THE SPOTLESS CRAKE (*Porzana tabuensis*) ON AORANGI, POOR KNIGHTS ISLANDS

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ABSTRACT

Fewer than 50 adult Spotless Crakes plus 24 chicks and four juveniles were found on Aorangi in February and March 1980. They were confined to the valley and preferred a low mixed forest which is being replaced by a less favoured habitat. Habitat preference is discussed and related to changes in numbers in the past. Clutch size is lower than on the mainland and chick production probably lower. The breeding cycle is long. Some observations on the adult-chick relationship are presented.

INTRODUCTION

I was on Aorangi, Poor Knights Islands, from 19 February to 9 March 1980. The Poor Knights are a group of about 23 islands and stacks lying in subtropical water 20 km off the east coast of Northland, near the edge of the continental shelf. The rock is rhyolitic breccia of Miocene age. The region has a high annual mean temperature of over 13 °C, with a summer mean of 20 °C, varying by only a few degrees. Rainfall is probably similar to that of the Mokohinau Islands which have a mean rainfall of 1000 mm (Whitaker 1968).

The two main islands, Aorangi and Tawhiti Rahi, were intensively cultivated by Maoris until 1823, when intertribal war resulted in depopulation. The only introduced mammals were pigs, present on Aorangi until their extermination in 1936.

Aorangi consists of a broad north-south running valley in the northern part, bounded by steep cliffs to the west and a sharp peak to the east. The southern part of the island rises to the highest point, Oneho Hill, in broad complex ridges. Figure 1 shows the main peaks and ridges.

Most of Aorangi is now covered in forest and the approximate distribution of the main types is shown in Figure 1. The following description of the main forest types is based on work done by G. N. Park and is supplemented by my own notes.

Mixed low forest

A low, 3-4 m high canopy is dominated by tawapou, *Coprosma macrocarpa* and *Myrsine divaricata*, forming together 60-80% of the canopy cover. *Carmichaelia* forms up to 10% of the canopy with mahoe occasionally as important. Kohekohe forms 15-20% of the canopy in places. *Macropiper excelsum* is an important understorey

element. The slopes are gentle and the ground is sparsely vegetated and has thick litter and occasional boulders. The canopy is often broken and the probability of whau gap development is high. A whau gap forms when a windfall opens the canopy; whau grows rapidly to fill the gap temporarily. These open places have a thick ground cover of bush grasses and frequent whau to 3 metres and kohekohe, flax, *Carmichaelia, Macropiper excelsum* and *Myrsine divaricata* occurring in varying amounts to 1 metre high.

Karo-dominated mixed low forest

The canopy is low, 4-5 m, with karo forming about 50% and tawapou, *Coprosma macrocarpa* and mahoe forming another 20% of the canopy cover. Overall the ground surface is steep but flat terraced areas are frequent at the old pa site near Urupa Point. Litter accumulation is thick on flat terraces only, with scree on steeper slopes. *Macropiper excelsum* is frequent in the understorey and some supplejack thickets occur.

Tall tawapou-kohekohe forest

Tawapou forms 20-60% of the canopy and kohekohe 15-30%. Large pohutukawa trees form up to 20% of the canopy in some places, especially just west of Tatua Peak. Canopy height is 6-14 m. Kohekohe. tawapou, karaka, *Coprosma macrocarpa, Myrsine divaricata,* mahoe and pigeonwood are the main subcanopy species. Lower levels are generally open, although *Macropiper excelsum* and supplejack form thickets. The ground is open, the litter cover is thick, and slopes are moderate or gentle. The probability of whau gap development is medium. The ground in these gaps is strewn with dead wood, covered with bush grass, a *Polygonum* species, thistles and nightshade. Whau up to 7 metres high is present with, frequently, a thick growth of *Myrsine divaricata, Coprosma macrocarpa* and mahoe up to 1.5 metres. There is often a fringe of thick *Macropiper excelsum* and supplejack.

Pohutukawa (Broadleaf) forest

The canopy is almost exclusively pohutukawa (over 90%) at heights up to 12 m. Mahoe and *Coprosma macrocarpa* are important elements in the subcanopy (up to 20% each), while the understorey and ground layers are rather sparse. Slopes are steep. Litter accumulation varies considerably. The probability of whau gap development is very low.

Kanuka-pohutukawa forest

Kanuka forms over 50% of the canopy and pohutukawa about 40%. Canopy height decreases towards the summit of Oneho Hill. Pohutukawa is important in the subcanopy (c. 15%) along with *Myrsine divaricata* and *Coprosma macrocarpa* (c. 20% each) away from the summit. The shrub layer is 0.5-1.5 metres high and thick. The ground, in contrast to other forest types, is thickly covered with

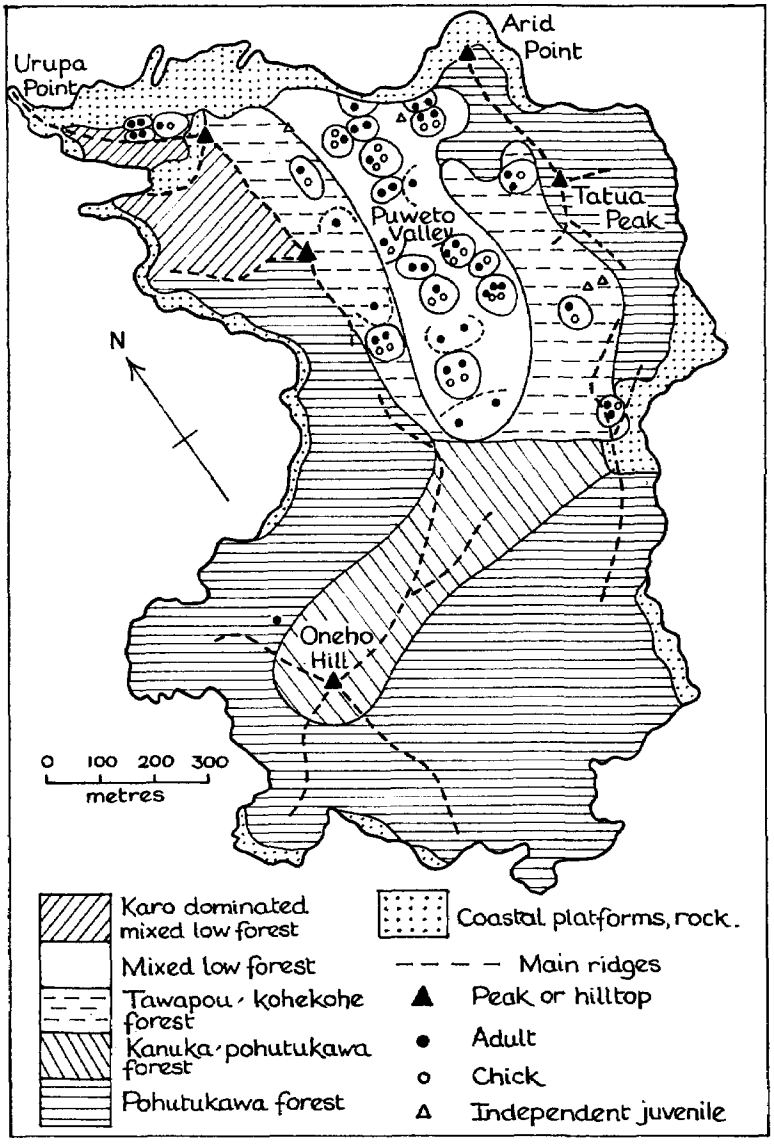

FIGURE 1 — Distribution and territories of the Spotless Crake on Aorangi, Poor Knights, February-March 1980.

Blechnum capense, dead kanuka, *Metrosideros perforata* and mosses near the summit and on southern slopes. Litter accumulation is noticeably less than in other forest types. The probability of whau gap development is medium to high only on the lower slopes where the kanuka is large and old.

CENSUS METHODS

I covered the island several times during our visit and plotted, as accurately as possible in the thick bush, the position of all crakes that were seen or heard. I could soon recognise family groups by the size and number of young and other birds by leg colour (which varied from dull brownish orange to bright orange-red) and behaviour. Adults, chicks and immatures could be distinguished in the field. The positions of the birds are shown in Figure 1.

Approximate territory boundaries are shown in Figure 1. The solid lines show well-defined territories where the birds could be individually recognised, occurred regularly, and showed territorial defence where territories adjoined. Dotted lines show territory boundaries that were not completely mapped because the birds were difficult to recognise as individuals or were only infrequently seen.

RESULTS

I recorded a total of 44 adults, 4 independent juveniles and 24 dependent young. Figure 1 shows 22 definite and 5 possible territories.

Territories were occupied by several combinations of birds (Table 1).

TABLE 1 — Composition of Spotless Crake groups occupying territories on Aorangi (excluding territories that were possible only)

	Number of territories
2 adults with young	6
1 adult with young	8
3 adults with young	1
2 adults	6
1 adult	1

I cannot claim a complete precise census, mainly because of the difficulty of finding my position in the thick bush and the lack of a good large-scale map, but I would be surprised if there were more than 50 or less than 40 adult birds on the island. Young were more easily counted as they usually all appeared after 5 or 10 minutes' quiet waiting and the behaviour of adults with young was distinctive. Independent juveniles did not call and often remained well hidden until the last moment (before the boot descended), and so the number of juveniles may well be an underestimate.

DISTRIBUTION AND HABITAT PREFERENCES

During our visit Spotless Crakes were found in Puweto Valley, apart from three territories near Urupa Point and a single record of a bird seen west of Oneho Hill (Fig. 1).

Within the valley crakes were most numerous in mixed low forest and less so in tawapou-kohekohe forest. Those at Urupa Point occurred in karo-dominant mixed low forest, but none occurred in a similar forest west of the valley cliffs. Apart from one record, no crakes were seen in pohutukawa (broadleaf) forest or kanuka-pohutukawa forest. Table 2 shows the numbers of adults and definite territories recorded in each vegetation type.

Territories were closer together in mixed low forest than in tawapou-kohekohe forest and closely packed in the small part of the karo forest occupied. Territorial disputes were observed in 15 of 17 territories in mixed low forest, in all three in karo-dominated forest, and in none of the six in tawapou-kohekohe forest.

TABLE 2 — Number of adults and definite territories in each vegetation type on Aorangi

	No. adults	% total adults	No. territories	% total territories
Mixed low forest	28	64	14	64
Tawapou-kohekohe forest	10	23	5	23
Karo, mixed low forest	5	11	3	13
Pohutukawa (broadleaf) forest	1	2	0	0
Kanuka-pohutukawa forest	0	0	0	0
Totals	44	100	22	100

DISCUSSION

Habitat preferences

Buddle (1941 and 1951) observed that Spotless Crakes ate " worms, spiders, beetles and insect larvae " from the litter on the forest floor. All my feeding observations were of birds turning over litter in search of such prey. The preference for the valley floor forests may be due to the quality and quantity of litter under these forests and the food therein. Litter derived from a canopy of 90% pohutukawa and 50% kanuka-pohutukawa will certainly be different from that of the valley forests and may have a different or scarcer invertebrate fauna. The kanuka-pohutukawa forest of the Oneho Hill area has a thick ground cover of *Blechnum capense,* poor litter

accumulation and extensive areas of mosses, all of which suggest that ground litter foraging would be less successful than in the valley floor.

Within the valley crakes favoured flatter areas, especially those near the stream, along Maori terrace edges and on the wide shoulders of small ridges. Those territories in karo-dominated forest near Urupa Point, although on an overall steep slope, included areas of flatter Maori terracing. Litter accumulation is generally higher on flatter sites and the mobility of litter on steep slopes prevents the build-up of high invertebrate numbers.

All but four of the territories included some thick low cover, even if only a few metres square, consisting of bush grasses, a *Polygonum* species and introduced plants over dead fallen trees. This low cover was invariably associated with whau gaps. Crakes were most numerous in areas where whau gap development was most extensive (mixed low forest), less numerous where whau gap development was medium (tawapou-kohekohe forest) and absent where gap development was low (pohutukawa forest). The only place where whau gap development was medium to high and crakes were absent was tall kanuka-pohutukawa forest on the lower slopes of Oneho Hill.

Buddle (1941 and 1951) mentioned the association of nesting crakes with bush grass. During my visit adults with small young were found near or in thick ground cover. So although they forage in the open, some thick cover in the territory is usually required for nesting. Possible predators of eggs and young on Aorangi are tuataras, harriers and kingfishers. (I have seen both harriers and kingfishers taking small Pukeko chicks on the mainland.) Roy Bell (unpubl. ms. Diary 1908-1911) noted that Spotless Crakes on Raoul Island preferred to nest in swampy areas, emerging to drier open habitats after the young had hatched. He suggested this may be a response to predation by rats. On mainland New Zealand, where there are yet more predators, crakes are always associated with thick marshy cover. With increasing predator pressure there seems to be an increasing trend for crakes to live in areas of thick cover.

Changes in crake numbers on Aorangi

The first mention of Spotless Crakes on Aorangi was by Hamilton (1925), who in 1924 saw one bird, which suggests that numbers were low. Not until December 1938 was any estimate of numbers attempted, when Fleming (1941) estimated 12 pairs on Aorangi. He and his party, which included Buddle, camped on the southern part of the island and visited Puweto Valley and the northern coast only once, and so actual numbers could well have been higher (Fleming, pers. comm.). Two years later, in November 1940, Buddle (1941) found crakes well distributed over the greater part of the island (he mentions nests in sedges at high altitude) with the highest concentrations being near the saddle and throughout the valley. He estimated 100 pairs and said that " the evident increase in the numbers of the Crake was

hardly believable." Although it is apparent that crakes were increasing rapidly at this time and had an extensive range on the island, the evidence for an increase from 12 to 100 pairs cannot be taken literally. Although Chambers (1955) mentioned six pairs and Kinsky & Sibson (1959) " quickly located " six pairs in January 1956, both these visits were short and not designed to count crakes, and so actual numbers were certainly higher. Bartle (pers. comm.) estimated that numbers were constant between December 1963 and January 1978 at about 16 pairs. My estimate of 22 territories would seem to be in line with Bartle's estimates for the 1960s and 1970s, suggesting that little change has taken place in recent years.

Briefly; numbers appeared to be low in the 1920s, with a rapid increase in the late 1930s to very high numbers in 1940. By the mid-1950s, numbers had probably fallen to a level that remained throughout the 1960s and 1970s.

Rapid and extensive habitat changes have taken place on Aorangi since Maori occupation ceased. In 1823 most of the island was clear and all forest trees are post-Maori except for scattered large pohutukawas and a group of puriris and associated trees under the valley cliffs (G. N. Park, pers. comm.). When the Maoris left, pigs remained, ranging freely over the island and restricting regeneration, although low mixed forest, pohutukawa forest and kanuka forest probably grew slowly. Hamilton visited the island during this stage, noting only one crake. Pigs not only restricted regeneration of low mixed forest but prevented, by constantly digging and turning over the ground, the accumulation of litter and build-up of invertebrates, destroyed low nesting cover and probably directly interfered with nesting crakes. After the pigs were removed in 1936, a low mixed forest developed throughout the valley, favouring the rapid increase in crake numbers suggested by Buddle 4 years after the extermination. Buddle's reason for the large increase in crake numbers was that the birds favoured the extensive bush grass that grew after the pigs were exterminated. The ill effects of pigs on the crakes had been more on their favoured habitat and litter feeding than on their nesting habitat.

The low mixed forest is gradually being replaced by tawapou-kohekohe forest, and the decline in crake numbers by the 1950s might be attributed to the reduction in their favoured habitat. This replacement is expected to continue and crake numbers can be expected to decline in the future. A further increase in Buller's Shearwaters, which have doubled since 1964 (Bartle, pers. comm.), may also affect the crakes as their digging disperses much of the leaf litter.

BREEDING

This section brings together notes from my visit to Aorangi on breeding and behaviour of crakes and such scattered references as I could find in the National Museum, Wellington.

Territory

During our visit the breeding season was well advanced, with newly hatched to independent young present.

Birds with and without young were strongly territorial. Boundary disputes consisted of one bird calling a short sharp trill preceded by a low quiet *ooh ooh ooh*. The non-calling bird left, often rapidly, and there was no pursuit. Occasionally the *ooh ooh* noise was enough to deter another bird, and several times a crake that had moved into a territory occupied by a bird with young would rapidly depart when the territory holder approached without any aggressive behaviour. It seems likely that boundaries between territories were well known and well defined because boundary disputes of any intensity were unusual during our visit, being most frequent in the densely populated areas near the stream. Territorial calls are apparently more common earlier in the season, and chasing is frequent (Bartle, pers. comm.).

Territory size could be estimated only in the area near the stream, where boundaries between pairs abutted and the smallest territory was 45 x 50 metres, but birds ranged more widely in the tawapou-kohekohe forest. Birds with small young were closely associated with small areas of low, thick cover, often not moving more than 10 metres. Bryant & Amos (1949) estimated that territory size near Melbourne, Australia, was as small as 50 sq. ft. (c. 5 m^2). Hadden (1970) at Waingaro, New Zealand, estimated the cover in the nesting territory to be no more than 12 yards square (c. 120 m^2), although some open land might also be used. These areas of cover are comparable to areas of thick ground cover within the territories on Aorangi.

TABLE 3 — Frequency of different clutch sizes in New Zealand and Australia

Location	Number of Eggs in Clutch					Average Clutch	Reference
	2	3	4	5	6		
Aorangi	9	11				2.55	Buddle (1941) Fleming (1941) Harper (pers. comm.)
Kermadec Islands	6	9	2			2.76	R. Bell (1908-1911)
Mainland New Zealand	1	5	1	1		3.25	Hadden (1970) Fraser (1972) O.S.N.Z. nest records
Australia and Tasmania		14	8	1	1	3.54	Bryant and Amos (1949) Fletcher (1914)

Breeding season

On Aorangi, Buddle (1941) suggested that egg laying began in October and continued at least until early December. In February 1980 I found newly hatched chicks in four crake territories, and so laying continues until late January.

On mainland New Zealand, Hadden (1970) found that egg laying started at the end of August and continued until mid-November, whereas Fraser (1972) found nests with eggs in mid-January and suggested that laying took place from August to January.

Roy Bell on Raoul Island (1908-1911) said that nests were built from the first week in September but that laying did not start until mid-October and continued until 10 December. Most birds laid between 10 and 20 November. He suggested that later nesting took place in high water years.

In Australia, dates from Bryant & Amos (1949) and Fletcher (1914) suggest that the breeding season is similar, ranging from late September to late January. Fletcher also suggested that laying may continue into February, depending on seasonal rains.

Clutch size

The commonest clutch size is three, with two frequent on Aorangi and the Kermadec Islands, and four frequent in Australia (Table 3). Although the sample is small there is a suggestion that clutches are larger on mainland New Zealand than on the islands and larger in Australia than in New Zealand. Australian handbooks also support the idea of a larger clutch size for Australia and Tasmania than for New Zealand — 4-6 (Macdonald 1973), 4-7 (Frith 1969), 4-6 (Readers Digest 1976). Smaller clutches on islands have been demonstrated for many species (Bull & Whitaker 1975).

Buddle also suggested a reduction in clutch size from three to two later in the season on Aorangi.

Incubation

Two birds, presumably both parents, incubate (Hadden, *in* OSNZ nest records). From the date of the last egg to hatching inclusive is 21 days (Hadden, *in* OSNZ nest records). Fraser (1972) gave c. 19 days for incubation (not defined) and Fletcher (1914) gave 18 days.

Young

The young stay in the nest for up to 2 days (Hadden, *in* OSNZ nest records, Buddle, 1941). Roy Bell said that on Raoul Island the young leave the nest on hatching for other nests on dry land.

Information on the rate of growth of young after leaving the nest is sparse. Roy Bell says that the young grow very slowly; those hatching at the end of December were only half-grown by April.

During my 18 days on Aorangi, it was difficult to see any growth changes in the chicks. Buddle estimated the earliest nesting on Aorangi would be in October, and newly independent young were present during our visit in February. Obviously, the adults attend the chicks for a long period, probably 4-5 months. Newly hatched chicks on Aorangi during our visit at the end of February would therefore not reach independence until June or July.

Spotless Crakes take a long time to raise young. Nest building, preceded by an unknown time when territories are established, starts several weeks before laying. Incubation takes 3 weeks and the young may be accompanied for 4-5 months before becoming independent — a total of 5-6 months. Egg laying from August to late January suggests that some part of the population is involved in raising chicks for most of the year.

The immature plumage was overall browner than that of the adult, lacking the blue sheen on the head and breast of the adult and the golden brown on the back of the adult. The chin was white with whitish striations on the breast, and legs were a light pinkish brown but rather variable, occasionally still dark as in the downy chicks. Immatures were noticeably smaller. An immature female in the National Museum weighed 28 g in contrast to adult female weights of 43.0 g and 43.2 g.

Breeding success

Apart from newly hatched chicks, the young seen during our visit to Aorangi were impossible to age, but they were divided into four categories on the following basis:

1. Small — weak twittering call, not very mobile, staying close to the adult, occasionally being brooded.
2. Medium — single thin rising call, constantly repeated. Downy. Mobile, following adult often at a distance of 20-30 metres.
3. Old — fully feathered but still accompanying adult. No call.
4. Independent — immature plumage, not associated with an adult.

Table 4 shows the numbers of young seen on Aorangi in February and March 1980. The large number of " medium " young seen is to be expected as this category probably includes chicks of the greatest age range.

A very rough measure of breeding success can be derived from these figures. It is unlikely that all the young seen would reach independence, and two " medium " young from a group of three were lost and two newly hatched young disappeared during our visit. Also the small number of " old " young seen were singles. If 20 of the young reached independence and if all 44 adults counted had bred, less than one half a young per adult would reach independence in a year.

TABLE 4 — Frequency of different-sized groups of young seen on Aorangi, February-March 1980

Age of young	Number of young in group			Total no. of young
	1	2	3	
Small	1	3		7
Medium	3	4	1	14
Old	3			3
Independent	4			4
Totals	11	7	1	28

Bartle's records for the 1960s and this study suggest that the population of crakes is stable at about 40 individuals. A production of 20 young a year suggests that mortality or movement accounts for about one-third of the over-winter population of adults and juveniles if numbers are to remain stable.

Attendance of the young by the adults

During our visit to Aorangi the number of adults attending young varied according to the age of the juvenile birds. Small newly hatched young were always accompanied by two adults. During the " medium " stage one adult stops accompanying the young, and so by the time the young are fully feathered, only one adult is in attendance. There was one record of three adults accompanying young. The assistance of 1-year-old birds in feeding downy young has been noted for the Tasmanian Native Hen (Ridpath 1968).

The behaviour of young and adults throws some light on this seeming lack of parental attention. Small young were not very mobile and stayed close to one parent and were occasionally brooded. The other adult sounded the alarm, at which the young stopped calling, and investigated intruders. As the young became older they foraged widely in the open forest floor, called constantly, and often moved

20-30 metres away from the adult. The adults did not call to the young and did not respond to intense calling by the young by returning to them. It seemed, in fact, as though the young followed the adult round the territory. At an alarm call from the adult the young would run rapidly for several metres, sometimes managing to hide and at other times quickly giving up the attempt. Often they continued to call loudly while the adult was calling the alarm. Fully feathered young accompanied the adult at distances of up to 40 metres and were silent. They seldom heeded the adults' alarm calls and continued feeding unconcerned. So, after the initial stage, when there is some division in the adults' roles attending the young, the adults' role is minimal and there seems little need for two adults to look after the young.

In two cases the adult not accompanying the young was still in the breeding territory, and one of them was actively defending the territory against a neighbouring crake. In six other cases of a single adult attending young no other adult could be found in the territory. One territory was definitely occupied by a single adult and three other less well defined territories had a single adult only. Whether these birds were the missing parents is not known.

CONCLUSION

Although Spotless Crakes are being found in many places on mainland New Zealand with the help of taped calls, the reduction in their marshland habitat is a cause for concern. Aspects of this study illustrate the danger in New Zealand of assuming that our island sanctuaries and reserves are a substitute for adequate mainland reserves. Island systems, especially those of smaller islands, are very specialised, and processes on islands may be very different. This study suggests that for Spotless Crakes, and possibly other species, islands such as Aorangi are not ideal refuges because

1. The population is small — between 40 and 50 individuals.
2. The crake reproductive rate may be slow — clutches are smaller than on the mainland and less than one chick per pair is raised to independence for each breeding attempt.
3. Their favoured habitat is gradually changing as the forest matures.

A small population and a low reproductive rate mean that the birds are susceptible to catastrophes such as bad weather or habitat destruction and cannot easily recover their numbers. With the changing habitat, the occupation of Aorangi by Spotless Crakes may well be temporary.

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GLOSSARY OF ANIMAL AND PLANT NAMES

Tuatara	**Sphenodon punctatus**
Buller's Shearwater	**Puffinus bulleri**
Harrier	**Circus approximans**
Pukeko	**Porphyrio porphyrio**
Tasmanian Native Hen	**Gallinula mortierii**
Kingfisher	**Halcyon sancta**
	Blechnum capense
Flax	**Phormium tenax**
Supplejack	**Rhipogonum scandens**
Pigeonwood	**Hedycarya arborea**
Kawakawa	**Macropiper excelsum**
Mahoe	**Melicytus ramiflorus**
Karo	**Pittosporum crassifolium**
Kanuka	**Leptospermum ericoides**
Pohutukawa	**Metrosideros excelsa**
	Metrosideros perforata
Whau	**Entelea arborescens**
Karaka	**Corynocarpus laevigatus**
Kohekohe	**Dysoxylum spectabile**
Tawapou	**Planchonella novo-zealandica**
	Myrsine divaricata
	Coprosma macrocarpa
Puriri	**Vitex lucens**
Bush grass — 2 species	**Oplisuenus undulatifolius**
	Microlaena stipoida

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