THE DISTRIBUTION AND NUMBERS OF NEW ZEALAND FALCONS (*Falco novaeseelandiae*)

By N. C. FOX

ABSTRACT

Data on the distribution of the New Zealand Falcon were collected from all likely sources and from field studies in five areas. The known status of the falcon is given and is summarised in two distribution maps. The entire population is estimated using known densities in study areas. About 3100-3200 pairs of "Eastern Falcons," 450-850 pairs of "Bush Falcons" and 140-280 pairs of "Southern Falcons" (total about 3700-4350 pairs) may exist. Probably 3000-4500 pairs is a realistic estimate of the falcon population; 2000 pairs at the least.

INTRODUCTION

No estimate of the New Zealand Falcon population has been published. Only fragmentary, local information exists, which is combined in this paper with more recent data to produce national distribution maps. When estimating breeding ranges, it is important to differentiate between records of transients and of breeders but at the same time to realise that the regular presence of juveniles in certain districts indicates the presence of a reasonable breeding population in adjacent ranges.

METHODS

Data on falcons were obtained from the annual Classified Summarised Notes of the Ornithological Society of New Zealand since 1950, from McKenzie (1972), and from the Bird Mapping Scheme (P. Gaze, pers. comm.). Written enquiries were made to the secretaries of branches of OSNZ and the Royal Forest and Bird Protection Society, and articles were placed in *Outdoor* magazine, the Deerstalkers' Association magazine and the Tussock Grasslands and Mountain Lands Institute magazine. Short items were given on Radio New Zealand and Television One. Letters were sent to people, such as National Park and Forest Service personnel, known to have had contact with falcons or who knew a certain area well. Field work on falcon densities in five study areas containing 142 pairs (Fox 1977) gave useful comparisons between reported sightings and probable densities.

From many sightings the problem was to eliminate those referring to drifting, non-breeding juveniles. Descriptive atlases (McLintock 1959, Wards 1975) were used to eliminate all areas, such as cities, cultivated farmlands and orchards, permanent snow and glaciers, in which it would be unlikely that falcons are breeding. Reports from these areas, e.g. Gill (1976), were considered to refer to non-breeders.

NOTORNIS 25: 317-331 (1978)

The remaining areas were then evaluated block by block, using the information available and historical records. Large, uninhabited areas and the low density of observers made more detailed census methods (e.g. Prestt & Bell 1966), or road-counts not feasible.

RESULTS

The results are summarised in two maps (Figs 1 & 2). Meridian squares are described by their northern latitude and western longitude, and concise data for each square are shown below. Abbreviated sources: HRMcK = McKenzie (1972), OSNZ = Ornithological Society's Classified Summarised Notes, BMS = Bird Mapping Scheme. Unspecified data are mine.

NORTH ISLAND

34° x 172°, 34° x 173°, 35° x 173°, and 35° x 174°.

Rare or absent in Northland; Watt (1974) saw only one falcon in 32 years. One or two unconfirmed sightings (1970 OSNZ) were probably of juveniles. The presence of a falcon in Omahuta State Forest (D. Bartram, pers. comm.) may indicate occasional breeding. Skegg (1964) considered that falcons became extinct on the Hen and Chickens by 1914, but these islands could barely support more than one pair.

36° x 175° and 36° x 174°

No sightings on mainland.

36° x 175°

Great Barrier Island: visited occasionally by falcons (1960 OSNZ) but no nest records. Bell & Brathwaite (1964) did not record it, nor did Turbott (1974) on Little Barrier.

Coromandel Range: odd birds have been recorded (1974 BMS) and probably a few pairs still breed.

37° x 174°

South Auckland: very rare, not resident (OSNZ; S. Reed, pers. comm.). Occasional sightings (1968 OSNZ) are probably of immatures. One bird was seen at Waikato Heads estuary (1974 BMS).

37° x 175°

Moumoukai: a pair at Bombay (1963 OSNZ), growing scarcer but often seen (1964 OSNZ) and one bird seen (1970 OSNZ).

Mt Pirongia: usually seen (1964 OSNZ); fairly common (1976 L. A. Hedley, pers. comm.), possibly an isolated population of 5-6 pairs. One seen at Raglan Harbour (1974 BSM) may have come from Mt Pirongia.

Kaimai Range: one seen at Whakamaramara (1963 OSNZ) and one present at aviaries at Tauranga in June (1963 OSNZ). One sighting South Kaimais (1974 BMS) and three sightings North Kaimais (1974-5 OSNZ). Falcons are still present in the Kaimais (Mrs R. V. McLintock 1975, pers. comm.) and presumably still breeding.

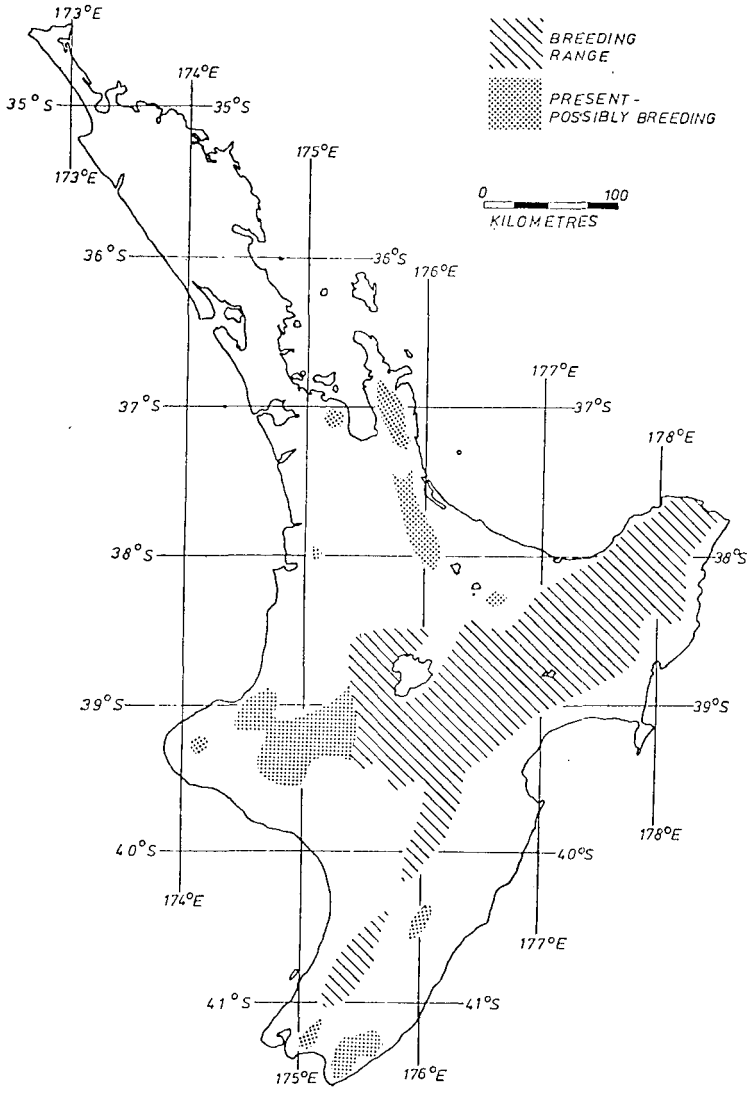

FIGURE 1 — The range of the New Zealand Falcon in North Island.

37° x 176°

Occasional sightings in farming districts between Tauranga, Whakatane, Matata (1961 OSNZ) and Kawerau (1956-64 OSNZ) were probably of juveniles which had strayed from the main ranges further south. A dead falcon was found on Mt Maunganui Beach 22 June 1969 (Davenhill OSNZ).

37° x 177° and 37° x 178°

The bush-clad Raukumara Range of East Cape is probably one of the major breeding areas in the North Island. HRMcK classified falcons as common there and reports in OSNZ and BMS are too numerous to detail.

38° x 174°

A pair at Kawhia Harbour (1966 OSNZ) probably came from Mt Pirongia but may breed, as a pair was also seen there in 1976 (P. Bradfield, pers. comm.).

North Taranaki: three records in the Waitaanga area (1967-8 OSNZ) indicate that there are probably scattered breeding pairs.

38° x 175°

HRMcK considered that falcons were disappearing in the Hauhungaroas due to clear felling, but odd sightings (Te Kuiti 1960 OSNZ) indicate that a few may still breed. At Pureora, West Taupo, they were seen almost daily (1964 OSNZ) and an old inhabitant had killed 20 in one year since the war (OSNZ). Falcons are still present (1974 BMS) but the area is rather inaccessible and more information is required.

38° x 176°

Relatively frequent sightings of falcons at Rotorua, Mamaku, Kawerau, Taupo, Kaingaroa, Lake Rotoiti, Galatea and Wairapukao (1960-75 OSNZ and 1974 BMS) indicate a low density breeding population in the Kaingaroa State Forest area. The range may well be more extensive than shown in Figure 1.

38° x 177° and 38° x 178°

Numerous observations show that falcons may be rather common in the Huiarau and South Raukumara Ranges, extending as far as the cultivated country around Gisborne. Juveniles are frequently seen in Gisborne and a pair lived for at least two years in exotic forest at Patunamu (M. Orchard, pers. comm.). Falcons breed in the Urewera National Park and are seen or heard frequently (W. Berger, pers. comm.).

39° x 174°

Mt Egmont: Falcons are seen occasionally in the National Park (K. A. Mawhinney, pers. comm.) and may still breed.

Taranaki: odd birds seen along bush ridges near Marco (OSNZ), and settlers state the species is quite common in and around the dense bush (OSNZ). A pair was present at the Tangarakau Gorge, Taumarunui (1975 R. Weston, pers. comm.) and falcons probably nest in all bush areas from the Matemateonga Range to Tongariro National Park.

39° x 175°

Five records (1974 BMS) in Tongariro National Park and OSNZ records from the adjacent bush ranges, as well as a number of specimens collected from the Raetihi area, indicate that falcons may be commoner here than at Kaingaroa but less so than at East Cape.

39° x 176°

Numerous records from the Kaimanawa, Ahimanawa, Kaweka and Ruahine Ranges show that a substantial breeding population is present. Juveniles stray annually to Napier and Hastings (W. J. Powell, pers. comm.) and one or two pairs may possibly breed at Maraetotara.

39° x 177°

There is no suitable nesting habitat here, so any records are probably of juveniles.

40° x 174°

Falcons were frequently seen on Kapiti Island but were not known to nest (Wilkinson 1952).

40° x 175°

Numerous records indicate a substantial number breeding in the Tararua Range. Pairs probably breed in the Otaki (1941 OSNZ), Akatarawa, Hutt (1972 J. A. Fowler, pers. comm.) and Kaiparoro (1973 R. White, pers. comm.) Valleys. Juveniles from the Tararuas are probably responsible for reports from Kapiti, Pukerua Bay (1962 OSNZ) and Wellington.

40° x 176°

A sighting of three falcons in the Makuri Gorge (1972 E. Dear, pers. comm.) indicates that a few pairs may exist in the Puketoi Range. Generally the South Hawke Bay, Dannevirke, Masterton area is now too densely settled and cultivated to support falcons, but they used to nest at Mt Oporae (J. Meacham, pers. comm.).

41° x 174°

Frequent sightings from Wellington, Upper and Lower Hutt are almost all attributable to stray juveniles from the Tararuas or Rimutakas. It is possible that one or two unreported pairs of falcons nest in the hills around Cape Terawhiti.

41° x 175°

The presence of falcons during the breeding months (Sir Robert Falla, pers. comm.) and frequent sightings of juveniles in the Eastbourne area suggest that a few pairs of falcons probably breed in the Rimutaka Range. Despite its proximity to Wellington there is little information for this area.

Falcons are present and probably breeding in the Aorangi Mts (1976 G. Woodward, pers. comm.).

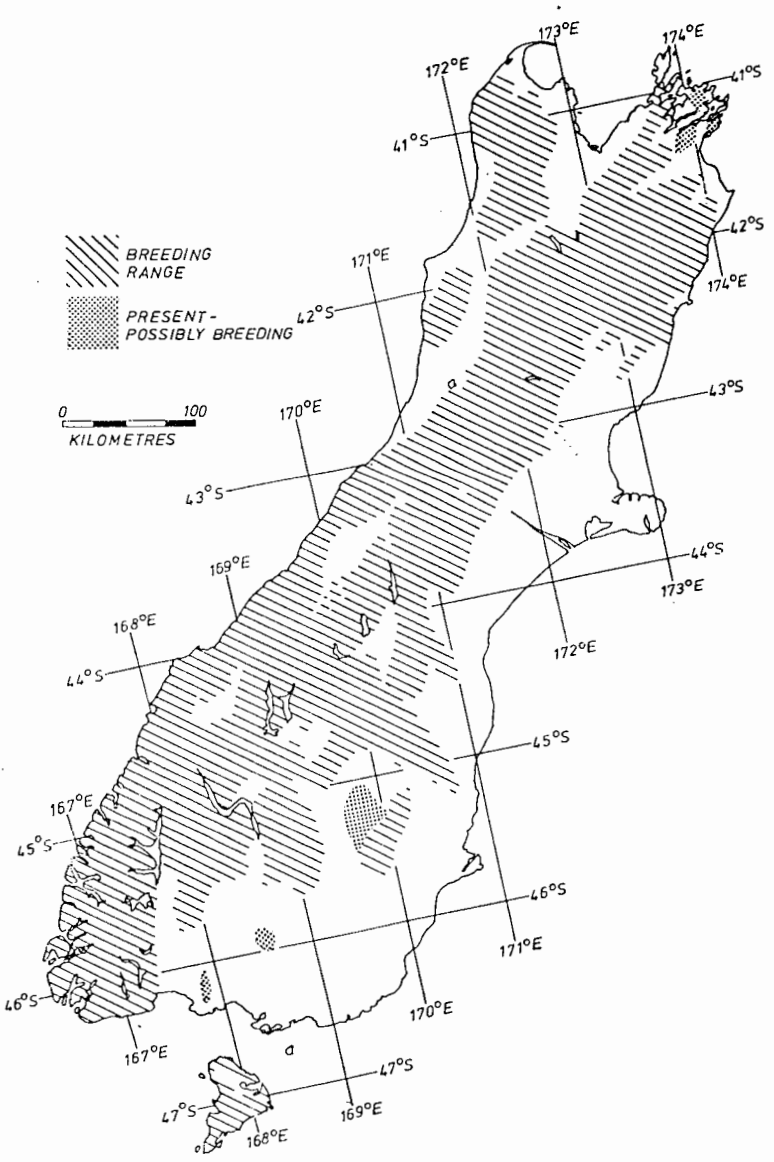

FIGURE 2 — The range of the New Zealand Falcon in South Island.

SOUTH ISLAND

40° x 172°

Wakamarama Range and Tasman Mts: numerous records, mainly in forest areas (OSNZ, BMS). Apparently uncommon now in Abel Tasman National Park (G. Rennison, pers. comm.).

40° x 173°

A falcon was shot on D'Urville Island in 1927 and falcons may breed there. A pair was present on Stephens Island about 1950 (L. Bell, pers. comm.) and falcons were seen occasionally on the Chetwode Islands (D. Flack, pers. comm.).

41° x 171°

Falcons breed in the Paparoa Range (three sightings near Mt Uriah 1974 BMS, and 1976 C. Wynn, pers. comm.).

41° x 172°

Falcons breed in the Mt Arthur Range, Marino Mts, Lyell Range and Nelson Lakes National Park, and reports (BMS, OSNZ, HRMcK) are numerous. Two pairs of falcons nested in the Cobb Valley 1951-2 (G. Davis, pers. comm.) and a well-known pair has nested at Mt Robert in recent years. Although occupying hilly or wooded tracts, the falcon has been eradicated from most marginal agricultural areas by shooting.

41° x 173°

Falcons breed in the Bryant and Richmond Ranges (HRMcK, OSNZ), extending as far as the Marlborough Sounds. Although seen occasionally in the Sounds (1976 A. Shanks, pers. comm.; 1974 BMS) their breeding status is unknown. South of the Wairau River there is a dense, well-documented population (study area A, Fox 1977).

41° x 174°

Although there are imposing sea-cliffs, such as Wellington Head, there are no records of falcons breeding on cliffs which directly overlook water. The status of the falcon in Queen Charlotte Sound seems to be unknown. The most easterly extent of the falcon's breeding range in central Marlborough is Richmond Brook, Seddon.

42° x 170°

Falcons are occasionally seen at Hokitika and Ross (OSNZ) and breed in any areas remote from human activity.

42° x 171°

Probably now eradicated from all flat areas around Greymouth but still seen occasionally (OSNZ). Records are numerous east of Lakes Kaniere, Brunner, Ahaura and Hochstetter, as far north as Reefton and Inangahua Junction, and the breeding range extends across the Canterbury Plains.

42° x 172°

Falcons are present and breeding in all the main ranges east to the Hawarden-Waiau basin but excluding all cultivated areas. Although absent from the Hanmer Springs flats, falcons still breed in the

adjacent hills, including Lochiel Station where Edgar Stead studied them in the 1930s.

42° x 173°

Falcons breed throughout the Kaikouras and in the Hundalee Hills as far south as the Conway River mouth (see study area B, Fox 1977). One or two pairs breed south of the Conway, east of Parnassus (J. West, pers. comm.) and in the Lowry Peaks Range (1976 J. Satterthwaite, pers. comm.).

43° x 168-171°

Falcons breed in all areas between Jackson Bay, Wanganui Bluff, Mt Grey (North Canterbury) and Mt Peel (South Canterbury) — many records — excluding those areas which are permanently snow-bound or involved with human activities. The breeding range extends to within 5 km of the flat Canterbury Plains, usually avoiding the front faces of the hills. Pairs nest up to 1520 m a.s.l. (5000′) in the Craigieburn Range. One or two pairs are also present in the Doctor's Hills, North Canterbury, separated from the main ranges. Stead (1944) considered the falcon uncommon throughout Canterbury back country where he thought numbers had just been maintained between 1920 and 1944. In 1977, falcons were comparatively plentiful in this area but affected by pesticides on the edge of their breeding range.

The falcon probably became extinct on Banks Peninsula around 1900 although one or two pairs may have hung on longer, as P. A. G. Howell (pers. comm.) saw a pair kill a White-backed Magpie *(Gymnorhina tibicen hypoleuca)* near Castle Rock in January 1947. Although occasional single birds and possibly a pair have been seen in Governors Bay (H. Ensor, pers. comm.; B. Calder, pers. comm.) since then, there have been no records of breeding, and runholders in the interior have not seen falcons on Banks Peninsula (W. Aitken, pers. comm.). The falcons probably disappeared because of man but, with increased public tolerance, they may well re-colonise the Peninsula, despite the great reduction in forest.

44° x 167-170°

Numerous records indicate that falcons breed in all areas, excluding alpine barrens and areas of human activity, from Jackson Bay and Caswell Sound to Mt Peel and the Dansey Pass. On the low-lying areas around Wanaka and the Lindis, as well as in the flatter parts of the McKenzie Country, they apparently do not breed, although records indicate that these areas may be occupied by non-breeders. The Hunters Hills, Kirkliston Range and St Mary's Range mark the eastern-most extremity of the breeding range. There are no data on breeding falcons in the Pentland Hills.

44° x 171°

There are no known breeding falcons on the Timaru plains, although juveniles may stray as far as the coast (R. McCully, pers. comm.).

45° x 166-167°

Falcons breed throughout Fiordland National Park (A. Cragg, pers. comm.), Kaherekoau Mts and are common in the Takitimu Mts (1975 R. R. Sutton, pers. comm.; 1975 J. von Tunzelman, pers comm.), but are absent from the low-lying country between Monowai and the eastern shores of Lake Te Anau.

45° x 168°

Falcons breed in the Livingstone Mts, Thompson Mts, Eyre Mts, Remarkables, Hector Mts and Garvie Mts (many records). A breeding pair near Dipton (1955-60 OSNZ) may indicate that falcons still breed in the Hokonui Hills. Breeding falcons are absent from all areas exposed to persistent human disturbance.

45° x 169°

Falcons breed in the Umbrella Mts, Old Man Range and Dunstan Mts (many records), but are absent from the more populated areas of the Clutha and Manuherikia Rivers. There is little information on the presence of falcons in the Knobby Range, Rough Ridge, Rock and Pillar and Lammermoor Ranges, but a pair nesting near Lawrence (1969 OSNZ) and another at North Rough Ridge (J. Mathewson, pers. comm.) suggest that falcons probably breed throughout these hills.

45° x 170°

Falcons are present in the Kakanui Mts (1974 BMS) and breed regularly as far south as Trotters Gorge, Hampden (Prof. P. A. Smithers, pers. comm.). A record from Hindon (1974 BMS) may mean that falcons breed in the hills around Mt Hummock, extending to the Taieri Ridge. There are probably no breeding falcons in the low-lying areas adjacent to Ranfurly and Middlemarch, nor in the cultivated coastal districts.

46° x 166-167°

Falcons breed in southern Fiordland, including Hump Ridge (1974 BMS, 1974 OSNZ). A pair nesting, possibly for several years, just inland from Colac Bay (1956 J. A. Mathieson, pers. comm.) shows that falcons probably still breed in the Longwood Range.

46° x 168°

Falcons are absent as breeding birds from the Southland Plains; reports of single birds at Invercargill and Otatara (1961 OSNZ) were probably of stray juveniles.

46° x 169-170°

It is possible that some falcons breed in the hilly district around Mt Pye but there are no records.

Stewart Island

Information on falcons in Stewart Island is scanty. Sightings include Island Hill, Thompson Ridge and Ackers Point (OSNZ); as these are all near tracks it is logical to assume that falcons are widespread throughout Stewart Island, if at a low density. Wilson's (1959: 75) discovery of two breeding pairs on Codfish Island supports this assumption.

Auckland and Adams Islands

Five or six pairs of falcons were discovered in the 1972/73 expedition to the Auckland Islands, concentrated at the south end, mainly on Adams Island (B. D. Bell, pers. comm.). This may represent a decrease since the war years. Theoretically the Auckland Islands should support at least 12 pairs, but the high pesticide levels in a collected egg (see Bennington *et al.* 1975) may suggest a reason for the decrease.

Macquarie Island

Buller (1888: 221) recorded a specimen collected at Macquarie Island. This appears to be the only record and must be considered dubious.

Chatham Islands

Buller (1888: 224) recorded a falcon egg from the Chatham Islands in the Canterbury Museum collection. The history of this egg and its present location are not known. The falcon probably became extinct in the Chatham Islands before 1892 when Forbes (1893) collected sub-fossil bones, and there have been no further records apart from bones (Scarlett 1955, Dawson 1957).

DISCUSSION

The main problem in this type of analysis is the reliance on a large number of independent observers whose estimates of status, such as "common" or "scarce," vary widely. Because people in New Zealand are used to the unusually high population levels of the Australasian Harrier *(Circus approximans gouldi)*, of which it is common to see 1-10 sightings from one place daily, they tend to measure the falcon by the same yardstick. Thus even scientists working on birds thought that falcon densities of one pair per square mile (2.6 km^2) could be expected in a healthy population.

In Marlborough, where the population density is now known with some accuracy, Handly (1895) considered the falcon "fairly numerous," measured presumably against his knowledge of other falcons overseas. In the OSNZ notes there are scattered records for Marlborough, and S. R. Kennington's estimate "found in small numbers throughout the district, generally avoiding more populated areas" may be considered a fair comment, typical of other OSNZ notes. The Bird Mapping Scheme (1974) had no records for most of this area. There is thus nothing on record to suggest that the Marlborough population is a particularly dense one as, in fact, it is. This same comment also applies to my other four study areas. It therefore seems reasonable to assume that those areas of New Zealand recorded as containing falcons on the distribution maps probably contain similar densities to those study areas of similar ecotype.

Statements are frequently made that the falcon appears to have decreased in numbers in recent years. One of the reasons for this supposed decrease is that farms have become increasingly mechanised

and have better tracks. Horses, being slow, silent and self-steering, were ideal mounts from which to notice falcons. Now that four-wheel drive vehicles are used the noise, restricted vision and concentration on driving, as well as the shortened period of time spent on the hill, greatly diminish the chances of seeing falcons. Many runholders have put this point to me and it is a valid one.

In other areas observers may be gauging the falcon population, unknowingly, on the fortunes of only one pair. If a homestead lies within the territory of a pair, then falcons will be seen reasonably often and the comment will be that falcons are " present " or " common." Should that pair move or die, it is probable that no, or very few, falcons will be seen at the homestead, resulting in the opinion that " falcons have noticeably decreased in this area." As many pairs near homesteads are on marginal territories, this may be a common occurrence.

As observers grow older and less active, far less time is spent in falcon habitat. Thus comparisons made by the same person between numbers of sightings in the 1970s and numbers of sightings in the 1930s or 1940s will differ. One old man in Marlborough had not seen a falcon for 15 years — despite the presence of five pairs within 5 km of his homestead !

The breeding range of the falcon has undoubtedly shrunk in the last 30 years. The study areas which were on the edges of the breeding range contained marginal sites which were no longer active, suggesting a retreat of from 1-8 km. In the Ward area of Marlborough DDT was used between 1950-1972 and the disappearance of some marginal pairs from that area in the early 1950s coincided with the use of DDT (Fox 1978a). There was no persecution of falcons on these stations at that time (T. J. Taylor, pers. comm.). It is possible that, without further pesticides or undue disturbance, falcons will nest in these areas again. In North Canterbury, falcons still nest even on the front faces of Mt Grey and also in the Doctors Hills and the Lowry Peaks Range, both of which are isolated from the main ranges. This indicates that there is a reasonable falcon population in the main hills because population strength generally is lowest at the edges of the breeding range and increases inwards.

Whether or not falcons bred in pre-European times on the flat plains, such as Canterbury, is not known. Although it apparently uses a wide range of nest sites, the falcon has some strict limitations. For example, no nests have been found directly overlooking water; and no nests have been found in flat open country. Perhaps any falcons nesting on the plains used small patches of bush, especially those on higher ground. However, if a falcon such as the Peregrine *(Falco peregrinus)*, which has very conservative nest site requirements, can adapt to flat land and scattered trees (Hickey 1969: Plates 7, 24, 25, 26), probably the New Zealand Falcon could also do so.

If this plains population existed, it seems to have been extinct

by 1882, when Potts mentioned the presence of a pair in Governor's Bay, Banks Peninsula, but did not mention any seen on the plains. M'Lean (1911: 12) specifically stated " in the lower open country the Bush-hawk is seldom seen, and then only in winter. I have never seen a Falcon about the cultivated plains of the coast." Potts also thought that neither falcons nor their prey were so common in 1882 as previously. Why this should have been so is not clear but it appears that the decrease of the falcon was linked to that of the prey (Galushin 1974), rather than to any more direct factor.

Breeding falcons have inevitably been eliminated from the lowland areas of New Zealand by drastic ecological changes, the natural boldness of the species, unsympathetic treatment by man, and by pesticide contamination. In forests, low-pressure logging is unlikely to have affected the falcon but the monoculture of exotic *Pinus*, especially the even canopy formed by stands of one generation, is definitely unsatisfactory for falcons. Hunting conditions are difficult and these forests support only a poor range of prey.

Reischek (1881, 1886) recorded falcons on the Chicken Islands and Little Barrier Island. Oliver (1955: 425) summarised records from the Hen and Chickens, Little and Great Barrier, Kapiti, D'Urville, Stewart Island, Codfish Island, Auckland Islands and Campbell Island. Most of these records gave no positive evidence of breeding; probably the fortunes of pairs on the small off-shore islands, such as Kapiti, D'Urville and those in the Hauraki Gulf, depend on the presence of a strong falcon population and of suitable habitat on the adjacent mainland.

As long as present conditions remain, the falcon should maintain its present numbers. Increasing replacement of indigenous forest by exotic forests, increasing human population, and chemicals in the food chain are probably the main threats. The species can survive well where there is extensive hill sheep and cattle farming and thus has a more encouraging future than have many native birds which depend heavily on indigenous forests.

ESTIMATED POPULATION SIZE

In the North Island the falcon breeding range (Fig. 1) is about 24 986 km², with an additional 6152 km² in which falcons may possibly breed. In the South Island and Stewart Island the falcon breeding range (Fig. 2) is about 83 654 km², with an additional 1682 km² in which falcons may possibly breed.

Apparently three forms of New Zealand Falcon exist (see Fox 1978). In the North Island and north-western South Island there is a small dark form called the " Bush Falcon." In the eastern half of the South Island the falcon inhabits open terrain and this " Eastern Falcon " is a large pale form. In Fiordland and the Auckland Islands is a form intermediate in size and colour between " Bush " and " Eastern Falcon " which I call the " Southern Falcon."

The range of the "Bush Falcon" covers about 24 986 km² in the North Island and about 14 895 km² in the South Island. "Bush Falcons" may also be breeding in a further 6 833 km². Thus the total breeding area for "Bush Falcons" is about 39 881 (+6 833) km².

The range of the "Eastern Falcon" covers about 44 884 km² plus about 10 662 km² of forested terrain in Westland and a further 1 000 km² of open country in which it may possibly be breeding.

The range of the "Southern Falcon" covers about 13 213 km² including Stewart Island but excluding the Auckland Islands. These breeding range estimates are probably accurate to confidence limits of below 20%.

Estimates of falcon numbers depend heavily on estimates of falcon densities in forest habitat. Reports by Guthrie-Smith (1927), John Powell (pers. comm.) and St Paul (1977) indicate that falcon densities in bush areas may reach as high as those found in open terrain in Marlborough and North Canterbury. Therefore a mean home range size of 190 km² for falcons in Westland (Fox 1977) seems an over-estimate and it is likely that only one in 3-5 pairs was actually found. If this was the case, the probable home range size of falcons in wooded areas may be about 40-100 km², perhaps dropping as low as 20 km² in some places. In open country the home range of falcons is about 15 km² (Fox 1977).

If it is assumed that (a) in areas where falcons may only possibly be breeding they are at a density of one pair per 100 km², and (b) that only 10 pairs exist on the Auckland Islands, then two estimates can be made (Table 1).

TABLE 1 — Estimate of total numbers of breeding pairs of each form of the New Zealand Falcon, based on densities of one pair per 15 km² in open country and on one pair per 50 or 100 km² in forest.

	No. prs. in forest	No. prs. in open country	Possible extras	Total
Eastern	107	2 992	10	3 109
Bush	399	0	68	467
Southern	142	0	0	142
Estimated falcon numbers if one pair per 100 km² in forest assumed =				3 718
Eastern	214	2 992	10	3 216
Bush	798	0	68	866
Southern	284	0	0	284
Estimated falcon numbers if one pair per 50 km² in forest assumed =				4 366

Depending on which estimate of density in forest is used it seems likely that there are about 3000-4500 breeding pairs of New Zealand Falcons. Of these, about 3100-3200 pairs are of the " Eastern " form, 450-850 are " Bush Falcons," and 140-280 are " Southern Falcons." Considering the area of falcon habitat in New Zealand, and the absence of specialised avian competitors, these estimates seem reasonable. More accurate estimates will not be possible until better information on the variables is obtained, but at present it seems most unlikely that there are less than 2000 breeding pairs. How many non-breeders exist is not known.

Changes in land use and destruction of forests make the " Bush Falcon " the most vulnerable form. Most of the " Southern Falcons " are contained in the Fiordland National Park and thus are protected, but the Auckland Islands representatives of this form are very exposed to pesticides in the marine ecosystem. The " Eastern Falcon," being adapted to introduced prey and to new types of land use, seems reasonably secure.

ACKNOWLEDGEMENTS

This paper is part of a wider study of New Zealand Falcons made possible by a scholarship from the Drapers Company, London. I would like to thank the many correspondents, especially those who by their contributions to the Classified Notes of the Ornithological Society or to the Bird Mapping Scheme have made this paper possible. Dr John Warham kindly gave his comments on an earlier draft of this paper.

LITERATURE CITED

BENNINGTON, S. L.; CONNORS, P. G.; CONNORS, C. W.; RISEBROUGH, R. W. 1975. Patterns of chlorinated hydrocarbon contamination in New Zealand sub-antarctic and coastal marine birds. Environmental Pollution 8: 135-147.

BELL, B. D.; BRATHWAITE, D. H. 1964. The birds of Great Barrier and Arid Islands. Notornis 10: 363-382.

BULLER, W. L. 1888. History of New Zealand Birds. 2nd ed. 1967, E. G. Turbott (Ed.). Whitcombe & Tombs.

DAWSON, E. W. 1957. Falcon in Chatham Islands. Notornis 7: 113.

FORBES, H. H. O. 1893. On the birds inhabiting the Chatham Islands. Ibis (6) 5: 521-546.

FOX, N. C. 1977. The biology of the New Zealand Falcon (**Falco novaeseelandiae** Gmelin 1788). Unpubl. Ph.D. thesis, University of Canterbury, Christchurch. 421 pp.

FOX, N. C.; LOCK, J. W. 1978. Organochlorine residues in New Zealand birds of prey. N.Z. Jour. Ecol. (in press).

FOX, N. C. 1978. The morphology of the New Zealand Falcon (**Falco novaeseelandiae** Gmelin, 1788) and the question of its polytypy. N.Z. Jour. Zool. (in press).

GALUSHIN, V. M. 1974. Synchronous fluctuations in populations of some raptors and their prey. Ibis 116 (2): 127-134.

GILL, B. J. 1976. New Zealand Falcons at Round Bush, Foxton. Notornis 23: 356-7.

GUTHRIE-SMITH, H. 1927. Birds of the Water, Wood and Waste. Whitcombe & Tombs.

HANDLY, J. W. 1895. Notes on some species of New Zealand birds. Trans. N.Z. Inst. 28: 360.

HICKEY, J. J. (Ed.). 1969. Peregrine Falcon populations, their biology and decline. Univ. Wisconsin Press.

McKENZIE, H. R. 1972. In search of birds in New Zealand. A. H. & A. W. Reed.

M'LEAN, J. C. 1911. Bush-birds of New Zealand. Emu 11: 1-17.

McLINTOCK, A. H. 1960. A descriptive atlas of New Zealand. Wellington: Govt. Printer.

OLIVER, W. R. B. 1955. New Zealand birds. A. H. & A. W. Reed.

POTTS, T. H. 1882. Out in the open. Christchurch: Lyttelton Times Co. 301 pp.

PRESTT, I.; BELL, A. A. 1966. An objective method in recording breeding distribution of common birds of prey in Britain . Bird Study 13: 227-283.

REISCHEK, A. 1882. Notes on zoological researches made on the Chicken Islands, East Coast of the North Island. Trans. N.Z. Inst. for 1881, 14: 274-277.

REISCHEK, A. 1887. Description of the Little Barrier or Hauturu Island, the birds which inhabit it, and the locality as a protection to them. Trans. N.Z. Inst. for 1886, 19: 181-184.

SCARLETT, R. J. 1955. Falcons in Chatham Islands. Notornis 6: 57.

SKEGG, P. D. G. 1964. Birds of the Hen and Chicken Islands. Notornis 11: 159-182.
STEAD, E. F. 1944. In Summarised Notes. Notornis 1: 76.
ST PAUL, R. 1977. A bushman's seventeen years of noting birds. Part F — notes on other native birds. Notornis 24: 65-74.
TURBOTT, E. G. (Ed.) 1967. Buller's Birds of New Zealand. Whitcombe & Tombs.
WARDS, I. 1975. New Zealand atlas. Wellington: Govt. Printer.
WATT, A. H. 1947. Birds of Parengarenga Harbour and farthest north. Notornis 2: 115-120.
WILKINSON, A. S.; WILKINSON, A. 1952. Kapiti Bird Sanctuary. Masterton Printing Co.
WILSON, R. 1959. Bird islands of New Zealand. Whitcombe & Tombs.

N. C. FOX, *Department of Zoology, University of Canterbury, Christchurch*

★

SHORT NOTE

UNUSUAL FLOCK OF FAIRY TERNS

On 11 May 1978, at Tapora on the eastern side of Kaipara Harbour, I was surprised to find a flock of small terns, 13 of which were Fairy Terns *(Sterna nereis)*. This is the first such flock to be recorded in New Zealand. With me were Richard Hooper from Warkworth, his wife and his son Peter, and my son Geoffrey. The terns were with other roosting birds on the northern end of a sandspit opposite the houses at the end of Beach Road, a piece of shore known locally as Bird's Beach. High tide was at 1210 hrs and we crossed to the spit by dinghy at 1300 hrs in fine, clear weather.

When first seen, the terns were roosting well spaced out in ones, twos and small groups on the sand. At our approach, they flew before we could see them clearly. Some went fishing while the rest flew down the beach. There were 25 small terns altogether. When we returned later, most of the terns were roosting again. After a quiet stalk, I examined them closely through 7 x 50 binoculars. Thirteen were Fairy Terns, one with a red band on its left leg. This was an adult female which had been banded at Mangawhai Spit on the east coast some 40 km away on 3 December 1977. The birds' bills were yellow right to the tip and the black patch on the crown extended only to about the eye. Also in the flock were eight Little Terns *(Sterna albifrons)*; one was in full breeding plumage, two were in the final stages of change into breeding plumage and five, with dark grey, almost black legs and bills, were probably immature. The four other terns seen earlier had not returned.

I am familiar with both these species, having studied the stray Fairy Tern and the Little Terns at Sulphur Point in Tauranga Harbour on many occasions.

From information given by G. J. H. Moon and B. D. Heather, it appears that 13 is the largest flock of Fairy Terns yet seen in New Zealand. Until now, it has not been known where these terns go from their breeding areas in Northland.

R. BRUCE GOFFIN, *133 13th Avenue, Tauranga*