotis*, *Poa*, and *Festuca*. The closest tall shrubs or trees to nests were willows (*Salix* sp.) c. 30 m away on the Ashburton and Tekapo Rivers. Nests were depressions in the ground with little or no lining, but one nest on the Tekapo River was in a disused Black-backed Gull nest of the previous season and the nest consisted of grasses and a few branches. October appeared to be the main month for nesting. The earliest completed clutch was found on 30 September and the earliest chicks on 3 November, at separate nests on the Tekapo River. Laying, including of repeat clutches, occurred until the end of November. The laying of first clutches approximated (and sometimes preceded) laying times of the Black-backed Gulls. Normal clutch size was 2 (\bar{x} = 2.3, range 1-3, n = 17). The only 1-egg clutch found was an infertile egg on the Godley River in November-December 1977.

Table 2 shows the outcome of the 37 Caspian Tern nests that I was able to follow closely. Of these 37 nests, 28 (75%) reached the hatching stage and 20 (54%) produced flying young. The average number of young reared per pair per season was 0.6 (n = 35 pairs). Only one pair reared a brood of two (at Lake Ellesmere in the 1973-74 season), all other successful pairs rearing one young only. Of the ten clutches that did not hatch, four were flooded, two had infertile clutches, one was deliberately run over by motorcycles, and three had an unknown fate. Seven nests failed during the fledging period, and on four occasions I found dead chicks: one nest with three dead chicks less than 1 week old, one with a dead chick 2-3 weeks old, and two

TABLE 2 — Fate of 37 nests

Locality	No. nests	No. nests hatched	No. nests productive	Total no. of flying young	Infertile egg(s)	Flooded	Nest driven over	Dead chick(s) found	Dead adult found	Unknown, during incubation	Unknown, during chick stage
Godley River	5	3	3	3	1	1					
Cass River	13	9	5	5		2	1	2	1	1	1
Tekapo River	4	3	2	2	1			1			
Awariri River	1	1	1	1							
Ashburton River	2	2	1	1				1			
Rakula River	5	3	2	2		1				1	1
Lake Wainono	1	1	1	1							
Lake Ellesmere	6	5	5	6						1	
Total	37	27	20	21	2	4	1	4	1	3	2

with a dead chick 4 weeks old. One of the 4-week-old chicks was emaciated when it died but the other seemed to be of normal weight.

During the nesting period, off-duty Caspian Terns hunted over rivers, inland and coastal lakes, lagoons, and the sea. Some pairs, e.g. on the Tekapo River, appeared to feed only along rivers. At the Cass and Godley Rivers, almost all hunting was done around the shores of Lake Tekapo, up to 10 km from the nest sites, and only during times of steady river flow did birds hunt over the rivers. At the Cass River Delta, where I had many observations, other Caspian Terns were not tolerated on or near the delta and were "escorted" from the area by the off-duty bird, which would call frequently. Repeated flooding disrupted river feeding in much the same way as it did for some other riverbed species (Pierce 1983). Thus, during repeated flooding in 1983 there was no successful nesting on the Cass, Godley and Tekapo Rivers at least.

After breeding, Caspian Tern pairs and family parties converged on coastal and inland river deltas and at coastal lagoons and lakes. All far-inland birds appeared to move to the east coast for autumn and winter, but single birds occasionally visited the inland lakes in winter. A chick colour-banded on the Tekapo River in 1981 was seen at Lake Wainono in April 1982, but the mouth of the Opihi River attracts many more Caspian Terns (Pierce 1980).

DISCUSSION

Caspian Terns nest in colonies of other species not only in New Zealand. In the Northern Hemisphere, single pairs have nested in colonies of Black Skimmers (*Rhynchops nigra*), Herring Gulls (*L. argentatus*) and Ring-billed Gulls (*L. delewarensis*) (Pettingill 1958, Woolfenden & Meyerriecks 1963), although these single pairs seem to constitute a very small percentage of the breeding population (Fergusson-Lees 1971). In the North Island of New Zealand, colonies

of Red-billed Gulls (*L. novaehollandiae*) and Black-billed Gulls have been used also (Falla *et al.* 1970), and at Nelson a few pairs nest among Black-backed Gulls each year (J. Hawkins, pers. comm.). Presumably the terns, which are normally gregarious, are attracted to the gull colonies, which may stimulate them to start breeding and/or reduce the chances of their eggs or young being preyed on.

The raising of 0.6 young per pair per season is much less than the approximately 1.5 young per pair per season at colonies in North America and Scandinavia (Ludwig 1965, Soikkel 1973). The low productivity in Canterbury did not appear to result from predation. Although introduced carnivorous mammals often cause heavy losses to several species of riverbed birds (Pierce, in prep.), I found no evidence that these take the eggs or young of Caspian Terns. Oliver (1955) thought that Black-backed Gulls killed Caspian Tern chicks, but I found no evidence of this: none of the six dead chicks I saw seemed to have been injured. Adult Caspian Terns usually tolerated Black-backed Gulls (both on the ground and in the air) to within several metres of the nest or young before diving at them. Black-backed Gulls may well occasionally kill tern chicks, but they do not seem to be as important a cause of breeding failure as are Red-billed Gulls at some colonies of Caspian Terns (e.g. Soper 1965).

The fact that only one young (and not two or three) was usually reared suggests that food was the limiting factor in Canterbury. Caspian Terns lay their eggs at 2-3 day intervals and begin incubation after the first egg is laid, which results in asynchronous hatching. This is said to be an adaptive mechanism producing potentially more survivors in good years and ensuring the survival of at least one chick in poor years (Lack 1954, Soikkel 1973). Except at one Lake Ellesmere nest, the siblings (presumably the second and third chicks to hatch) at all the nests found died within a few days of hatching. This suggests that the feeding conditions in Canterbury provide only "poor years" for Caspian Tern breeding. Moreover, I found no successful riverbed pairs in 1979 and 1983, when there was repeated flooding, although nests were not necessarily destroyed by flood water.

Soikkel (1973) found that Caspian Tern chicks in Sweden often died of starvation and that fledging success (and possibly clutch size) was related to availability of food. In the Great Lakes area, Ludwig (1965) found that Caspian Terns were declining up to 1957 but that, in 1957, an increasing fish population resulted in an increased fledging success and that, by 1960, the breeding population began increasing. Unfortunately, Ludwig's study did not include data on breeding success during the period of Caspian Tern decline, and so we do not know the level of breeding success needed for a stable population. If a fledging success of 1.5 young per pair per season is enough for an expanding population in North America, and if we bear in mind the high mortality of immatures (Ludwig 1965), then the Canterbury population with its low productivity may be only marginally self-

perpetuating. It is even possible that the population is supplemented by birds from other areas. For example, at the Opihi River mouth, P. M. Sagar (pers. comm.) found several birds which had been metal-banded at an unknown breeding locality outside Canterbury. Nevertheless, several apparently suitable areas (e.g. the delta of Tekapo River, near the Waitaki River mouth and Lake Wainono) are used irregularly or not at all for nesting.

It is not surprising that, earlier this century, colonies of Caspian Terns nested in coastal localities in Canterbury where the birds could fish in a range of habitats, e.g. river, lagoon and open sea, and not necessarily be dependent on any one habitat. These habitats have, however, been severely modified by man and are also subject to much disturbance. Lake Ellesmere may be the only coastal locality where these changes have not prevented successful nesting by pairs or small groups of Caspian Terns. Data from a colony at Mangawhai near Auckland (M. Taylor, pers. comm.) indicate that fledging success is less than 0.9 per pair per season. Clearly there is a need for a concerted study of the breeding biology and population dynamics of Caspian Terns throughout New Zealand, in relation to local habitat quality (especially food supply) and the possible effects of disturbance, disease and predation.

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NORTH ISLAND BROWN KIWI VOCALISATIONS AND THEIR USE IN CENSUSING POPULATIONS

By ROGAN COLBOURNE and RUUD KLEINPASTE

ABSTRACT

Vocalisations of the North Island Brown Kiwi (*Apteryx australis mantelli*) were monitored from March 1981 to July 1982 in Waitangi State Forest, Northland. Calling rates were found to be seasonally cyclic and correlated with breeding. Males called more often than females. Four categories of kiwi sounds are described and their possible functions discussed. A census of kiwis based on counts of calls underestimates the population: a banding study in a small area gives a much better indication of kiwi numbers. An estimated 800-1000 kiwis inhabit Waitangi State Forest. Calling rates are density dependent and so can be used for comparison of kiwi population densities between two areas.

INTRODUCTION

Because kiwis produce a variety of sounds and because they have large ear apertures, it is inferred that vocal communication is important and the sense of hearing is well developed. This aural sense, together with the bird's keen sense of smell, may compensate for its reputed near-lack of vision.

At present a census based on calls is the only practical way to estimate a kiwi population on a large scale, and yet very little information on kiwi calls is available. Robson (1947) stated that calling occurred more often in the mating season, and some authors (Buller 1888, Clark 1952) reported that kiwis are particularly active and noisy on dark wet nights whereas on moonlit nights they are generally silent. Moreover calling was found to cease during the incubation period (Buller 1888, 1905). No suggestions were given as to the purpose of kiwi calls.

In 1978 Corbett surveyed the kiwi population in Waitangi State Forest by means of a vocalisation census, and his report included a map showing the locations of kiwi pairs and single birds (Corbett *et al.* 1979). He estimated the population to be 444-520 birds. During our study of kiwis in this exotic forest, it quickly became apparent that a vocalisation census underestimates actual kiwi numbers. This paper records our observations on vocalisations and calling behaviour and evaluates the use of call counts for kiwi census purposes. For a description and map of Waitangi State Forest and the study area, see Colbourne & Kleinpaste (1983).

METHODS

From March to June 1981, we monitored kiwi calls from a network of listening stations spaced evenly throughout the forest along roads and firebreaks in compartments 5, 6, 7, 8, 9, 25, 26, 27, and 31. Listening stations were visited for at least 1 hour, and up to 3 hours at a time if the station commanded a good acoustic advantage. Listening, done mainly on wind-free nights, started 40 minutes after sunset, and data on weather conditions, degree of darkness, and phase of the moon were noted on field sheets. Each observer recorded the following information: position of listening station, time of call, sex of calling bird, number of cries per call, direction (compass bearing), and estimated distance of calling bird. The locations of calling birds, often obtained from cross bearings, were plotted on to detailed maps. It took us 3-7 nights to survey each compartment.

From June to December 1981, we duplicated exactly Corbett's listening schedule of 1978 (Corbett *et al.* 1979) for the above compartments to determine any changes in calling rates. The maximum number of calls per hour was noted for each month throughout the study.

From May 1981 to July 1982, we banded 79 kiwis in our study area (compartments 5-9). Resightings and recaptures of these individually colour-coded birds and knowledge of the positions of unbanded birds enabled us to determine accurately the number and distribution of kiwis in the study area.

RESULTS AND DISCUSSION

During our study four categories of kiwi sounds were distinguished:

1. Loud calling (song);
2. Sniffing and grunting;
3. Mewing or purring; and
4. Billsnapping, hissing, squealing, and growling.

CALLS

The loud call of the North Island Brown Kiwi consists of a series of cries, a throaty *ah-eh* of the female and a shrill *ah-eel* of the male. While calling, a kiwi often attains an erect posture, throws its head upwards, uttering a cry when the beak is held vertical. It then quickly bows its head in preparation for the next cry. A call can comprise 1-42 continuously repeated cries, but a series of about 20 cries per call, lasting about 30 seconds, is the average. Some kiwis uttered a short series of cries while others called longer, but individuals could not be identified reliably by this means alone. Apart from some alterations of cries in a series most calls sounded very similar. One male's call had a vibrato reminiscent of a Little Spotted Kiwi (*Apteryx owenii*). As many birds appear to have a finer time perception than

humans and are hence able to distinguish notes that, to our ears, would merge into a uniform sound (Thorpe 1964), the monotonous calls may mean more to kiwis than they convey to us. Sonograms of kiwi calls might reveal finer aspects of the structure of calls and the function of calling in social structure and behaviour.

Territory and pairbonding

Colbourne & Kleinpaste (1983) showed the kiwi to be a strongly territorial bird, and hence it is likely that the function of kiwi calls is closely analogous to that of passerine song. In passerines, singing is widely used to proclaim occupancy of a territory and is particularly important in enclosed habitats where contact is seldom visual. Typically, when a kiwi of either sex called it was answered almost immediately by its mate. The initial calls were usually by males and often birds from the neighbouring territories (mostly males) responded shortly afterwards.

Of 1032 calls recorded, 75.3% were from males, a ratio of three male calls to one female call. However, the higher-pitched sound of a male carries further than the hoarse cries of a female, causing a bias towards males in the calling ratio. To eliminate this bias, we excluded all calls estimated to be further away than 200 m — a distance inside which the female's call is always heard. The result was a male:female calling ratio of 2.54:1, still a considerable male dominance. As males defend the territory, their frequent calling and loud shrill voice facilitate this task: a male bird can be heard anywhere in a territory of 3-5 ha.

Thorpe (1964) stated that singing can be a substitute for fighting and that it probably plays an important role in preventing the development of actual physical combat. During our study only two kiwi fights were seen, but we often observed that a trespassing kiwi hastily retreated to its own territory after excited and repeated calling by the male of the territory it was in (Colbourne & Kleinpaste 1983).

Often the male and female of a kiwi pair called simultaneously or shortly after each other, and we believe that this "duetting" helps to maintain the pair bond. Duetting often occurred early in the evening when a pair emerged from different, widely spaced burrows ("contact calls" or "waking-up calls") but it also occurred when the male and female were very close together. When a bird was displaced or chased out of its territory, e.g. for banding purposes, the displacement sometimes initiated a burst of calls, which was often answered by the bird's mate and sometimes by its neighbours. These reply calls may guide the displaced kiwi back to its own territory and mate. On many occasions kiwis were observed to stop and call while we were chasing them.

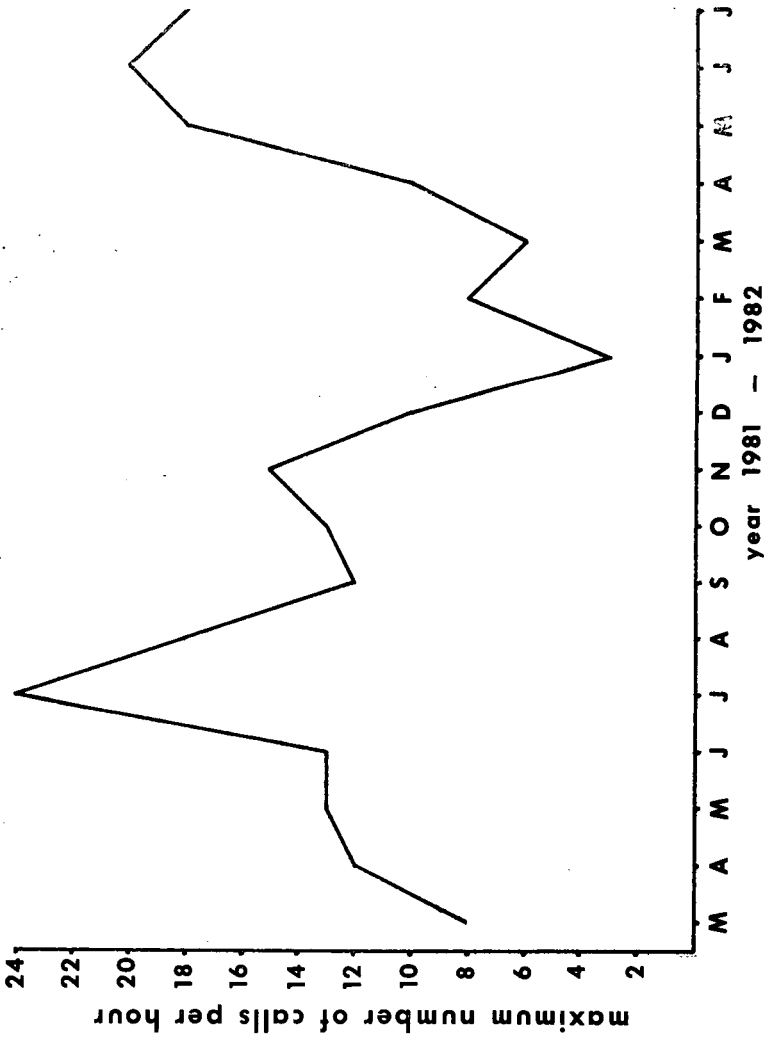


FIGURE 1 — Kiwi calling rates in Waitangi State Forest, May 1981-July 1982

Breeding

Song is primarily under the control of sex hormones and is generally linked to the reproductive cycle (Thorpe 1964). A rise in the level of testosterone in the blood produces a dramatic increase in the aggressiveness of many birds, often involving the defence of a territory (Marler 1964). Probably the kiwi is the same as other birds in this regard. Calling rates were highest from June to August (Fig. 1), which coincides with the main mating period in Waitangi State Forest (Colbourne & Kleinpaste, in prep.). Kiwis called least in mid-summer.

Nightly fluctuations

Kiwi calling rates fluctuated not only seasonally but also nightly. On two consecutive nights with identical weather the number of calls per unit time could vary greatly. Occasionally kiwis were heard calling during heavy rain or with high winds, but, under those conditions, increased levels of background noise considerably reduced the receiving distance and hence the area monitored by the observer.

Of all factors, the brightness of the moon was found to affect calling rates most. In the period from first quarter through full moon to last quarter, the forest could be absolutely silent, especially when the moon was high overhead. Usually kiwis could be heard feeding (sniffing) and moving through the undergrowth, but they seemed very wary. On some nights with a very bright full moon, the complete absence of any kiwi sounds made us wonder if the birds remained in their burrows. Dark moonless nights in general gave the highest calling rates, but on very black nights the calling rates were often reduced.

Juveniles

In captivity juveniles do not make the adult call until their first year (Robson 1947). Reid & Rowe (1978) found that the male adult starts calling when about 14 months old and that the female starts calling when about 2 years old.

Eighteen juveniles were banded; however, none were subsequently heard calling when subadults later in the study. Juveniles are tolerated within their parents' territory for at least one year (Colbourne & Kleinpaste 1983), after which they leave or are evicted and can be found roaming randomly through the forest. Until a roaming subadult male finds itself a vacant territorial area it would gain by remaining relatively silent as calling could court trouble from territory owners.

On one occasion a chick under parental care was heard to call. This was very distinct and sounded intermediate between male and female calls but with longer intervals between cries. Occasional chick calls may help maintain the family unit.

Surveying

On a few occasions kiwis were heard calling only 5 minutes after sunset, but usually calling began 45 minutes after sunset with the maximum calling frequency occurring during the first 1-3 hours of darkness. During the rest of the night, until dawn, irregular bursts of vocal activity revealed the kiwi's presence. Dense vegetation was found to muffle kiwi calls, whereas certain topographical features such as certain valley configurations amplified them. In general, in flat forest with still conditions, calls could be heard up to a distance of 350 metres; over clearfelled areas they could be heard faintly about 1 km away.

Cross bearings and estimated distance were usually accurate when a kiwi called from within 200 metres of both observers. Calls from further afield were often misinterpreted, resulting in inaccurate compass bearings and/or wrongly estimated distances. When the two observers were too far apart confusion arose sometimes when two neighbouring birds called simultaneously and were plotted as one. These errors occurred most in steep dissected terrain. We found a distance of 100-200 metres between listening stations to be ideal.

On windy nights listening became very difficult as the source of the calls appeared to change with each gust and often the first cries seemed to come 180° away from the true direction.

OTHER SOUNDS

Sniffing and grunting

These sounds are associated with feeding. While searching for food in soil and litter, kiwis rely on their well-developed sense of smell and the sniffing noises, which are also made when clearing the nostrils of dirt after probing, can be audible for up to 15 metres. Nasal grunts were mainly produced when a pair was feeding close together and so grunting may serve to maintain contact between birds at close range.

Mewing and purring

Reid & Rowe (1978) suggested that these sounds may precede mating. In all observed cases the pair were very close together and the mewing, often culminating in loud purring, was audible up to 50 metres away. These noises could be heard from May to November, but most frequently in June. On one occasion we heard a copulating kiwi produce rhythmical purring sounds.

Billsnapping, hissing, squealing and growling

When handled, both sexes could produce a range of sounds which varied from hissing to a deep guttural growling. Loud billsnapping noises were predominantly made by males, whereas females tended to utter more pig-like squeals and growls. The sounds produced

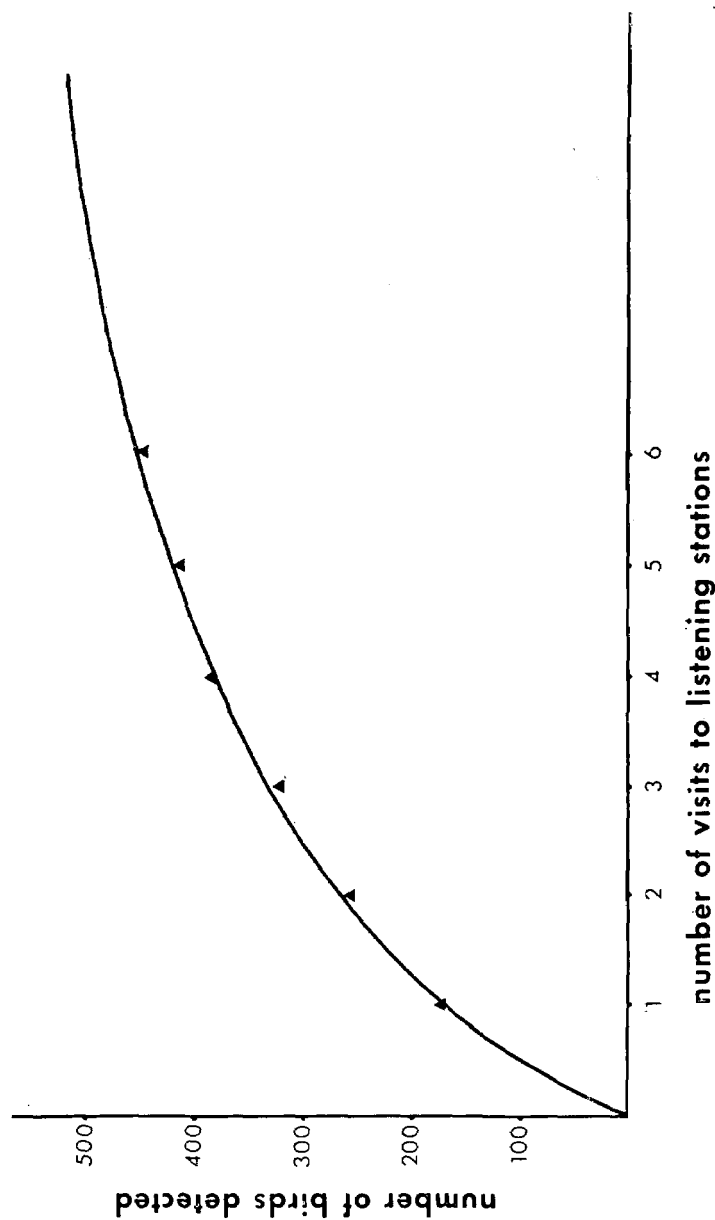


FIGURE 2 — Estimation of Brown Kiwi population (520 birds) by extra-polation of data from a 1978 vocalisation census (after Corbett *et al.* 1979)

differed between individual kiwis and possibly reflected differences in 'personality and moods.' Billsnapping and growling were heard several times when two males were fighting, which suggests that these sounds are associated with aggression or submission.

THE VALUE OF CALLS FOR CENSUS WORK

Comparison of 1978 and 1981 vocalisation censuses

The 1978 survey of Corbett *et al.* (1979) to estimate the population size and distribution in Waitangi State Forest was based solely on kiwi calls. Corbett monitored the whole forest from June to December 1978 by systematically following a listening schedule. His 112 listening stations were spread evenly and gave as much coverage of the forest as possible. Each station was visited six times during the 7-month period for an average of 12 minutes per visit. The population size was estimated from the data by accumulating the number of new birds found. The rate of finding new birds decreased with increasing number of visits to listening stations. When the number of kiwis was plotted against the number of visits on a graph, the curve approximated an asymptote: the estimated population size of 520 birds. See Figure 2.

As a result of a detailed listening census of the population in five compartments in two major forest areas from March to June 1981, we arrived at figures exceeding those found by Corbett (Table 1). The discrepancy was especially large in compartment 6: our census method, however, differed from Corbett's method because we visited many more and more closely spaced listening stations, each for a longer period of time. Moreover, the possibility of taking cross bearings of calls greatly enhanced the accuracy with which each bird could be plotted. By applying Corbett's criteria to our census results, we could estimate that 600 kiwis live in Waitangi State Forest.

TABLE 1 — Comparison of estimated numbers of Kiwis in certain parts of Waitangi State Forest, as revealed by vocalisation census methods in 1978 (Corbett *et al.* 1979) and 1981 and by a banding study in 1981-1982.

Compartment	Area (ha)	Census Jun-Dec 1978	Census Mar-Jun 1981	No. Banded 1981-82	Total Birds (est.)
5	54	10	14	15	35-40
6	84	1	18	19	30
7	84	12	15	13	19
8	88	18	27	22	30
25	93	4	3	-	-

The exact duplication of Corbett's census methods, with identical listening stations, sequences of visits and listening periods (June to December 1981), yielded a 1% increase in the number of calls from the western compartments (25-27 and 31) and a 1% decrease in the number of calls in the eastern compartments (5-9). Both differences were not significant.

Banding study and vocalisation census

The ideal way to know the size of a kiwi population is to band as many birds as possible until no unmarked kiwis are caught or seen over a long period. Soon after starting the banding programme in the study area, it became apparent that our census of calls (March to June 1981) was greatly underestimating the number of birds present but that we could reliably estimate the number of kiwis in our study area when we thoroughly knew the positions and territories of banded and unbanded birds.

To evaluate the accuracy of a vocalisation census, we intensively monitored compartment 6 for calls from April to June 1982, using five listening stations that gave complete coverage of that compartment. Banding (Colbourne & Kleinpaste 1983) revealed the presence of 30 resident kiwis: 24 adults (12 pairs) and 6 juveniles. In addition, some transitory females and roaming subadults were known to visit this compartment, but these birds were not considered to be long-term inhabitants. By listening for a total of 15 hours, knowing the positions of permanent territories, we could differentiate 16 birds (9 males), but without this knowledge only 13 kiwis (7 males) could be plotted with confidence. Therefore, our vocalisation census, done in a medium-to-good calling period of the year (Fig. 1), revealed only 54% of the adults, that is, 43% of the kiwi population. A similar survey in a 25 ha strip of mature *Pinus elliotii* in compartment 7 identified three pairs of kiwis, whereas banding revealed the presence of ten birds. That is, detection was only 60%.

These results and similar observations in compartments 2, 5, 8 and 9, suggest that substantial numbers of kiwis in the population do not call as frequently as others. Combining these findings with the March-June 1981 vocalisation census results, we could estimate the kiwi population in Waitangi State Forest at 800-1000 birds, giving an overall density of one kiwi per 2.9-3.6 ha. When allowances are made for areas which are unsuitable as kiwi habitat (deep swamps, clear-felled and recently planted compartments) and areas which have few kiwis (compartments 16, 24 and 25), these figures are comparable to the reported territory size of about 5 ha per pair (Colbourne & Kleinpaste 1983).

Problems with vocalisation census

Preferably, kiwis should be counted by calls when the birds are calling most; summertime appears to be the least and winter the most suitable period for surveys (Fig. 1). At Waitangi, an average

visit of 12 minutes per listening station is not long enough to pick up all the response calls from neighbouring birds. We recommend one hour per station as a reasonable length of time. Visits much longer than an hour compound the problem caused by kiwis changing position within their territory. Similarly, if a survey is extended over several nights, confusion may arise as to whether a bird, plotted on a particular site, is the same bird as was recorded 100 metres further away on a previous night. Only knowledge of the exact location and shape of territories can resolve these problems.

Obviously, juveniles are not picked up during a vocalisation census and apparently some adults call very infrequently or not at all. As calling rates are correlated with the breeding cycle, the presence of silent adults could indicate that not all adult kiwis breed every year.

Use of calling rates as a population index

Establishing calling rates by counting kiwi calls on several successive nights would be a relatively simple method (and far less time consuming than a banding study) to index the kiwi population density in a certain forest compartment. Calling rates were found to differ from area to area. In compartment 5 the kiwi population density was one and a half times greater than in compartment 6, and yet the calling rates were generally about three times higher. Recent clear-felling on each side of compartment 5 had probably caused a build-up of kiwi numbers there as the population density (1 kiwi per 1.5 ha) proved to be higher than elsewhere. With smaller territories the chance of border encounters by kiwis increases and hence the frequency of vocal display is likely to increase.

On the basis of this observation, we surveyed four Northland forests, Puhipuhi, Glenbervie, Waipoua and Puketi State Forests. By comparing the calling rates in these forests with the calling rate in the control area (compartment 6 of Waitangi State Forest), we could gain an impression of the relative kiwi population densities (higher calling rates, higher kiwi population density; lower calling rates, lower population density). Puhipuhi and Waipoua State Forests had higher calling rates than the control area, Glenbervie State Forest had about the same rate, and Puketi State Forest had a lower rate. These results were supported by the level of probing sign found in these forests.

Calling data should be interpreted very carefully. When comparing calling rates between two forests it is important to monitor calls in each forest for several successive nights to get an average calling rate for that forest. This reduces the effects of erratic calling by kiwis on some nights. It would be desirable to obtain much more data, linking kiwi population densities with calling rates, so that calling rate comparisons can be more reliable.

ACKNOWLEDGEMENTS

We would like to thank the New Zealand Forest Service for funding our kiwi study, for the use of their equipment and facilities, and for permission to use the 1978 survey results of Harold Corbett, Brian Reid and Peter Thode.

We are grateful to Anne Grace, Barrie Heather and John Innes for improving earlier drafts of this paper and to Mrs Marjorie Davidson for typing these various drafts.

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SHORT NOTE

SWALLOWS AT SEA AND ESTABLISHED ON THE
KERMADEC ISLANDS

Welcome Swallows have been reported at sea to the north-east (Jenkins 1978), the north-west (Lovegrove 1978), and the west (Syms 1978) of mainland New Zealand. In a recent trip from Auckland to Raoul Island, we saw Welcome Swallows out to sea and on the Kermadecs.

On 16 March 1984 at 0812 h one Welcome Swallow briefly circled our yacht and then disappeared. Our position was 179°15'E 32°20'S, which is about 470 km NNE of Great Barrier Island and 200 km SSW of L'Esperance Rock. Later the same day at 1430 a pair of Welcome Swallows flew close to the yacht and stayed with us for minutes. We were then 160 km SW of L'Esperance Rock. All were flying strongly. Our route took us between Curtis and Cheeseman Islands in broad daylight, but no more swallows were seen till we were ashore on Raoul Island.

On Raoul, swallows were seen daily feeding over the paddocks near the Meteorological Station. The greatest number seen foraging

together was 8. One was feeding over the crater lakes on one of three visits there, but none was seen on other parts of the island.

On the return journey on the freighter *Vili*, the only Welcome Swallow seen at sea was encountered soon after sighting Great Barrier Island (about 50 km from land). This swallow landed on the ship and allowed us to approach to within a few metres.

The number of swallows on Raoul Island suggests that they are now firmly established in the Kermadecs. This is a further extension of their increasing range (Claridge 1983). It is possible that the birds seen SE of L'Esperance Rock were from the rock although the distance was great and if swallows were feeding at sea around all the islands, we should have encountered them around Curtis or Raoul Islands. Furthermore, the first sighting early in the morning suggests at least that swallows had been at sea all night.

Swallows must disperse over sea, and events of the previous day suggest that the movements of the swallows to sea may have been involuntary. For the day before the sightings, we encountered large numbers of insects at sea, the four predominant species being common blue butterflies (*Zizina otis*), a dark winged moth, a dragonfly and an unknown hymenopteran. None of these were seen the same day as the swallows, however. The weather before these sightings had been relatively calm and stable, and we had sailed in NW winds of 5-20 knots. Subsequent weather was affected by cyclone Cyril. The origin of the swallows at sea remains in doubt but further expeditions to this area may be able to confirm the presence of swallows in the southern Kermadec Islands and whether they do forage out to sea.

Financial assistance for this expedition was provided by the Auckland University Research Committee and the amateur radio members of the group arranged yacht transport one way.

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Welcome Swallows are seen regularly on Norfolk Island in winter months (O. Evans, pers. comm.), presumably from New Zealand. Few are recorded in summer, and breeding has not been confirmed — (Schodde et al. 1983, *A review of Norfolk Island birds: past and present*, Aust. NPWS) — Ed.

BULLER'S MOLLYMAWKS BREEDING AT THE THREE KINGS ISLANDS

By A. E. WRIGHT

ABSTRACT

A small breeding colony of Northern Buller's Mollymawks (*Diomedea bulleri platei* Reichenow, 1898) is recorded from the Three Kings Islands off northern New Zealand. The subspecies was previously known to breed only at the Chatham Islands, which lie 10° of latitude south of the Three Kings.

During the Offshore Islands Research Group expedition to the Three Kings Islands (November-December 1983) a brief landing was made on Rosemary Rock, the south-easternmost of the Princes Islands. About 170 x 70 m at sea level and rising to some 50 m, Rosemary Rock (34°09'S, 174°03'E, Fig. 1) is the smallest of the Princes Islands, a chain of steep vegetated stacks between the larger West and South West Islands. The Rock is named after the yacht *Rosemary*, which transported several naturalist-explorers to the Three Kings Islands in the late 1940s and early 1950s.

The landing on 1 December was made to investigate the vegetation of the steep-sided Rock. Five species of native plant were present: glasswort (*Salicornia australis*), NZ iceplant (*Disphyma australe*), shore groundsel (*Senecio lautus*), taupata (*Coprosma repens*), and *Chenopodium allanii*. The Rock was heavily populated by Red-billed Gulls (*Larus novaehollandiae*), which were sitting on eggs.

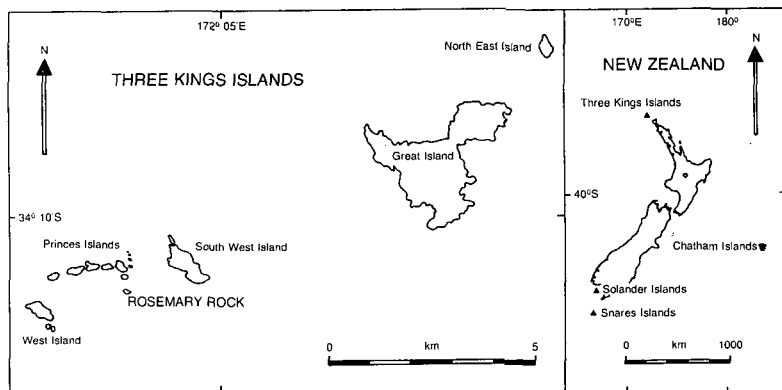


FIGURE 1 — Maps showing the location of Rosemary Rock in the Three Kings Islands and the distribution around New Zealand of island groups mentioned in the text

(A gull chick found on this islet was the only one seen in any of the many gull colonies encountered throughout the Three Kings Group.) Apart from a few low taupata shrubs around rocky outcrops on the dome-shaped summit of the islet, the dominant vegetation was mats of NZ iceplant, which provided the only material used in Red-billed Gulls' nests.

While making notes on the vegetation and gulls on the summit of the island, my attention was arrested by a strident, somewhat duck-like call nearby. Turning, I was greatly surprised to find six very large seabirds occupying a small embrasure in the rocks just off the south-eastern corner of the summit (Fig. 2).

I sketched and noted their prominent morphological characters. Although I saw no birds in flight (or even with wings extended), several features proved to be diagnostic. The bills, estimated to be 8-9 cm long, were a continuous bright yellow on the upper and lower surfaces and black on the sides. On each side of the base of the lower mandible was a narrow strip of bright orange skin. The grey head was capped by very pale grey (almost white) feathers, and the prominent eye was marked by a white crescent just below and behind it. The sitting birds were estimated to be 30 cm from the tip of their tail to the back of the neck, and 10 cm from the flat of the back to the top of the head. However, when rearing up, the length from tail to bill exceeded 50 cm.

On comparing my notes with the illustrations and descriptions in Falla *et al.* (1981) and Harper & Kinsky (1978) immediately after



FIGURE 2 — Five of the six Buller's Mollymawks seen on Rosemary Rock

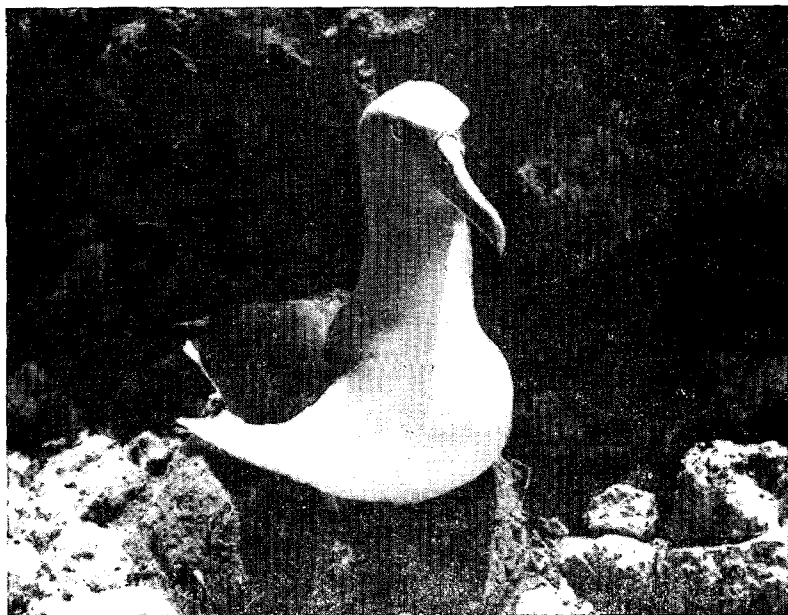


FIGURE 3 — Buller's Mollymawk on raised earthen nest at Rosemary Rock, Three Kings Islands

leaving Rosemary Rock, I had no doubt that the birds were Buller's Mollymawks (*Diomedea bulleri*), formerly known to breed only on the Chathams, Snares, and Solander Islands. Colour slides of the Three Kings birds (two of which are reproduced here in black and white — Fig. 2 & 3) were viewed by E. G. Turbott and R. B. Sibson, who confirmed this identification.

Five of the birds occupied raised earthen nests, spread over a distance of 4-5 m, while a sixth was engaged in display with one of the birds at nest. Four of the five birds on nests were sitting on single eggs, still clean and chalky white. (This need not indicate recent laying as, with the fairly dry climate and lack of mud around the nesting site, the eggs could have remained clean for a long time.) The fifth bird on a nest was engaged in display behaviour with the sixth bird, including the occasional calling which had first attracted my attention. I did not determine whether this bird was sitting on an egg. The display behaviour, which did not correspond with any described by Richdale (1949a), consisted mainly of neck and bill rubbing, similar to the greeting behaviour carried out by Australasian Gannets (*Sula bassana serrator*) when changing over at the nest (Fig. 97A in Serventy *et al.* 1971).

The nesting platforms were of dry, sun-baked earth mixed with unrecognisable plant material. They presented a clean, eroded appearance, suggesting brief occupation this breeding season, and ranged in height from no more than a few centimetres to the largest (Fig. 3) c. 20 cm tall. The nests were near the top of the coastal cliffs, where the birds could take off from or close by their nests.

Two of the birds were approached for close-up photography. They refused to leave their nests, even with a camera lens centimetres from their beak, leaning right back on their tarsi, raising their heads and quivering their throats, all the while emitting gentle gulping noises. They remained quiet and unflustered while being photographed.

Discussion

Buller's Mollymawks have been known to breed solely on islands 1300-1600 km south of the Three Kings Group. Oliver (1955, quoting in part from Richdale 1949b) and Serventy *et al.* (1971) recorded one breeding season for the populations inhabiting the Chatham Group, and another for the populations on the Snares and Solander Islands. On the Snares, Richdale (1949b) observed a 7-week laying period from 16 January until early March. Serventy *et al.* (1971) noted that the Chatham Islands population breeds "two or three months earlier" than the Snares colony. Falla *et al.* (1981) gave October-November as the laying period on the Chathams and February as the laying month on the Snares and Solander Islands. Robertson (1974) recorded laying from 26 October to 23 November in one season on the Middle Sister in the Chatham Islands. Thus, the present record of birds sitting on eggs on 1 December places the small Three Kings population close to the Chatham Island birds in terms of breeding time.

Robertson (1984) states that recent field studies suggest two subspecies. The Southern Buller's Mollymawk (*Diomedea bulleri bulleri* Rothschild, 1893) breeds at the Snares and Solander Islands (Fig. 1). The Northern Buller's Mollymawk (*D. b. platei* Reichenow, 1898) breeds at the Forty Fours and Sisters Islands in the Chatham Islands (Fig. 1). This taxonomy was adopted by Peters (1979) in his checklist.

After examining all the colour slides of the Three Kings mollymawks, C. J. R. Robertson (pers. comm.) ascribed the birds to the Northern Buller's Mollymawk on the following major grounds:

1. The heavy "eyebrow" reaching to the base of the bill;
2. The yellow stripe of the lower mandible less than half the width of the mandible;
3. The generally dark colour of mantle, cheeks, chin, nape and throat, and the silvery grey of the forehead; and
4. The breeding time.

A further minor but suggestive ground is that the habitat shown in Fig. 2 is very similar to that at the Sisters Islands in the Chathams.

Although apparently suitable habitat for many more mollymawks exists on Rosemary Rock (and, indeed, other of the Princes Islands) at the Three Kings, the small number of breeding birds does not necessarily mean recent colonisation. The larger nests are substantial, indicating many years of occupancy. Small colonies of large seabirds take a long time to grow by natural increase without waves of new immigrants (C. J. R. Robertson, pers. comm.). On the other hand, judging by the general condition of the habitat surrounding the colony, the birds are not likely to be a relict of an old colony.

Although the beak and body sizes quoted above are only estimates, I have included them because they are significantly smaller than the measurements given in Robertson (1984). He records beak lengths ranging 11.7-12.9 cm in 18 Chatham Island birds. I was particularly careful in estimating measurements and do not think that my figure of 8.9 cm could be as much as 3 cm out. From my handling of museum skins, I believe the Three Kings mollymawks may be smaller than the Chathams birds. In view of Robertson's (1984) conclusion that "the significant morphological and ecological differences between the [existing] southern and northern breeding populations seem to warrant serious consideration of reclassification as separate species," the Three Kings Buller's Mollymawks deserve closer attention.

Acknowledgements

I thank the Offshore Islands Research Group for the opportunity to participate in the 1983 Three Kings expedition; E. G. Turbott and R. B. Sibson for examining slides and for useful discussion; and J. Warham and C. J. R. Robertson for information and valuable criticism of a draft of this paper.

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SHORT NOTE

FOOT-PADDLING BY A NEW ZEALAND DOTTEREL

On 19 March 1984, at Te Matuku Bay, Waiheke Island, I was out on the tidal flats in an area covered by about 20 mm of sea water at low tide. The seasonal flock of New Zealand Dotterels (*Charadrius obscurus*) close at hand numbered 18, and I was looking for the colour-banded birds usually to be seen in this bay.

My attention was drawn to one dotterel as it hunted for food by the method sometimes used by Red-billed Gulls; that is, 'paddling' vigorously with the feet to bring tiny aquatic creatures to the surface. I followed this bird for 10 minutes and saw it use alternate feet as it moved forward. The physical effort was such that its whole body shook during the paddling, and judging by the quick short jabs of the bill, to right or left, food items must have surfaced frequently.

Foot-paddling by New Zealand birds has been considered before (Heather 1977, *Foot-trembling by the Black-fronted Dotterel*, *Notornis* 24: 1-8) and contrasted with foot-trembling, where the foot does not touch the surface, which is a feeding method of the Black-fronted Dotterel (*C. melanops*). I am not aware of any report of either method being used by *C. obscurus*.

BETTY SEARLE, 10 Tainui Road, Titirangi, Auckland 7

It is worth recording here the several observations of the late Alan Jones of Whitianga (in litt.) of foot movements by New Zealand Dotterels on Buffalo Beach, Whitianga. In December 1974, he watched a bird feeding in loose sand where the top of the beach merged with the foredune. It would stand on one foot, rubbing the other foot sideways over the sand surface with toes roughly parallel to the surface. After about six such passes of about 1 second, it would stand on both feet, watching the sand, and then take up something. In October 1977, he saw single birds on two occasions foot-trembling. One fed in this way for at least 15 minutes on dry sand above high-tide mark. It would tremble for about 5 seconds, stand still a few seconds, and then lunge ahead or to one side, usually picking up small "insects," presumably sandhoppers. Both feet were trembled alternately, so vigorously that foot, leg and half the body would tremble.—Ed.

BIRDS OF THE WESTERN CHAIN, SNARES ISLANDS 1983-84

By C. M. MISKELLY*

ABSTRACT

Birds observed during landings on four islets of the Western Chain, Snares Islands, in February 1984 are discussed. A census of Salvin's Mollymawk revealed 586 chicks on two of the islets and one stack, and so the population is not likely to exceed 650 pairs. The numbers of the eight other bird species known to breed on the Western Chain were estimated, and their distribution is described. Measurements of 20 chicks of Snares Crested Penguin indicate that the breeding cycle on the Western Chain is about six weeks later than on Main Island.

Buller's Mollymawk, Mottled Petrel, Sooty Shearwater, Southern Skua and Red-billed Gull are new breeding records for the Western Chain, and eight other species observed had not been reported previously.

INTRODUCTION

The Western Chain is a group of five islets and a number of smaller stacks that lie 4.5 km south-west of the main Snares Islands (48°02'S, 166°36'E; Fig. 1). The islets are steep sided, rising to fairly uniform heights of 29-45 m (Fig. 2), and are composed largely of muscovite-rich granite, with overlying biotite-rich schist on some islets (Fleming 1953; Watters & Fleming 1975). From the sea they appear devoid of vegetation other than lichens, but the summit of Tahī, the northern end of Toru, and a tall stack east of Toru have small patches of *Poa astonii*. The succulent herb *Crassula* (= *Tillaea*) *moschata*, which was first recorded on the Western Chain from specimens collected by Falla (Fineran 1969), was found on all islets visited (Tahī, Rua, Toru and Rima), occurring usually as isolated patches in crevices but as large mats on the plateau of Rua. Isolated clumps of the rush *Scirpus cernuus* were on Toru and Rima, and mats up to 10 m² were on Rua.

The first recorded visit by a scientist to the Western Chain was by R. A. Falla, who landed with A. J. Black on Rua Islet for an hour on 4 December 1947 (Stead 1948). They confirmed the breeding of Cape Pigeons (*Daption capense*), reported "populous penguin colonies," and the presence of "White-capped Mollymawks" on adjacent islets (Fleming 1948). On 13 January 1964, E. W. Dawson

* University of Canterbury Snares Islands Expeditions Paper No. 46

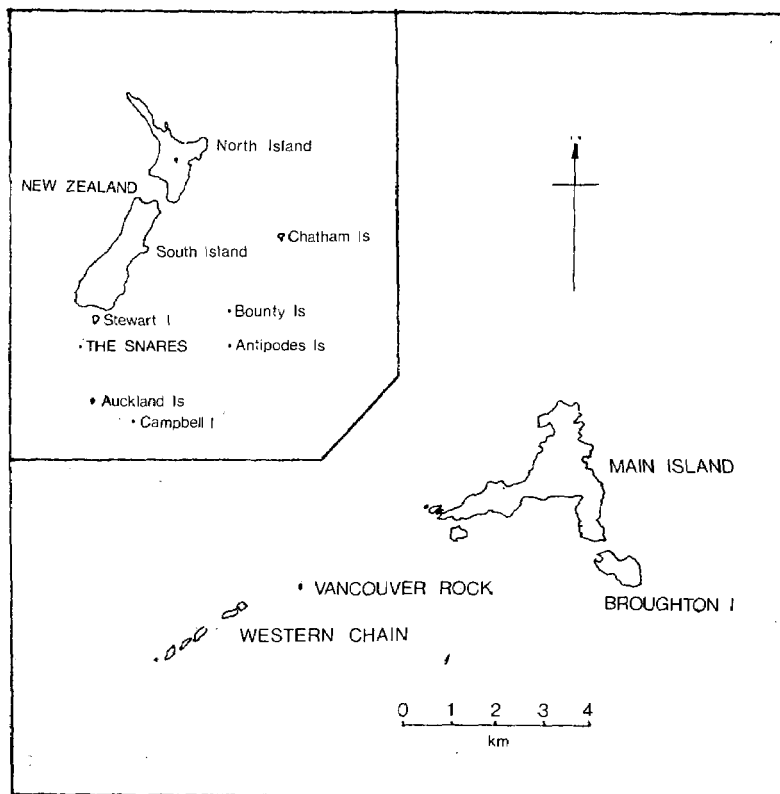


FIGURE 1 — The Snares

and R. Singleton landed on Tahi Islet (Dawson 1964) where they found Cape Pigeons and collected marine invertebrates (Fleming & Baker 1973). C. A. Fleming and A. N. Baker landed on Toru Islet on 2 December 1972, while S. Black and E. McDonald landed on Tahi. Fleming & Baker (1973) gave the first published summary of seabirds on the Western Chain and proposed names for the five main islets. These names were accepted and gazetted by the New Zealand Geographic Board in 1974 (C. A. Fleming, p. 293 in Yaldwyn 1975).

This phase of initial exploration of the five main islets of the Western Chain was completed on 21 November 1976 when the five members of the University of Canterbury 1976-77 Snares Expedition (J. W. Early, G. D. Fenwick, D. S. Horning, P. M. Sagar and J. L. Woods) landed on Rima Islet and D. S. Horning landed on Wha Islet. The breeding seabirds on Rima were counted, and a distribution of the four known breeding species on the Western Chain was proposed (Sagar 1977a).

During February 1984, four members of the University of Canterbury 1983-84 Snares Expedition (P. W. Carey, G. J. Eller, C. M. Miskelly and P. J. Wilson) travelled out to the Western Chain on three occasions, once on *FV Sea Way*, skippered by M. Schofield, and twice on *FV Sea Emerald*, skippered by K. Schofield. Landings were made on Tahi Islet (PWC and CMM, 19 February), Rua Islet (PWC and CMM, 19 February), Toru Islet (PWC and CMM, 12 February) and Rima Islet (PWC, CMM and PJW, 11 February; PJW, 19 February). On Tahi Islet we landed in a small protected inlet on the south-western side, apparently at the point where Dawson and Singleton got ashore (Fleming & Baker 1973). On Rua Islet we landed on a steep face on the north-western side of the islet, and on Toru we went ashore about halfway along the steep western face, while leaving from the penguin and seal landing spot on the south-eastern side (where Fleming and Baker are presumed to have landed). We landed on the northern point of Rima Islet, at the same location where the 1976/77 Expedition party landed (G. D. Fenwick and P. M. Sagar, pers. comm.). All the landing points known to have been used on the Western Chain are shown in Fig. 3. Some points are taken from Figure 1 of Fleming & Baker (1973). The landing point used by D. S. Horning on Wha Islet was supplied by G. D. Fenwick (pers. comm.).



FIGURE 2 — Main Island and Broughton Island (right) viewed from the summit of Rima Islet, with other islets of the Western Chain in foreground

Photo P. Carey

The main objectives of our visits were to count fur seals (*Arctocephalus forsteri*) and Salvin's Mollymawks (*Diomedea cauta salvini*), to determine the precise delay in breeding of Snares Crested Penguins (*Eudyptes robustus*) compared with those on Main Island, to search areas of tussock for burrowing petrels and to make entomological collections. The observations made while on the Western Chain are supplemented by observations made from FV *Sea Emerald* on 26 January 1983 (CMM) and 15 January 1984 (GJE), and from FV *Sea Way* on 10 February 1984 (GJE and CMM).

SYSTEMATIC ACCOUNT

BLUE PENGUIN *Eudyptula minor*

The head of a freshly dead Blue Penguin (presumed skua-killed) was found near the south end of Toru, c. 15 m a.s.l. on 12 February 1984. This is the southernmost known record for this species, which has been recorded from The Snares on four previous occasions.

SNARES CRESTED PENGUIN *Eudyptes robustus*

This species was breeding on Toru and Rima Islets. (It also breeds on Main and Broughton Islands.) Contrary to the distribution proposed by Sagar (1977a), it does not breed on Rua Islet.

Fleming & Baker (1973) and Sagar (1977a) commented on the later breeding cycle of Snares Crested Penguins on the Western Chain than on Main Island. On 2 December 1972, Fleming & Baker (1973) found the penguins on Toru sitting on eggs when "... nests on the main Snares Island all had downy chicks," and Sagar (1977a) found incubating birds on Rima Islet on 21 November 1976. On 11 February 1984, most of the chicks on Rima Islet were totally downy, but a few were starting to lose down from the flippers and the base of the tail. Chicks were in a similar but slightly more advanced stage on Toru Islet on 12 February 1984. We caught 20 chicks on Toru to describe the stage of down loss and measure their bills. This sample was not random (chicks were selected for ease of capture among the rock piles) but was thought to be representative. Three chicks were totally downy, 11 were downy except for the anterior edge of the flipper, three had also lost down from the base of the tail, and three had lost some down from the centre of the belly or lower back. Bill measurements averaged $43 \text{ mm} \pm 2 \text{ mm}$ (range 40-50 mm).

Most chicks had left Main Island by the end of January, the last being observed in Station Cove on 13 February 1984.

During the 1968-69 breeding season chicks on Main Island were first seen shedding down about 24 December and most were down free by 16 January (Warham 1974). In 1983-84 some chicks had started losing down by 11 December (G. J. Eller, pers. comm.). Judged by the pattern of down loss described by Warham (1974),

the Western Chain chicks were at least 44 days later in their development than chicks on Main Island. Sagar (1977a) calculated that the breeding cycle was delayed by at least 15 days at the time of his visit and by at least 26 days at the time of Fleming & Baker's visit. (No eggs were collected by either party to determine stage of development.)

Hatching is presumed to occur around mid-December on the Western Chain, compared with early November on Main Island (Warham 1974).

The Snares Crested Penguins on Toru and Rima Islets have a similar breeding distribution to the Salvin's Mollymawks (Fig. 3). Most chicks were under boulders and in crevices that were too small for the mollymawks to use, and this, plus the limited time we had on each islet, made an accurate count of penguin chicks impractical. However, we estimated that 100-150 chicks were on Rima Islet and 300-400 on Toru Islet. Sagar (1977a) found 74 occupied nests on Rima in November 1976 but considered this an underestimate.

During February large numbers of moulting non-breeding Snares Crested Penguins are on the main Snares Islands. No moulting birds were seen on Rima Islet, but c. 30 in premoult fat (but not yet losing feathers) were found on Toru Islet in 12 February. Thus, moulting also may be delayed on the Western Chain, and Toru may be the only islet where non-breeders moult.

Only one area on each of the two islets is used by penguins as a landing, our landing point on Rima and the east landing on Toru (Fig. 3). No penguins were seen south of the gut on Toru Islet or on any of the other islets and stacks.

ERECT-CRESTED PENGUIN *Eudyptes sclateri*

An immature Erect-crested Penguin in premoult fat was found at about 15 m a.s.l. on Rima Islet on 11 February 1984. This species has not been found on the Western Chain before but small numbers moult on the main Snares Islands each year.

BLACK-BROWED MOLLYMAWK *Diomedea melanophrys*

On 11 February 1984 an adult Black-browed Mollymawk was observed flying over Toru Islet and another was seen sitting among the Salvin's Mollymawks. When we landed on Toru the following day we found three Black-browed Mollymawks ashore, all of the dark-eyed nominate race *D. m. melanophrys*. Two birds were displaying to each other on the edge of a large group of Salvin's Mollymawks, but there was no sign of a nest. The third bird was sitting among some Salvin's Mollymawks c. 40 m from the pair. All were low on the eastern side of the islet.

Elsewhere in the New Zealand region this subspecies breeds only (in low numbers) on Bellons Island in the Antipodes group. Both races of *D. melanophrys* should have half-grown young in mid-February (Oliver 1955, Serventy *et al.* 1971).

BULLER'S MOLLYMAWK *Diomedea bulleri*

While counting the Salvin's Mollymawks on Toru Islet on 12 February 1984, we found five Buller's Mollymawks sitting on nests, and an additional vacated nest. All the nests were near vegetation (*Poa astonii* or *Scirpus cernuus*) and were the same characteristic earth pillars as on the main Snares Islands. Two of the nests were c. 2 m apart, but the other three and the vacated nest were isolated. Four nests were at the northern end of the islet and two were on the western face. None was less than 10 m from breeding areas of the Salvin's Mollymawks. The four nests that could be reached each contained one fresh egg. Several Buller's Mollymawks were seen flying over both Toru and Rima Islets.

WHITE-CAPPED MOLLYMAWK *Diomedea cauta cauta*

On 12 February 1984 an adult White-capped Mollymawk was found displaying with a group of non-breeding Salvin's Mollymawks on the north-west face of Toru Islet. Two were seen flying over Rima Islet on 11 February 1984.

SALVIN'S MOLLYMAWK *Diomedea cauta salvini*

This race of mollymawk breeds on nine islands and islets in the Bounty Islands (Robertson & van Tets 1982) and Toru and Rima Islets in the Western Chain.

Sagar (1977a) counted 706 adults, 122 live chicks, 13 dead chicks and 9 eggs on Rima Islet on 21 November 1976. This represents a minimum of 144 breeding pairs.

On 11 February 1984, I counted 150 chicks and 263 adults on Rima Islet. No evidence of chick mortality was seen, which indicates that the population has remained fairly stable over the intervening seven years. The lower number of adults present was probably due to a decline in the numbers of non-breeding birds visiting the colony three months later in the season.

On 12 February 1984 we counted 435 chicks and 673 adults on Toru Islet. Two dead chicks were found (one recent, the other just out of the egg and long dead). One chick and two adults were seen on the tall stack east of Toru Islet. Thus the breeding population of Salvin's Mollymawks on the Western Chain is unlikely to exceed 650 pairs (allowing for unobserved egg and chick losses).

Robertson & van Tets (1982) estimated that over 76 000 pairs of Salvin's Mollymawks were breeding on the Bounty Islands, and so only c. 0.8% of the subspecies breed on the Western Chain.

The distribution of Salvin's Mollymawks on the Western Chain is shown in Fig. 3. Most nests were under overhangs or in crevices between boulders, but on the relatively sheltered eastern sides of the islets the mollymawks tended to form open colonies. The largest basin on the eastern side of Toru Islet contained a continuous colony of c. 120 chicks. The nests, constructed mainly from guano with

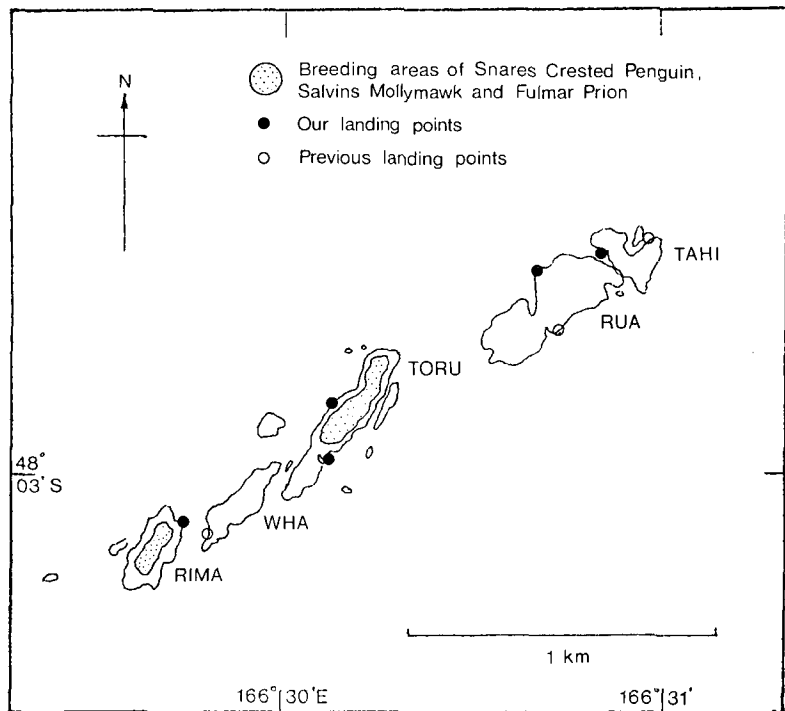


FIGURE 3 — The Western Chain, showing landing points and breeding distribution of Snares Crested Penguin, Salvin's Mollymawk and Fulmar Prion (modified from NZMS 272/1)

some granite fragments, feathers and fish and bird bones, were not as high as those that the Buller's Mollymawks manage to build, even on Toru.

The chicks were well past the guard stage and ranged from the "french-poodle" stage with just the wings free of down (Fig. 4) to being fully feathered except for a large patch of down on the nape. From the hatching dates deduced for The Snares by Robertson & van Tets (1982) from Sagar (1977a), these chicks should have been about 15 weeks old. The fledging date is not known, but I suspect some of the more advanced chicks would have left the islets in early March.

Most chicks responded to our presence by sitting upright on their nests and "clipping" their bills. If we approached closer they would make noises as if they were going to regurgitate, but this only occurred twice (to the dismay of PWC as their capacity exceeds that of Cape Pigeons). Some chicks were observed soliciting food



FIGURE 4 — Salvin's Mollymawk chick on nest, Rima Islet, 11 February 1984

Photo C. Miskelly

from adults and being fed. Fish remains and squid beaks were common around the nests. The more advanced young were seen exercising their wings.

CHATHAM ISLAND MOLLYMAWK *Diomedea cauta eremita*

On 26 January 1983, during the University of Canterbury 1982-83 Snares Expedition, I observed a Chatham Island Mollymawk that was sitting among some Salvin's Mollymawks halfway up the eastern side of Toru Islet. This bird later flew down to the boat and was photographed while feeding with Salvin's and Buller's Mollymawks on fish scraps. On 10 February 1984 GJE and CMM observed a Chatham Island Mollymawk c. 1 km south-west of the Western Chain. Although easily discernible from the many *D. c. salvini* around the boat, this bird was neither as dark on the head nor as brightly coloured on the bill as Chatham Island Mollymawks I have seen before or since. The bird was apparently adult as the only dark area on the bill was the mandibular unguis.

While counting Salvin's Mollymawks on Rima Islet on 11 February 1984 I found two Chatham Island Mollymawks. One was sitting among some unoccupied Salvin's Mollymawk on a granite slab, and the other was sitting on an empty nest with a Salvin's Mollymawk beside it (Fig. 5). A third Chatham Island Mollymawk flew over the islet.

On 12 February 1984 on Toru Islet, two Chatham Island Mollymawks were seen sitting next to adult Salvin's Mollymawks that were on nests. One 'pair' were high at the northern end of the islet, and the other bird was among the lowest group of Salvin's Mollymawks on the eastern side (where one was seen on 26 January 1983).

I am not aware of any published account of *D. c. eremita* on land away from its only known breeding island, Pyramid Rock in the Chatham Islands. Murray Schofield (pers. comm.) has seen several birds at sea near The Snares.

CAPE PIGEON *Daption capense australe*

Cape Pigeons were found breeding on Rua Islet in 1947 (Stead 1948), on Tahi in 1964, on Tahi and Toru in 1972 (Fleming & Baker 1973) and on Wha and Rima in 1976 (Sagar 1977a). We found them breeding on Tahi, Rua, Toru and Rima Islets in February 1984, and observed them sitting on several of the smaller stacks. Cape Pigeons also breed at many localities around the main Snares Islands and associated stacks (Sagar 1979) and at other island groups south of New Zealand (Kinsky 1980).

On 11 and 12 February 1984 on Rima and Toru Islets most of the chicks were almost free of down, and the presence of down in empty nests showed that some had already fledged. We estimated about 500 chicks on Rima and 1000 chicks on Toru. Most nests

were in crevices open from above, rather than under boulders. A week later on Tahi and Rua few chicks remained (c. 10 and 100 respectively) but several thousand pairs must breed on the Western Chain.

MOTTLED PETREL *Pterodroma inexpectata*

An adult Mottled Petrel and a downy chick were removed from separate burrows in *Poa astonii* on Toru Islet on 12 February 1984. A broken egg containing a fully-formed chick was also found. About 20 skua-killed birds were found near the areas of *Poa* on Toru, and two pairs of wings were found on Rua and several in skua middens on Tahi (19 February 1984).

There are sufficient areas of tussock (all intensively burrowed) on Toru for at least 100 pairs and a similar area is on a tall stack to the east of Toru. No Mottled Petrels were found during a quick search of burrows on Tahi Islet, but they may nest there also.

BROAD-BILLED PRION *Pachyptila vittata*

Sagar (1977a) found the skull of a Broad-billed Prion on Rima Islet, 21 November 1976. A freshly killed adult Broad-billed Prion was found in a skua midden on Tahi Islet on 19 February 1984. These birds are presumed to have been caught at sea.

FAIRY PRION *Pachyptila turtur*

Three of the seven identifiable *Pachyptila* skulls found in a skua midden at the southern end of Rua Islet on 19 February 1984 were referable to *P. turtur*. This species is not likely to breed on the Western Chain as the limited breeding habitat is occupied by *P. crassirostris*.

FULMAR PRION *Pachyptila crassirostris*

The nominate race of *P. crassirostris* breeds only in the New Zealand region at the Chatham Islands, The Snares and the Bounty Islands (Harper 1980). The breeding of Fulmar Prions on the Western Chain was confirmed on Toru Islet (Fleming & Baker 1973) and on Rima Islet (Sagar 1977a).

We recorded Fulmar Prions ashore only on Toru and Rima Islets, although flocks were common close off all the islets and one bird was observed circling over the saddle on Rua Islet. Four skulls of *P. crassirostris* were found in a skua midden on Rua Islet.

On Toru and Rima Islets some Fulmar Prions were observed sitting on the surface, but most were deep in crevices under boulders as described by Sagar (1977a). Chicks were presumed to have fledged as none was seen. The birds present were quite vocal, and so a resurgence of courting behaviour may follow chick fledging. We estimated 100-200 pairs on Rima Islet and 300-400 pairs on Toru Islet.

Sagar (1977a) found eggs on Rima Islet on 21 November 1976, but no other information is available on the breeding cycle of Fulmar

Prions on the Western Chain, and little from other breeding islands. Robertson & van Tets (1982) suggested that laying started about the beginning of November at the Bounty Islands, and Fleming found eggs on Pyramid Rock (Chatham Islands) on 16 December (Oliver 1955). These dates agree with the findings of Downes *et al.* (1959) for *P. c. eatoni* at Heard Island. Assuming an incubation period of about 56 days and a fledging period of 44-55 days, as in the Fairy Prion (Serventy *et al.* 1971), Fulmar Prions on the Bounty Islands would fledge in the third week of February. Our observations suggest that the Fulmar Prions on the Western Chain have completed fledging by this time, but further data are required from all breeding localities.

SOOTY SHEARWATER *Puffinus griseus*

One adult, one egg and four downy chicks were removed from some of the many burrows in the *Poa astonii* cap of Tahi Islet on 19 February 1984. Sooty Shearwaters may also breed in other areas of tussock on the Western Chain. One skua-killed adult was found on Rua Islet.

DIVING PETREL *Pelecanoides urinatrix*

Remains of skua-killed Diving Petrels were found on Tahi, Rua and Toru Islets and they seemed to comprise the bulk of skua prey items. Fleming & Baker (1973) commented on regurgitated bones of Diving Petrels that had been collected on Tahi Islet. We found no live birds, but small burrows among the tussocks on Tahi and Toru Islets may have been of this species.

BLACK SHAG *Phalacrocorax carbo*

Sagar (1977a) reported four Black Shags that were flushed from Rima Islet at their approach on 21 November 1976, and also 17 on a rock between Toru and Wha Islets on 4 December 1976 (Sagar 1977b). During the period November 1976-February 1977 there were large numbers of Black Shags on The Snares (Sagar 1977b) but these remain the only records.

SOUTHERN SKUA *Stercorarius skua lonnbergi*

Skuas were found breeding on Tahi and Rua Islets on 19 February 1984. On Tahi a pair had raised two large chicks, and on Rua a trio had raised one chick to fledging. Skua regurgitations or middens were found on all islets visited. The main prey species being taken by skuas on the Western Chain were Diving Petrels, prion species and Mottled Petrels. No evidence was found of the skuas preying on the young of Snares Crested Penguins, Salvin's Mollymawks or Cape Pigeons, but this is assumed to occur earlier in the season.

At the southern end of Rua Islet are two areas of bone deposits, each about 10 m², being uncovered by wind action. The layers are c. 5 cm thick and covered with *Crassula* and *Scirpus*. These bones

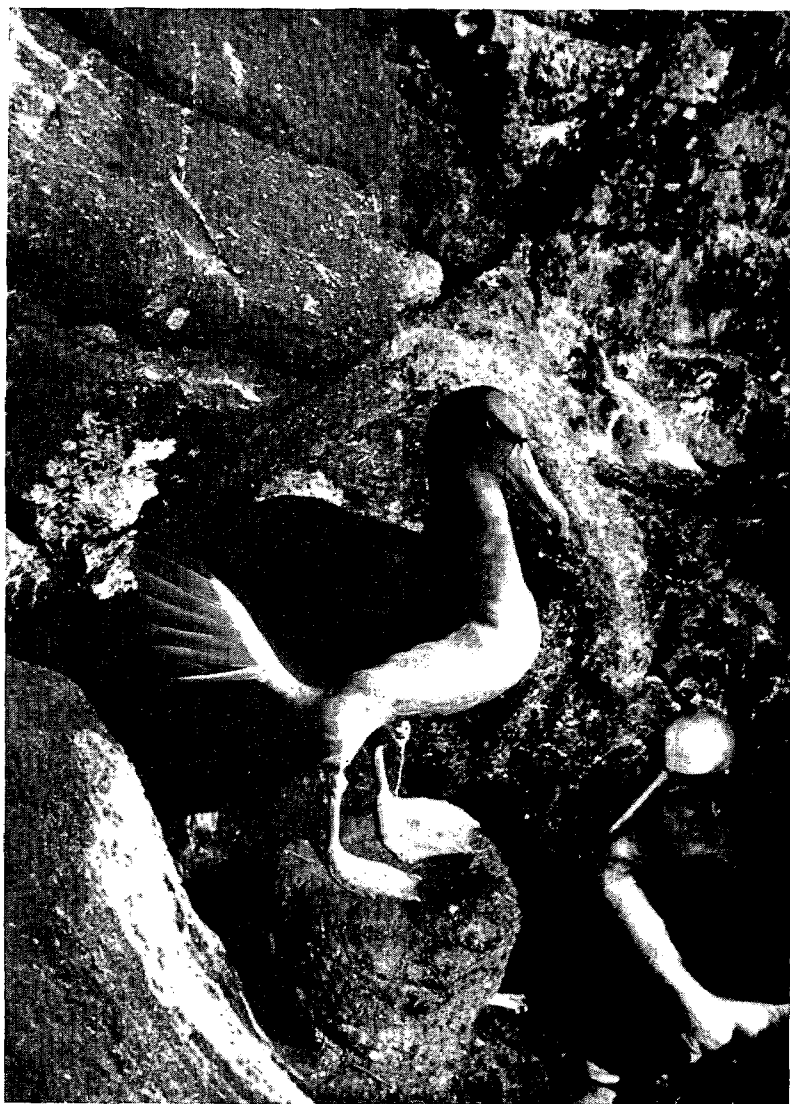


FIGURE 5 — Chatham Island Mollymawk (on nest) displaying to Salvin's Mollymawk. Height of nest exceptional. Rima Islet, 11 February 1984

Photo C. Miskelly

are presumably derived from skua middens and it would be interesting to identify past prey items.

RED-BILLED GULL *Larus novaehollandiae*

Adult and juvenile Red-billed Gulls were found on all the islets we landed on. The largest groups were 40 adults and 9 juveniles on Toru (12 February 1984) and 22 adults and 4 juveniles on Rua (19 February 1984). Fourteen juveniles with 3 adults were seen on Tahī (19 February 1984). Breeding was suspected on Rua and Toru Islets and was confirmed on Rima, where a large chick was seen on 11 February 1984.

ANTARCTIC TERN *Sterna vittata*

Antarctic Terns were observed at sea near the Western Chain during each visit but were not seen roosting on any of the main islets. On 15 January 1984 4 adults, 1 immature and 1 juvenile were roosting on a rock east of Rua Islet. The largest flock seen comprised 5 adults, 3 immatures and 1 juvenile feeding close to the western coast of Rua Islet on 19 February 1984.

WHITE-FRONTED TERN *Sterna striata*

An adult White-fronted Tern was feeding with nine Antarctic Terns west of Rua Islet on 19 February 1984. Although this species breeds as far south as the Auckland Islands (Oliver 1955) there are no recent records from The Snares.

SONG THRUSH *Turdus philomelos*

A fledgling Song Thrush was flushed three times on Toru Islet on 12 February 1984. This bird was a competent flier and so had presumably flown across the strait between the Western Chain and Main Island.

DISCUSSION

The breeding distribution of bird species within the Western Chain apparently depends on the topography and geology of the main islets, except for burrowing petrels, which are confined to the small areas of *Poa astonii*. The Cape Pigeon is the only species known to breed on all five main islets. The breeding distribution of birds on the Western Chain is given in Table 1.

The three southern islets (Toru, Wha and Rima) have several conspicuous joint systems that dissect the granite, forming crevices and piles of boulders. These areas are used for nesting on the two higher islets (Toru and Rima) by Snares Crested Penguins, Salvin's Mollymawks and Fulmar Prions. The lower relief of Wha (max 37 m a.s.l.) may be the factor preventing Salvin's Mollymawks from breeding, although they nest down to c. 15 m a.s.l. on Toru. Wha is the islet considered most suitable for the mollymawks to spread onto. An absence of suitable landing places may keep penguins from Wha Islet.

TABLE 1 — Breeding distribution of seabirds within the Western Chain, Snares Islands. X = breeding confirmed; ? = breeding suspected

SPECIES	ISLET	Tahi	Rua	Toru	Wha	Rima
Snares Crested Penguin				X		X
Salvin's Mollymawk			X	X		X
Buller's Mollymawk				X		
Cape Pigeon		X	X	X	X	X
Mottled Petrel		?		X		
Fulmar Prion				X		X
Sooty Shearwater		X		?		
Southern Skua		X	X			
Red-billed Gull			?	?		X

Tahi, and particularly Rua, are lower lying with a covering of schist (Watters & Fleming 1975), which weathers to form shallow pans separated by narrow ridges. Such relief does not provide suitable crevices for Snares Crested Penguins or Fulmar Prions, nor does it appear to provide enough shelter for mollymawks. The summit of Tahi is more like the southern islets — rounded granite with a cap of tussock — but this area is small.

The skuas are presumably confined to the northern islets for breeding to avoid interference by mollymawks and penguins. Skuas are not known to breed on Wha Islet, possibly because of a lack of vegetation for nest construction.

The five sightings of adult Chatham Island Mollymawks on Toru and Rima Islets raise the question of whether these birds are breeding with the Salvin's Mollymawks on the Western Chain, particularly as three were apparently attached to nest sites. No chicks were found associated with these birds, but unaccompanied *eremita* or *eremita* x *salvini* chicks would not have been recognised. The 'cauta' mollymawk seen 1 km south-west of the Western Chain on 10 February 1984 had characteristics suggestive of a hybrid.

The breeding Salvin's Mollymawks on the Western Chain appear to act as a lure for other mollymawks that feed in the area. The few Buller's Mollymawks that breed on Toru may have been attracted by the presence of the Salvin's Mollymawks and managed to find enough soil to construct nests, or they may be the remnant of a larger population that has declined with decreasing vegetation cover and

island size. It would be of interest to measure and map the existing areas of *Poa astonii* on the Western Chain at intervals in order to determine whether the vegetative cover is increasing, static or declining.

Other problems that could be given attention by future visitors to the Western Chain include looking for breeding by the various mollymawks, determining the timing of the breeding cycle of the Fulmar Prions, and working out whether the delay in the breeding cycle of the Snares Crested Penguins on the Western Chain has a genetic or environmental basis.

ACKNOWLEDGEMENTS

The University of Canterbury 1982-83 and 1983-84 Snares Expeditions were financed by the Department of Lands and Survey. I thank Murray Schofield, skipper of FV *Sea Way*, and Kevin Schofield, skipper of FV *Sea Emerald*, for transport to the Western Chain and P. W. Carey and G. J. Eller for help with field work. J. Warham and P. M. Sagar kindly criticised the manuscript.

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SHORT NOTES

BLACK-BILLED GULL FOOD PREFERENCES

In late November 1983, I was helping my son sow his swede crop on his Hokonui farm in Southland. My job was to ride on the back of the ridger and watch the seed boxes. The day being fine and calm, I sat on the machine facing backwards and watched the Black-billed Gulls feeding as they followed the machine. All day, a constantly changing flock of 40-60 birds followed closely, often at arms length, and I was in a good position to observe. Presumably most of the flock were breeding birds, the nearest breeding colony being on the Oreti River bed 12 km away.

Most of what the birds were feeding on was too small for me to see, but any grass grubs or porina grubs were eaten. Although earthworms were plentiful they were not taken. Twice during the day I saw a gull pick up a worm but promptly drop it.

With over 200 000 Black-billed Gulls in Southland, it is interesting to contemplate the volume of agricultural pests they take annually.

GRANT G. ALLEN, 48 Grange Street, Winton



FAIRY MARTIN AT CAPE REINGA

On the morning of 30 November 1983, during a visit to Cape Reinga, we noticed a small swallow-like bird with a white rump flying around the lighthouse buildings with a group of Welcome Swallows. After we had watched it for several minutes, it flew close enough for us to pick out the rusty-red colour of its head, identifying it as a Fairy Martin. Eventually it settled on the roof of the post office building (in spite of some harassment from the larger Welcome Swallows), and we were able to watch it in bright sunlight through binoculars from about 10 metres away. We could then see that the reddish coloration of the head extended on to the upper breast and had a faintly streaked appearance, particularly under the chin. The black tail contrasted strongly with the pale belly and white rump and was only slightly forked. The wings were black above, paler underneath, and relatively shorter than those of the swallows. In all we watched it for about half an hour. This sighting is particularly interesting in view of the sighting of other Fairy Martins in New Zealand earlier in the year.

DAVID RIDDELL, Gordonton Road, R.D. 1, Taupiri; ANNETTE TAYLOR, 49 Wynyard Road, Mt Eden

NOTES ON SOOTY SHEARWATERS AND OTHER AVIFAUNA OF THE CHILEAN OFFSHORE ISLAND OF GUAFO

By G. S. CLARK, A. P. VON MEYER, J. W. NELSON and J. N. WATT

ABSTRACT

According to available literature, Isla Guafo, Chile, has been rarely visited by ornithologists. The authors have produced a tentative species list. Birds observed within 1 km of the island are included in the total of 62 species. Breeding information was obtained for some species.

The discovery of a large breeding colony of Sooty Shearwaters (*Puffinus griseus*) is important because it is the first known large colony in Chile north of the Fuegian area.

INTRODUCTION

The Chilean offshore island of Guafo, centred in 43°36'S 74°43'W, lies in the middle of the seaward approach to the Gulf of Corcovado and is about 39 km south-west of the island of Chiloe. It consists of hills up to 240 m, with valleys, ridges, and steep-sided stream gorges, covered with dense temperate rainforest. It is approximately 15.7 km north to south and 19.4 km east to west (Fig. 1).

High cliffs, more or less vegetated, surround much of the island, but there are some slopes and sand beaches. Most of the coast is rock bound and is unapproachable in normal weather conditions.

The greater part of Isla Guafo is in its virgin state. A small whaling station used to operate in Caleta Samuel, but it closed about 50 years ago and the only conspicuous evidence remaining is the secondary growth over a few hectares around the caleta (small bay) where trees were felled for fuel. A lighthouse at Punta Weather on the top of a high cliffy peninsula is manned by Chilean naval personnel. A small farm is maintained close to the lighthouse with a few cattle, sheep, goats and hens, a dog, and pet rabbits. None of these animals seems inclined to stray into the forest, where generally wet conditions prevail.

The island is visited occasionally by fishermen for shellfish, but only in exceptionally good weather. In the past it was also visited by sea-lion hunters. The lighthouse keepers had been told that wild dogs and wild cats were on the island. We found no evidence of either, except for some cat footprints in thick dust in a cave near a human skeleton, but they could have been very old. Some rats (? species) were seen in the forest near Caleta Samuel,

and mice visited the Expedition's food store. Many burrows in the forest floor indicated the presence of small underground-living animals.

METHODS

The Totorore Expedition, whose team consisted of the four authors, arrived at Isla Guafo on 26 September 1983 and camped there until 20 October 1983. During this time 17 km of the east coast and Punta Weather were examined closely, but the rest of the coast was observed only from close offshore because unfavourable sea conditions prevented our landing. We explored the forest for several kilometres from Caleta Samuel, from near to Punta Norte, and from Punta Weather, but most of the interior remains unexplored.

Day watches and some night watches were kept offshore to observe the movements of seabirds. A watch was kept one night from the lighthouse to observe any birds attracted to the light. Bad weather restricted many of our activities.

The scientific nomenclature used in the list is in accordance with the Lista Patron de las Aves Chilenas by Braulio Araya (1982).

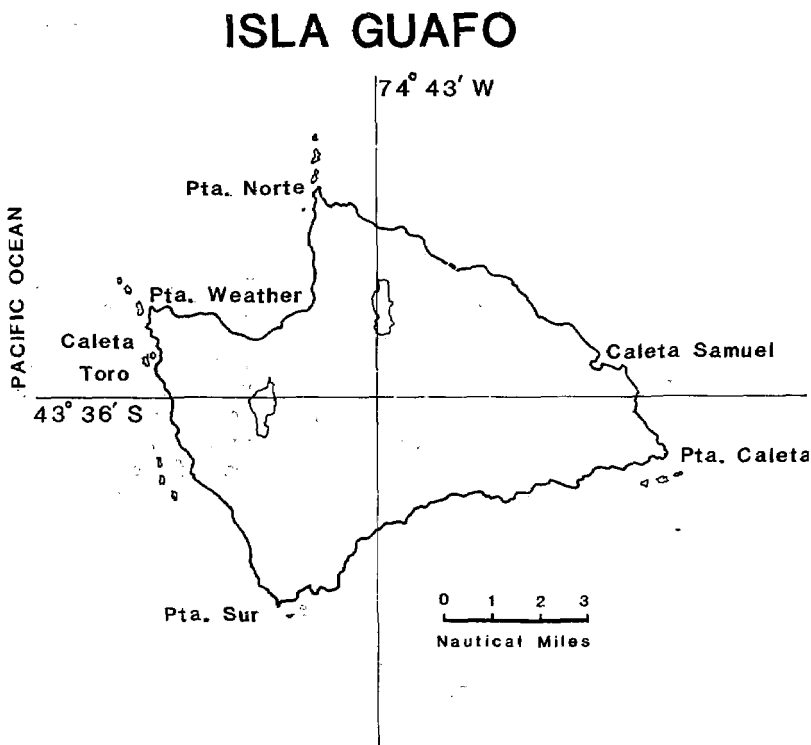


FIGURE 1

ANNOTATED SPECIES ACCOUNT

MAGELLANIC PENGUIN *Spheniscus magellanicus*

Common close offshore. We found a breeding colony of unknown extent in dense scrub near Punta Norte. Of several burrows which we examined on 9 October, some had 2 eggs, and some had 1.

ROYAL ALBATROSS *Diomedea epomophora sanfordi*

Singly, seen frequently offshore, occasionally within 0.5 km of the coast.

BLACK-BROWED MOLLYMAWK *Diomedea melanophrys*

Common offshore, and occasionally into Caleta Samuel; up to 5 at a time. Two-thirds, approximately, were juvenile or immature.

GIANT PETREL *Macronectes* sp.

One or two frequently offshore and flying over coastal rock shelf.

ANTARCTIC FULMAR *Fulmarus glacialis*

Common offshore. Several seen on rocky islets near Caleta Toro, close to a colony of Imperial Shags.

CAPE PIGEON *Daption capense*

Occasionally singly offshore.

PRIONS *Pachyptila* sp.

Loose flocks seen frequently offshore. Two dead specimens found floating were identified as Thin-billed Prions (*P. belcheri*). Many remains were found on north-east coast, some identifiable as *P. belcheri*.

WHITE-CHINNED PETREL *Procellaria aequinoctialis*

Common offshore in groups up to 12. One flock of 40 encountered 8 km from island.

SOOTY SHEARWATER *Puffinus griseus*

We discovered that Sooty Shearwaters breed on Isla Guafo in large numbers. From observations of birds coming to land in the late evening we estimated that the colony consists of at least 200 000 birds.

Sooty Shearwaters were seen to be gathering within 3 km of the shore from mid-afternoon, sometimes circling about low over the water and sometimes in extensive rafts on the water, in many locations all round the island. Soon after sunset they became very active and gained height, and the first crossed the coast, flying 80-100 m high, about 20 minutes after sunset. They continued to stream in until long after dark, when they could only be heard. The main concentrations of incoming birds were at Caleta Samuel, Punta Weather, and wherever a stream gorge or valley opened to the sea. On 27 September at Caleta Samuel, bird counts gave a rate of 200-300 birds per minute, but by 20 October this number had more than trebled. On 9 October, 700 birds per minute were counted flying inland at Punta Weather.

Over land, the Sooty Shearwaters circled and dispersed towards the higher hills. We tried to locate a main colony, if such exists, by camping in the forest and tracing the movements of the birds by their calls, but we were not successful, and any large colonies are probably further into the vast interior than we could reach in the time available. At each of six camp sites, however, birds were heard crashing through the canopy to the forest floor in small numbers, the most being 15 on a high hill not far from Punta Weather. Nesting birds may therefore be scattered all over the island, and some birds were even heard close above the beach at Caleta Samuel.

In the dense forest with thick and tangled undergrowth it was very difficult to locate either grounded shearwaters or their burrows (cf. Murphy 1936). Most of the burrows found were under the roots of large trees or under huge fallen tree trunks, and few of those found were actually occupied. Three birds which we captured were in fresh plumage and still had fully downy brood patches, from which we concluded that laying had not begun.

WILSON'S STORM PETREL *Oceanites oceanicus*

Common offshore in small numbers.

DIVING PETREL *Pelecanoides* sp.

A few seen close offshore; one dead on the east coast.

OLIVACEOUS CORMORANT *Phalacrocorax olivaceus*

Seen in small numbers around the shore. No nests found.

ROCK SHAG *Phalacrocorax magellanicus*

Common around the island, breeding in scattered colonies on suitable rock ledges or in caves. One colony at Punta Weather had 18 nests, one south-east of Caleta Samuel 14 nests, and one 1 km north-west of Caleta Samuel 22 nests.

IMPERIAL SHAG *Phalacrocorax atriceps*

Very common, breeding in at least six colonies around the island on suitable rocks, on Punta Norte, and on a small headland about 1.5 km north-west of Caleta Samuel. At the last on 16 October there were 75 nests, of which 8 were empty, 7 contained 1 egg, 24 had 2 eggs, 31 had 3 eggs, and 5 were inaccessible.

WHITE-NECKED HERON *Ardea cocoi*

One seen.

BLACK-CROWNED NIGHT HERON *Nycticorax nycticorax*

One.

BLACK-NECKED IBIS *Theristicus caudatus*

Groups of 2-9.

KELP GOOSE *Chloephaga hybrida*

Abundant all around the coast. Average of 30 pairs per kilometre of north-east coast. Nests with 4-6 eggs found from 26 September onwards.

ASHY-HEADED GOOSE *Chloephaga poliocephala*

Small numbers around coast. Nesting; goslings seen on 28 September.

FLIGHTLESS STEAMER DUCK *Tachyeres pteneres*

Common on more sheltered parts of north-east coast. No nests found.

SPECKLED TEAL *Anas flavirostris*

Moderate numbers.

CHILOE WIDGEON *Anas sibilatrix*

Uncommon.

TURKEY VULTURE *Cathartes aura*

Common.

CINEREOUS HARRIER *Circus cinereus*

Uncommon.

CHIMANGO CARACARA *Milvago chimango*

Scarce.

CRESTED CARACARA *Polyborus plancus*

Locally common.

PLUMBEOUS RAIL *Rallus sanguinolentus*

Sparse.

AMERICAN OYSTERCATCHER *Haematopus palliatus*

One only, at Caleta Samuel.

MAGELLANIC OYSTERCATCHER *Haematopus leucopodus*

Common on rocky shores and beaches. First nests with eggs found on 18 October.

BLACK OYSTERCATCHER *Haematopus ater*

Commonest oystercatcher on all coasts. Nests with eggs found on 18 October. Two eggs were laid in a Kelp Goose nest after the first two goose eggs. When we left on 20 October the goose appeared to be incubating.

SOUTHERN LAPWING *Vanellus chilensis*

Common.

BAIRD'S SANDPIPER *Calidris bairdii*

Three only.

WHIMBREL *Numenius phaeopus*

Common.

RED PHALAROPE *Phalaropus fulicarius*

Seen at very close range and easily identified. Often 100-200 in disturbed water around Punta Norte, and a flock of over 5000 was counted between Punta Norte and Caleta Samuel on 20 October.

AMERICAN SHEATHBILL *Chionis alba*

One in attendance at a sea lion colony on Punta Norte.

CHILEAN SKUA *Catharacta chilensis*

A few around the coasts and near Imperial Shag colonies. One seen to stoop on a small bird at sea, thought to be a prion, and carry it to the shore.

DOLPHIN GULL *Leucophaeus scoresbii*

Common near sea lion and Imperial Shag colonies. Breeding colony at Punta Norte with 80 nests. On 9 October some nests contained 1 egg.

SOUTHERN BLACK-BACKED GULL *Larus dominicanus*

Common all around the island. Seen to be nesting on offshore rocks and headlands. No nests examined.

BROWN-HOODED GULL *Larus maculipennis*

Few groups, up to 4, north-east coast. All seen were adults in breeding plumage.

SOUTH AMERICAN TERN *Sterna hirundinacea*

Small numbers seen close off south-east coast.

ARCTIC TERN *Sterna paradisaea*

Three arrived in Caleta Samuel on 17 October, and by the next day there were 23, and 1 dead on the shore.

AUSTRAL PARAKEET *Enicognathus ferrugineus*

Locally in small groups.

GREEN-BACKED FIRE-CROWN *Sebanoides galeritus* CommonSTRIPED WOODPECKER *Picoides lignarius* SparseCHILEAN CINCLODES *Cinclodes patagonicus* CommonDES MUR'S WIRETAIL *Sylviorthorhynchus desmursii* Quite commonTHORN-TAILED RAYADITO *Apharastura spinicauda* CommonPLAIN-MANTLED TIT SPINE-TAIL *Leptasthenura aegithalodes* OneWHITE-THROATED TREE-RUNNER *Pygarrhichas albogularis* OneMAGELLANIC BABBLER *Scytalopus magellanicus* CommonFIRE-EYED DIUCON *Pyrope pyrope* CommonBLACK-FACED GROUND TYRANT *Muscisaxicola macloviana*

Locally common

RUFIOUS-BACKED NEGRITO *Lessonia rufa* SparseTUFTED TIT TYRANT *Anairetes parulus* CommonPATAGONIAN TYRANT *Colorhamphus parvirostris* SparseCHILEAN SWALLOW *Tachycineta leucopyga* CommonBLUE-AND-WHITE SWALLOW *Notiochelidon cyanoleuca* SparseHOUSE WREN *Troglodytes aedon* SparsePATAGONIAN THRUSH *Turdus falcklandii* CommonAUSTRAL BLACKBIRD *Curaeus curaeus* Common

PATAGONIAN SIERRA FINCH <i>Phrygilus patagonicus</i>	Common
RUFIOUS-COLLARED SPARROW <i>Zonotrichia capensis</i>	Common
BEARDED SISKIN <i>Carduelis barbatus</i>	Locally common

ACKNOWLEDGEMENTS

The Totorore Expedition received financial assistance from the New Zealand Minister of Internal Affairs, the Ornithological Society of New Zealand, the World Wildlife Fund NZ, and Northern Branches of the Royal New Zealand Forest and Bird Protection Society, and many private donations in New Zealand. Our grateful thanks to all of these and also to Dr Roberto Schlatter of the Universidad Austral de Chile and Sr Braulio Araya of the Instituto de Oceanologia, Universidad de Valparaiso, who reviewed this manuscript and gave the Expedition technical help and encouragement. We are very grateful to the Armada de Chile for its support and advice and particularly to the personnel at Guafo lighthouse for their help and hospitality.

We thank A. J. Goodwin, B. D. Heather and especially M. J. Imber for help in preparing the script for publication.

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SHORT NOTE

UNUSUAL DISPLAY BY TUI

On 22 June 1984, a pair of Tuís (*Prosthemadera novaezeelandiae*) flew in to perch on the topmost bare twigs of a tall silver birch on the roadside near my home. Presently the male took off in level flight for 3-4 metres and then, to my surprise, flew vertically upwards in a flycatcher-like flight for about 4 metres and remained almost stationary for 5-6 seconds, with wings beating strongly, and angling acutely above the back to give more power to each downward stroke. He then dropped to the level of the female, circled her in level flight at 3-4 metres several times, and then repeated the vertical flight. This performance continued for some 9 minutes, with the vertical flights always in the quarter which the female was facing. It was obviously mating display, perhaps induced by a succession of clear spring-like days.

A. BLACKBURN, 10 Score Road, Gisborne

THE DISTRIBUTION AND NUMBERS OF GANNETS (*Sula serrator*) IN NEW ZEALAND

By K. WODZICKI, C. J. R. ROBERTSON, H. R. THOMPSON
and C. J. T. ALDERTON

ABSTRACT

The 1980/81 distribution of the Australasian Gannet (*Sula serrator*) in New Zealand is described and population changes since 1946 are examined. A brief history of the 26 breeding colonies and 23 roosts is given. Over 99% of gannets nested in the 23 colonies round the northern half of the North Island in 1980/81. Gannet roosts are mostly near the breeding colonies.

The results of three national censuses taken since 1946 give an indication of the changes of the New Zealand gannet population in 34 years. The 1946/47 population was assessed at 21 115 pairs; 37 774 pairs were counted in 1969/70 and 46 004 in 1980/81. The mean annual rate of increase for the whole population between 1946/47 and 1980/81 was 2.3%. In comparison with gannets in Australia, South Africa, and the North Atlantic, the gannet in New Zealand seems to be the only one steadily increasing and free from human interference.

INTRODUCTION

Gannets (Sulidae) comprise three geographically widely separated species — the North Atlantic Gannet (*Sula bassana*) in the eastern and western parts of the North Atlantic and in the North Sea, the South African Gannet (*Sula capensis*) round the southern coast of South Africa, and the Australasian Gannet (*Sula serrator*) in New Zealand (Falla *et al.*, 1979), Victoria, South-eastern Australia and Tasmania. The breeding range of the Australasian Gannet is marked by the parallels of 29°S and 47°S latitude and the meridians of 141°E and 178°E longitude.

Gannets are one of the very few vertebrate species in which the whole population can be assessed with a high degree of accuracy. As gannets congregate at breeding colonies, during the nesting season the whole breeding population may be counted. National censuses of the Australasian Gannet in New Zealand have been done in the 1946/47, 1969/70 and 1980/81 breeding seasons, allowing an assessment to be made of the changes in gannet numbers in New Zealand over a 34-year period.

METHODS

The first (1946/47) census of gannets in New Zealand (Fleming & Wodzicki 1952) was based partly on direct observations and partly

TABLE 1 — Time of day aerial photographs taken in 1969/70 and 1980/81 censuses (excluding RNZAF photographs 1968, 1969)

TIME	<u>1969/70 Census</u>		<u>1980/81 Census</u>					
	Day One (20/10/69)	Day Two (21/10/69)	Day One (22/10/80)	Day Two (11/11/80)	Day Three (12/11/80)	Day Four (13/11/80)	Day Five (14/11/80)	Day Six (25/11/80)
10.00-10.59	Tolaga Bay (10.00)	Poor Knights Is (10.00)		Three Kings Is (10.45)	White I. (10.45)	Kawhia (10.00)	Nuggets (10.35)	
11.00-11.59	White I. (11.30)				Schooner Rocks Aldermen Is Mercury Is Cuvier I. Arid I. (11.15-13.15)			Marlborough Sounds (11.30)
12.00-12.59		Cape Karikari Stacks (12.00)	Tolaga Bay (12.00)	Cape Karikari Stacks (12.30)			Little Solander I. (12.10)	
13.00-13.59		Muriwai (13.00-14.00)	Hawkes Bay (13.30)		Mokohinau Is (13.30)			
14.00-14.59	Aldermen Is (14.00)			Cavalli I. (14.15)	Mahuki I. (14.00)			
	Colville/ Horuhoru (14.30-16.00)				Colville (14.45)			
15.00-15.59		Kawhia (15.00)		Tikiliki I. (15.00) Bird Rock (15.10) Poor Knights Is (15.30) Sail Rock (15.45)	Horuhoru (15.45)			
16.00-16.59	Mahuki I. (16.30)			Muriwai (16.30)				
17.00-17.59	Mokohinau Is (17.15)	Hawkes Bay (17.00)						

on indirect methods such as aerial photography. Direct observations included walks through a gannetry counting the numbers in the regularly arranged rows of nests. An alternative for gannetries with shy birds was to make several counts using binoculars and to average the counts. Fleming and Wodzicki found that small gannetries of up to 100 nests could be counted on the ground without significant error but that counts of large congregations of 1000 or more nests might differ by up to 10%. They found aerial photographs to be satisfactory for counting gannets, except when the weather had deteriorated during the taking of photographs. They estimated that "with good photographs the margin of error in counting nesting gannets is small" but that "with poor photographs the margin of error may be up to 25%."

The 1969/70 and 1980/81 gannet censuses were based solely on aerial photographs. Those used were taken on 17, 25 October and 5 December 1968 and 20-21 October and 17 November 1969. In the 1980/81 breeding season photographs were taken on 22 October and 11-14 and 25 November. All the photographs were taken in fine weather from altitudes of 150-500 m in 1968/69 and 200-650 m in 1980. Because gannet numbers fluctuate during the day and during the breeding season, the times when photographs were taken are summarised in Table 1.

The Three Kings gannetries were photographed by the RNZAF at 12.00 h on 25 October 1968 and at 12.30 h on 17 November 1969 at 150-500 m. For all islands except Arbutus Rock, only the 1969 photographs were used for counting because the photographic coverage was more comprehensive than in the 1968 series. A small section of the South West Island gannetries was not photographed. The Nuggets gannetry was photographed by the RNZAF at 12.00 h on 17 October 1968 and Little Solander Island on 5 December 1968.

Other gannetries were photographed in 1969 from a Piper Cherokee 6 aircraft. The plane was piloted by P. Wilson and navigated by D. G. Cooper, and photographs were taken through the open door by C. J. R. Robertson. RNZAF photographs were taken in black and white 130 x 120 mm film. Other photographs were taken with a Pentax camera and 135 mm telephoto lens in Agfacolor colour transparency and Ilford FP4 black and white 35 mm film.

In 1980 the Department of Civil Aviation provided extensive assistance by making available a Piper Seneca twin-engined aircraft and a single-engined Cessna 172 aircraft for all localities except the most southern colonies. R. Shand and J. Snow were the main pilots while R. Cossee and G. Park provided navigation and other assistance. All photographs were taken through an open door or window. A. Wright photographed the Nuggets and Little Solander Island gannetries with a Pentax 35 mm camera and 80-220 zoom telephoto lens. C. J. R. Robertson photographed all other gannetries using Nikon 35 mm automatic-exposure cameras with motor drives and 70-210 mm zoom

telephoto lenses. All photographs were Ektachrome 64 colour transparencies and Ilford FP4 black and whites.

When conditions allowed, air speeds were restricted to 80-110 knots. To prevent camera shake and aircraft movement from blurring the film image, all exposures were above 1/500th of a second. The best coverage of gannetries was obtained by means of a direct intercom link between photographer and pilot to assist with aligning the aircraft and by means of automatic-exposure motor-drive cameras.

In November and December 1968 C. J. R. Robertson (unpubl.) tested the accuracy of comparative counts taken from aerial photographs and ground counts (where each nest site was checked) at a gannetry with 200-400 sites. These tests showed that, although aerial photographs could not allow the breeding status of gannets to be assessed reliably (also referred to by Nettleship 1976) the counts were accurate to within $\pm 3\%$ of nest sites recorded on the ground.

As the number of birds present on a gannetry can vary according to nesting or site-occupying status, time of day, inter- and intra-seasonal fluctuations and latitude, any counts taken from aerial photographs may be subject to several sources of error. These factors will be discussed and related to the census data in a separate paper. However, with improved photographic methods, gannetries can be counted over a short period of time and the population size can be assessed more reliably.

Photographic transparencies from the 1969/70 and 1980/81 census surveys were projected on to a plain sheet of white paper and all sites with one or two gannets were marked on the paper. The marked sheets were then divided up into groups of up to 50 sites, and the groups were counted and totalled.

Each site with one or two birds was counted as a single site representing one site-occupying pair. Throughout the rest of the paper, we shall refer to these 'site-occupying pairs' as 'pairs.'

NEW ZEALAND GANNETRIES AND ROOSTS: A BRIEF HISTORY AND PRESENT STATUS

The first count of gannets breeding in New Zealand was provided by Wodzicki & McMeekan (1947). They listed 12 'breeding localities' with an estimated total population of 11 777 pairs. Fleming & Wodzicki (1952) described 32 'gannet stations' in New Zealand in 1946/47. However, nine of these were roosts or extinct gannetries, and so there were 23 breeding stations in 1946/47. In this paper we use the word 'colony' to represent a collection of occupied sites completely separate from any other collection, and 'gannetry' to represent a collection of colonies in the same geographic location. Thus, the terms 'localities' and 'stations' are synonymous with 'gannetries.'

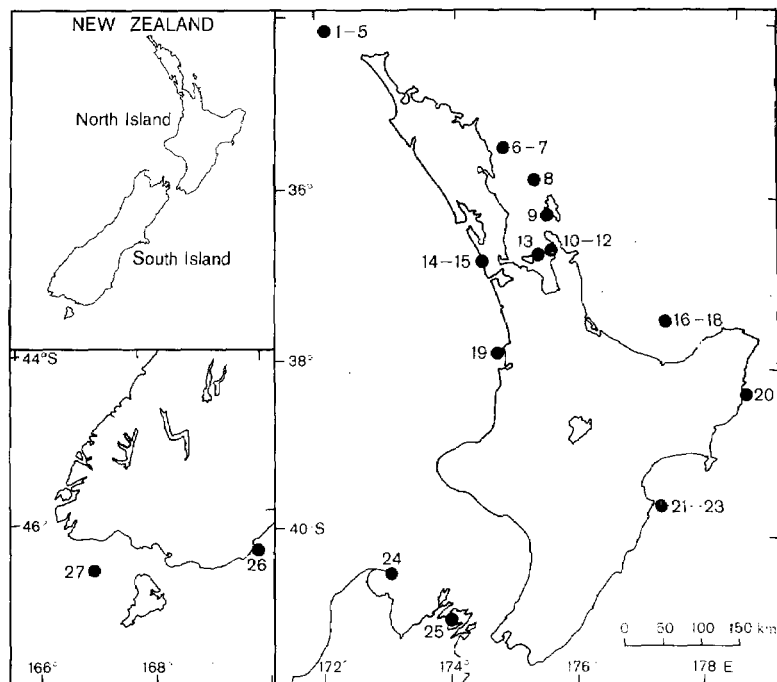


FIGURE 1 — Distribution of breeding gannetries in New Zealand

- | | |
|-------------------------|----------------------------|
| 1. South West Island | 15. *Muriwai Stack |
| 2. Hinemoa Rock | 16. West Point |
| 3. Hole-in-the-Wall | 17. Rocky Point |
| 4. Tutanekai Rock | 18. Gannet Point |
| 5. Arbutus Rock | 19. Gannet Island (Karewa) |
| 6. High Peak Rocks | 20. Moutara Rock |
| 7. Sugarloaf | 21. Black Reef |
| 8. Cathedral Rocks | 22. Cape Kidnappers Saddle |
| 9. Mahuki Island | 23. Plateau |
| 10. Double Island Stack | 24. †Farewell Spit |
| 11. Bush Island | 25. *Waimaru Bay |
| 12. Motutakapu | 26. Nuggets |
| 13. Horuhoru Rock | 27. Little Solander Island |
| 14. Oaia Island | |

(established since the 1946/47 (*) or 1980/81 (†) census)

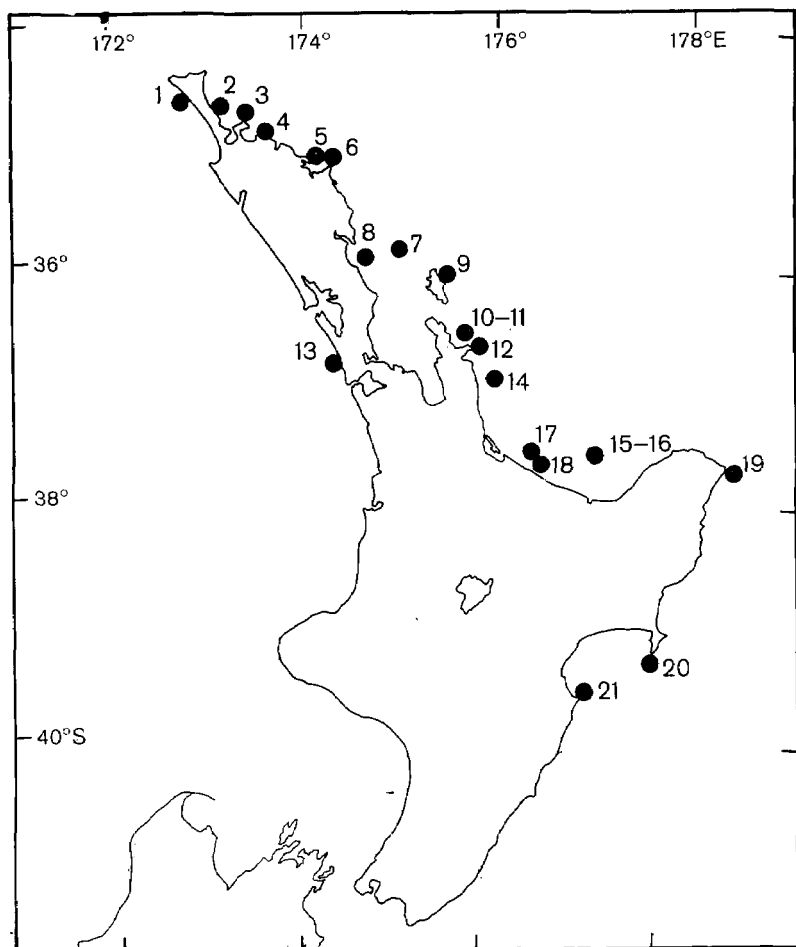


FIGURE 2 — Distribution of gannet roosts in New Zealand

- | | |
|-------------------------|----------------------|
| 1. Matapia Islet | 12. Korapuki Island |
| 2. Hapuku Rock | 13. Muriwai Mainland |
| 3. Cape Karikari Stacks | 14. Sugarloaf Rocks |
| 4. Berghan Point | 15. Dam Site |
| 5. Tikitiki Rock | 16. Club Rock |
| 6. Bird Rock | 17. Motuhaku Islands |
| 7. Groper Rock | 18. Motunau Island |
| 8. Sail Rock | 19. East Island |
| 9. Arid Island Stack | 20. Portland Island |
| 10. The Sisters | 21. Plateau Beach |
| 11. Never Fail Rock | |

In 1980/81, 34 years later, we recorded 26 gannetries in New Zealand. This figure does not include the Farewell Spit gannetry, established after the 1980/81 census, or the gannetry contained within the Napier Marineland. Information on the history, distribution and subdivisions of the present gannetries is given below. Descriptive material given in Fleming & Wodzicki (1952) has not generally been repeated. Gannetries are listed from north to south. Roosts have been distinguished from breeding gannetries by means of (R) or (G), respectively, after the names (see also Fig. 1 and 2 and Table 2).

THREE KINGS (G) 34°11'S 172°02'-172°04'E

This group consists of five gannetries (South West Island, Hinemoa Rock, Hole-in-the-Wall, Tutanekai Rock and Arbutus Rock), described in Fleming & Wodzicki (1952). Note that in Figure 5 of Fleming & Wodzicki (1952), Tutanekai Rock should be labelled as Hinemoa Rock. Gannets were presumably breeding in this area when noted near the Three Kings by Captain Cook in 1769. Breeding was first reported in 1889. Pairs counted were 4134 in 1946/47, 7235 in 1969/70, and 9855 in 1980/81. Changes in the numbers of pairs at each gannetry are given in Table 2.

By 1980 there were some new colonies on South West Island and some of the 1946/47 colonies had changed or disappeared. Vegetation encroachment recorded in the 1969 photographs had continued and it is possible that some nest sites were obscured. On all other islands there had been a steady increase in the extent and size of surrounding vegetation between 1946 and 1980.

MATAPIA ISLET (R) 34°38'S 172°49'E

For the history and description of this roost see Fleming & Wodzicki (1952). The nearest established breeding colony is at the Three Kings Islands c. 60 km away. No recent records of roosting.

SIMMONDS ISLAND (R) 34°45'S 173°09'E

Hapuku Rock, about 41 m long by 23m wide, lacks vegetation, rises 6-9 m above the water, and is often covered during high seas. Roosting was reported on Hapuku Rock in December 1965 (Wagener 1966). During the day small flocks of 5-10 birds were seen fishing around Simmonds Island and at dusk about 20 roosted on the north-east portion of the rock. The nearest established breeding colony is at the Three Kings Islands c. 140 km away.

CAPE KARIKARI STACKS (R) 34°46'S 173°24'E

An estimated 30 pairs were first reported breeding on the two small rocks in 1946/47. There was no breeding in 1947/48 (Fleming & Wodzicki 1952) and no birds were present in 1969/70 or 1980/81. Currently regarded as an abandoned gannetry, the nearest established gannetry is at the Three Kings Islands c. 115 km away.

BERGHAN POINT (R) 34°55'S 173°35'E

After a report of gannets roosting on the islet at the end of Berghan Point in large numbers (up to 200 per night), Stein (1962) visited the point in December 1960. He saw about 20 ashore near midday and 24 at daybreak but there was no sign of nesting. No birds were seen in the 1969/70 and 1980/81 censuses. The nearest breeding colony is at the Poor Knights Islands c. 130 km away.

TIKITIKI ROCK (R) 35°09'S 174°09'E

This small steep island at the northern entrance to the Bay of Islands has some vegetation on the summit. During the census in November 1980, a tight group of 22 birds was on part of the summit and some birds were in the air. There was no evidence of breeding. Roosting birds were also present on 11 January 1981 (C. J. R. Robertson, unpubl.). The nearest established breeding colony is at the Poor Knights Islands c. 65 km away.

BIRD ROCK (R) 35°11'S 174°17'E

This small bare rocky islet with a gently rounded top about 20 m a.s.l. is inside the southern entrance to the Bay of Islands. Fleming & Wodzicki (1952) discussed possible sporadic breeding up to 1933. During the 1969/70 census no gannets were present, but the island was white with guano. In November 1980, 147 birds were present, covering some 60% of the top of the island. On 11 January 1981, on a close approach by boat, 125 roosting birds but no chicks were recorded (C. J. R. Robertson, unpubl.). The nearest established breeding colony is at the Poor Knights Islands c. 60 km away.

POOR KNIGHTS ISLANDS

The Pinnacles or High Peak Rocks (G) 35°33'S 174°43'E

(Northwest and Southwest Pinnacles and Gannet Stack)

These were described by Fleming & Wodzicki (1952) as the 'Poor Knights Rocks.' Gannet Stack was the only one occupied in 1946/47, with 100 pairs. The correct names and positions of the High Peak Rocks are shown in Fig. 3. Note that the relative positions of the three members of the Pinnacles (or High Peak Rocks) are incorrect in Fleming & Wodzicki's map. Fleming & Wodzicki in their text also described Gannet Stack as 'nearer to the Poor Knights,' whereas it is actually to the east of the other two Pinnacles (E. G. Turbott, *in litt.* 1983).

In the 1969/70 aerial survey the largest of the three islands (Northwest Pinnacle) had 89 pairs of gannets whereas in 1980/81 the several groups on this island totalled 960 pairs. The colonies on this location are apparently increasing and reducing the amount of scrubby vegetation on the islet (E. G. Turbott, *in litt.*, 1983). On the second largest island (Southwest Pinnacle) a group of 36 birds was present in 1980/81, but they may have only been roosting.

Sugarloaf (G) 35°38'S 174°43'E

This stack (Fig. 4) has been used as a breeding colony since the late 19th century. There were 1410 pairs in 1946/47, 2462 in 1969/70 and 2617 in 1980/81.

A total of 1510 pairs was counted at the Poor Knights Islands in 1946/47 but the margin of error was accepted as being large. There were 2990 pairs in 1969/70 and 4170 in 1980/81.

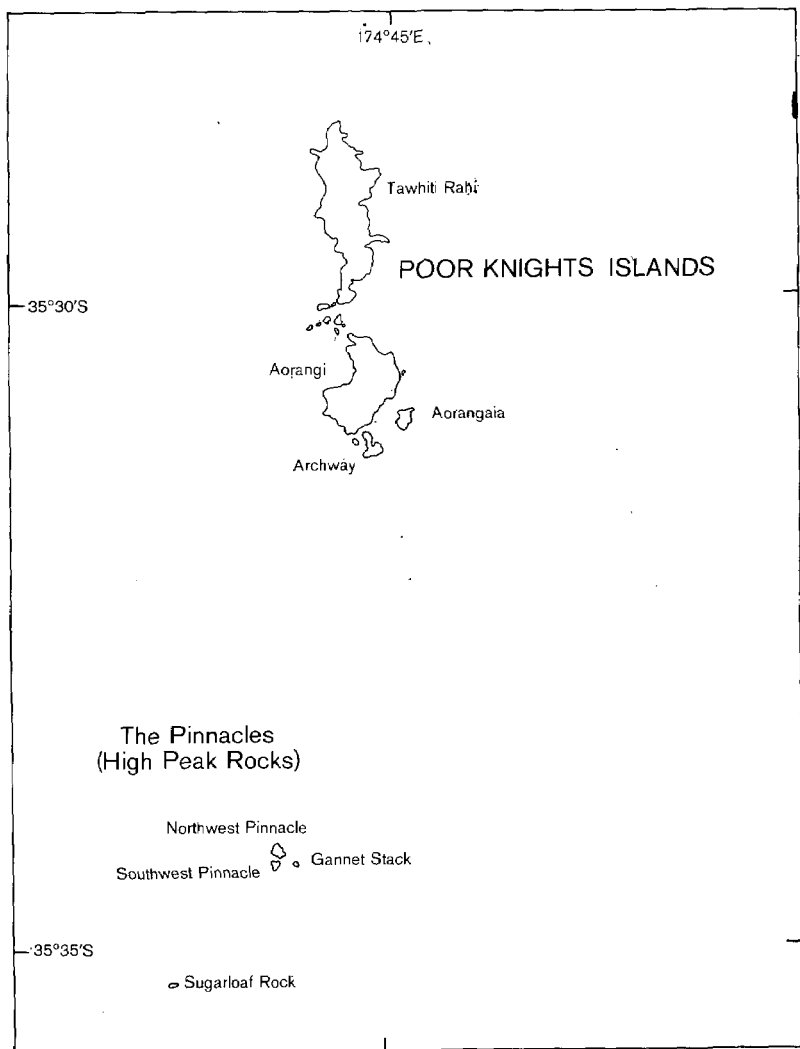


FIGURE 3 — Location of the Poor Knights Islands gannetries (after Turbott 1983)



FIGURE 4 — The Sugarloaf, Poor Knights Islands in October 1965, as an example of a stack gannetry
(Courtesy of NZ Wildlife Service, C. J. R. Robertson)

MOKOHINAU ISLAND

Groper Rock (R) 35°54'S 175°10'E

Gannets were first noted as probably breeding on this rock in 1945/46 but it was not visited during the 1946/47 census (Fleming & Wodzicki 1952). No birds were present in the 1969/70 and 1980/81 censuses. The nearest established breeding colony is at Cathedral Rocks c. 10 km away.

Cathedral Rocks (G) 35°55'S 175°10'E

Two prominent bare rocks which were probably first used only for roosting. Twelve pairs attempted to breed in 1947/48. Three small groups, totalling 25 pairs on the smallest rock and groups of 18 and 6 on the largest, gave a total of 49 pairs present in 1969/70. In 1980/81 a single colony of 92 pairs was on the smaller rock and three groups of 158, 83 and 11 were on the larger rock, giving a total of 344 pairs.

HEN AND CHICKEN ISLANDS

Sail Rock (R) 36°00'S 174°42'E

During the 1980/81 census, 26 gannets were photographed occupying ledges on the steep northern face of this island, which is probably a roost. From the photographs it appears that four sites were occupied by pairs of birds. Landing is probably impossible, and so any breeding here would be hard to confirm. The nearest established colony is at the Mokohinau Islands c. 40 km away.

GREAT BARRIER ISLAND

Arid Island Stack (R) 36°07'S 175°30'E

Breeding is not known on the stack off Arid Island, but a few roosting gannets were noted in 1937 and 1944 (Fleming & Wodzicki 1952). No roosting was recorded in the 1969/70 and 1980/81 censuses. The nearest established breeding colony is at Mahuki Island c. 20 km away.

Mahuki Island (G) 36°14'S 175°18'E

Locally known as Gannet Island, this is the most south-westerly of the Broken or Pig Islands south of the southern entrance to Port Fitzroy. This old, established gannetry on a narrow north-west promontory of the island is known to have existed before 1867. In 1946/47 the colony seemed to have been raided before counting as only one chick, 50 eggs and 600-700 adult birds were present. An estimate of 325 pairs was used for the 1946/47 census (Fleming & Wodzicki 1952).

By 1969/70 the gannetry had expanded considerably, with 1869 pairs recorded. In 1980/81, 2092 pairs were on the peninsula and a further four groups of gannets, totalling 589 pairs, were to the south and north along cliff tops within a few hundred metres of the main

colony. These extra groups were probably largely young birds holding sites, but possibly not yet breeding.

MERCURY ISLANDS

The Sisters (R) 36°37'S 174°46'E

These two small stacks off Huruhi Bay, Great Mercury Island, were not occupied by gannets in the 1920s. Between 1935 and 1938 there were unconfirmed reports of breeding. There was evidence of roosting in the 1940s and again in 1963 (Skegg 1963) but no sign of birds in 1969/70 and 1980/81. The nearest established breeding colony is at Colville, Coromandel Peninsula, c. 35 km away.

Never Fail Rock (R) 36°37'S 175°48'E

This is a small rock just north-east of Great Mercury Island. One pair of gannets was seen breeding there in 1960/61 and 1961/62, but definitely not in 1959/60. On 27 November 1962 the rock was examined from Arimiwhai, Great Mercury, and no gannets could be seen (Skegg 1963). There was no sign of birds in 1969 or 1980. The nearest established breeding colony is at Colville, Coromandel Peninsula, c. 40 km away.

KORAPUKI ISLAND (R) 36°40'S 175°51'E

A roost was discovered on a small stack off the southern extremity of Korapuki in 1962. On 4 September 1962, three gannets were sitting on the stack and six were circling it (Skegg 1963). The amount of droppings on it suggested that it was in regular use, but there was no sign of gannets in the 1969/70 or 1980/81 censuses. The nearest established breeding colony is at Colville, Coromandel Peninsula, c. 40 km away.

COLVILLE

Gannetries are on three of the islands named Motukawao Group, south-west of Colville on the west side of the Coromandel Peninsula.

Double Island Stack (G) 36°40'S 175°24'E

An estimated five pairs were breeding in 1946/47. The aerial photograph for 1969/70 was too blurred for an accurate count, and an assessed 50 pairs in one group was used for the census. In 1980/81 there were two colonial groups with a total of 96 pairs.

Bush Island (G) 36°41'S 175°24'E

This has the largest population of the group, and the gannets there were the subject of a 3-year study by E. Waghorn from 1978 to 1980 (Waghorn 1982). In 1946/47, the four colonies on the island had a total population of 1513 pairs, rising to 2834 in 1969/70 and 3530 in 1980/81. Expansion is now becoming restricted by terrain and vegetation at some colonies.

Motutakapu (G) 36°41'S 175°23'E

This long-established gannetry has a first estimate in 1928 of 200 pairs. Some 288 pairs were counted in 1946/47, 777 in 1969/70 and 925 in 1980/81.

Thus, for the Colville group of gannetries the total population had increased from 1806 pairs in 1946/47 to 3661 pairs in 1969/70 and 4551 pairs in 1980/81.

HORUHORU ROCK (G) 36°43'S 175°10'E

This gannetry off Waiheke Island was established well before 1900. The population increased steadily from about 1000 pairs in 1928 to 1228 in 1946/47. Further counts gave 1503 pairs in November 1949 and 1573 pairs in November 1958 (Stein 1971). After this date a new part of the island was colonised, a low rocky platform at the northern end. In 1969/70 a total of 2526 pairs was present, increasing slightly to 2647 by 1980/81.

*MURIWAI**Oaia Island* (G) 36°50'S 174°25'E

The gannetry on this small dome-shaped islet was apparently occupied well before 1914. In 1940 the number was estimated to be 160 pairs, but by 1946/47, the population had risen to 338 pairs. The total was 892 pairs in 1969/70, decreasing to 761 in 1980/81.

Muriwai Stack (G) 36°50'S 174°26'E

This gannetry was recently established on Sugarloaf Rock, about 30 m offshore from the coastal cliffs between Maori Bay and the south end of the main Muriwai Beach. The nearest established gannetry is Oaia Island, about 2 km seaward. Sugarloaf Rock is sheer-sided and high with a flat top sloping towards the mainland. Gannets began breeding there in 1975/76 (Reed 1979). Twenty-eight nests were occupied on 22 November 1975, and the colony has increased rapidly since then, with 93 chicks being observed on 23 January 1978. Some 298 pairs were recorded in 1980/81.

Muriwai Mainland (R) 36°50'S 174°26'E

This roosting site on the Muriwai mainland consists of two platforms adjacent to the new Muriwai Stack colony. Breeding was attempted in 1979 but was disrupted by visitors and dogs. This is a popular place for viewing the gannetry on Sugarloaf Rock.

*ALDERMEN ISLANDS**Sugarloaf Rocks* (R) 36°58'S 176°05'E

A few gannets (5-10 pairs) were breeding there between 1921 and 1927. No gannets were seen there in the 1946/47 and 1947/48 breeding seasons (Fleming & Wodzicki 1952) or in 1980/81. The nearest established breeding colony is at Horuhoru c. 85 km away.

WHITE ISLAND

This group is situated on an active volcano and consists of three gannetries: *West Point* (37°03'S 177°10'E), *Rocky Point* (37°32'S 177°11'E) and *Gannet Point* (37°32'S 177°12'E). Breeding was recorded before 1872 (Fleming & Wodzicki 1952). These gannetries were described by Robertson & Wodzicki (1948) and Wodzicki & Robertson (1959). Since early this century the volcano has attracted many visitors, which has helped to provide historical information on the gannetries. In 1946/47, the counts were taken late in the season and there was evidence of some disturbance by muttonbirding parties. According to P. Burstall, former Conservator of Wildlife, Rotorua (*in litt.* 1983), Maoris used to take gannets from White Island, more as a sideline to their muttonbirding activities than as a distinct activity, but after prosecution in the 1960s this practice seems to have ceased.

The 1946/47 total of 5227 pairs at White Island increased slightly to 6713 in 1969/70 and has remained relatively stable with 6793 pairs in 1980/81.

Eruptions of the volcano may have affected gannet numbers. After a major eruption in December 1976, the breeding population at the beginning of the 1977/78 breeding season was estimated at 2755 pairs (Wodzicki 1978). However, V. T. Davis (*in litt.*), who has banded gannet chicks at White Island for many years, did not notice any change in numbers in the 1977/78 season. In April 1979, after further eruptions occurred, he reported that, although the land and sea had been affected, the gannets appeared to be breeding in the usual numbers.

Dam Site (R) 37°32'S 177°12'E

An estimated 100-150 birds were seen there in 1925-27, although it was noted that this locality might not be regularly occupied. Gannets were not seen at this site in 1912, in the 1946/47 breeding season (Fleming & Wodzicki 1952) or later. The nearest established breeding colony is at Gannet Point, also on White Island.

Club Rock (R) 37°33'S 177°11'E

Breeding was reported on this group of small rocks off White Island in 1912. In 1925-27 gannets were present but not breeding, and in January 1947 no birds were present (Fleming & Wodzicki 1952), nor have there been any since. The nearest established breeding colony is at Gannet Point on White Island.

KAWHIA

Gannet Island (Karewa) 37°57'S 174°35'E

This is the largest single gannetry in New Zealand and one of the oldest recorded, as Captain Cook noted it as a gannet nesting place in 1770. There was always a large gannet population, and

counts in 1946/47 gave a total of 3715 pairs. In 1969/70 the total was 6132 pairs, and in 1980/81 it had risen to 8003 pairs.

MOTUHAKU ISLANDS OR SCHOONER ROCKS (R)

37°35'S 176°32'E

At the northern end of the largest rock, 6-8 birds were seen roosting at 1600 h on 13 November 1972 (L. Moran, pers. comm.). The nearest established breeding colony is at White Island c. 60 km away.

MOTUNAU OR PLATE ISLAND (R) 37°40'S 176°34'E

At the north-eastern end of the small stack at the northern end of the main island, 6-8 birds were seen roosting in the early evening of 14 November 1972 (L. Moran, pers. comm.). The nearest established breeding colony is at White Island c. 60 km away.

EAST ISLAND (R) 37°40'S 178°35'E

During December 1979, groups of gannets were seen roosting on a small, low, rocky islet south-west of East Island by several observers. About 50 birds were photographed on 6 December 1979 (E. J. Jones, pers. comm.). Local fishermen saw 30 roosting on a point of East Island in mid-December 1979, and the whole of a point at the north-east corner, about 60 m a.s.l., was covered with birds in the last two weeks of January 1980 (Cade, pers. comm.). The nearest established breeding colony is at Moutara Rock c 80 km away.

TOLAGA BAY (G) 38°25'S 178°21'E

Moutara Rock is about 5 km south of Tolaga Bay and about 300 m off Moutara Point at the northern end of Waihou Bay. This gannetry was not recorded in the 1946/47 census, being first described by Blackburn (1956). However, local residents had reported to Blackburn the presence of nesting gannets about 30 years before, in the late 1920s. The rock on which the gannetry is situated is bare, rises about 15 m a.s.l. and has a total area of c. 1.6 ha. The nesting area covers two low hummocks and a basin in between and is exposed to north-easterly winds. During Blackburn's first visit several estimates were made and the numbers of gannets averaged 230. Access to the colony is difficult and population estimates are few. In 1969/70 two groups of 388 and 79 were present (467 pairs). Only the smaller group has continued to expand and in 1980/81 the two groups numbered 384 and 227 (611 pairs).

PORTLAND ISLAND (R) 39°18'S 177°52'E

Birds were first reported roosting on the beach at the end of a spit at the north end of the island, close to a Black-backed Gull colony and the island airstrip, in about 1972. Twelve were present at the same spot in January 1973. On 24 December 1973, 25 birds were on the spit site. Two eggs and one chick had been seen at that site earlier in the breeding season. In the same season another

12 birds were recorded at a new site on the flat top of cliffs by the lighthouse at the southern end of the island. On 10 December 1974, 60 birds were roosting at the spit, and on 21 December 1974, 65 birds were roosting on a steep grassy slope on the south-eastern side of the island about 50 m above the sea, below the previous cliff-top site. However, no birds have been reported since 1975. The nearest established breeding colony is at Cape Kidnappers c. 80 km away.

NAPIER MARINELAND (G) 39°30'S 176°55'E

This captive colony at Marineland on the Napier foreshore originated in 1970 from a few juvenile gannets deserted by parents at the Plateau colony at Cape Kidnappers and brought into captivity for a study of plumage changes by C. J. R. Robertson. Subsequently, young birds stranded on beaches have been added to the original stock. The colony (Fig. 5) gradually grew, and at present it is kept at a maximum of some 20 gannets allowed for by the Marineland Zoo licence. They are provided with food and shelter but are able to fly in and out, free to return to the wild should they choose to do so. As this is a man-made and man-maintained colony, it has not been included in Table 2.

The first egg was laid in the 1977/78 nesting season but was infertile. A year later a chick was hatched in captivity for the first

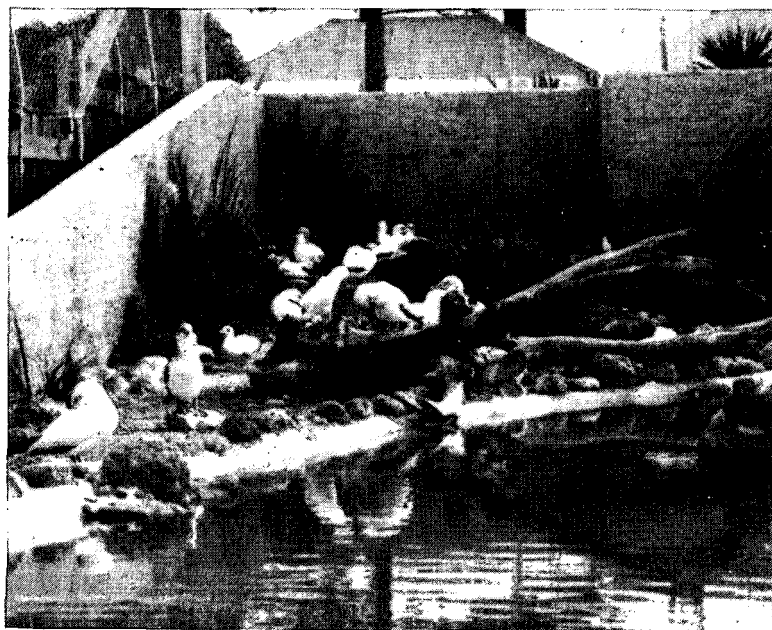


FIGURE 5 — The gannet colony at Marineland, Napier, in 1983
(Courtesy of G. J. Macdonald)

time.' Although more chicks have hatched since then, many eggs that have been laid did not hatch. The colony represents a successful attempt to have Australasian Gannets permanently living and nesting in a man-made environment. It also provides a year-round opportunity for the public to view gannets at close quarters. The nearest established breeding colony is at Cape Kidnappers, c. 25 km away.

CAPE KIDNAPPERS

This group comprises three gannetries: Cape Kidnappers or Saddle, Black Reef and Plateau. The existing records (Fleming & Wodzicki 1952) state that the Cape Kidnappers gannetry was probably already occupied in about 1879 and that the first use of the Black Reef locality was reported in 1938/39. Nesting was first reported from the Plateau gannetry in 1936 (W. B. Stewart, pers. comm.). The Cape Kidnappers gannetries have been extensively studied between 1947 and 1964 by K. Wodzicki and since 1959 by C. J. R. Robertson. Annual ground counts have been made at the Plateau gannetry in the period 12-25 December since 1945 (except in 1975) and many aerial surveys have been made and photographs taken during each year since 1966 to keep a record of population changes. Wodzicki (1967a) recorded details of the colonies and population changes on all three Cape Kidnappers gannetries between 1945 and 1964.

Black Reef (G) 39°38'S 177°07'E

In 1980/81 this gannetry comprised 11 groups of gannets on low flat-topped stacks and one on the mainland. The existing records show that most of the colonies started as roosts (C. J. R. Robertson, unpubl.). The mainland part of the colony became well-established in 1977 after ladders allowing public access to the nesting sites were removed. Black Reef gannet numbers rose from 263 pairs in 1946 to 1579 pairs in 1969 and 1821 pairs in 1980.

Cape Kidnappers (Saddle) 39°38'S 177°08'E

The area occupied by this gannetry has declined since 1939, mainly because of the reduction of nests on the landward and seaward slopes and on the northern edge of the saddle. Wodzicki (1967a) suggested that erosion may have caused this decline, but C. J. R. Robertson believes that a preference for nesting on flat ground could be a contributory factor. The matter might be more complicated, however, as in recent years a large former nesting area on previously flat ground has remained unoccupied (Fig. 9). The build-up of guano within the adjacent colony is producing an increasingly steep smooth slope towards the northern edge, which is not being reoccupied by nesting birds. This gannetry, which had risen from 2337 pairs in 1946/47 to 2705 in 1969/70, decreased to 2200 pairs in 1980/81.

Plateau (G) 39°38'S 177°08'E

Fifty roosting birds were photographed here in 1934 (N. Carroll, pers. comm.) and breeding was first reported in 1936 (W. B. Stewart,

pers. comm.). Since 1946, this colony has been the main viewing area for the public and its growth was restricted by this both directly and indirectly (by increased Black-backed Gull predation, Taylor & Wodzicki 1958 and Robertson 1964) until 1968, when a low guide-wire fence was erected to keep visitors from approaching too closely.

The colony originally comprised one group, but a second group developed between 1946 and 1950. After the erection of the guide wire in 1968 the groups joined together, and they have developed as one colony since.

Plateau Beach (R) 39°38'S 177°08'E

During the 1972/73 season various groups of birds roosted on the steep slopes and beach south-east of the Plateau gannetry. From 1974 to 1980 the main roost was a raised sandy beach, extending on to a steep slope at the back of the beach. Eggs were laid in 1975 and 1976, but no chicks were reared. This site is subject to disturbance by stock, goats and fishermen.

FAREWELL SPIT (G) 40°27'S 173°00'E

Gannets were reported roosting on a sand spit approximately 15 km from the base of the inner beach between 11 and 15 November 1981 (B. D. Bell, pers. comm.). Some of these birds had scraped the ground and were displaying. Additional birds were observed joining and leaving the group. In excess of 300 gannets were reported roosting on the shell banks at the end of the Spit from 13 to 23 January 1983 (B. D. Bell, pers. comm.). Much activity and displaying were noted.

On 23 November 1983 about 600 gannets were noted at shell banks on Farewell Spit. These birds were divided into two groups, each of which had 35-40 nests, most apparently containing eggs (B. D. Bell, pers. comm.). As the first record of breeding at Farewell Spit was made 3 years after the 1980/81 census, their numbers are not included in Table 2.

MARLBOROUGH SOUNDS (G) 41°04'S 174°00'E

Roosting birds were first reported from Forsyth Island in 1969 (A. Galsworthy, pers. comm.). Breeding was attempted in 1970/71, and in 1971/72 at least four nests were reported. Although two chicks were reared, the site was abandoned in following years (R. Redwood, pers. comm.). Between 1972/73 and 1975/76, breeding was attempted at West Entry point but apparently no chicks were raised (W. Brown, pers. comm.). This site has since been abandoned (R. H. Taylor, pers. comm.). N. Judd (pers. comm.) reported 14 birds roosting and displaying on neighbouring Te Puraka Point on 20 November 1974.

The present colony is at Waimaru Bay on a small rocky islet which is 6 m a.s.l. and separated from the mainland only at high tide, at the tip of a peninsula forming the northern part of the bay. Five nests were recorded in 1975/76 (W. Brown, pers. comm.). On 7

January 1978, nine live chicks and two dead chicks were present with 26 adults (P. Gaze, pers. comm.). On 10 January 1980, 11 live chicks, 2 dead chicks and 20 adults were counted (C. J. R. Robertson, unpubl.). During the 1980/81 season, two ground counts were made. Of 29 nests counted on 21 October 1980, 8 had eggs, 16 had chicks and 5 were empty (P. R. Wilson & R. H. Taylor, pers. comm.). By 24 December 1980 there were 22 live chicks, one dead chick and one egg (D. A. Harvey, pers. comm.).

OTAGO

The Nuggets (G) 46°27'S 169°51'E

Apparently gannets were nesting for some time before 1946 when 40 pairs were estimated (Fleming & Wodzicki 1952). Only 10 pairs were recorded in 1969/70, and 9 pairs in 1980/81.

FOVEAUX STRAIT

Little Solander Island (G) 46°36'S 166°57'E

Although confined to one group with 20 pairs in 1946/47 and 17 in 1969/70, by 1980/81 this had increased to three groups with a total of 62 pairs. This suggests some immigration to this location.

RESULTS

The census results of 1946/47, 1969/70 and 1980/81, showing the increase in the New Zealand gannet population, are given in Table 2. During the 1946/47 census some present gannetries were overlooked (Tolaga Bay) or the numbers were simply estimated (Double Island, Colville). However, as these gannetries are relatively small, the results of the three censuses can, in our opinion, be compared. Figure 6 shows the change in gannet numbers at various localities and gives the mean annual percentage increase since 1946/47.

In 1980/81 the New Zealand gannet population was 46 004 pairs (Table 2). The increase or decline at individual gannetries is of interest, and Table 2 shows that numbers at various gannetries changed greatly. Table 2 shows that between 1946/47 and 1969/70 only four gannetries declined — two gannetries at Three Kings and those at the Nuggets and Solander Islands. All the other gannetries showed increases ranging from 13% (West Point, White Island) to 500% (Black Reef, Cape Kidnappers). Between 1969/70 and 1980/81, only five gannetries declined — Tutaneikai at Three Kings, Oaia Island at Muriwai, Rocky Point at White Island, the Saddle colony at Cape Kidnappers and Nuggets, South Island. Increases at the other gannetries ranged from 5% (Horuhoru) to 602% (Cathedral Rocks, Mokohinau Islands).

Table 2 also shows the overall changes in numbers at the gannetries for the whole period 1946/47 to 1980/81. Within this period only three gannetries decreased (Rocky Point at White Island, the Saddle colony at Cape Kidnappers and the Nuggets, South Island).

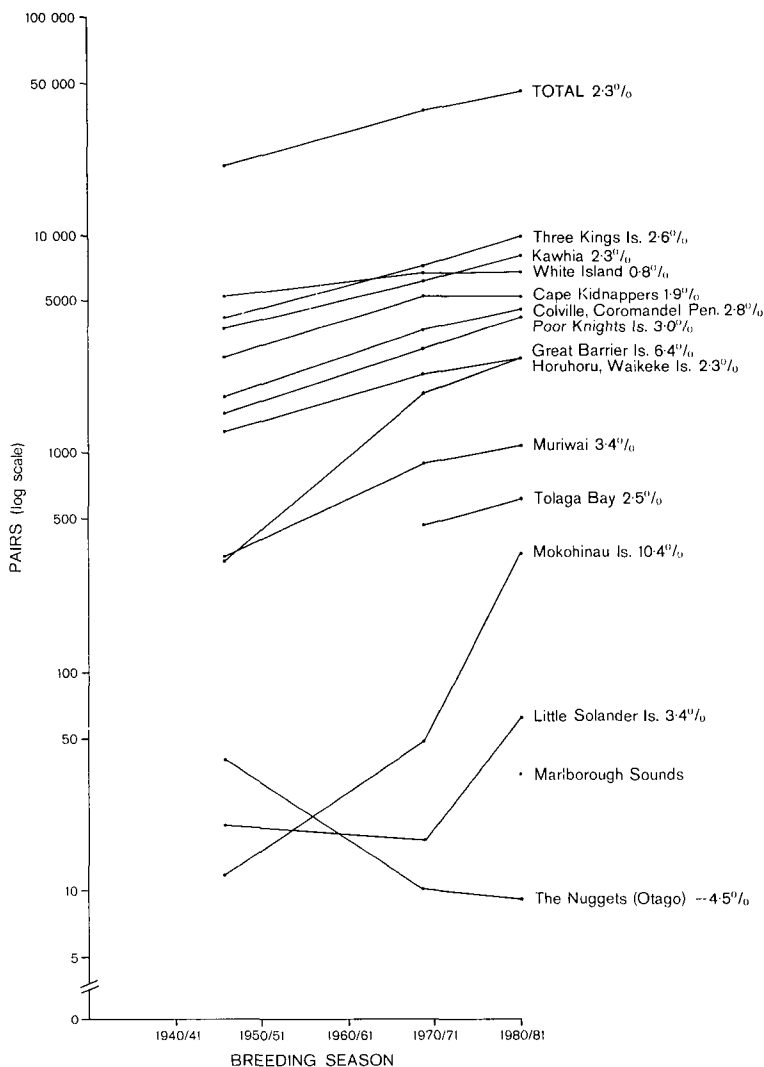


FIGURE 6 — Mean annual percentage change in gannet numbers at various gannetries 1946/47 to 1980/81 (except Tolaga Bay 1969/70 and 1980/81)

Over the same period increases at other gannetries ranged from 24% (West Point, White Island) to 2767% (Cathedral Rocks).

When we examine the census results for groups of gannetries, we can see that the overall numbers for some groups increased, even though numbers at some of their component gannetries declined, e.g. at Three Kings between 1946/47 and 1969/70. Alternatively, the overall numbers for some groups remained constant because some of the component gannetries increased in size while others decreased, e.g. at the Cape Kidnappers group between 1969/70 and 1980/81.

In conclusion, we find that the New Zealand gannet population has been steadily increasing since the 1946/47 census.

DISCUSSION

Census methods

In 1943, Fisher & Vevers stated that of all the species of birds and mammals which were not regarded as rare, accurate world figures were available for only four, including the North Atlantic Gannet. Several other non-rare species had been counted world-wide, but less accurately. With new techniques this number has increased, as has the reliability of the assessments. Such censuses are important because they provide information on the distribution and numbers of whole species and, if repeated at reasonably long intervals (perhaps every decade), may supply information on the species' welfare within that period.

Until the technique of aerial photography was suitably developed, nesting gannets were counted mainly by direct counts of occupied nests by eye, with binoculars, or from ground photographs. Indirect methods included counting eggs and young or estimating the total area occupied by gannet nests (Fisher & Vevers 1943, 1944, Nelson 1978). Nelson (1978) has classified gannets on gannetries at nesting time into five categories: (1) breeding pairs; (2) non-breeding nest owners; (3) non-breeding site owners; (4) casuals; and (5) club birds.

Our experience that aerial photographs are the best way to assess gannet populations has been confirmed by other research workers. Nettleship (1976) found that aerial photography is the most satisfactory method for population analysis, provided the camera is about 550-600 m from the colony. However, since only attended sites are counted, the assessment of a "... breeding population represents the number of nest-site holders rather than the number of true breeders."

The work of Wanless *et al.* (1982) on cliff-nesting seabirds in Orkney shows the difficulties in determining correct numbers of birds due to natural fluctuations in the location of nests and technical difficulties in sampling. The latter applies less to New Zealand gannets, whose nesting colonies are mostly on flat terrain.

Fleming & Wodzicki (1952) assessed the New Zealand gannet population as nesting pairs, using a mixture of ground counts, aerial

TABLE 2 — Census results for breeding colonies

Gannetry	1946/47 A	Pairs 1969/70 B	1980/81 C	Percentage A/B	Difference Census B/C	Between A/C	Mean Differences A/B	Annual Between B/C	Percentage Census A/C
Three Kings									
South West Island	824	804	1135	-2	41	38	-0.1	3.2	1.0
Hinemoa Rock, Princes Islands	1520	3232	4136	113	281	172	3.3	2.3	3.0
Hole-in-the-Wall Rock, Princes Is.	490	618	1530	26	148	212	1.0	8.6	3.4
Tutanekai Rock, Princes Islands	300	406	402	35	-1	34	1.3	-0.1	0.9
Arbutus Rock	1000	2175	2652	118	22	165	3.4	1.8	2.9
	4134	7235	9855	75	35	138	-2.1	2.9	2.6
Poor Knights Islands									
High Peak Rocks	100	528	1553	428	191	1453	7.5	10.3	8.4
Sugarloaf Rock	1410	2462	2617	75	6	86	2.5	0.5	1.8
	1510	2990	4170	98	39	176	3.0	3.1	3.0
Mokohinau Islands									
Cathedral Rocks	12	49	344	308	602	2767	6.3	19.4	10.4
Great Barrier Islands									
Manukū Island	325	1869	2681	475	43	725	7.9	3.3	6.4
Colville (Coromandel Peninsula)									
Double Island	5	est. 50	96	-	-	1820	-	-	9.1
Bush Island	1513	2834	3530	87	25	133	2.8	2.0	2.5
Motutakapu	288	777	925	170	19	221	4.4	1.6	3.5
	1806	3661	4551	103	24	152	3.1	2.0	2.8
Moruhopy Rock	1228	2526	2647	106	5	116	3.2	0.4	2.3
Muriwai									
Gaia Island	338	892	761	164	-15	125	4.3	-1.5	2.4
Muriwai Stagk	-	-	298	-	-	-	-	-	-
	338	892	1059	164	19	213	4.3	1.6	3.4
White Island									
West Point	1254	1419	1550	13	9	24	0.5	0.8	0.6
Rocky Point	1408	1615	1257	15	-22	-11	0.6	-2.3	-0.3
Gannet Point	2565	3679	3986	43	8	55	1.6	0.7	1.3
	5227	6713	6793	28	1	30	1.1	0.1	0.6

TABLE 2 — Census results for breeding colonies (contd.)

	1946/47 A	Pairs 1969/70 B	1980/81 C	Percentage A/B	Difference Censuses B/C	Between A/C	Mean Differences A/B	Annual Between B/C	Percentage Censuses A/C
Kawhia									
Gannet Island (Karewa)	3715	6132	8003	65	31	115	2.2	2.5	2.3
Tolaga Bay									
Moutara Rock		467	611	-	31	-	-	2.5	-
Cape Kidnappers									
Black Reef and Mainland	263	1579	1821	500	15	592	8.1	1.3	5.9
Cape Kidnappers Saddle	2337	2705	2200	16	-19	-6	0.6	-1.9	-0.1
Kidnappers Plateau	160	929	1165	481	25	628	8.0	2.1	6.0
	2760	5213	5186	89	-1	88	2.8	-0.1	1.9
Marlborough Sounds	-	-	33	-	-	-	-	-	-
Otago									
Nuggets	40	10	9	-75	-10	-78	-6.2	-1.0	-4.5
Foveaux Strait									
Little Solander Island	20	17	62	-15	265	210	-0.7	12.5	3.4
	21 115	37 774	46 004	79	22	118	2.6	1.8	2.3

FOOTNOTE. Fleming and Wodzicki (1952) give the census total for 1946/47 incorrectly as 21 033 instead of 21 131. In this paper Cathedral Rocks has been added and Cape Karikari deleted from the list of breeding colonies giving the total of 21 115.

photographs, and qualified estimates. In conclusion, they accepted that there was a large margin of error with a possible range in the population counts from 18 000 to 24 000 pairs. They suggested that the number of birds on a gannetry is subject to inter- and intra-seasonal fluctuations and that there were several sources of error in the actual counting of gannets, depending on the method used.

Waghorn (1982), after three years of observation at the Bush Island gannetry, showed that gannet numbers fluctuated greatly. She found that the largest number of gannets during the day occurs at about 0600 hours. With intra-seasonal fluctuations, the number of gannets at a breeding colony depends on the phase of the breeding cycle. Gannets arrive at the breeding colony from June to August and the numbers increase as pair formation and nesting take place. The numbers reach a peak around laying time and decline when fledging begins. With inter-seasonal fluctuations, Waghorn found that, for the three breeding seasons 1978/79-1980/81 at Bush Island, the earliest and latest median laying dates were 34 days apart. Similar continuing observations of intra- and inter-seasonal variation have been made at the Cape Kidnappers Group since 1959 (C. J. R. Robertson, unpubl.).

It is also known that young birds, before reaching site-holding or breeding age, spend part of each season as casual, club or roosting birds. Although they do not belong to the nesting population it is usually impossible to determine the nesting or roosting status of a bird recorded on a site from an aerial photograph (Robertson, unpubl.).

These data, with inter- and intra-seasonal material from Cape Kidnappers, are still being analysed in an attempt to determine the correlation between sites recorded on aerial photographs and the likely breeding population at a gannetry.

Excluded from the censuses are the large numbers of immature birds which disperse across the Tasman to Australia. It is known that New Zealand gannets can remain in Australian waters until they are 5 years old but may return at the age of 2 or 3 years (Wodzicki 1967b and Robertson, unpubl.). Therefore, a substantial proportion of the total gannet population lives temporarily away from the nesting colonies and is excluded from censuses.

Distribution of gannetries and roosts

New Zealand gannetries are located between 32°S and 47°S and the recorded roosts between 34°S and 40°S. However, examining the distribution of gannetries, we find that in 1980/81 only 104 pairs were in the South Island compared with 45 900 pairs counted in the 23 gannetries in the North Island. We hope that an investigation of gannet food based on collections made in 1981/82 and 1982/83 may help explain the distribution of gannetries in New Zealand. (D. A. Robertson, Fisheries Research Division, Ministry of Agriculture and Fisheries, is currently studying the relationship between gannet feeding and the distribution and numbers of gannets in New Zealand).

Crawford & Shelton (1978) have shown that the distribution and abundance of the Cape Gannet is determined by the availability of pelagic fish.

Note that most roosts lie within the area of the largest concentration of gannet nesting places and that few roosts have been recorded from the South Island. It is also of interest to note that the distance of a roost from the nearest gannetry ranges from 10 to 140 km. The Marineland gannet colony, Napier, is a new development, showing that gannets can live and breed in semi-captivity on land in a man-made environment.

The three censuses compared

Although the distribution of gannets in New Zealand has altered little, the number of gannetries and the number of birds in individual colonies have changed. In 1980/81 the 26 gannetries ranged in numbers from 9 pairs (Nuggets, Otago) to 8003 pairs (Gannet Island, Kawhia). During the 34 years covered by the censuses, one new gannetry (High Peak Rocks, Poor Knights Islands) was established between 1946/47 and 1969/70 and two new natural gannetries (Muriwai Stack and Marlborough Sounds) between 1969/70 and 1980/81. A further gannetry has been established at Farewell Spit since the last census. No established gannetry disappeared, but five gannetries showed a decrease in numbers between 1969/70 and 1980/81 (Table 2). However, this is more than compensated for by 19 gannetries showing an increase in numbers.

Because the 1946/47 census was only partly based on aerial photographs the three censuses can be compared only in general terms. Figure 6 shows substantial differences in the growth of various colonies between 1946/47 and 1980/81. They range between the West Point gannetry, White Island (0.6% annual increase) to the Cathedral Rocks gannetry, Mokohinau Island (10.4% annual increase). The mean annual rate of increase for the whole New Zealand gannet population between 1946/47 and 1980/81 was 2.3%.

The annual growth rate from 1969/70 to 1980/81 shows certain trends overall or at particular gannetries:

1. The weight of the population has shifted northward slightly with a greater proportion being north of 37°S in 1980/81 than in 1969/70.
2. The most northerly gannetries, containing about 50% of the total population, are increasing at a rate above the national average.
3. Certain gannetries are increasing at rates above 3% p.a., which suggests that immigration has contributed to the increase. This trend has occurred at South West Island and Hole-in-the-Wall (Three Kings), High Peak Rocks (Poor Knights), Mokohinau and Great Barrier Islands.

4. Some gannetries may have become exporters, the available nesting space being fully occupied. Examples where this may have occurred are Oaia Island (Muriwai) and Rocky Point (White Island).

Another important factor to consider in assessing the gannet population is the movement of gannets to new or recently established colonies. The decrease in numbers at the Oaia Island colony, Muriwai, between 1969/70 and 1980/81 coincided with the establishment of the nearby Muriwai Stack colony. Such movements emphasise the need for all colonies to be counted in the one season.

Some gannetries such as the Northwest Pinnacle of the High Peak Rocks, Poor Knights Islands and Cathedral Rocks, Mokohinau Islands, have shown great increases of 1028% and 602% respectively between 1969/70 and 1980/81. It is suggested that such large increases in population numbers are due to immigration. An increase of similar magnitude was seen in the Funk Island gannetry, Newfoundland, where the number of North Atlantic Gannets rose from seven nesting pairs in 1936 to about 3000 pairs in 1959. This increase was attributed to immigration from other colonies, corresponding to a sharp rise in mackerel stocks in the area (Montevocchi *et al.* 1980).

An example of the long-term growth of a gannet population based on the three censuses in the three Cape Kidnappers gannetries

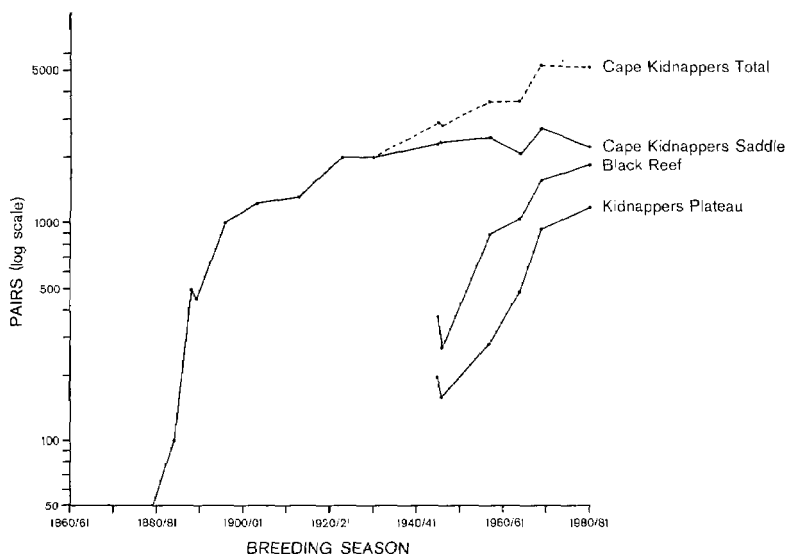


FIGURE 7 — Changes in gannet numbers at Cape Kidnappers over the past century

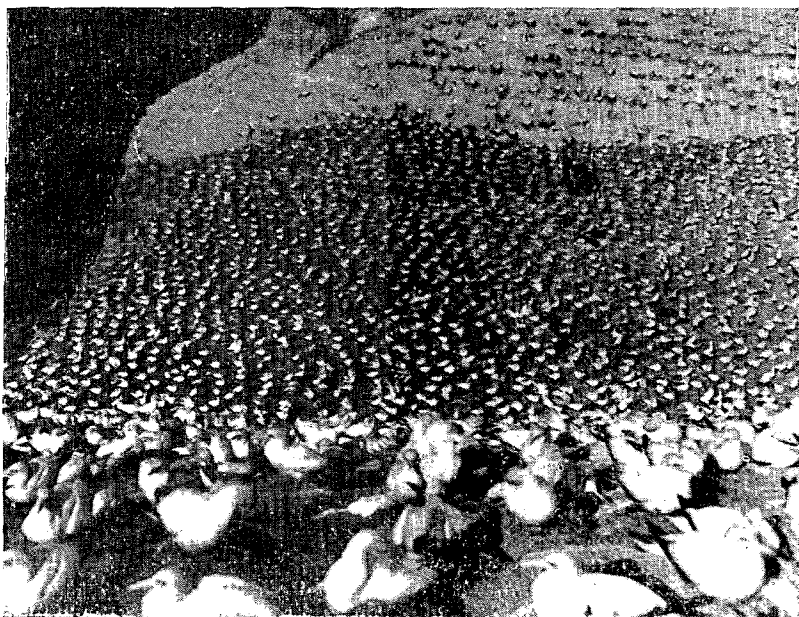


FIGURE 8 — Part of the Saddle colony at Cape Kidnappers, an example of a typical flat gannetry in December 1945

(Courtesy of Ecology Division, DSIR)

is shown in Figure 7. Both the Plateau and the Black Reef gannetries have grown steadily but the Saddle gannetry has remained steady, and even declined, recently, perhaps partly because erosion has forced gannets to abandon the seaward and landward slopes or possibly because of a preference for nesting on flat ground (Fig. 8 and 9).

Comparison with gannets elsewhere

Because the Cape Gannet and the North Atlantic Gannet have not been counted by repeated large-scale censuses similar to those done in New Zealand, and because the methods of counting have varied, we can draw comparisons between gannets in New Zealand and the other two gannet species only in broad terms.

Between 1956 and 1978 the total Cape Gannet population decreased from approximately 221 000 to 186 000 adult birds (Crawford & Shelton 1981). The development of the inshore fishing industry, the destruction of gannets by fishermen and the loss of nesting sites because of guano collecting have been linked with the decline of the Cape Gannet (Jarvis 1971, Nelson 1978).

In 1976 the world population of the North Atlantic Gannet was 213 000 site-occupying pairs (Nelson 1978). In Canada, gannet colonies at Funk Island, Cape St Mary's, and Bird Rocks, Magdalen Island, have increased or remained unchanged in numbers. Two other colonies (Bonaventure Island and Gullcliff Bay, Quebec) have declined in numbers since 1969 (Nettleship 1975, 1976). Nettleship suggested that contamination by toxic chemicals was a prime cause of this decline.

A comparable census undertaken for the Australasian Gannet in Australia during 1980 and 1981 gave a total of 6660 pairs (C. J. R. Robertson, unpubl.). However, historical data are sparse for some of the seven breeding colonies and at least one was severely endangered by predation. The Cat Island gannetry near Tasmania showed a drastic reduction from 5000-10 000 birds in 1908 to a population of 14 adults and six chicks in 1977 and 12 pairs in 1980. This appalling decrease has been attributed to predation and vandalism by fishermen and others (Warham & Serventy 1978). The Lawrence Rocks gannetry has increased at a similar rate to the trend in New Zealand over the past 20 years (C. J. R. Robertson, unpubl.).

Gannets elsewhere have mostly been counted by techniques different from those used in New Zealand. Nelson (1978) estimated an increase over the period 1939-1969 for the North Atlantic Gannet cf from 2.4% p.a. to 3.4% p.a. This compares with the New Zealand

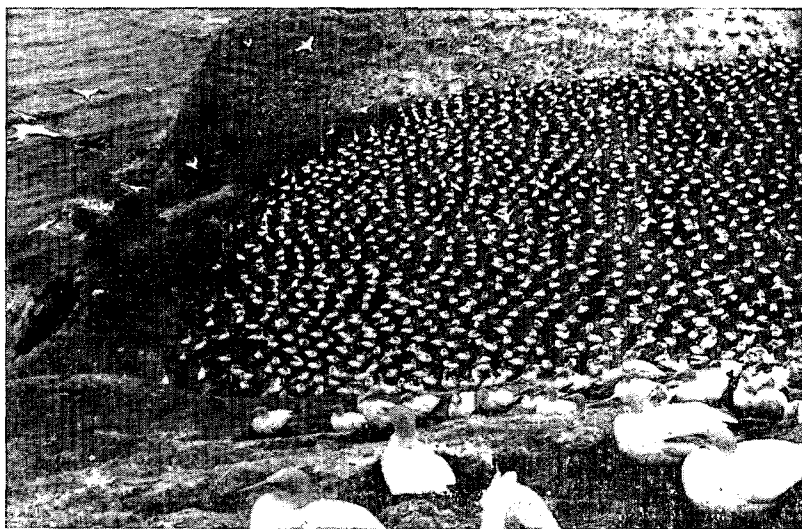


FIGURE 9 — Same view of the Saddle colony in November 1983 showing abandonment of the northern edge by gannets

(Courtesy of L. S. Davis)

increase of 79% (2.5% p.a.) between 1946/47 and 1969/70 and 22% (1.8% p.a.) between 1969/70 and 1980/81. The increase from 21 115 pairs in 1946/47 to 46 004 pairs in 1980/81 gives New Zealand gannets a mean increase of 2.3% p.a.

Both Nettleship's work and our data show that aerial photographs are the most exact direct method of censusing. However, until specific methods for assessing the effect of population variables on counts caused by diurnal, intra-seasonal and inter-seasonal fluctuations and the numbers of roosting and non-breeding site-holders, aerial photographs cannot be used directly to determine the breeding population.

Summing up, we find that the populations of Australasian Gannets in Australia and Cape Gannets in South Africa have been, or still are, affected by human predation. The North Atlantic Gannet, which, in the British Isles, is recovering after a long history of predation by man, may be increasingly vulnerable throughout its range to contamination by toxic chemicals. It appears that the Australasian Gannet population in New Zealand is perhaps the only one that is thriving and is largely free from human interference.

ACKNOWLEDGEMENTS

We are very grateful to the New Zealand Wildlife Service which allowed the use of material obtained by their staff and which, together with the Golden Kiwi Lottery Scientific Distribution Fund and University Grants Committee, provided funds for the employment of special Project Employment Programme staff to obtain counts from the aerial photographs.

Our thanks also to the Royal New Zealand Airforce and the Department of Civil Aviation which provided aircraft and to the pilots and crews who made the census flights.

The tedious task of counting gannets from aerial photographs was ably done by Anthony Cairns and Shelley Wright. E. G. Turbott provided a map of the Poor Knights Islands and up-to-date information on the Poor Knights Islands gannetries.

We are grateful to Brian D. Bell, W. Brown, P. Burstall, N. Carroll, Mr Cade, V. T. Davis, A. Galsworthy, P. D. Gaze, D. A. Harvey, N. Judd, G. J. Macdonald, P. Redwood, W. B. Stewart and R. H. Taylor for important unpublished information. M. C. Crawley reviewed the final manuscript.

We thank Nesta Black, Olga Vincent, Marie Speir and June Bullock who typed the manuscript and Brian Luey who drew the final figures.

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SHORT NOTES

FIRST RECORDS FOR NEW ZEALAND OF MOSELEY'S ROCKHOPPER PENGUIN (*Eudyptes chrysocome moseleyi*)

The Rockhopper Penguin (*Eudyptes chrysocome*) is usually classified into two subspecies (Condon 1975, Kinsky 1980). The nominate form is circumpolar in distribution, occurring at most subantarctic islands in colder waters towards the Antarctic Convergence and also at Heard Island on the southern side of the Convergence. In the New Zealand region substantial numbers breed at Macquarie, Campbell, Auckland and Antipodes Islands. The second subspecies, *E. c. moseleyi*, breeds only at four island groups close to the Subtropical Convergence — Gough and Tristan da Cunha Islands in the South Atlantic Ocean and Isles Amsterdam and St Paul in the Indian Ocean. This is the larger of the two subspecies (Williams 1980) and has especially luxuriant yellow plumes on the sides of the head. *E. c. chrysocome* from the Australasian Subantarctic are distinguishable from other populations of this subspecies and also from *E. c. moseleyi* by the presence of pink (rather than black) margins of skin around the base of the beak (Carins 1974). In this note, we give details of the first two records of *E. c. moseleyi* for New Zealand.

On 26 August 1968, DVM caught a Rockhopper Penguin ashore on the southeast coast of South East Island (44°21'S, 176°10'W) in the Chatham group. F. C. Kinsky later identified it from photographs as *E. c. moseleyi* (Kinsky 1980). Two years later, on 8 November 1970, a Rockhopper Penguin, presumably the same individual, was seen at the same place, this time standing beside an empty nesting scrape in the lee of a large boulder near the shoreline. The bird had disappeared when DVM checked the site five days later, and it was not seen again during subsequent visits to the island at that time of year. Copies of the photographs were lodged at the National Museum, Wellington.

On 14 January 1984, an employee of Wellington City Council found an unusual penguin sheltering among rocks at Moa Point (41°21'S, 174°48'E) on the Cook Strait coast 3 km west of the entrance to Wellington Harbour. Fearing that it might be injured by people or dogs, he took it to Wellington Zoo, where it was identified as a Rockhopper Penguin. An article about the bird was published in the Wellington *Evening Post* on 23 January 1984, together with a close-up photograph. PJM was alerted to the possibility that it did not belong to the local subspecies by the absence in the photograph of any pale margin at the base of the bill. When examined next day the bird proved to be a specimen of *E. c. moseleyi*, having the typical characteristics of long pendulous plumes on the head, a dark face lacking any pink flesh around the bill, and extensive dark feathering

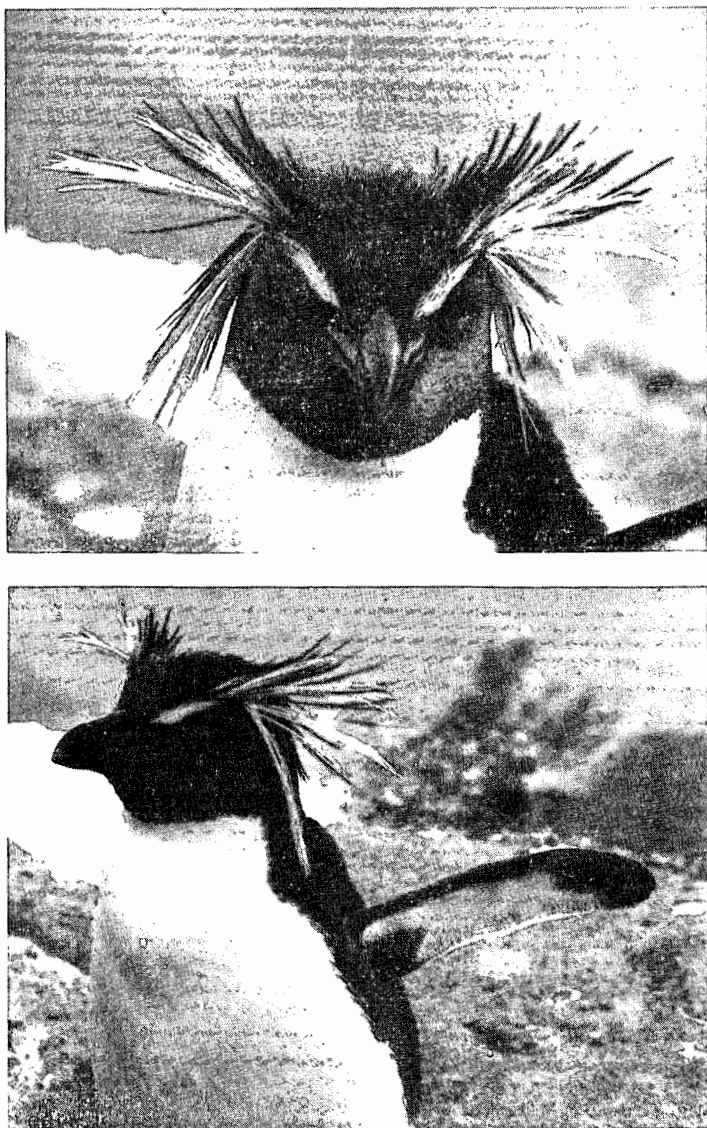


FIGURE 1 — Immature Moseley's Rockhopper Penguin in fresh plumage, 1 March 1984, showing characters to aid field identification of the subspecies. **Upper:** Long pendulous plumes and large occipital crest with no pink flesh around the margins of the beak. **Lower:** Prominent dark feathering along the leading edge and at the distal end of the under-flipper.

on the distal under-surface of the flippers (Serventy *et al.* 1971, Duroselle & Tollu 1977).

The bird weighed 3.45 kg and was in the early stages of moult, with feathers being shed from the tail, belly, flippers and crest. The throat and cheeks were tinged with pale feathers, indicating that it was an immature bird (Harrison 1983). It gave several loud trumpeting calls, at the same time rapidly shaking its upraised head from side to side. Warham (1963) has observed this display being given only by male Rockhopper Penguins.

Zoo staff cared for the bird while it completed moulting. PJM examined it again on 1 March 1984 in its fresh plumage (Fig. 1), which still retained tinges of grey feathering on the throat and cheeks. It weighed 2.15 kg. The following body measurements were taken according to Warham's (1972) methods: culmen length 45.3 mm, culmen width 10.3 mm, bill depth 19.2 mm and flipper length 180 mm. These measurements are less than the averages for adult male *E. c. moseleyi* from Gough Island (Williams 1980) and Isle Amsterdam (Duroselle & Tollu 1977) but are consistent with this bird being immature. The long pendulous plumes in the crest varied in length from 80 mm to 85 mm, compared with an average of 91.3 mm for adult males from Isle Amsterdam. By contrast, the corresponding average for eight adult *E. c. chrysocome* of both sexes measured by PJM on Campbell Island in February 1984 was 66.2 mm (range 62-70.5 mm).

The penguin repeatedly gave the male display call, which was noticeably lower in pitch than the same call of Campbell Island males. Jouventin (1982) has shown with sonograms that *E. c. moseleyi* calls at lower frequencies than *E. c. chrysocome*, and in fact he has suggested elevating *moseleyi* to full specific status on the basis of vocal and reproductive behaviour and morphology.

The penguin was banded and released at sea on 15 March 1984 about 6 km south of the entrance to Wellington Harbour.

Rockhopper Penguins, even of the local subspecies, are uncommon vagrants on New Zealand coasts. The nearest populations of *E. c. moseleyi* are at Isles Amsterdam and St Paul, about 7800 km to the west in the Indian Ocean. Penguins from these islands come ashore fairly often in southern Western Australia and in Victoria (Condon 1975), travelling eastward on the circumpolar currents driven by the West Wind Drift. These islands are therefore likely to be the source of the two *E. c. moseleyi* found in New Zealand. Similarly, individuals of this subspecies seen in South Africa are thought to come from Tristan de Cunha and Gough Islands in the Atlantic Ocean to the west (Cooper *et al.* 1978). In both Western Australia (Anon 1983) and South Africa most records are of moulting birds, often juveniles, in January and February.

We thank staff at Wellington Zoo, especially Murray Roberts,

Greg Parfitt, Frank Coles and Alasdair Lees, for housing and looking after the 1984 penguin while it was moulting; Dr P. H. J. Castle, Victoria University, for arranging to have the bird released from MV *Tirohia*; and Mr Duncan Cunningham for technical assistance.

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CONFIRMATION OF BREEDING BY BLACK-WINGED PETREL ON SOUTH EAST ISLAND, CHATHAM ISLANDS

The Black-winged Petrel (*Pterodroma nigripennis*) which, in the New Zealand region, is known to breed in the Kermadecs and Three Kings Islands, has been recorded frequenting several more southern islands over the last few years, including Mangere, Black Rock (Pitt Island) and South East Island in the Chathams group. Although recorded in the *Annotated checklist of the birds of New Zealand*, (1970, 1980) and *The new field guide to the birds of New Zealand* (1979) as breeding on South East Island, breeding had not in fact been confirmed in the Chatham Islands. During January 1984 I was a member of the Wildlife Service's Black Robin management team on South East Island. On 26 January, Phil Clerke, Phil Thompson and I visited the summit of South East Island at about 10.30 p.m. to observe incoming petrels. As on previous nights, moderate numbers of Black-winged Petrels (several hundreds) were circling the summit area and calling from the air, and others were noted on the ground. Smaller numbers of Sooty Shearwaters (*Puffinus griseus*) were heard and seen in the summit area.

In a short burrow on the western summit I found a Black-winged Petrel with an egg. The bird was incubating and the egg was warm. The bird was examined, photographed, and released. This burrow was inspected again by Phil Clerke and Don Merton

on the night of 17 February, when the egg was being incubated by a Black-winged Petrel bearing a band (D-101292).

The steep faces of the summit are covered in dense *Olearia* scrub, making burrows very hard to find. The party left the island soon after this date, and so the fate of the egg is not known.

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ORANGE-FRONTED PARAKEETS IN THE HAWDON VALLEY, ARTHUR'S PASS NATIONAL PARK

On 5 February 1984, while studying habitat requirements of Yellowheads (*Mohcua ochracephala*) in the Hawdon Valley, Arthur's Pass National Park, we came across two Orange-fronted Parakeets (*Cyanoramphus malherbi*) on the eastern slopes of The Pyramid, a peak 1600 m a.s.l. and north of the junction of Sudden Valley and the Hawdon River.

The first Orange-fronted Parakeet was seen 3 m away in good light at 2.00 p.m. while we were following a flock of 10-12 Yellowheads at 860 m a.s.l. in mixed red and mountain beech forest (*Nothofagus fusca* and *N. solandri* var. *cliffortioides*) with a canopy up to 20 m high. Our attention was initially drawn to it because it flew through the understorey and landed very close to us. It was identified by its orange forehead.

We continued to follow the Yellowhead flock for 4½ hours, during which time an Orange-fronted Parakeet was seen several times. At 6.30 p.m. two Orange-fronted Parakeets were seen in the same tree in good light from 3 m away. The parakeets followed the Yellowheads for about 1.5 km, across several guts and slips and through a range of forest types, including 3 m high mountain beech and 25 m high red beech. The altitude varied from 840 m to 920 m a.s.l.

Up to three Yellow-crowned Parakeets (*C. auriceps auriceps*) also followed the Yellowheads. Warblers (*Gerygone igata*), Tomtits (*Petroica macrocephala*), Fantails (*Rhipidura fuliginosa*) and Brown Creepers (*Finschia novaeseelandiae*) were also associated with the flock of parakeets and Yellowheads. Mixed species flocks were common in the Hawdon Valley from mid-January until the end of February 1984, although parakeets were seen following and feeding with Yellowheads from November 1983 onwards.

Between mid-November 1983 and early February 1984, 58 man-days were spent in the Hawdon Valley. During that time 149 parakeets were seen or heard, of which 43 were identified as Yellow-crowned Parakeets. PJMcC saw a Red-crowned Parakeet (*C. novaezealandiae*) on 23 November 1983 on the true left of the Hawdon, and another was seen on the eastern slopes of The Pyramid on 22 December 1983 (P. Pearson, pers. comm.).

On 15 April 1984, AR and Clive Copeman saw two Orange-fronted Parakeets near the junction of the east and west branches of the Hawdon River at 850 m a.s.l., about 2 km from the first sighting. The birds, identified by their orange foreheads, were seen 10 m away, feeding in the upper understorey/lower canopy zone in mountain beech forest. They were not with other parakeets or with Yellowheads.

This century, only eight confirmed sightings of Orange-fronted Parakeets have been made (Harrison 1970, Gray 1982), the most recent being in 1980 by officers of the NZ Wildlife Service in the Hope-Kiwi area of North Canterbury, about 50 km from the Hawdon Valley. Our sighting is only the second this century from outside the midwest Nelson-North Canterbury region, the other being at Manapouri in 1949 (Tiley 1949).

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BIRDS ON AITUTAKI, ATIU AND MAUKE, SOUTHERN COOK ISLANDS

Although there have been a number of accounts of the birds of Rarotonga in the past few years, records for other islands are still sparse. Holyoak's (1980) guide summarises the distribution on most of the islands of the group, based mainly on a visit in 1973. Since then Child (1981) has recorded birds on Aitutaki and his map includes the place names mentioned here. All these records are confined to the months July-September.

In November-December 1983 my wife and I visited the Southern Cook Islands, including Aitutaki (26 November to 2 December), Atiu (2-5 December) and Mauke (5-8 December). Aitutaki is an "almost atoll" with a large lagoon, one large volcanic island and 15 smaller motus. Atiu and Mauke are "concentric islands" with a central volcanic core surrounded by a ring of raised coral limestone (the makatea) and a fringing reef. Neither has a lagoon, access from the sea being through small canoe passages in the fringing reef. On both these islands the volcanic regions are cultivated and the makatea, with its very rough limestone surface, is covered with forest. Where the volcanic core meets the makatea there is usually a swampy area, parts of which are cultivated with taro plantations.

SYSTEMATIC LIST

Regular surveying of the lagoon at Aitutaki and the sea areas round Atiu and Mauke yielded no petrels, storm petrels or shearwaters. Child saw none from Aitutaki, but Holyoak saw nine species on interisland trips.

TABLE 1 — Shore birds seen on transect from Arutanga to the airport, Aitutaki, on 26 November 1983. Section A was counted in the morning, sections B and C in the afternoon. The first figures are the numbers of birds seen on the outward trip from the Rapae Motel and the figures in brackets are the numbers seen on the return trip.

Section	A	B	C
	Rapae Motel - Arutanga	Rapae Motel rocks	Rapae Motel - airport
Distance (km)	2.5	0.4	1.8
Wandering Tattler	24 (22)	2 (4)	12 (8)
Lesser Golden Plover	16 (17)	2 (2)	8 (6)
Reef Heron — dark phase	7 (7)	5 (5)	5 (2)
white phase	0 (0)	2 (2)	5 (3)
mottled phase	0 (0)	1 (1)	0 (0)

WHITE-TAILED TROPICBIRD *Phaethon lepturus*

Two pairs on Aitutaki, one on the rock face just below the summit of Maungapu and the other on a rock face some 2 km further south. These are the only suitable nesting sites on the island. Both pairs kept landing on specific ledges, but nests could not be seen.

BLUE-FACED BOOBY *Sula dactylatra*

One over the southern end of Aitutaki lagoon on 27/11. Readily recognised at close range by the black tips to the wings and tail on a large white bird. This is the second record for the Southern Cook Islands and the first for Aitutaki.

LESSER FRIGATE BIRD *Fregata ariel*

Two adult males and one adult female seen on 1/12 flying over the northern end of Aitutaki. One male was seen over the north-eastern end of Atiu on 4/12. (At Titikaveka, Rarotonga, one male, one female, and one immature were seen together on 25/11, and one male on 8/12.)

REEF HERON *Ardea (Egretta) sacra*

Very common on Aitutaki on the main island and motus, and fishing from coral heads in the lagoon. A beach transect from Arutanga north to the airport on 26/11 (Table 1) yielded 25 herons, of which 17 were dark phase and seven white phase, giving a dark/white ratio of 2:5. One bird was in a mottled phase. We saw no white birds south of the Rapae Motel during this transect and on three further walks along this beach area saw only one. This suggests that each bird tends to patrol a specific stretch of beach. This is borne out by the fact that the mottled bird was always seen on the same part of the beach.

Numbers on Atiu were much lower, only five dark phase birds being seen, possibly because it has no lagoon. On Mauke only two birds, both dark phase, were seen.

GREY DUCK *Anas superciliosa*

Reported by Holyoak from all three islands and Child flushed a flock of ten on Aitutaki. We saw none on Aitutaki or Mauke, although we were informed that they were present on Mauke. We saw a pair on open water in a swamp on Atiu.

DOMESTIC FOWL *Gallus gallus*

Birds heard well away from habitations on Aitutaki and Atiu were presumably all feral. Birds seen on cultivated land on Atiu were said by our guide to be "wild," i.e. not owned by anybody.

GOLDEN PLOVER *Pluvialis fulva*

Common on shores round Aitutaki (see Table 1) and on open grassy spaces, frequently under trees. Not often seen on the fringing reefs of Atiu and Mauke (five birds on Atiu, three on Mauke) probably because they prefer soft muddy shores to the coarse sand of the makatea coast. Much commoner inland on these two islands on open grassy places (e.g. eight on the old airstrip on Atiu on 3/12).

WANDERING TATTLER *Heteroscelus incanus*

Holyoak noted that this is the commonest shore bird in the Cook Islands, although it had not been formally recorded from Aitutaki at that time. Subsequently Child recorded it from Aitutaki. Holyoak's comment is borne out by Table 1. On Atiu and Mauke it was uncommon along the coast, like the Golden Plover, but frequent inland on grassy places (e.g. eight on the old airstrip on Atiu on 3/12).

SIBERIAN TATTLER *H. brevipes*

One bird on the shore just north of Arutanga, Aitutaki, was a "different" tattler with a lack of barring on the underparts, paler grey upperparts, and a more conspicuous eyestripe. We finally decided that it was of this species, which was confirmed by its voice on the third sighting. Previously recorded for Aitutaki by Child.

TURNSTONE *Arenaria interpres*

One seen on Papuaetai, Aitutaki (southern end of the lagoon), on 27/11 is only the second single bird seen on Aitutaki.

BROWN (COMMON) NODDY *Anous stolidus*

Five cruising low over and among coconut palms on Tapuaetai Island, Aitutaki, on 27/11, but no nests were distinguishable. Single birds frequently seen over Aitutaki lagoon.

BLACK NODDY *A. tenuirostris*

Three over Aitutaki lagoon and five resting on a sandspit on Tekopua Island, Aitutaki, on 27/11. Readily distinguished from the Brown Noddies nearby at the same time by their smaller size, darker plumage, and forked tail. Two over the fringing reef at Atiu on 4/12. Not listed for the Southern Cooks by Holyoak, but recorded for Aitutaki by Child.

WHITE TERN *Gygis alba*

Frequent on all three islands among trees, although we saw no signs of eggs or chicks.

ATIU FRUIT DOVE *Ptilinopus rarotongensis goodwini*

This endemic subspecies on Atiu was more often heard than seen. We saw seven in the makatea forest and heard about 20.

PACIFIC PIGEON *Ducula pacifica*

Heard throughout the makatea forest on Atiu, but only one bird seen. It did not seem to be as common as the Fruit Dove. From the number of calls heard on Mauke it seems less common there than on Atiu.

TAHITI LORIKEET *Vini peruviana*

Now confined to Aitutaki, where it was probably introduced as a cage bird. It is readily located by its call, being the only land bird other than the Myna on the island, with which its call cannot be confused. It seemed to be especially vocal in the evenings. We heard or saw 21 along 1 km of road through coconut plantations and scrub in Amuri village on 1/12.

In view of its disappearance from Atiu and Mauke over the past century with only unconfirmed reports in recent years (see Holyoak), we listened for it carefully on these islands without success.

ATIU SWIFTLET *Aerodramus sawtelli*

Endemic to Atiu. Nine nests in the Cave of the Kopeka were occupied on 4/12 with either eggs being incubated or unfeathered nestlings in the nests. Five nests were apparently unoccupied. The nests were mostly on inaccessible ledges near the roof of the cave. One accessible empty nest was examined. It had a cup 7 cm diameter with a 2.5 cm wall and was built of coconut fibre.

CHATTERING KINGFISHER *Halcyon tuta*

Endemic subspecies occur on Atiu (*Halcyon tuta atiu*) and on Mauke (*H. t. mauke*). On Atiu the birds were thinly scattered throughout the makatea, being more often seen than heard. The Mauke subspecies seemed to be more abundant and was especially common along the road round the island through the makatea forest, where we saw or heard up to seven birds at one spot.

INDIAN MYNA *Acridotheres tristis*

Abundant in the inhabited areas of all three islands, but scarce or absent in the makatea forest. We found no nests, but newly fledged young were being fed in Arutanga village, Aitutaki, and fresh egg shells were noted in Amuri village, Aitutaki.

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REVIEW

A review of Norfolk Island Birds: past and present by R. Schodde, P. Fullagar and N. Hermes. Australian National Parks and Wildlife Service Special Publication [8] 1983. 119 pp.

This excellently researched and produced little volume provides the Norfolk Island group with a reference document which in the breadth of subjects covered is unlikely to be matched for any other SW Pacific island group.

An outline of the history of the islands is given with special reference to changes in their vegetation and to their ornithological exploration. This is followed by a review of their geological history.

Recent research into fossil remains dating from c. 700 to 850 BP has yielded evidence of several species not previously recorded at Norfolk Island, including four which may be forms new to science. Fossil evidence also shows the kiore (*Rattus exulans*) to have been present at this early date, although the authors' assumption that the kiore is now extinct is probably incorrect.

The fossil record of birds on islands is reviewed, and the value of such fossil avifaunas in predicting evolutionary patterns is discussed. The origins of the Norfolk Island avifauna is examined, although without reference to Oliver's 1911 work on this subject.

A checklist of modern Norfolk Island birds is provided and analysed according to status. Endemism is high with 5 species and 9 races in this category, of which 2 species and 3 races are classed as recently extinct.

Each of the 43 breeding species has a page devoted to it providing information on distribution and taxonomy, historical records, present status and breeding, together with a summary of the results of the RAOU census of December 1978 and a distribution map based on observations made at that time. No plumage descriptions are given, and although for most species this aspect is adequately covered elsewhere, good descriptions of the endemic forms are not readily available and their inclusion would have enhanced this section of the book.

Summaries are provided for each of the 50 non-breeding migrants or vagrants, but because of their brevity, the reasons for decisions made by the authors, particularly in regard to some of the earlier records, are not given. It is for example regrettable that no reasons are provided to support either the acceptance of the 1951/52 'Egretta species' as *E. alba* or the listing of Pelzelns' early record of Greenshank (*Tringa nebularia*) as unconfirmed. The inclusion of *H. unicolor* as one of the species to which c. 30 Pied Oystercatchers seen in 1960 could be attributed also merits some explanation, as does the listing of Little Egret solely on the basis of its inclusion in de Ravin's 1975 paper. The 1977 records of Australasian Grebe and

Australian Pelican, although attributed to M. F. Soper, were not seen by him personally and should therefore be listed as unconfirmed.

The distribution patterns of both the pre-European indigenes and the post-European arrivals have been mapped from the results of the RAOU census and these data have also been used to demonstrate the dependence of several of the endemic forms on the Mt Pitt reserve.

A few small proofreading errors appear to have slipped through giving rise to minor inconsistencies in the maps comprising fig. 18; also the references to Stuart on pages 63 & 64 should be dated '1838-40' and not '1938-40.'

Finally a comment on nomenclature and classification. The book follows the RAOU Checklist, and with over 80% of the birds listed being common to both Norfolk Island and New Zealand, no better case could be made for the need for closer cooperation between the RAOU and OSNZ Checklist committees than the almost continuous, often quite minor, differences which beset the reader accustomed to New Zealand nomenclature. Such minor disagreements as 'Red-fronted' versus 'Red-crowned' Parakeet, 'Australian' versus 'Eurasian' Coot, 'Nankeen' versus 'Australian' Kestrel and many others are surely capable of resolution.

For those with a particular interest in Norfolk Island birds this publication is available from the Government Conservator, P.O. Box 310, Norfolk Island, South Pacific 2899.

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