SOME POPULATION STATISTICS AND MOVEMENTS OF THE WESTERN WEKA

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ABSTRACT

In central Westland, 110 Western Wekas *(Gallirallus australis australis)* were marked between August 1975 and May 1978, and 38 corpses were examined. Wekas occurred throughout the study site but preferred ecotonal scrublands while avoiding dense forest. Captures fell by 50% over the study period and the number of sightings also decreased significantly. Adults were sexed by a discriminant function based on the bill measurements of dead birds, with a probability of misclassification of live adults of about 4.6%. A sex ratio biased towards males was revealed. Breeding began in late June/July when both sexes had attained maximum annual body weights and fat reserves. Home ranges were generally less than 4.5 ha. The main foods identified from birds collected during June-August and in November were fruits of indigenous forest plants, especially *Coprosma* spp., and plant foliage, insects and earthworms.

INTRODUCTION

Although the weka *(Gallirallus australis)* is often locally abundant, it is absent from large tracts of seemingly suitable habitat throughout its range. Its disjunct distribution may be only recent because it vanished from most of the North Island between 1918 and 1940 and from the eastern side of the South Island by 1924 (Falla *et al.* 1979). Conversely, populations in central Westland and and in north-west Nelson are recolonising old range (JDC, pers. obs.) and wekas introduced on to Chatham, Macquarie and numerous small offshore islands have prospered. Wekas continue to flourish about Gisborne and have provided the nucleus of liberations elsewhere in the North Island (Falla *et al.* 1979).

The reasons for local fluctuations are not known. Anecdotal reports abound in early New Zealand literature (summarised by Oliver 1968) and in general ornithological texts, but only Carroll (1963 a, b, c) has given a substantial description of the species' diet, breeding cycle and sexual characteristics. Little is published on its movements, densities, diseases or favoured habitat — data crucial to the understanding of fluctuating weka populations.

A chance to investigate one subspecies, the Western Weka *(Gallirallus a. australis)*, arose during a study of brush-tailed possums *(Trichosurus vulpecula)* in central Westland. As the box traps used for possums also caught wekas, we undertook a limited study of the

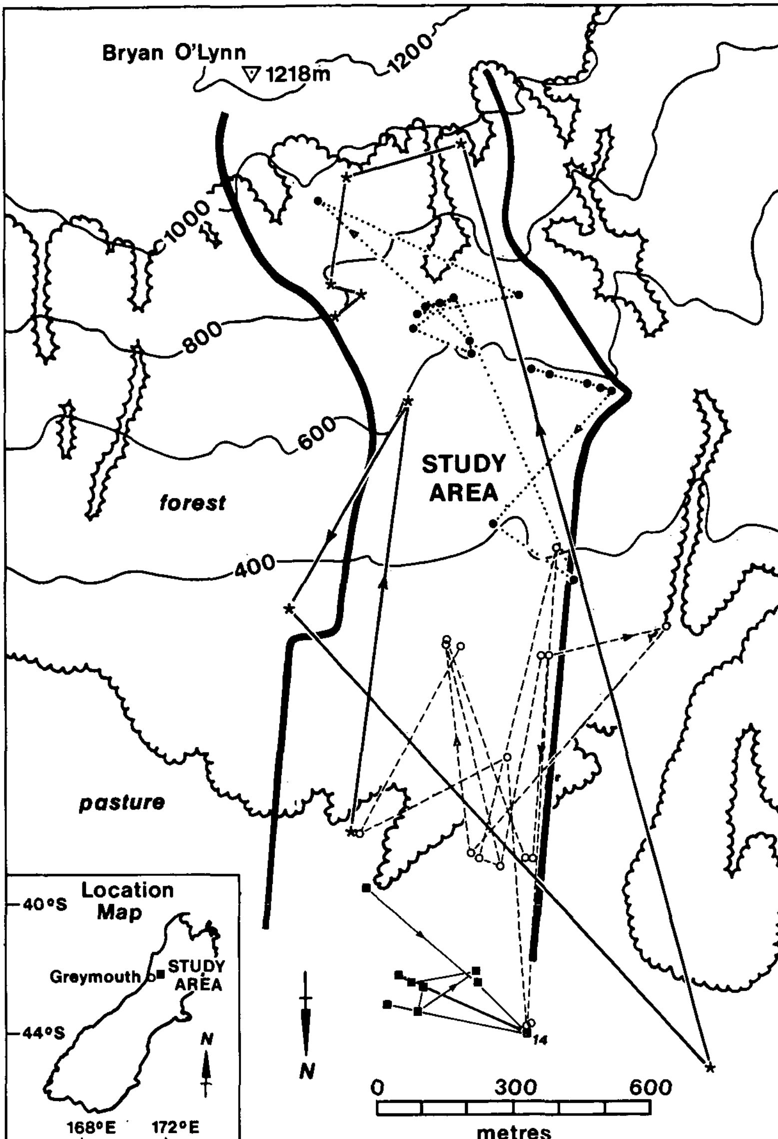

FIGURE 1 — The Mt Bryan O'Lynn study site, with the movement patterns of four frequently observed wekas superimposed on it. The birds include numbers 29363 (solid squares), 29364 (open circles), 37130 (closed circles) and 37138 (asterisks).

bird's population density, movements, habitat use, diet, and breeding biology in an area of farm edge and native forest.

The study area, which was described in detail by Coleman *et al.* (1980), comprises a belt of forest and adjacent pasture 1.5 km wide extending from farmland at 220 m a.s.l. to alpine grassland at 1200 m a.s.l. on the north-facing slopes of Mt Bryan O'Lynn (see NZMS 1, S52, 190690; also Fig. 1). At low altitudes morainic terraces support either rough pasture dotted with clumps of scrub or cutover podocarp forest dominated by hardwood canopy species and tree ferns. On the steep schistose hillside, the forest shows a regular altitudinal progression of dominant trees, viz. *Weinmannia racemosa, Quintinia acutifolia, Metrosideros umbellata* and *Libocedrus bidwillii,* with alpine scrub at the upper forest limit. Ground cover varies from a cryptogamic and vascular vegetation at low altitudes to litter or bare soil on ridge and many high-altitude sites.

Wekas have been present on Mt Bryan O'Lynn only since the mid-1960s, according to M. Wallace, a local farmer. The birds seem to be colonising adjacent habitat and the study population may not be stable.

METHODS

Wekas were captured in 240 permanently sited drop-door box traps set in lines at 300-m intervals from the forest/pasture margin to the lower limits of the alpine scrub. Each line consisted of 30-40 traps aligned along a contour. From August 1975, all traps were set for three fine nights each month.

In all, 110 wekas were captured, banded and colour marked. For each, the length and depth of the exposed culmen, tarsus length and body weight were measured (Gurr 1947) with vernier calipers accurate to 0.1 mm and a spring balance accurate to 50 g, and the colour of the irides was recorded. On subsequent captures, adult birds were reweighed, but all measurements were taken again for immature birds. Lastly, blood samples were collected from the radial artery of 30 adult wekas and checked for haematozoan parasites.

Free-ranging marked birds were noted incidentally during the possum studies, which kept six observers in the study area for 8-10 days each month. Whenever possible, birds were identified by their colour-band combinations and located precisely on a grid system (Coleman *et al.* 1980). Home ranges were calculated for each marked bird from capture and sighting records with a minimum area polygon technique (MAP) based on the minimum area circumscribed by all sightings (King 1975). Isolated but extensive forays away from their normal centre of activity extended the home ranges of some birds dramatically. A modified MAP technique (MMAP) was developed which excluded any record further away than one half of the range diameter of all other sightings.

From possum trappers working about Mt Bryan O'Lynn, 38

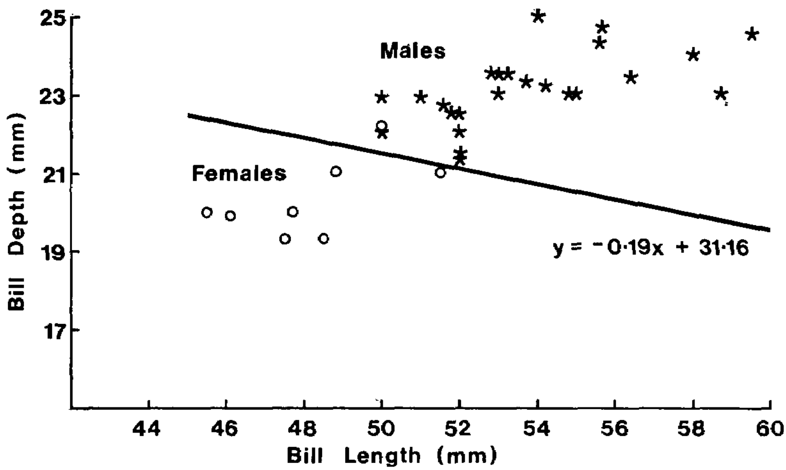

FIGURE 2 — Bill measurements of autopsied adult males (*) and adult females (o). The line which cuts across the intermixed cluster of data provides a means of predicting the sex of other adult Western Wekas of known bill dimensions.

dead wekas, 32 of which were adult, were recovered. Each carcass was measured, the size of the perivisceral fat depot overlying the alimentary tract was scored on a 0-10 scale, and the condition of the gonads and bursa Fabricii was recorded. The last, a bulbous lymphoid sac opening into the upper cloaca, is conspicuous only in juvenile birds.

The contents of 35 gizzards (three were empty) were analysed, including a microscopic search for earthworm setae. Most macroscopic remains and seeds were identified and quantified as total numbers. Foliage was recorded simply as present or absent.

RESULTS

Sexing and ageing studies

The bill measurements of 32 autopsied adult wekas revealed that males had significantly longer and deeper bills than females (Table 1). Both measurements showed some overlap between the sexes, which limited their value for sexing birds in the field. However, from both bill measurements, valid predictions of sex were possible through the development of a discriminant function (Bock 1975) $z = 0.14\ BL + 0.74\ BD - 23.06$, where BL is bill length and BD is bill depth. For autopsied males all values of z were positive, whereas for females all but one value (12.5%) were negative (Fig. 2). That is, the errors of classification for the autopsied sample, though not symmetrical, amounted to 3.13% overall. The theoretical probability of misclassification of live-captured adults, if one assumes a balanced sex ratio, was 0.0455 or approximately 4.6% (Bock 1975).

TABLE 1 — Bill measurements of autopsied adult wekas

	MALE			FEMALE			Fs	P
	N	Mean	95% C.L.	N	Mean	95% C.L.		
Total length (mm)	24	53.76	1.026	8	48.20	1.358	31.2	<0.001
Total depth (mm)	24	23.13	0.375	8	20.35	0.679	51.8	<0.001

The age of wekas was indicated by progressively darkening irides as birds grew and matured. Small to very small birds, which by their behaviour towards siblings or parent birds were clearly chicks of the year, always had olive-green irides. Larger birds not accompanied by offspring or by defensive adults, which were larger each time they were measured, were classified as juveniles and usually had liver irides. Birds with chicks clearly were adult and always had red irides. Birds with intermediate liver-red irides, which appeared to be approaching sexual maturity, were harder to age. Some could be aged from their previous measurements and trap history.

Life history

Nests and incubating birds were not seen on Mt Bryan O'Lynn, but 22 adult corpses recovered in June, July and August all had enlarged gonads and one female recovered on 7 June 1979 had a fully developed egg in its oviduct. Five adults taken in November showed no heightened gonadal activity.

The laying period was further indicated by the presence of small but rapidly growing chicks with body weights of 0.2-0.3 kg, seen between early October and late January. As the incubation period for wekas is approximately 27 days (Oliver 1955), we conservatively estimate that females in our study area laid between late June and early December.

Parent/chick combinations were seen from October to April, though mostly before February. We found no chicks weighing less than 0.2 kg, presumably because they did not move about much. Parent birds accompanied and defended broods for several months and were agitated onlookers while young chicks were being measured.

Young birds apparently lose their chick features of body size and iris colour when they become independent of their parents, as all those trapped after April had full juvenile plumage. Adult body weights were attained by mid-winter (AM = 1.33 kg, JM = 1.28 kg, Fs = 0.70, P >0.50), 6-9 months after hatching, and some young birds bred soon afterwards.

Fifteen broods with attendant parents were seen: six of one chick, three of two chicks, five of three chicks, and one of four chicks —

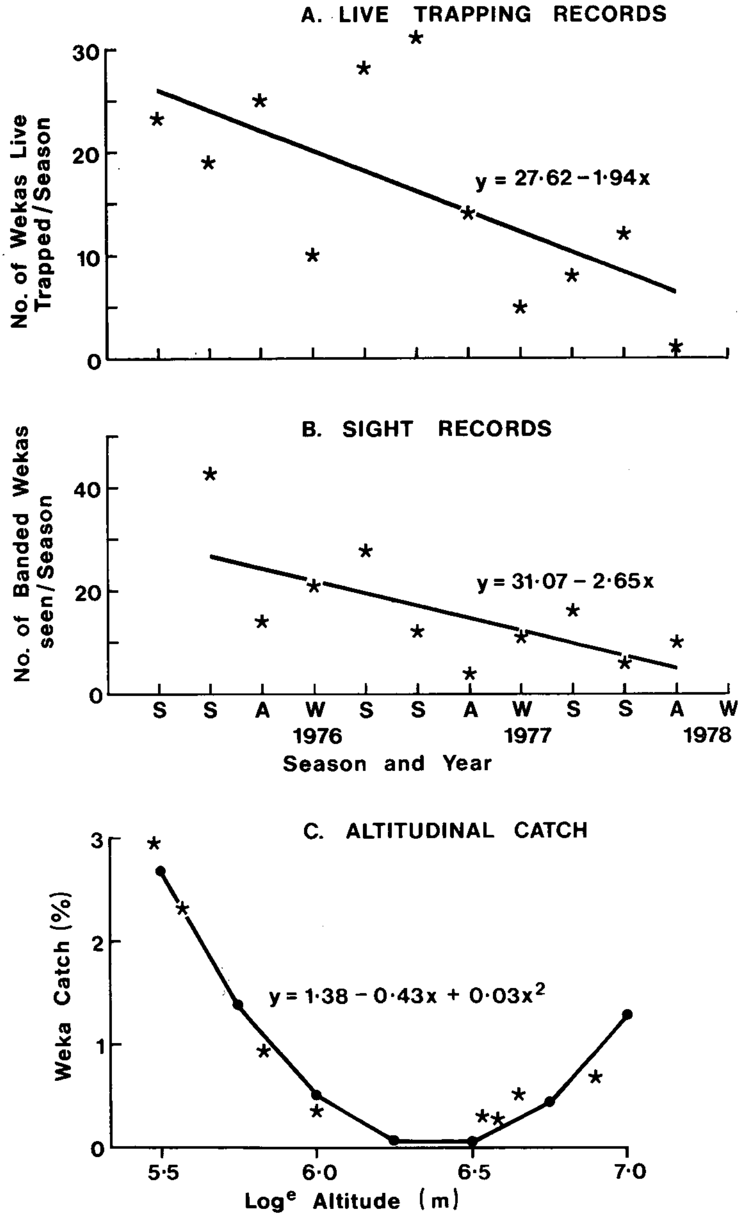

FIGURE 3 — Changes in weka numbers within the study area over time (A & B) and over an altitudinal gradient (C)

a mean of 2.1 chicks per brood. Most of these chicks were in the 0.5-0.8 kg range of body weight and so probably survived to independence. Sequential brooding was recorded for two mated pairs. One pair was seen with three broods over a 10 month period, and the other pair had four broods over 15 months.

Population trends

Numbers and habitat preferences: The combined number of adult and immature wekas trapped each season fell significantly over the 1975-78 study period (Fig. 3A, slope significance : $Fs_{1,9} = 6.61$, $F_{1,9}(0.05) = 5.12$). Likewise, the number of marked wekas (adults, juveniles and chicks) seen in the study area also fell significantly as the study progressed (Fig. 3B, slope significance: $Fs_{1,9} = 7.21$). Overall, the number of birds captured and seen in 1978 was about half that captured and seen in 1976.

Wekas on Mt Bryan O'Lynn showed distinct habitat preferences. From trapping records, as shown in Fig. 3C, most were in the low-altitude rough pasture and forest/pasture margins (<300 m a.s.l.), fewest in the mid-altitudinal forest (400-800 m), and intermediate numbers in the high-altitude scrub forest (800-1000 m). Unfortunately, no trapping was attempted in the high-altitude grasslands, although weka 'sign' (probe holes, litter disturbance and feathers) was seen there. Overall, the altitudinal 'catch' was best described by a curvilinear regression of quadratic form which accounted for 96.5% of the sample variation ($Fs_{2,5} = 68.72$, $P<0.001$). In addition, 60% of the wekas seen were on the rough pasture or pasture-forest interface, which comprised only 26% by area of the study site. Although wekas are easier to see in rough pasture than in forest, this result supports the trend shown by trapping.

Losses: The disappearance of marked wekas from the study area was substantial. Statistics of dispersion and death are always hard to get and in this study few dispersing birds were recorded or corpses recovered. For example, at the beginning of the final 12 months of the study (June 1977), 100 marked wekas were presumed to be in the study area and yet only 23 were seen again. As resighting intervals for all marked birds averaged 3.1 ± 0.60 months and only 7 out of 110 birds marked were seen after a 12-month 'absence,' most birds marked before June 1977 apparently left the study area. Some infrequently trapped birds may have lived outside the study area and have been captured during isolated forays into it, and others may have been immature transients, but many of the birds that disappeared had long trap histories and must have been residents.

The reasons for most weka "losses" were unknown (Table 2). A few corpses were recovered from commercial possum trappers, and local trapping may have been a significant cause of death. Two long-distance dispersers were found dead (see below) but had no obvious injury. Survival of adults appeared lower than that of juveniles or of chicks.

TABLE 2 — Weka losses

Status at Banding	Number Banded	Corpses Recovered	CAUSE OF DEATH Gin Trap	Unknown	Vanished	(%) 'Survival'
Adult	39	5	3	2	30	10.3
Juvenile	41	3	2	1	23	36.6
Chick	30	-	-	-	24	20.0
TOTAL	110	8	5	3	77	22.7

Information gleaned during this study on weka diseases was inconclusive. The bloods of 30 adult birds showed no pathogenic haematozoa. However, during the autopsy of trap-killed birds, distinct lesions were recorded on the livers of 8 of 32 adults and in none of six juveniles. The lesions were small white spots up to 3 mm in diameter, generally subcapsular but sometimes extending into the liver parenchyma (J. Hutton, Animal Health Division, MAF), and were typical of parasitic granulomas.

Sex ratios: The sex ratio of 38 autopsied birds collected over 3 years significantly favoured males (Table 3A). Similar imbalances were shown by captured birds sexed by the discriminant function based on bill measurements (Table 3B). Here, however, juvenile wekas were hard to assign. Young birds with positive discriminant values were clearly male, but those with negative discriminant values may have been of either sex. At the end of the study the banded population included eight unsexed birds with small bills, but even when all of these were lumped together in the analysis as " young females," males remained more numerous (M:F = 50:24, $X^2 = 8.45$, $0.01 > P > 0.001$).

Sex ratios amongst trapped and seen adults also varied seasonally. Males were most predominant in mid-winter (June/July, Table 3C). As this period coincided with the beginning of breeding, the scarcity of females was probably related to egg laying and incubation.

Body weights: As Fig. 4 shows, adult males were heavier than adult females at all times of the year, with seasonal means showing significant differences ($P < 0.05$). Within the sexes, males were significantly heavier in autumn and winter than in spring and summer ($P < 0.01$). Females showed a similar pattern, but with winter weights not differing significantly from autumn or spring and summer weights ($P > 0.05$). Overall, males and females showed late-winter weight losses of 18.4 and 23.2% respectively, coincident with the onset of breeding.

Perivisceral fat measurements both reflected and influenced the trends recorded for adult body weights. Scale measurements from 10 adults collected in June, 9 in July, 7 in August and 5 in November

TABLE 3 — Sex ratios of wekas trapped or seen

Note: Seasonal data include all capture and sight records collected over the three years of study.

	AM	JM	AF	JF	x^2	P
A. Autopsy sample	24	3	8	3	5.92	0.05>p>0.01
B. Banded sample - Adult	44	.	16	-	12.15	<0.001
- Adult + juvenile	44	6	16	0	16.50	<0.001

C. Seasonal Variation	AM	AF	%F	x^2	P
Dec/Jan	48	13	27.1	18.95	<0.001
Feb/Mar	25	7	28.0	9.03	0.05>p>0.01
Apr/May	36	5	13.9	21.95	<0.001
Jun/Jul	24	1	4.2	19.36	<0.001
Aug/Sep	34	7	20.6	16.49	<0.001
Oct/Nov	45	11	24.4	19.45	<0.001

averaged 8.3, 5.8, 5.8 and 2.1 respectively. Skeletal elements such as bill size were also greater in males and Western Wekas clearly follow the usual ralline pattern of males being larger.

Movements and home ranges

To study the movement and home range of any long-lived bird, a large number of marked birds must be seen repeatedly for several years. On Mt Bryan O'Lynn 110 wekas were marked, comprising 39 adults, 41 juveniles and 30 chicks, with 20 young birds seen subsequently as adults. Of 410 resightings only 22 birds were seen on six or more occasions and of these, only 13 were seen as adults. The rest were seldom seen and provided only incidental information on movements. Altogether, our home range information is limited and should be considered indicative rather than absolute.

Birds often moved long distances between sightings on successive days. Adults, on average, moved a minimum of 189.0 ± 80 m (n = 20) and juvenile birds 170.0 ± 94 m (n = 13), with one young adult moving overnight from the bottom to the top of the study area, a distance of 2050 m (No. 37138, Fig. 1).

The areas of the home ranges occupied by adult wekas seen on six or more occasions varied greatly and appeared to be independent of the period of residency (Table 4, MMAP values). Nine adults were

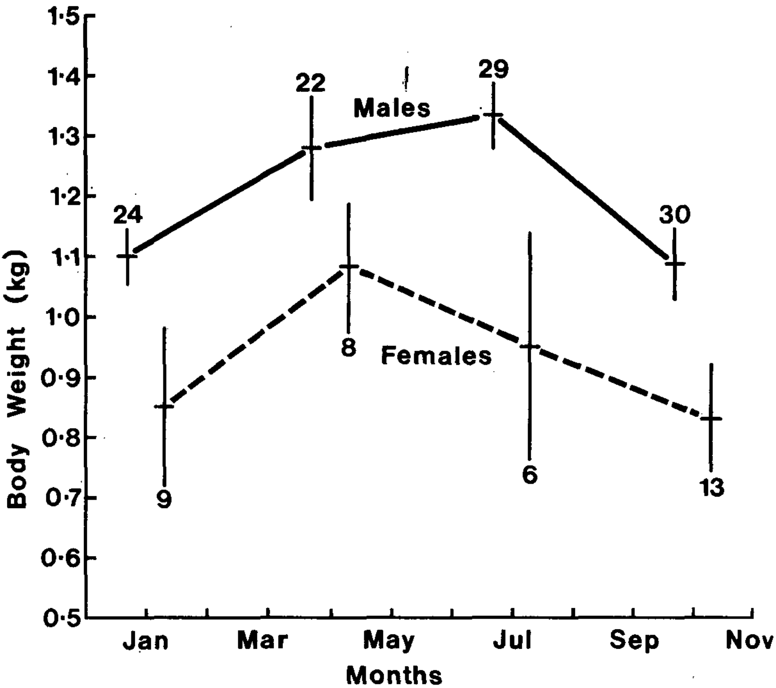

FIGURE 4 — Seasonal variations in the body weights of adult males and adult females. Each seasonal entry is represented by a mean, 95% confidence limits, and the sample size.

confined to areas of 4.5 ha or less. For example, weka 29363 was seen on 22 occasions over 33 months and had a home range of only 1.75 ha (Fig. 1). Even smaller home ranges were recorded for some adults, but these birds were rarely seen. Conversely, four adults had much larger home ranges (e.g. 29364, see Fig. 1) and appeared to move freely throughout them. The data were not robust enough for a detailed study of sex-related home ranges. Only two adult females were seen repeatedly, and their limited ranges may not have been typical.

Home range diameters of adult wekas averaged 710 ± 268 m and, like range areas, were quite variable (Table 4).

Two juveniles were seen on 11 occasions each. Both birds occupied ranges between 5.5 and 6.0 ha, a little greater than that of most adults.

Only five birds were seen often enough as both juveniles and adults to show any change in range location with age. Four moved to new ranges at maturity, while one retained its juvenile range.

TABLE 4 — Home range sizes and range diameters of adult wekas

Band Number	Sex	No. of Sightings	Period of Residency (months)	Home Range Diameter (m)	Home Range Area (ha) MAP	MMAP*
29363	M	22	33	300	1.75	1.75
29364	M	16	25	1000	28.25	28.25
29381	M	6	5	290	0.50	0.50
29382	M	6	33	900	11.00	1.75
37101	F	7	20	425	3.75	0.50
37104	M	10	18	600	7.75	4.50
37113	M	8	7	800	9.25	9.25
37119	M	9	17	850	2.25	1.65
37124	M	11	15	700	14.75	14.75
37130	M	10	9	350	3.00	2.00
37135	F	8	5	400	2.50	2.50
37138	M	8	9	2100	69.00	12.75
37159	M	6	3	500	1.10	0.75

Note: MAP and MMAP expanded in methods section.

Some data on the long-range dispersal of wekas was obtained. The most dramatic were an adult male found dead 35 km from the study site 7 weeks after banding and an unsexed juvenile found dead 9 km away 6 weeks after banding. Lesser movements were shown by two other unsexed juveniles seen 2.0 and 4.5 km from the study site about 12 months after banding. All four recoveries were made beyond major rivers or lakes, and two from beyond major mountain ranges.

Foods

The foods identified from 35 Western Wekas taken mostly in winter consisted of a very wide range of plant and animal tissues (Table 5). Dominant vegetative items included both plant foliage and fruits, mostly from forest species. Animal foods included invertebrates and vertebrates. In addition, all birds contained enough gravel to suggest deliberate ingestion.

The commonest food was fruit scavenged from the forest floor. Large numbers of seeds of *Coprosma* spp. (particularly *C. pseudocuneata, C. parviflora, C. rigida* and *C. rhamnoides*) occurred in 86% of all stomachs examined. Other hardwood fruits included those of *Carpodetus serratus, Myrsine divaricata* and *Pennantia corymbosa.*

TABLE 5 — The foods identified from the stomachs of 35 wekas

CLASSIFICATION			N	%F	$\%F^{c}$
Plant Foods					
Foliage -	Dicotyledoneae		-	65.7	16.7
	Monocotyledoneae		-	17.1	61.1
	Pteridophyta		-	28.6	11.1
Seeds -	Forest spp. -	Coprosma spp.	1875	85.7	5.6
		Nertera sp.	250	25.7	-
		Podocarpus spp.	34	20.0	-
		Dacrydium sp.	125	2.9	-
		Carex sp.	32	14.3	-
		Other	62	20.0	/
-	Pasture spp.-	Gramineae	9	8.6	50.0
		Other	5	8.6	/
Animal Foods					
Insecta -	unident. remains		-	51.4	/
	Diptera		14	11.4	5.6
	Coleoptera		20	8.6	>44.4
	Other		4	11.4	>50.0
Arachnida			8	22.9	5.6
Crustacea			1	2.9	22.2
Myriapoda			1	2.9	38.9
Mollusca			5	5.7	5.6
Annelida			-	80.0	66.7
Vertebrata -	Reptilia		1	2.9	-
	Amphibia - Litoria sp.		1	2.9	-
	Marsupialia - Trichosurus sp.		-	14.3	-
	Rodentia		2	5.7	-
	Unident. flesh		-	22.9	-

Note: N - Total number of items ingested, %F - Percentage of stomachs containing each food item. Items which defied numerical estimation have been scored only as %F.

$\%F^{c}$ gives percentage frequency of food items of 18 North Island Wekas (Gallirallus a. greyi) taken during June-August (Carroll 1963a) when data are comparable. Items identified from both studies but not in a comparable form (/) and Western Weka food items not identified by Carroll (-) are also listed.

Fruits of *Podocarpus ferrugineus* and *P. totara* were also taken. Fruits of pasture species were insignificant in the diet. Foliage occurred in many stomachs, mostly as unidentified dicotyledonary tissue, but grasses, fern and moss leaves were also common.

Wekas ate a wide range of invertebrates, mostly insects, spiders and worms. Few birds ate vertebrates but the size of the vertebrates made them more important in the diet than their numbers suggest. Thus, remains from a lizard, a frog, two rodents and several possums were identified as well as several unidentified portions of flesh. The wekas had probably captured the smaller vertebrates but scavenged the possum tissue from carcasses. Other mammals were also eaten because on one occasion, we saw a weka kill a young (1 kg) hare.

DISCUSSION

The population statistics of *Gallirallus a. australis* outlined above show close agreement with those presented in the limited literature available. The most striking observation made during the present study was the apparent reduction in population size between 1975 and 1978, indicated through trap catches and live sightings, despite seemingly unlimited food and vigorous breeding, i.e. clutches of up to four eggs, multibrooding (also recorded elsewhere, see Trail 1951, Martin 1954), attentive and defensive parents, and rapid maturation of chicks. Trap catch alone is unconvincing evidence of population change as wekas clearly differ individually in how readily they can be trapped. Live sightings of marked birds is a more reliable indicator of population change, as free birds seemed uninterested in nearby human observers throughout the study period. Certainly, there is no evidence of an increasing avoidance of observers as the study progressed. Taken together, we believe trap catch and live sightings reliably reflect trends in the total population.

Fluctuations in weka populations are almost legendary. Not only have there been dramatic reductions in the overall range occupied by the species since European colonisation, but in the last half century many local colonisations and population collapses have been recorded, e.g. Davenport (1950), Gee (1956), Carroll (1963a). Suggested reasons have included local migrations (Oliver 1955), burning of tussock lands (Smith 1888, Buller 1898), death in possum traps (Moncrieff 1941), avian epidemics (Carroll 1963a) and predation by small mammals (Kirk 1895, Deeming 1948). However, Williams (1973) argued that wekas appeared to maintain themselves quite successfully in the presence of mammalian predators. The presence of stoats *(Mustela erminea)*, rats (*Rattus* spp.) and feral cats *(Felis catus)* has not prevented the weka from recently colonising our study area or other South Island areas known to us, and so predators are unlikely to cause the weka's demise elsewhere.

Food is a factor which limits some bird populations, particularly of species with specialised diets (Lack 1954). Western Wekas appear quite catholic in diet, and the same seems true of the North Island Weka (Carroll 1963a, see Table 5). Birds in both areas rely heavily on foliage, on insects and on earthworms. Dietary differences result mainly from the differences in the habitat occupied by wekas in each area. Thus, birds taken from a forest-dominated environment in Westland depend heavily on the fruits of forest species. By comparison birds collected from rough pasture/scrubland situations about Gisborne depend largely on the fruits of Gramineae and pasture weeds. Vertebrates were commonly taken by Western Wekas but only rarely by Gisborne birds. Altogether, the availability of food seems unlikely to be limiting the weka population of this study.

Likely reasons for local weka losses are avian diseases, endoparasites, or both. Laird (1950) argued that avian diseases are " perhaps the only theory which can even partially explain the wholesale disappearance of certain species . . ." No avian diseases were detected in our study. However, a heavy infestation of an endoparasite was recorded and although its identity is unknown, its incidence and the amount of non-functioning liver tissue indicate a local epidemic leading at the very least to birds in suboptimal health. Similar parasitic granulomas have been seen in other wekas and in Pukeko *(Porphyrio porphyrio melanotus)* (J. Hutton, AHD, MAF), but their effect on the host is not known.

Weka samples trapped or sighted in the study area contained a preponderance of males amongst both juveniles and adults. Sex ratios in nature are not always at 1:1 equilibrium ratio — indeed extraordinary sex ratios are frequently described (Hamilton 1967). Some form of sampling bias can often be responsible, although in the present study we found no evidence that female wekas are less mobile or observable than males. Trapping may well have been male selective, and if so, would in turn have led to male-dominated sight records. The strongly biased kill-trap sample was less easily dismissed, as there wekas were taken in unlured gin traps set on possum 'runs' which rely on animals unwittingly entering them. We therefore argue that such consistent and overwhelming bias must reflect the sex ratio of the total population. Such an imbalance in the sex ratio of a monogamous species like the weka is unlikely to be a permanent population feature. We suggest that the reduction in population size recorded in this study could be due to a recent differential loss of females, resulting from a seasonal increase in the pathogenicity to females of the liver parasite described. For all birds, the liver stores considerable food reserves which in females are in part mobilised for egg production (Bellairs 1964). Thus a decrease in liver function for whatever reason can result in critical physiological stresses during egg laying.

The recolonisation by wekas of lands formerly occupied by them occurs freely and frequently and is attributable directly to the species' remarkable mobility and dispersal capabilities — especially when its flightlessness is borne in mind. Seemingly severe geographic barriers are overcome regularly and with ease. Blackburn (1964) and Trail (1951) recorded wekas regularly swimming substantial rivers and estuaries, Penniket (1955) found abundant weka sign on the crests of mountain ranges, and Robertson (1976) recorded a weka 'transplant' moving about 300 km in 6 weeks, including a traverse of the Auckland Isthmus. Not to be outdone, Wright (1981) reported three transplanted birds returning to old home ranges in several days via 900 m of strong tidal current. By comparison, dispersal movements witnessed in the present study almost pale into insignificance, except that the outflow of young birds into adjacent weka-free areas may also help account for the real losses of birds recorded from the study area.

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