

THE PUKEKO (*PORPHYRIO MELANOTUS*) IN NEW ZEALAND

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HISTORICAL

According to Maori tradition the Pukeko was brought here from Hawaiiiki, approximately twenty-four generations ago, in two canoes of the great Fleet — *Aotea* and *Horouta* — and was known as “pukeko” in the former and “pakura” in the latter (Buck 1949). Referring to *Aotea*, Best (1942) wrote that Pukekos “are said to be natives of Rangitahuna or Sunday Island, 600 miles from Auckland, and there is some evidence to show that *Aotea* tarried there awhile when coming hither to Aotearoa.”

Whether or not tradition be true, the Pukeko, like many other species now resident in New Zealand, almost certainly arrived here from Australia in comparatively recent times. Fleming (1961) wrote of it as a “young colonist,” while Falla (1953), commenting that the Pukeko is still taxonomically indistinguishable from the swamp-hen of eastern Australia, described it as a “non-endemic native” exhibiting “all the vigorous adaptability of a new migrant.”

Whatever its origins, that the species was already widely distributed in pre-European times is shown not only by reference in Maori lore but by place-names incorporating the word “pukeko” or one of its variants such as “pukaki” and “pakura,” e.g. Kai-pakura Swamp near Balfour translates “to eat swamp-hens” (Beattie 1919) and Pukeko-nui Swamp (nui = plentiful) in the Horowhenua dune belt (Adkin 1948). Indication of early wide dispersal also lies in archaeological occurrences of its bones. Trotter (1965) reported three finds in probable moa-hunter deposits (about 500 years old) at Ototara (South Canterbury), Timpendean (Weka Pass, North Canterbury) and Sumner (Christchurch); and one in a late Classic pa site (possibly 200 years old) in Auckland. Hutchinson (1897) found bones in an ancient undated midden at Wainui Beach (Gisborne).

The first European to record his observation of Pukekos was Sir Joseph Banks in 1769 or 1770. Subsequently Crozet (1772) noted “Blue Fowls” at the Bay of Islands and Yate (1835) briefly described their habitat and habits (Oliver 1955). Buller (1877) reported Pukekos abundant throughout the Rotorua-Taupo district especially at Rotomahana, where “several hundreds may be seen in a single flock” and in 1888 he wrote, “A favourite resort of this bird is the swamp at Te Aute.” He noted that at Tokaanu the Maoris annually snared thousands during June and July, the birds being then very fat. They were plentiful enough in many areas not only to be an important item of food, but also a nuisance in Maori cultivations. Best wrote of Maoris constructing light fences of reeds, etc., to protect crops from their depredations.

POPULATION CHANGES

Pre-European Pukekos lived in a comparatively stable environment, prospering in favourable habitats, forming large colonies in the extensive swamps of Waikato, Canterbury, Southland and Westland. They had few enemies apart from the Maoris, whose hunting was regulated by strict tribal laws which fostered conservation of all food species and appeared to have no deleterious effect on populations.

Even so, changes inevitably occurred. As Frauca (1967) observed of *Porphyrio melanotus* in eastern Australia, a flock may long remain stationary in an area provided the ecological balance is undisturbed, but pressure of increasing numbers would eventually force birds to move elsewhere.

The advent of European settlers brought widespread and rapid changes as a consequence of conversion of wilderness into farmland. Since then, drainage of thousands of acres of swampland has progressively modified and obliterated much Pukeko habitat. Fortunately the birds have proved themselves remarkably adaptable and, exploiting their new environment, flourish in many areas where land development has occurred.

Guthrie-Smith (1953) wrote of birds on his land in 1914, "The Pukeko has gained by every step in the development of the station — by the increase, in fact, of treadable surface. Hundreds run in swamps now drained dry, hundreds explore the hills; cropping, the anathema of many species, is a boon to the breed."

The Pukeko benefits from land settlement only as long as sufficient water and cover remain. Nests can be constructed on reedy margins of drains, and crops and pastures provide easier foraging than swamps. Further development of many areas has resulted in final obliteration of any remaining Pukeko habitat and disappearance of the birds. However, in recent years, the raising of lake levels, the construction of new lakes for hydro-electric purposes, and the increased development of farm ponds and dams has provided new wet areas, many of which support Pukekos.

Since records were first kept, there have been reported fluctuations in their numbers, distinct from seasonal flocking and dispersal and attributed to a variety of causes. Buller received at least three reports of rapid colonization of districts where Pukekos were previously almost unknown, namely Amuri (on the West Coast - Canterbury border) in 1861, Whangarei in 1865 and Lake Hawea at about the same time. Handley (1895) noted a decrease about Picton and Nelson; Kirk (1895) commented that a "marked diminution," following an earlier expansion, might be traced to destruction of eggs by rats; Fulton (1907) mourned, "The Pukeko . . . is fast going — his swamps extensively drained, his nests easily found," but he continued, "he is on the increase at Waimate, Streamlands and Waikaka Valley and is held as common at Ramarama, but elsewhere throughout the Islands he is very scarce." When Guthrie-Smith returned to Tutira in 1919 after an absence of five years, he found the Pukekos, which were abundant when he departed, now reduced to five pairs. There was no obvious cause: the swamp was unchanged; no poisoning or shooting had occurred; depredations by

weasels were unlikely and many other species of birds had increased. He suggested the possibility of emigration, the habitat of Tutira perhaps having become over-stocked. However, by 1962 Pukekos were again plentiful here.

Recently, a 1967 report from Cust, North Canterbury, noted a sudden increase in Pukeko numbers in swampy areas which coincided with markedly declining numbers in adjacent districts where wetlands had been extensively drained.

Although usually fairly sedentary, Pukekos are capable of making long and often arduous journeys, frequently flying high and at night. Douglas wrote in 1893 Pukekos "can cross the main ranges but many must perish on the journey as I have often found them dead on glacier and snowfield."

Unfortunately, banding returns are few. The sixteen most recent are as follows:—

<i>Banding Date</i>		<i>Recovery Date</i>		<i>Distance from Liberation Point</i>
Feb.	1967	May	1967	0 miles
Dec.	1966	April	1968	0 miles
Sept.	1960	May	1961	$\frac{1}{2}$ mile
June	1960	Sept.	1960	1 mile
Feb.	1963	June	1967	4 miles
Feb.	1967	—	1967	4 miles
July	1963	—	1967	4 miles
June	1960	May	1964	9 miles
Sept.	1966	June	1967	10 miles
June	1960	March	1961	15 miles
July	1967	May	1968	20 miles
July	1967	May	1968	31 miles
July	1967	May	1968	36 miles
July	1963	May	1968	46 miles
Feb.	1967	May	1967	105 miles
Feb.	1967	May	1967	112 miles

The last two birds had travelled from Lake Tuakitoto, one to Otiake, Upper Waitaki, the other to Waikakahi, north of the Waitaki River.

SHOOTERS AND OTHER PREDATORS

Although modification of habitat has undoubtedly effected great changes in Pukeko populations, depredations of predatory birds, mammals and shooters have also played a part.

Pukeko nests, constructed on the ground, are especially vulnerable to predation by, for example, rats. However, the extent to which predators influence Pukeko numbers is not known.

As for shooters, until 1900 Pukekos received no legal protection. Native game birds listed in the Animals Protection Act of 1867 excluded Pukekos. The Animals Protection Act of 1900 carried an amendment, "Every third year, commencing on the first day of April, 1901, shall be a close season in which the native pigeon, pukeko and kaka shall not be shot, taken or killed." The Animals Protection and Game Act, 1921-22, declared Pukekos an absolutely protected

species, but in 1923 they were again gazetted as native game and have been so ever since, with seasons at the discretion of the Minister. Before 1958 the daily bag limit varied considerably, there being no limit for several years in the Westland, West Coast, Wanganui, Taranaki, Stratford, Rotorua, Hawkes Bay, Gisborne - East Coast, Hawera and Otago acclimatization districts. In 1958 and subsequently daily bag limits have been imposed on all districts. From 1958-61 these were usually 15 birds. Since 1961 the limit has been reduced to a maximum of 10 per day. Shooters diaries for the 1968 season show 413 Pukekos killed on 75 licences. The total number of diaries so far received is 219, nine of these being from districts where Pukekos are at present protected. Thus the average number of Pukekos shot per diary returned is 1.9 for the season.

Where Pukekos are numerous enough to be a nuisance, residents may apply for, and usually receive, special permits to destroy, these permits being usually limited to a period of one month. Birds thus shot are relatively few. From 1955 to 1967 inclusive, 7,442 were shot on 328 special permits, an average of 22.7 birds per permit. The annual total of birds killed on these permits averaged 572.5, by far the greatest numbers being in South Auckland - Waikato and South Otago - Southland.

Illegal hunting also undoubtedly occurs but to what extent is naturally not known.

Probably shooting usually causes more concealment and dispersal than destruction of birds.

THE REASON FOR THE PRESENT INVESTIGATION

Where numerous, Pukekos frequently are regarded as pests — by farmers for raiding crops and pastures and by sportsmen for their alleged taking of duck eggs and ducklings. From time to time these people have sought the removal of protection from Pukekos, a move vigorously opposed by conservationists, who advocate complete protection as the only safeguard against final extinction. This conflict has caused the Department of Internal Affairs to make a study of the past and present status of Pukekos in New Zealand in the hope of assisting all interested bodies to reach agreement on the future management of the species.

MATERIAL

Material was gathered from all available sources: departmental records, books, journals, reports, letters, shooters' diaries and personal comments. Most was supplied by acclimatization societies, Field Officers of the Wildlife Service and members of the Royal Forest and Bird Protection Society and the Ornithological Society of New Zealand. During 1967 these groups conducted a Pukeko survey throughout the South Island and the resulting reports and bird counts are incorporated in this study.

All verified records that I have found of occurrences have been grouped geographically and arranged chronologically in an attempt to estimate overall trends in population changes. These data are in the possession of the Department of Internal Affairs and may be consulted on request. Their significance is restricted by several factors: the conflicting interests of observers, seasonal variation in flock size and unequal and discontinuous sampling.

With such a widespread and numerous species, no clearly defined result is possible. A project of this kind, however, may yield useful information from a study of locality records and especially valuable are authoritative reports on population trends in counties and districts.

The accompanying grid map shows, in very general terms only, estimated and reported occurrences of Pukekos since 1960. Sight records have been consistently received from most permanent wetland areas and those regions remaining blank roughly coincide with the main mountain systems, where little Pukeko habitat occurs. Some of the blank sectors in low-lying districts may indicate a dearth of observations rather than of Pukekos. Where discrepancies in reporting occurred, I have used my own judgement, based on the origins and numbers of the reports.

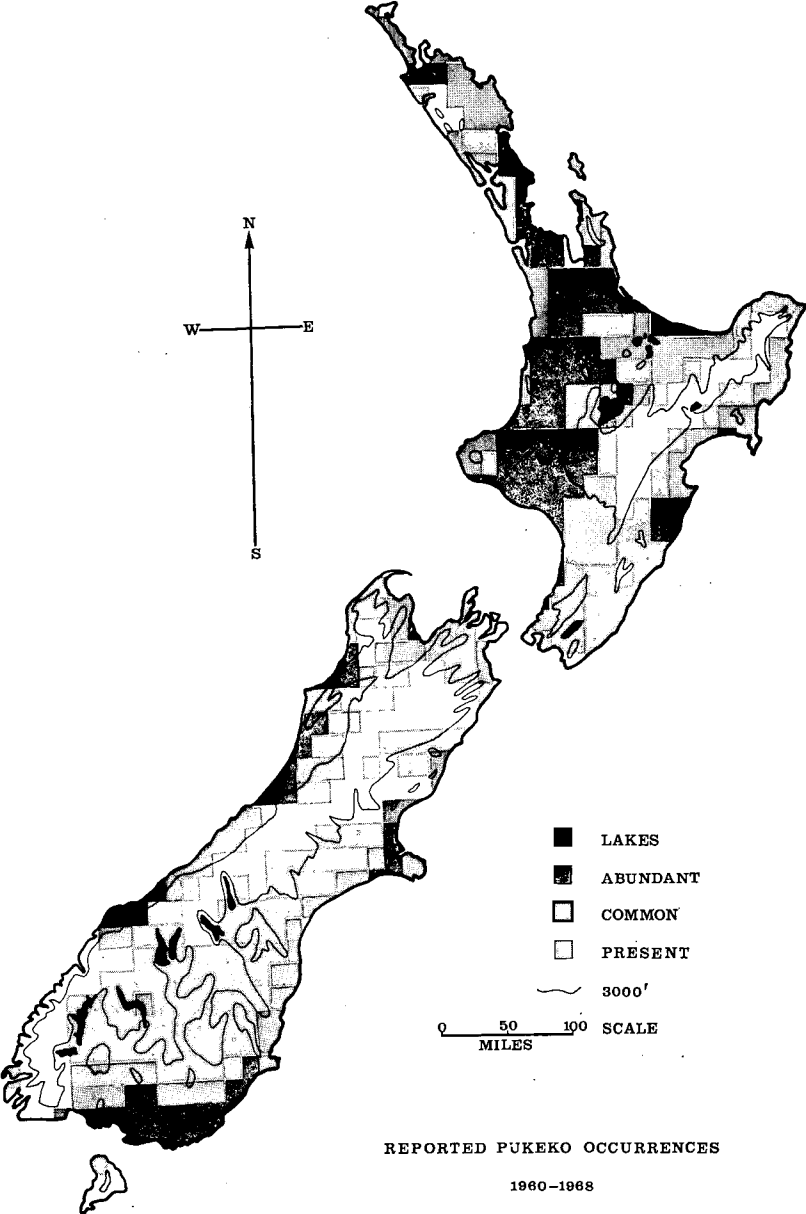
Use of a grid map was considered the best method of using incomplete material, despite the attendant risk of distortion through over-simplification. The New Zealand Zootopographic map has been used, its lines co-incident with those of the New Zealand National grid. Grids were halved longitudinally, making sectors 12.75 miles x 17 miles (216.75 sq. miles), thus allowing for the showing of more detail. Population densities were indicated by shading. The terms used were "abundant," "common" and "present," the last including all references which described the birds as scarce or present only or which gave no indication of numbers.

RESULTS

These are presented in order of districts from north to south. Although they roughly coincide with acclimatization society districts, there is deviation when another arrangement seems geographically more suitable.

North Auckland — Predominantly lowland, this district is characterized by shallow harbours and tidal estuaries backed by extensive wetlands which provide suitable habitat throughout almost the whole area. Earliest sightings of Pukekos in the far north were by Crozet (1772) at the Bay of Islands. I have found no further reports until 1896 when Pycroft described them as common. They have persisted until the present: Edgar (in litt) reported about 20 birds on his property at Kerikeri in 1968 and noted they were increasing.

At Whangarei, Captain Mair informed W. L. Buller (1865) that Pukekos, not seen during the fifteen years preceding 1865, appeared during that year and by 1877 were plentiful in many localities. Subsequent reports include comments on flock movements. At Mata, south of Whangarei Harbour, Sanderson reported they were unknown until 1937, when they arrived in numbers from the south and by 1940 were abundant. Conversely, plentiful and destroying maize at Parua Bay in 1907 (Fulton), Pukekos were very scarce by 1948. Birds remained numerous in the vicinity of Whangarei until the late 1940s, but by 1951 a closed season was requested because the population was then reported seriously depleted by shooting. However, entries in 1968 shooting diaries indicate that birds have again increased here almost to pest proportions. Saul (pers. comm.) confirmed this fluctuation in numbers, noting birds were scarce about Whangarei from 1949 to 1954 but once again very numerous by 1968. He observed no change in habitat during this period.



Further south, growing numbers were recorded (Fulton) in 1907 at Streamlands, near Warkworth. As late as 1964 they were plentiful enough to be described as a nuisance in Rodney County, despite the drainage here of at least 1800 acres of swamp during the past fifteen years.

The west-coast wetlands have long supported many Pukekos. They were reported abundant in Ahipara (1942), Hokianga (1946), Dargaville (1954-66) and Kaipara district (1956-63), although Robertson (pers. comm.) in June 1968 saw only one in extensive suitable habitat at Mapiu.

In the farthest north in 1946, well-established but restricted colonies occurred from Parengarenga Harbour to Spirits Bay. In 1961 Stead recorded their presence at many localities between Houhora, Kaitaia and Kawakawa; in 1965-66 he noted that they were common at Kao and Kaimaumau and present at Rarewa; in 1963 Ritchie observed them at Te Kao and in October 1966 he remarked on their absence from swamps around Parengarenga.

The North Auckland Acclimatization Society in 1939 reported Pukekos to be generally plentiful in all four of its districts. Despite subsequent extensive land development, large tracts of suitable habitat remain and birds still occur in most localities except perhaps in the west and central areas between Dargaville and Hokianga. They are present from Hokianga to Ahipara and in country south-west of Whangarei Harbour; they are common in most of the far north, in all eastern districts as far south as Whangarei and in country adjacent to Kaipara Harbour; they are also abundant from Kaitaia to Whangaroa Bay and from Whangarei to Warkworth.

Auckland — This district extends from Helensville south to the Waikato River mouth and east to Waihi. As almost the entire area, excepting the Coromandel Range, was originally swamp it is reasonable to assume it was occupied by Pukekos in pre-European times. Evidence for this is afforded by the discovery of bones in an archaeological site, possibly 200 years old, at Taylor's Hill, Auckland (Trotter).

Early written records are surprisingly few, the first of which I am aware was in 1907 when Fulton reported Pukekos as numerous at Ramarama. Reports made between 1930 and 1940 confirm their early abundance in many localities: thus for Tuakau 1937, "there are just as many Pukekos about now as ever" (Collins); at Papatoetoe 1940, "they were present until drainage of lake"; Colville 1939, Pukeko were "decreasing because of drainage, very few now" (Wood). H. R. McKenzie recorded the population of Clevedon as sparse from 1940 to 1952, with usually only a few small parties of birds and occasional chicks. After 1952, numbers rapidly increased and remained high at least until 1964.

Despite the reclamation in this district of approximately 35,000 acres of wetland during the past ten to fifteen years, the numbers of Pukeko appear generally undiminished. In 1962-63 a rapid expansion was reported at Clevedon, Waiuku and Whitford, and at Karaka they were breeding freely along ditches and drains. Applications from many areas for special shooting permits and reports from field officers and shooters confirm their continuing and widespread occurrence except in the far north-east of Coromandel Peninsula. Heaviest

concentrations of birds occur north, east and south of Waitemata and Manukau Harbours and across to the south coast of the Firth of Thames.

South Auckland-Waikato — This district extends from Te Kauwhata southward to Te Kuiti and from the west coast to the eastern mountain ranges and embraces the lower Waikato River system and other extensive wetlands which have long afforded excellent Pukeko habitat.

The earliest European to record Pukekos here was Percy Smith who, travelling through Onaio in 1858, wrote "we heard several in the cultivations, one of which A.S. [A. Standish] shot." Conversion of at least 74,000 acres of swamp into farmland during the past fifteen years has not significantly reduced the population, which remains generally dense. In some localities numbers were, at least until recently, expanding; for example at Te Poi (Matamata) in 1962 "Pukekos appear to have increased rapidly over the last two years." Entries in shooters' diaries for 1968 confirm this trend at Lake Waikare, Whangamarino, Te Awamutu, Arohena and Whakamaru where populations, already large, have increased since 1967.

Waimarino — Extending from Taumarunui to Koriniti, this district is bounded on the west by the Wanganui River and on the east by high country from Waiouru to Tongariro.

An Acclimatization Society report in 1944 stated, "Not more than a dozen birds have been seen in the Waimarino during the whole of the forty years of the Society's existence." A "Forest and Bird" note (August 1962) recorded that Pukekos came into the district about twenty years previously, appearing "almost overnight" and that they were by 1962 in most places, having apparently migrated from both north and south. Applications for special permits to shoot Pukekos were received from Karioi (1958-59) and Raetihi (1960), indicating their presence then in nuisance numbers. One shooter's diary for 1968 recorded Pukekos at Waiouru and Field Officers of the Wildlife Service have reported their presence in many localities.

Taranaki — Extending from Mokau in the north to Waitotara in the south, Taranaki except for the country surrounding Mt. Egmont, lies predominantly between sea-level and an altitude of 1000 ft. and contains extensive areas of Pukeko habitat. It is divided into three acclimatization society districts — Taranaki, Stratford and Hawera.

In 1938 the Stratford society reported Pukekos as common to plentiful throughout its district, and all subsequent reports show them to be remaining so. The Taranaki Society recorded a marked increase in populations generally during 1944-45 and reported, particularly at Uruti in 1946, that Pukekos had "increased to such an extent as to be in droves." Later reports showed them as plentiful in the New Plymouth-Inglewood area. The first report from the Hawera Society (1943) described Pukekos as abundant in the district. Subsequently many special shooting permits have been issued, indicating birds to be still numerous.

Entries in shooters' diaries for 1968 note that more birds were seen than in 1967 at Opunake, Inglewood, Okaiawa, Omata, Te Wera, Lake Ratapiko, Midhurst and Kiore but no change at Mata, Pukengahu and Mangamingi. They had become scarce at Eltham.

During the past fifteen years the only recorded large-scale drainage of wetland in the three districts has been of 1204 acres at Makuri. Excluding Mt. Egmont and its surrounding high country, the Taranaki area appears to support a large Pukeko population, with heaviest concentrations in the north, east and south.

Wanganui — This district encompasses the lower Wanganui River system. It extends from coastal plains in the south to an altitude of 2000 ft. in the north and contains vast wetland areas. Acclimatization society reports in 1943 and 1946 described Pukekos as common to plentiful and subsequent applications for special shooting permits implied their continuing abundance in most localities. In 1963 Macdonald reported them to be "generally abundant but less than five years ago." Entries in shooters' diaries for 1968 record stable populations at Wanganui and Lakes Kohata, Wiritoa and Paurie, and that there were more at Waverley Lake than in the previous year. Field Officers of the Wildlife Service report Pukekos to be numerous throughout the Wanganui district.

Manawatu - Wellington — That part of the Wellington Acclimatisation Society's district lying west of the main watershed, it extends from the Kaimanawa Range south to Wellington. Except for the northern and eastern high country, the area is predominantly alluvial plains which descend to a west-coast dune belt with extensive swamps and numerous small lakes.

Pukekos have long occurred here, the name of Kaipakura Swamp indicating their presence in Horowhenua during Maori times. Buller observed them in the Manawatu district in 1875-76, after which date they apparently continued to flourish, as from 1937 to 1942 they were reported plentiful from Bulls to Palmerston North and south through Foxton, Levin and Waikanae to Paekakariki (Andrews, Yerex, Hobbs et.al.). Later reports indicated birds to be prospering at Halcombe, Pohangina Valley, Linton, Rangitikei River, Manawatu Estuary, Otaki, Forest Lakes, Paekakariki and the north shore of Porirua Harbour despite drainage of approximately 14,000 acres of wetland between Bulls and Otaki. Further north, they were a nuisance at Ohingaiti in 1958 (Kersey) and in 1959 nineteen birds were shot there on special licence.

Elsewhere they have been reported less numerous. Fleming (1940) noted Pukekos to be very local in the Manawatu watershed. At Marton in 1941 they were "rare to very rare" (N.L.S.) and in 1962 they were apparently still not numerous as a request for a special shooting permit was refused.

In the vicinity of Wellington City, Edgar observed them at Fitzroy Bay (1960); at Wainuiomata they appeared in 1955 but only after floods (Wellington Acclimatisation Society report) and in 1963 "one seen in the past year or two" in the same area (Nelson).

Most recently, shooters' diaries for 1968 record increased populations at Utiku, Tangimoana, Oroua Downs, in the Horowhenua district and that they had "increased greatly, almost to pest proportions" at Foxton. The general picture in 1968 is of heavy concentrations in coastal places as far south as Paekakariki, and moderate elsewhere except in the far north and south of the district, where they are sparse.

Bay of Plenty — This area extends in a wide belt from Katikati to Cape Runaway. Predominantly low-lying, including mud flats, river estuaries and swampland, it almost certainly supported a large waterfowl population in pre-European times, as it still does now. Pukekos were described as plentiful throughout the district in 1937 (Rod and Gun Club). Further reports of their abundance came from Opotiki (Dickinson 1937-63), Whakatane to Opotiki (Phillipps and Lindsay 1948-50), Matata (Westerskov 1950), Tauranga (Hodgkins 1942-62) and Te Puke (Prior 1945).

Extensive land development during the past hundred years has drained thousands of acres of swamps and lagoons. This appears in some areas to have caused a redistribution or diminution of Pukeko colonies, especially in recent years, for example decreasing populations in swamps near Mt. Edgecumbe and from Pongakawa to Pukehina (1964); Vercoe reported from Tauranga (in litt. 1962) a decline in numbers which he attributed to excessive drainage, but in 1963 the Tauranga Acclimatisation Society noted "more now evident probably due to the wet season." A "Forest and Bird" correspondent wrote in 1963 of birds, once plentiful at Opotiki, becoming rare there although remaining plentiful in the Waiotaki Valley. Two reports in 1968 noted large populations at Te Teko and Te Puke. Shooters' diaries in 1968 have reported numbers unchanged at Te Teko, Onepu and Tarawera River and increased at Otakiri and Edgecumbe.

It is not possible to be certain whether the total population has diminished during the past century; however Pukekos are still common throughout most of the Bay of Plenty and especially numerous from Katikati to Whakatane.

Rotorua-Taupo — This is taken to be that part of the Rotorua Conservancy lying west of the main ranges, including most of the central volcanic plateau. It is traversed by the Upper Waikato River and contains many lakes and extensive swamps.

Despite considerable farming development in the past thirty years, much swampland remains. Raising the level of Lake Taupo and the formation of new hydro-electric storage lakes has provided extensive additional wet areas; however, these may not yet be as attractive to Pukekos as their traditional habitats.

Abundant in the lakes district in the pre-European times, Pukekos were noted by Percy Smith (1858) as very numerous at Lake Rotomahana; Buller (1877) reported similarly and added they were numerous also in the Tokaanu swamps.

Since 1939, records indicate the species to be consistently numerous in most localities. During 1962 Hall noted birds "in problem numbers" at Sulphur Pt., Ohau Channel, Hamurana and Reporoa, but Main (in litt.) reported very few left in the Taupo district, where they were previously plentiful. However, subsequent liberations of Pukekos have been successful and several new colonies are now flourishing. Shooters' diaries for 1968 have noted birds to be numerous at Waitahanui Swamp, increased at Tauranga-Taupo River, the same as in 1967 at Motuoapa.

At Kaingaroa (1940-48) Weeks reported them common in swamps adjoining, but absent from those within, the forest. Occasional single birds and small parties were noted along the Rangitaiki River

(Ryder 1950). A shooter's diary for 1968 recorded their presence from Galatea to Horomanga.

At present birds are known to occur in all but the eastern part of the district. They are sparse in forested country south and east of Rotorua, west of Lake Taupo and south of Turangi, but present on Rotoaira in 1968 (Sibson); common to numerous elsewhere, with heavy concentrations along the Waikato River and the southern margin of Lake Taupo.

Gisborne-East Coast — This district extends south from Cape Runaway to Mohaka. Lowland areas are confined to parts of the coast and broad valleys and alluvial plains, especially of the Waipuu, Waipaoa and Wairoa Rivers.

Wetlands north of Gisborne are isolated and generally limited, except for swamps between Ruatoria and Cape Runaway. The Wairoa area in early times provided extensive waterfowl habitat of which a considerable part remains, although it is progressively being diminished by silting and drainage. Since 1950, 10,000 acres have been drained here and more than 2,500 acres from Gisborne northward.

Pukeko reports from this district are few. Bones found in an ancient midden at Wainui Beach, Gisborne (Hutchinson 1897), probably originated from local birds although their transportation here by Maoris as prepared food cannot be discounted.

In 1947 a few birds were reported at Mahia Peninsula in swamps near the sea. Special shooting permits were requested from Waerenga-o-kuri (1956, 1957, 1958), Ruatoria (1961, 1966) and Tolaga Bay (1962). Thus birds were sufficiently numerous to be a nuisance, at least in these areas. In 1964 Blackburn noted "a general decrease through shooting" though in a few places they were flourishing. In others they were common — Rototahi Swamp, Lake Repongaere and Mangaheia. Wildlife Field Officers have reported populations moderate in 1968 in coastal areas, with heavy concentrations around Wairoa. Occasional birds were observed in the foothills country from Tolaga Bay to the Mohaka River but none elsewhere. Shooters' diaries for 1968 record increased numbers at Ruatoria and Tolaga Bay but a decrease at Matokitoki Valley, Gisborne.

Hawkes Bay — This district extends from the Mohaka River to Cape Turnagain. Although predominantly hilly to mountainous in the north and west, it includes extensive alluvial plains, especially south of Napier. In the past these afforded wetland habitat which supported many Pukekos.

In 1880 Guthrie-Smith noted them to be present at Tutira, although limited to marshland. After 1890 they increased their numbers and extended their range, remaining abundant until 1915. By 1919 they had almost disappeared but were again common to plentiful in 1962.

Birds were reported present at Petane in 1885 (Hamilton), Maraetotara in 1887 (Buller) and Napier in 1900 (Hutchinson).

Despite intensive agricultural development, considerable wetland remains and later observations have confirmed the continuing presence of Pukekos in many localities. Applications for special shooting permits from Tangoio (1961), Napier (1964), Haumoana-Clive (1959-66) and Hastings (1960-65) indicate abundance of birds at those times.

In Southern Hawkes Bay, Fleming (1939-40) noted that Pukekos were widely distributed and abundant. Subsequent drainage greatly reduced wetlands especially at Poukawa, Hatuma and Wanstead. In 1963 Russell reported Pukekos at Poukawa and Hatuma to be dying out following partial drainage of the lakes. Although this may be so, some colonies yet remain. Stable populations were reported from the Dannevirke-Waitahora area in 1963 and special shooting permits were requested from Porongahau (1962), Takapau (1961), Woodville (1961 and 1963) and Papatawa (1962).

Birds are at present reported common in lowlands from the Mohaka River to south of Hastings, numerous thence to Porongahau and Takapau, scattered elsewhere except in the western high country. It appears that, despite some local diminution or redistribution of populations, Pukekos are maintaining a satisfactory status in Hawkes Bay.

Wairarapa — Is for the purposes of this paper that part of the Wellington Acclimatisation Society's district east of the main ranges, having its northern boundary from Woodville to Cape Turnagain. Wetlands, although limited, occur throughout, especially in association with Lakes Wairarapa and Onoke at the Ruamahanga River mouth.

Reports from north of Masterton are few. In 1942 Pukekos were described as abundant locally at Konini (Wodzicki) and "once common but disappeared" at Mt. Bruce (Welch). At Mauriceville-Alfredton they were reported numerous in 1953, considerably diminished by 1963. Applications for special shooting permits, one from Mt. Bruce in 1960 and one from Pahiatua in 1967, indicated birds were then numerous. Shooters' diaries in 1968 recorded them to be abundant at Makakahi (Eketahuna), present at Ngaturi and Pahiatua but absent from Konini.

Mr. R. Stidolph of Masterton considers Pukeko populations have fallen by half here, since his first observations in 1921; and believes that this has been caused by drainage of wetlands and by shooting. He reported birds plentiful in Carter's Bush (1944), Waingawa (1950 and 1953), Taueru (1952), Lake Wairarapa (1942), Lake Onoke (1943) and Gladstone (1948). Recently, many small areas from Pahiatua to Masterton and at least 3000 acres of good waterfowl habitat in South Wairarapa have been drained. In April 1968 he wrote, "The distribution in the Wairarapa Valley from north of Masterton to Palliser Bay would be general in suitable areas, with the greatest population, naturally, around Wairarapa Lake. Moreover, they occur much more sparingly in odd pockets in the East Coast farm country." Wildlife Field Officers' reports confirm this, noting also scattered occurrences as far north as Pahiatua.

Nelson — This district extends from south of the Heaphy River mouth east to Havelock and from Tasman Bay to Lewis Pass. Predominantly mountainous, it descends northward to extensive plains and to a coast characterised by deep bays, swamps and tidal flats. Southward it encompasses the upper Buller River system and Lakes Rotoiti, Rotoroa and Daniells.

Reported by Handley (1895) as diminishing in the Nelson-Picton area, Pukekos still survive and, according to Alack (in litt.), in some localities were "staging a come-back" by 1964.

During 1952-53, M. Small surveyed Pukeko populations in coastal areas from West Wanganui Inlet to Croixelles Harbour and inland to Wakefield, Murchison and Lakes Rotoiti and Rotoroa. Although not seen in many areas of apparently suitable habitat, e.g., Parapara Inlet, Wainui Inlet, Rockville Dam and Kotinga Lagoons (Takaka), birds were generally present although nowhere plentiful. He reported large populations at Bird's Lagoon and Windles' Sanctuary (Takaka), Pederson's Sanctuary (Riwaka) and Pugh's Sanctuary (Brightwater).

In 1963-65 Pukekos were stated to be numerous at Kaiteriteri, very numerous at Totaranui, numerous and increasing at Matakiri, Puramahoe and Riwaka, but decreasing at Motueka.

The 1967 Pukeko survey conducted by D. Zumbach showed birds were still widespread and moderately numerous in coastal areas and river valleys from Whanganui Inlet to Cable Bay. Further south he found them to be numerous at Matakitaki, Mangles and Matiri Valleys and at Murchison and present at Lake Rotoroa, Tutaki, Owen, Glengarry and Maruia. Here, as in the north, Pukekos appear to be maintaining their numbers, although, because of the nature of the country, colonies are more scattered and local than in the coastal region.

West Coast - Westland — This district extends from Karamea to Martin's Bay, the crest of the Southern Alps forming its eastern boundary. Suitable Pukeko habitat occurs throughout the long coastal plains, also in the northern high country where river valleys and lakes provide restricted wet areas.

Early accounts indicate Pukekos were well established in many localities before European settlement. They were reported as present at Okarito in 1878 (Hamilton), common at Martin's Bay from 1876-81, Reefton from 1881-85 (Phillipps 1948), and Lake Brunner in 1888 (Smith). At Amuri the advent of Pukekos in 1861 was reported to Buller by Shrimpton, who noted their arrival "first in small parties then numerous," and that they were "previously a stranger." In 1893 Douglas wrote of snaring Pukekos, of how easily they were tamed and of their fear of hawks. Although he made no comments on distribution, it appears he found them commonplace. Thereafter, in Westland generally, they continued "common in suitable country" (Sibson 1940). This was confirmed by Bell (1947).

Since European settlement, much wetland has been drained, including approximately 10,000 acres in the past ten years. In all areas where correlation of drainage and population data was possible, Pukekos were found to be numerous or increasing. This is the expected consequence of initial land clearance and pasture development in a district still well supplied with water.

During 1953 M. Small conducted a Pukeko survey from Karamea to Okarito. He reported light populations scattered throughout the district although birds were not seen in many apparently suitable habitats, for example, about the lagoon and river mouth at Karamea, Lakes Haupiri and Mudgie, Arahura, Totara and Okarito Lagoons. He found them to be abundant at Omoto Sanctuary (Greymouth), Kaniere Lagoon, Saleyards Lagoon (Kokatahi) and Koiterangi.

Between 1953 and 1967 these populations appeared to be maintained except at Amuri, where birds were reported in 1959 by Harris and Northcote to be dying from disease, although their numbers subsequently regenerated considerably. During the 1967 survey approximately 12,300 Pukekos were counted from Karamea to Taramakau.

Applications for special shooting permits indicated that birds were numerous at Hokitika (1966-67), Kokatahi (1965), Kowhitirangi (1960), Harihari (1962), Whataroa (1960-63) and Tatara (1966). According to shooters' diaries populations were maintained in these localities in 1968, also at Reefton, Ikamatua, Te Kinga, Kumera Dam, Arahura Valley, Mahinapua Creek, Arawata Valley and Tatara. They had increased at Waitaha and Kokatahi Valleys, and diminished at Lake Brunner, Rotomanu and Orangipuku River.

From further south only two reports have been found referring to the period between 1881 and 1965 apart from the general comments of Douglas (1893): Mrs. P. L. Moore in 1945 recorded numerous Pukekos at Haast and in January 1954 Small found them absent from the Cook River Lagoon.

The 1967 survey found colonies scattered from Bruce Bay to Cascade Point. They were large and increasing in the vicinity of Haast township, Okuru and Cascade River; small but growing at Bruce Bay, Waitoto Swamp, Haast River System and Jackson River; small and apparently stable at Lakes Paringa, Rasselas and Moeraki, Maori Lakes, Dismal Swamp (Lake Nisson), and the lower and middle reaches of the Arawata River.

Throughout the West Coast region Pukekos appear to be maintaining their numbers, but local fluctuations follow land development and weather changes. Wildlife field officers have reported in 1968 especially heavy concentrations from Karamea to Westport, from Fox River to Waitaha River, from Greymouth to Inangahua, and from Haast to Cascade River.

Marlborough — This district, predominantly mountainous, descends in the north and east to alluvial valleys and lowlands of the Marlborough Sounds, the valleys of the Wairau River system and a coastal belt, low-lying and comparatively wide as far south as Waima, narrow thence to Clarence and expanding again at Kaikoura. Suitable Pukeko habitat occurs in all lowland areas, particularly in wetlands associated with the Sounds and lower reaches of the Wairau River.

Despite Handley's report in 1895 of rapid diminution of Nelson-Picton populations, Pukekos still survive in many places.

In 1947, within a ten mile radius of Blenheim, they were reported plentiful, increasing rapidly and becoming a pest. During 1952 M. Small surveyed lowlands from Pelorus River Estuary to Kaikoura. He found small numbers in the vicinity of Havelock except at the Kaituna River Estuary. He reported birds to be numerous at Picton Swamp, present to numerous in the Blenheim district, present at Tarndale Lakes (Upper Wairau). He found none at three dams near Dashwood Pass or Blind River (Seddon), although there were a few at Lake Grassmere and many at Blairich Swamp, Lakes Jasper and Elterwater. At Kaikoura they were present (Leg-o-mutton Lake) to numerous (Lizard Swamp).

There were few other reports until the 1967 survey which recorded Pukekos as not seen at Waikakaho Valley, Wairau Lagoons and Taylor River; present at D'Urville Island and the Sounds area, Opouri Valley, Onamalutu Valley, Langleydale and Redwood Pass; and numerous at Para Swamp (Tuamarina Valley). They were reported as having disappeared from Pukako Valley and Riverlands; decreased at Canvastown, Spring Creek and Blairich Swamp; "still a few" at Pelorus Valley and Marshlands; and "remaining numerous" at Lake Jasper, Lake Elterwater and Kaikoura.

It appears that few notable changes have occurred in Marlborough Pukeko numbers during the past twenty-five years.

Canterbury — Lying between the Waiau and Waitaki Rivers, this district extends eastward from the Southern Alps to the coast.

Pukekos have been present in Canterbury from pre-European times. Ancient occupancy is indicated by the occurrence of bones in moa-hunter deposits at Timpendean (Weka Pass) and Moa-bone Point Cave (Sumner), these being possibly five hundred years old.

In 1882 Potts recorded "189 shot in eight days in the Canterbury highlands . . . [the Pukeko] is no friend of the farmer." Reischek (1885) reported Pukeko depredations among young grain crops and that Canterbury farmers were offering rewards for their destruction.

Apart from general comments, North Canterbury records before 1967 were as follows: E. Roberts noted that by 1900 Pukekos had already disappeared from the head of the Greta Stream and from the Motunau Stream, being then found only between Scargill and the sea; Rentoul reported from St. Anne's Lagoon (Cheviot) that birds were plentiful from 1924 to 1944 "increasing enormously" between 1940 and 1943; at Waikari township "a few present" before 1960; K. Roberts reported at Scargill in 1962, "all Pukekos gone"; Hampton at Rotheram in 1962 reported "increasing again after almost disappearing"; and at Lake Sumner area in 1964 Bell reported Pukekos present.

Many thousands of acres of wetland have been drained and cleared in North Canterbury, especially during the past fifteen years. In 1967 the Royal Forest and Bird Protection Society reported a significant decline in populations from Cheviot to Rangiora, Eyre and Oxford, excepting at Cust where a sudden increase occurred in swamps, probably an influx of birds from nearby drained areas. They were not seen at Scargill. The report concluded, "we consider that there appears over-all to be no marked change of numbers during the past three years, but considerable movement of birds in some areas caused by land development schemes." One shooter's diary noted fewer birds at Waiau, Leithfield and Amberley in 1968 than in the previous year.

From Rangiora and Kaiapoi to Christchurch Pukekos have remained abundant with especially large populations recorded at Burwood in 1967.

The country between Christchurch and Lake Coleridge has long supported a large number. In 1967 the Royal Forest and Bird Protection Society noted an expansion of colonies there, which they attributed to migration from nearby drained areas. Fluctuations at Lake Coleridge were also noted. These were thought to be caused

by unusually cold weather during which many of the birds died, their numbers increasing again during the following seasons.

In the vicinity of Lake Ellesmere this Society noted during the past thirty years a marked decline at Halswell, Ladbroke, Lincoln and Ahuriri. Considerable increases were recently observed west and south of Lake Ellesmere. Some permanent movement of birds away from the lake has been claimed and this is ascribed by the Society to changes caused by drainage of approximately 1340 acres of wetland.

Nevertheless, Pukekos remain abundant about Lake Ellesmere, except near the Ellesmere-Lyttleton road, where in 1961 Nelson reported that they had become scarce. During the 1967 survey a total of 3,600 birds was counted at Kaituna, Greenpark, Doyleston, Lakeside, Sedgemere and Taumutu.

Ashburton County reports note a declining population especially in the foothills district near Mayfield and Mt. Somers. However, applications for special shooting permits from Wakanui (1963) and Ashburton (1964, 1966, 1967) indicate the recent presence of birds in nuisance numbers in some localities.

An early report from Fulton (1907) noted Pukekos to be increasing at Waimate and in South Canterbury. They have generally remained numerous despite extensive drainage of wetlands from Clendeboye to Timaru and near Fairlie. However, local variations in populations have occurred; for example, the Forest and Bird Society reported in 1967 that birds had become scarce at Geraldine and had disappeared from Albury, Cave and Hook. In 1967 the South Canterbury Acclimatisation Society reported the presence of Pukekos on all river systems in its district, stating, "where habitat is suitable, reasonable numbers of Pukekos exist. Small isolated groups are scattered over most of the district and any wet areas have one or two birds in the vicinity. Birds can be seen as far back as Lake Alexandrina and Godley Peaks Station."

In 1968 Wildlife Field Officers reported them to be especially abundant from Milford to Timaru, at Wainono Lagoon, and in the lower Waitaki and Hakataramea Valleys.

Otago — This district extends between the Waitaki and Mataura Rivers and from the Southern Alps to the sea.

In North Otago suitable Pukeko habitat occurs along river valleys and coastal lowlands. Central Otago, although semi-arid, includes scattered wetland areas which support numerous colonies. South Otago, predominantly lowland with many lakes and swamps, provides habitat for large, widespread populations.

Pukekos apparently have been long resident in Otago. At Ototara (Teschemakers) bones were found in a moa-hunter midden approximately 500 years old (Trotter). Presumably the birds were of local origin although they may have been carried as food from elsewhere. Gray (1844) wrote, "at Mataineka, South Island, says Mr. P. Earl, it is named Pakura. In the summer months these birds are found in the fresh-water lagoons near the sea." Possibly this referred to a locality between Shag River and Waitaki, the territory in which he made his observations. Tily (1946) reported Pukekos as "quite common at least since 1870" at Long Beach (north of Dunedin), and Douglas (1893) noted they were becoming a nuisance in parts of Otago and Southland.

Subsequent reports showed birds had remained abundant throughout most of the district. However, the Royal Forest and Bird Protection Society (1967) reported a drastic decline in North Otago populations after 1962, attributable probably to recent drainage schemes, droughts and an "invasion of magpies." Even so, birds were still reported as present or numerous at Duntroon, in the coastal belt from Oamaru to Dunedin, and abundant enough to be a pest in the valleys of the Upper Taieri River system. A shooter's diary recorded increased populations in coastal areas near the Waitaki River in 1968.

The Forest and Bird Society recorded a decline in Central Otago Pukekos, thought to be caused by land development, stock damage and drought. However, in 1964 they were generally common in wetlands and lower reaches of alpine valleys and in 1967 were noted as numerous at Matakanui and Ida Valley, common from Moa Creek to Poolburn and present from Alexandra to Galloway.

In South Otago numerous reports since 1940 have indicated Pukekos to be remaining abundant despite considerable land development and shooting pressure. Between 1960 and 1962 several Pukeko drives were conducted: at Ranfurly (15/7/60 - 15/8/60) 950 were shot, at Mosgiel (17/2/61 - 4/7/62) 98 were shot and at East Taieri (22/8/62 - 22/9/62) 400 were shot.

During 1967 both the Forest and Bird and Acclimatisation Societies reported extremely large populations in most areas. Several localities in which Richdale reported small population in 1940 showed a marked increase in numbers by 1960 - 67, e.g., Dunedin, Taieri Plains, Lake Waiholo and Balclutha-Otanomo. The Forest and Bird Society noted a decline at Owaka in 1967, although Acclimatisation Society reports claimed that thousands were still present in the Owaka-Catlins area.

The 1967 survey of South Otago showed Pukekos abundant in the coastal belt from Dunedin to Fortrose especially from Berwick to Clarendon, at Lake Tuakitoto, Clutha River estuary and Catlins. Large numbers were also reported in valleys and plains associated with the Clutha and Mataura River systems.

In Otago generally, except for some local recessions in the north and west, Pukekos appear to be flourishing, with densest populations in lowlands from Dunedin to the Mataura River.

Southland — Like South Otago, this district is predominantly alluvial lowland, rising to high country in the north and west. It contains extensive wetlands including the great Awarua Swamp, which lies along the south coast between the Mataura and Oreti estuaries.

Pukekos have long been resident in this territory. Pre-European occurrence at Balfour is indicated by Maori naming of nearby Kaipakura Swamp. In 1870 birds were numerous enough to be snared for food by Maoris at Menzies Ferry (Beattie 1919). Later, Douglas (1893) found them increasing with civilisation and in places becoming a nuisance.

Their widespread distribution was indicated by scattered reports from 1937-40. Matheson recorded Pukekos as present at Pyramid, Castle Rock, Gore and Waikoura and numerous at Riversdale, Five Rivers, Otautau and Dipton. In 1948 they were present at Balfour

Swamp (Dunedin Field Naturalists Club) and, during May and June 1964, 415 birds were shot on special licence in the vicinity of Invercargill.

In 1967 the Southland Acclimatisation Society reported that the effects of extensive land drainage in the Lorneville area, although partly counteracted by establishment of new ponds, had greatly reduced Pukeko numbers there in recent years. Remaining colonies, although now scattered, appeared still capable of maintaining themselves, despite increased pressure during the shooting season. The Society's report continued that birds were recently numerous at Wallacetown Refuge, Oporo, Lakes Murihiku and Hawkins, with a fair population at Awarua Bay.

European settlement and land development in Southland resulted in extensive early drainage of wetland, e.g., thousands of acres in the upper Waimea Valley by 1900. Drainage schemes both large and small have continued to the present time and during the past twenty years more than 22,000 acres have been affected. Nevertheless, ample Pukeko habitat still remains. Wildlife Field Officers report birds generally present, with heavy concentrations on the plains between the Maitua Valley and Te Waewae Bay, and there appears little likelihood of the species becoming rare in this part of New Zealand.

Southern Lakes District — This extends south from Haast Pass to Te Waewae Bay. Its western boundary skirts the crests of the Southern Alps, turns westward at Mt. Aspiring and meets the coast at Martin's Bay. Although mainly mountainous, it contains considerable areas of Pukeko habitat in glacial and river valleys, lake margins and a narrow, discontinuous coastal strip. The earliest reference I have been able to find to Pukekos here is by Shrimpton to Buller (about 1861) noting that at Lake Hawea "they appeared first in small parties and then in considerable force, the bird having been previously quite a stranger to that part of the country. The increase was too rapid to have been the result of natural breeding and must have been occasioned by a sudden migration from the swamps near the coast." Thereafter Pukekos persisted in the area, being reported plentiful near Wanaka in 1907 (Fulton) and present in 1967 (Wright). Two shooters' diaries for 1968 record their presence at Glendhu Lagoon and Cattle Flat.

In 1946 Sinclair described Pukekos as common throughout the Southern Lakes district. At Lake Hayes they were reported plentiful long before 1941 and until 1967 (Yerex, Price et al.). In 1953 Condon recorded their presence in Eglinton Valley, Kakapo Swamp (Te Anau) and Horseshoe Bend (Waiau River) and in 1964 one was seen at Doubtful Sound (Dorizac per Mrs. M. Barlow).

During the 1967 survey, populations were found, apparently stable but sparse, at Lower Cardrona, Lower Motutapu River Flats, Scaife's Lagoon, Geordie Hill Station (Lindis Valley) and on the Clutha Islands between Lindis and Lowburn; they were in moderate numbers in swamps and river valleys west and south of Lake Te Anau; stable and moderate in the Matukituki River Valley (Wanaka) and numerous in places around Lake Wakatipu. In Makarora Valley no Pukekos were seen until two years ago and the population is now estimated to be seven birds.

In the Southern Lakes district generally it appears that a reasonably stable Pukeko population persists, with moderate numbers in most suitable territory.

Islands

Pukekos have been reported on many inshore islands with established populations at Stewart, Great Barrier, Great Mercury, Ponui and Waiheke Islands and stragglers at Kapiti, Little Barrier, Three Kings, Fanal and Mayor Islands. Merton (pers. comm.) recorded none seen during his visits to Fanal and Mayor Islands in September 1965. Birds are reported as increasing rapidly within the last few years at Great Barrier, Mercury and Ponui Islands.

They occur also on many outlying islands. In the Kermadec group one or more Pukekos were recorded as early as 1887 and in 1967 Merton reported a few at the crater and at Denham Bay swamp on Raoul Island, but none from other islands of this group, which, in any event, are unsuitable habitat. Stragglers have appeared at Campbell Island (Westerskov 1960). In the Chathams, a few were seen at Pitt Island and Bell noted in 1961 an established population throughout the main island except on the southern tableland, but he commented that birds were nowhere numerous by New Zealand standards. In September 1968 Pukekos were reported to be "fairly numerous" in swampy creeks on Pitt Island, especially in the vicinity of Tupurangi Lagoon. Scattered groups were also present on the main island but birds were less abundant than on Pitt Island. The total population appeared to be greater than in 1961 (Bell, pers. comm.).

SUMMARY AND CONCLUSION

Although comparatively recent migrants to New Zealand, Pukekos had achieved a wide distribution before European settlement. Primarily swamp-dwellers, they are adaptable and have survived, even exploited, changes in their environment as long as adequate water remains.

This study has not revealed any general trends in Pukeko population changes, the picture being rather one of local fluctuations. Much original habitat has been obliterated or modified by drainage but new wetlands are being formed by development of hydro-electric storage areas and, less importantly, by construction of farm dams. It appears that dehydration of habitat, either by drought or drainage, is the prime factor causing Pukeko movement from an area. Birds are known to leave localities when conditions become unfavourable and to return when they improve.

Classified as native game, Pukekos are exposed to hunting during the shooting season and may also be shot on special permit at other times when proved or alleged to be a pest to farmers and sportsmen. Shooting, apart from thinning of populations in concentrated drives, usually appears to cause harassment and subsequent seeking after concealment rather than a departure of the birds.

At present Pukeko occur in most parts of the country that are wetlands or well-watered farmlands. They rarely live at high altitudes and are most abundant from 1200 feet to sea level. In the North Island, the greatest concentrations of birds occur from Whangarei, through Auckland, Waikato, Taranaki, Wanganui and Horowhenua districts, with aggregations also at Kaitia, western Bay

of Plenty, Wairoa and central Hawkes Bay. In the South Island, heaviest populations are on the West Coast, in south Otago and Southland and also near Nelson, north of Christchurch and in the Lake Ellesmere area.

Although subject to a certain amount of redistribution, the Pukeko population of New Zealand appears generally to be prospering. Protection is warranted where local recessions occur, but the species as a whole seems well able to maintain its satisfactory status providing suitable habitat is available.

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