THE WEKA ON MACQUARIE ISLAND

By N. P. BROTHERS and I. J. SKIRA

ABSTRACT

Wekas have been on Macquarie Island for just over 100 years. They occur in the coastal tussock grassland, mainly in the northern half of Macquarie Island.

Males are larger than females and the sexes can be separated on a combination of culmen and tarsus lengths. The sex ratio in favour of males was considered to be due to behavioural differences. Breeding begins in August and, although four eggs may be laid, only one or two chicks are usually reared. Losses are probably due to predation by feral cats and skuas.

Preferred foods are vegetation, insects and spiders. Mammal and bird remains were present in fewer than half the gizzards examined, but rats and mice are thought to be important food because of their size.

The weka was introduced to Macquarie Island as a source of food for sealers, and all sources agree that it was the Stewart Island subspecies, *Gallirallus australis scotti*. The date of introduction is uncertain. It seems that the first release was in 1874 and another in 1879 (Falla 1937, Cumpston 1968). Buller (*in* Oliver 1955) said that wekas were taken down in 1830, but this date seems unlikely.

Initially wekas were scarce (Scott 1882), but they had become widespread by 1890 (Cumpston 1968). Hamilton (1894) recorded that they had " increased and multiplied in a most extraordinary way " and that they were all around Macquarie Island except at the extreme north. They were used as food by the Australasian Antarctic Expedition of 1911-13 and Falla (1937) found them plentiful during his visit in 1930. Sobey *et al.* (1973) recorded that their distribution largely coincided with the distribution of the tussock grassland on the coastal fringe.

The presence of wekas on Macquarie Island for over a century has had a disastrous effect on the native fauna (Taylor 1979, Brothers 1984). Attempts to eradicate them are now being implemented. The aim of this study was to collect information about the wekas before their extermination.

Wekas were counted monthly in 1976 along the coastline between the Nuggets and Sandy Bay (5 km) and in 1979 between Green Gorge and Brothers Point (5 km) by NPB, who also did night counts between Green Gorge and Brothers Point. See Fig. 1.

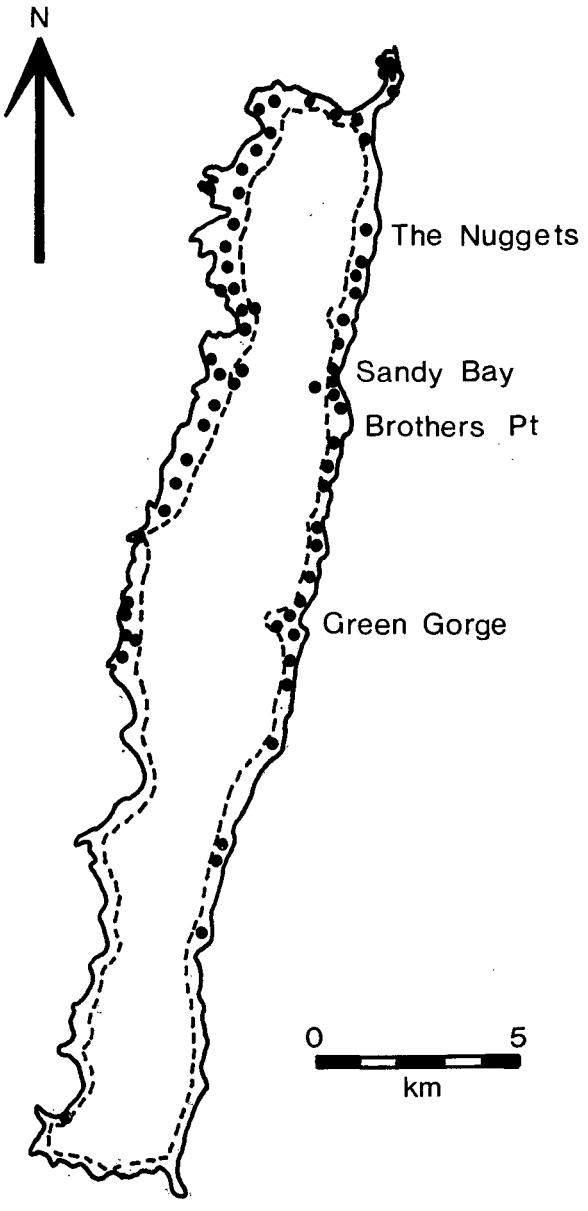

FIGURE 1 — Distribution of weka sightings on Macquarie Island. Each dot represents one weka. The dotted line indicates the edge of the plateau

Between January and October 1979, 98 wekas were shot. Standard measurements of 96 birds were taken, breeding condition was noted, and gizzards were examined microscopically for food items. General observations were made on distribution, habits and nesting.

POPULATION

Characteristics

Males were larger than females in all characters measured, except tail length, which had no significant statistical difference (Table 1). Carroll (1963) reliably sexed wekas using culmen length, tarsus length and body weight, and Coleman *et al.* (1983) by culmen length and bill depth. Discriminant analysis of the eight characters measured gave a discriminant function of $Z = 0.62\ C + 0.25\ T + 0.04\ MTC - 0.01\ MC + 0.03\ W - 0.008\ TAL - 0.002\ TLN + 0.001\ WGT$, where C = culmen length, T = tarsus length, MTC = middle toe and claw length, MC = middle claw length, W = wing length, TAL = tail length, TLN = total length, and WGT = body weight. All values of Z above O were males and below −2 were females, as

TABLE 1 — Measurements of male and female wekas on Macquarie Island. The mean ± one standard error and range in brackets are given. The F-ratio was obtained through U-statistic analysis. ***$p<0.001$.

	Males	Females	F-ratio
Weight (g)	1034 ± 16 (600 - 1425)	753 ± 17 (500 - 884)	85.5 ***
Culmen (mm)	50.2 ± 0.21 (46.2 - 54.2)	45.3 ± 0.42 (41.2 - 48.0)	135.3 ***
Tarsus (mm)	58.4 ± 0.26 (52.3 - 62.1)	51.7 ± 0.42 (45.5 - 54.5)	162.5 ***
Middle Toe & Claw (mm)	71.8 ± 0.32 (65.6 - 78.8)	64.9 ± 0.63 (59.5 - 68.6)	92.2 ***
Middle Claw (mm)	15.2 ± 0.19 (11.4 - 22.0)	13.8 ± 0.19 (11.7 - 15.7)	15.6 ***
Tail (mm)	125 ± 1.6 (74 - 175)	120 ± 1.0 (110 - 130)	3.5 NS
Wing (mm)	184.4 ± 1.2 (165 - 226)	162.5 ± 3.4 (110 - 180)	51.6 ***
Total Length (mm)	511 ± 3.1 (455 - 580)	471 ± 4.2 (425 - 503)	49.3 ***
Sample Size	70	26	

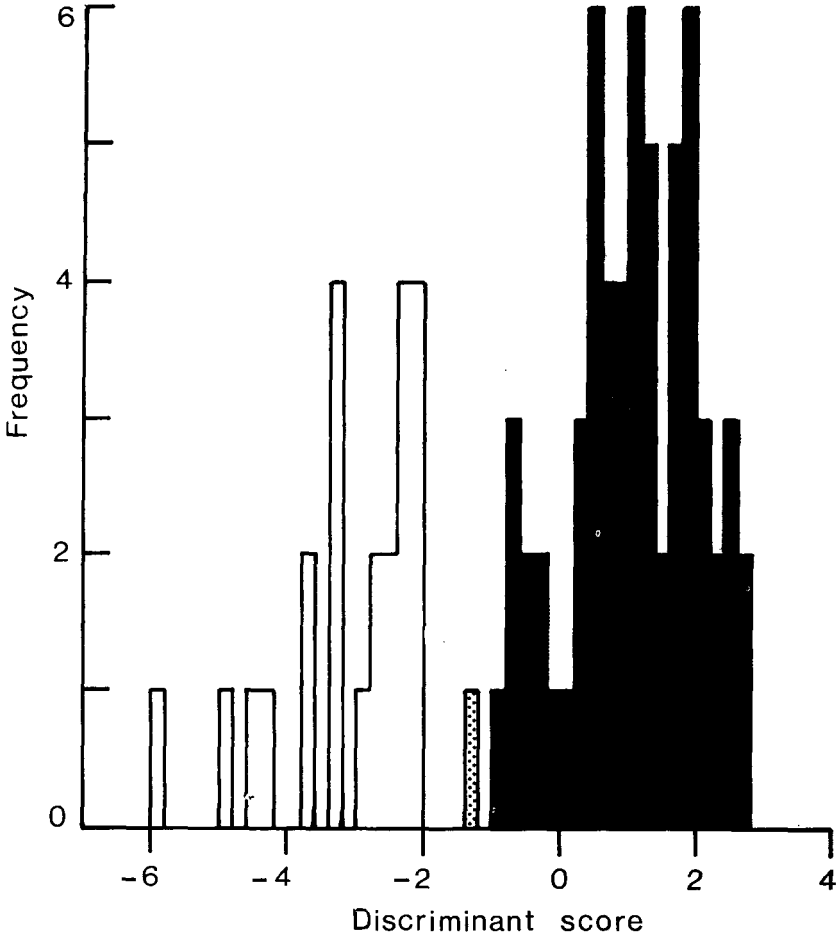

FIGURE 2 — Frequency histogram of the discriminant scores obtained for male (shaded) and female (unshaded) wekas. The light shade represents an overlap of one male and female weka. The class interval is 0.2.

shown in the histogram (Fig. 2). There was one overlap between 0 and −2, but the probability of classifying males correctly was 98.4% and females 100%.

In addition the variates measured were included in a stepwise discriminant analysis which used Wilks' criterion for selection of variables (Klecka 1975). The programmes used were those available on the SPSS package (Nie *et al.* 1975). The stepwise discriminant

analysis between males and females required only 4 of the 8 variables to achieve maximum discrimination. The standardised and unstandardised loading obtained were respectively as follows

Culmen	Tarsus	Wing	Weight	Constant
0.470	0.571	0.311	0.182	
0.273	0.261	0.026	0.002	— 34.191

We did not find any eggs but Gavin Johnstone (pers. comm.) measured six eggs from three nests in 1970. The means and ranges were 58.3 x 38.5 (55.4-61.0 x 38.1-39.0) mm.

The sex ratio was in favour of males, 70 : 26 ($X^2 = 20.16$, d.f. = 1, $p > 0.001$). Coleman *et al.* (1983) also found an imbalance in favour of males and thought that disease was responsible. In this study, however, all dissected females were disease free, and so the sex imbalance is probably a result of behavioural differences not necessarily related to the sampling technique.

Two colour phases of wekas occur on Stewart Island. The first introduction to Macquarie Island in 1874 is said to have been of the " ordinary chestnut form " (Falla 1937) and the second introduction in 1879 of a darker form (Oliver 1955). The lighter form dominates on Macquarie Island, and in 1976 and 1979 we saw only two very dark birds. The light form had red-brown feathers and chestnut legs, and the dark form had brown-black feathers and legs.

Distribution and numbers

Macquarie Island consists of a plateau averaging 250 m above sea level, bounded by steep tussock-covered slopes that are fringed by shingle beaches and raised coastal terraces. Almost all wekas were on the coastal terrace in a total area of about 50 km² (Fig. 1). Their habitat was the tussock grassland alliance of *Poa foliosa* and Macquarie Island cabbage *(Stilbocarpa polaris)*. Large areas of tussock grassland on the extensive coastal terrace in the northern half of the west coast are where most of the population occurred. Some wekas did venture up to 1 km inland in low coastal valleys, as at Green Gorge, up to an altitude of 100 m but very few ventured on to the plateau. All birds seen on the plateau were foraging near or in tussocks and not on the open herbfield.

Counts of wekas fluctuated throughout the year and more birds were counted at night than by day. Birds could only be seen when on or near the beach feeding out of the dense vegetation and numbers were higher when foraging conditions were most suitable such as when large numbers of kelp flies were present amongst rotting kelp *(Durvillea antarctica)*. On the Nuggets to Sandy Bay transect, 36 counts were made between 28 November 1975 and 11 February 1977. The most wekas seen were 17 on 15 April 1976 and 15 on 20 February 1976. The counts ranged between 0 and 17 at an average of 5.3 wekas. On the Green Gorge to Brothers Point transect, 13 counts were made

and the most seen were 12 on the night of 23 April 1979. The seven night counts ranged between 3 and 12 at an average of 7.6 wekas and the six day counts between 0 and 7 at an average of 4 wekas.

The population estimate for Macquarie Island derived from the maximum count of 17 over 5 km was only 170 wekas but the actual total is likely to be much higher. Some birds probably remained hidden among tussocks during counts and counting was impractical on the extensive habitat of the west coast, where the majority of wekas occur. We estimate that there may have been up to 500 wekas on the island.

Breeding

The weka hides its nest well in the middle of the base of tussocks, for we have found only four nests in October and November. The first indication of breeding was on 6 August, when the behaviour of two separate birds suggested that their mates were on a nest. On 9 August a female with a well-formed egg was shot near Green Gorge. Up to four eggs may be laid, for on 4 October a weka was shot that had four eggs in its oviduct.

The first chicks were seen on 27 August and the last chick, which was about three-quarters grown, on 22 May. There were 30 sightings of chicks in 1976 and 1979, of which 19 were of one chick and 11 of two chicks. Chicks accompanied by one or two adults were seen on 27 occasions and were all less than half grown. The three chicks unaccompanied by adults were all at least two-thirds grown. The prolonged breeding season suggests that more than one brood can be raised. One weka was known to have two broods (G. Copson, pers. comm.). It was accompanied by a very small chick on 28 November 1975, and on 19 January 1976 it was feeding another chick in down.

The discrepancy between the number of eggs that may be laid and the number of chicks seen indicates that chick mortality may be high. The period when losses occurred is not known. Chicks are predated upon by feral cats and skuas *(Stercorarius skua lonnbergi)* and we saw feral cats and skuas trying to catch adult wekas. Rats *(Rattus rattus)* may take eggs.

The mean monthly body weight of male wekas increased in the winter, but from July to when observations ceased in October, it was similar at 1028 g. From examination of gonads and sightings of chicks we concluded that the peak of breeding probably occurred between August and November. Seasonal differences in body weight of female wekas were not apparent, perhaps because the sample was small.

Diet

Gizzards of 25 female and 73 male wekas were examined. The occurrence of food items each month is shown in Table 2. Vegetable

TABLE 2 — Occurrence of food items in stomachs of 98 adult wekas on Macquarie Island. The figures are the number of stomachs in which food occurred.

	J	F	M	A	M	J	J	A	S	O	TOTAL
Grit/stones	3	12	8	10	7	5	9	14	9	20	97
Vegetation	3	8	7	9	5	5	5	11	7	18	78
Kelp			2	1	1		1	1			6
Earthworms		1			1			3		1	6
Molluscs	1	10	5	10	6	3	4	10	6	19	74
Crustaceans			2						1		3
Insects	2	11	9	9	7	3	8	12	7	13	81
Arachnids		7	8	10	3	4	4	8	5	14	63
Birds	1	4	4	5	1	1	2	3	4	3	28
Mammals	2	6	3	5	2	2	4	8	4	4	40
	3	12	9	10	7	5	9	14	9	20	98

material and invertebrates were most frequent, and mammal and bird remains less frequent. Grit and pebbles up to 5 mm in diameter were usually present.

Vegetation was in 78 of the 98 wekas examined and was in equal proportion throughout the year. It consisted mainly of fibrous material together with some seed. Carroll (1963) postulated that much vegetable matter may be accidentally eaten while wekas probe for invertebrates or other ground-dwelling animals. This possibility cannot be discounted on Macquarie Island.

Kelp occurred irregularly throughout the year but was found in only six wekas. Earthworms and crustaceans were rare, even though worms are widespread and abundant on the island. The intertidal copepod *Tigriopus angulatus* occurred only twice, each time over 50 of them, and a claw of a crab was found in a weka in September.

Marine shells were in 71 birds and land snails in 8. Marine shells were usually in fine pieces and may have been scavenged after storms, taken from intertidal pools, or picked up as grit while birds searched for invertebrates. One species of land snail, *Phrixgnathus hamiltoni,* occurs on Macquarie Island. Although it is very common under leaves of *Stilbocarpa polaris* and at the base of tussocks, only one was in each weka that had it, and so it may have been picked up accidentally.

Larvae of the kelp flies *Coleopa curvipes* and *C. nigrifrons* and adult *Apetaenus watsoni* were in 32 gizzards and occurred throughout the year. All three flies are widespread around the coast within decaying kelp, and *A. watsoni* is also found under stones. Over 100 and up to 358 larvae were present, but fewer than five adult *A. watsoni* were in any one of the gizzards. Other species of Diptera found were an *Erioptera macquariensis* pupa (one weka), *Drosophila melanogaster* adults (two wekas) and Dolichopodidae larvae (seven wekas).

Caterpillars of the endemic moth *Eudoria mawsoni* were in 36 wekas and occurred throughout the year. No adult moths were found. The caterpillars are widespread but are particularly abundant in the herbfield terrace of the island's north coast (Watson 1967).

Collembola (*Arthropleona* sp.) occurred in only five wekas and Coleoptera (Staphylinidae, Omalinae larvae and *Halmaeusa* sp.) in ten wekas.

Arachnids, mainly spiders, were often in the diet. No identification to species level was attempted and usually fewer than five spiders were in each weka. Acarina (Oribatei and *Ixodes* sp.), which were present in 11 wekas, may have been picked up accidentally among vegetation and in penguin colonies.

Bird remains consisted of penguin and weka feathers and eggshell fragments in two birds. Penguin feathers were probably picked up accidentally by wekas searching for invertebrates in penguin colonies. Weka feathers may have been ingested during preening, fighting or courtship. No petrel feathers were identified, probably because sampling finished in October before burrow-nesting petrels bred, most predation by wekas being early in the chick-rearing stage (Brothers 1984). About 20 colonies of Sooty Shearwater *(Puffinus griseus)* and White-headed Petrel *(Pterodroma lessonii)* occurred within weka habitat and contained generally less than 100 burrows each. Predation on individual colonies may be limited to only a few wekas, but more intensive sampling is necessary than we did to gauge the extent of damage by wekas. Other species of burrow-nesting petrels do not coincide with weka distribution or are present on inaccessible stacks.

Mammals were in 40 gizzards. Mice *(Mus musculus)* were in 23, rats in 19 and rabbits *(Oryctolagus cuniculus)* in 2. Rats are restricted to tussock, and mice occur in both tussock and herbfield (G. Copson, pers. comm.). Although less than half of the gizzards contained mammal remains, mice and rats may be important foods because of their bulk and because they occur abundantly. Although wekas were seen to catch rabbit kittens and remove them from burrows, the low frequency of their occurrence in stomachs reflects their minor importance, which is in part due to low rabbit numbers in weka habitat.

Incidental food items were unidentified flesh in two wekas and a squid beak in one.

Wekas were often observed feeding along the rocky beaches and coastline, where they overturned stones and rotting kelp in search

of food. Areas of vegetation on the coastal terrace were systematically turned over, as if ploughed, as wekas searched for invertebrates and perhaps seeds.

DISCUSSION

The weka is omnivorous and finds much of its food on the rocky beaches and among vegetation. Rabbits form a small proportion of its diet but rats and mice are probably important. They do not eat earthworms, which form a major part of their food in New Zealand, whether they are in farmland or forests (Carroll 1963, Coleman *et al.* 1983). However, no comparable study in New Zealand has been done of weka diet in lowland or alpine tussock grasslands. It may be that birds feeding in tussocks in New Zealand do not take many worms. Perhaps on Macquarie Island other invertebrates such as kelp flies, caterpillars and spiders are so abundant that wekas do not need to eat earthworms. This conclusion is supported by the absence from the stomachs of adult moths, which are very common, whereas caterpillars, which are even more abundant, were in many gizzards.

The great increase in weka numbers by 1890 was probably brought about by the introduction of rabbits in 1878. Between 1874 and the early 1880s, predation on wekas by feral cats and their slow natural increase made them scarce. However, the quick dispersal and increase in rabbits from 1878 alleviated predation on wekas and we postulate that they increased dramatically because of the abundance of burrow-nesting petrels as a source of food.

The Blue Petrel *(Halobaena caerulea)* and Common Diving Petrel *(Pelecanoides urinatrix)* were formerly abundant on the lower coastal slopes where wekas occur (Campbell 1901). Nowadays they are confined to offshore stacks but are resident throughout the year (Brothers 1984). Falla (1937) found many damaged burrows of Antarctic Prion *(Pachyptila desolata)* and remains of chicks in tussocks, which he attributed to wekas. Prions now breed only in the herbfield on the plateau, and their absence from tussock is largely due to predation by wekas.

Present-days changes in distribution of wekas can be accounted for by changes in numbers and distribution of rabbits. Sobey *et al.* (1973) recorded wekas even at the southern end of Macquarie Island. In this study, few wekas were seen south of Green Gorge. The habitat in the southern half is not as extensive as that in the northern half and rabbits have further reduced it by removing tussocks. The rabbits are localised and mostly at low density. Numbers of wekas are highest in areas where rabbit density is high, providing an abundant food supply for cats, and in habitat unsuitable for both cats and rabbits. That is, when rabbit numbers are low, cat predation upon wekas intensifies. The rabbit population on Macquarie Island was estimated at 150 000 in 1965 (Sobey *et al.* 1973), 50 000 in 1974 and 150 000 in 1978 (Copson *et al.* 1981). In a study of the diet of cats during 1974,

weka remains were found in 12% of cat guts examined (Jones 1977). Predation may have been alleviated when rabbits increased between 1974 and 1978 because Brothers (unpubl.) found weka remains in only 1% of cat guts examined in 1976 and 1979. These years, however, were too few for wekas to increase and disperse. The first introduction of myxomatosis in November 1978 reduced rabbits considerably (Brothers *et al.* 1982). This would have intensified cat predation on wekas, and at last observations in October 1983, wekas were rare in all areas.

The presence of feral cats, rabbits and wekas has had a severe effect on the native flora and fauna. Elimination of cats and wekas, and reduction of rabbits to an acceptable level where their damage is minimal, are the aims of the Tasmanian National Parks and Wildlife Service's management programme. Eliminating the cats and wekas should have little effect on rabbit numbers. The populations of all three are currently low and control of rabbits is proceeding successfully despite the low numbers of cats and wekas.

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N. P. BROTHERS and I. J. SKIRA, *National Parks and Wildlife Service, P.O. Box 210, Sandy Bay, Tasmania 7005*