THE DIET OF THE AUSTRALASIAN HARRIER (Circus approximans) IN THE MANAWATU-RANGITIKEI SAND COUNTRY, NEW ZEALAND

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ABSTRACT

Of the 477 food items identified in the diet of the Australasian Harrier, mammals (46%) were the main food. Birds and their eggs (41%) were the next most numerous food, and insects (8%) and fish and frogs (5%) were in about equal numbers. Live prey was numerically more important than carrion in all seasons and especially during summer. However, the biomass of carrion eaten annually was greater than that of live prey. Food items were taken according to their availability, and not according to preferences of the predator. The legal protection of the Australasian Harrier in New Zealand is recommended.

INTRODUCTION

Only two diurnal birds of prey are resident in New Zealand: the Australasian Harrier *(Circus approximans)* and the rarer New Zealand Falcon *(Falco novaeseelandiae)*. For a medium-sized hawk the Harrier is common in open country, having been recorded in favoured swamp and sand dune habitat at densities of one bird per 50 ha and one breeding pair per 120 ha (Baker-Gabb 1981). This breeding density is high and falls within the upper limits of the graphed relationship between female body weight and breeding density of 22 species of diurnal raptor (Newton 1979). These observations suggest that in New Zealand the Harrier occupies an unusually important position as a predator and as a consumer of carrion.

Turbott (1967) suggested that before the number of rabbits *(Oryctolagus cuniculus)* was brought under control in the 1950s, Harriers were more numerous in New Zealand than they are today, and Gurr's (1968) data on population declines on the Otago Peninsula clearly support this notion. It may have been this high population density that prompted Stead (1932) to state that the presence of great numbers of Harriers was one of the chief difficulties in establishing game birds in open country. For this reason, and perhaps also because they are said to attack weak lambs and cast sheep occasionally, Harriers remain one of three species of native bird not protected by law in New Zealand. Harriers are still often shot, trapped and poisoned, though not on the scale of former years when bounties were paid for their legs by acclimatisation societies. For example, in the 1930s

NOTORNIS 28: 241-254 (1981)

and 1940s the Otago Acclimatisation Society paid bounties for 26 184 Harriers killed in 7 years (L. Gurr *in litt.*) and the Auckland Acclimatisation Society paid for the killing of 200 000 Harriers in 15 years (Oliver 1938). With this in mind I shall describe the diet of Harriers from a 1200 ha area of the North Island. I shall also discuss whether the seasonal changes in diet I observed were due to changes in food availability or to changes in favour of more palatable prey, as concluded by Redhead (1969).

This research on the diet of the Harrier was undertaken as part of a wider study of the influence of predators on the fauna at Pukepuke Lagoon Game Management Reserve (40°10°S, 175°15°E). The diet of Australasian Harriers has been recorded in five other qualitative studies, but these differed from the present study in that data were not collected from a discrete area where prey populations were also studied. Furthermore, little use was made of field observations or of prey remains at nest sites, fewer food items were recorded, and no attempt was made to separate live prey and carrion in the diet. Carroll (1968) studied the stomach contents of 124 Harriers collected over 3 years from a wide range of North and South Island localities. Redhead (1968, 1969) made a similar study when he analysed the stomach contents of 129 birds and 20 pellets collected from the south-east of the South Island. Douglas (1970) analysed 99 pellets and Fox (1977) 18 pellets cast by Harriers from eastern South Island hill country.

Pukepuke Lagoon is situated 3 km from the coast near the centre of the Manawatu-Rangitikei sand country, an area of approximately 4200 km^2 on the south-west coast of the North Island. Detailed descriptions of the region can be found in the NZ Ecological Society Proceedings (1957), Cowie & Smith (1958), and Cowie *et al* (1967). The study area was dominated by rows of low dunes covered with marram *(Ammophila arenaria)*, spinifex *(Spinifex hirsutus)* and tree lupins *(Lupinus arboreus)*. Between the dunes there were extensive sand plains and peaty swamps where red rush *(Leptocarpus simplex)*, toetoe *(Cortaderia toetoe)*, flax *(Phormium tenax)*, raupo *(Typha orientalis)* and cabbage trees *(Cordyline australis)* were the common plants. Intensively grazed and well-drained pastures of introduced grasses covered about 50% of the study area. About 12% of the area had been planted with pines *(Pinus radiata)*.

METHODS

Data collection and analysis

Between March 1976 and August 1977 a total of 344 pellets (75 from the communal roost, 87 from nest sites, 182 from birds in cage traps), 120 prey remains (from five nest sites), and the stomach contents of five Harriers were collected for analysis. Also recorded were 36 successful attacks on prey and 28 instances of Harriers feeding from carrion.

Stomach contents: The crop and stomach contents of five Harriers found dead in the study area were analysed using the techniques described by Day (1966) and Redhead (1969).

Field observations: Regular field observations are important for recording food items such as frogs, fish and bird nestlings that leave few indigestible remains in pellets (Schipper 1973, Brown 1976). Casual observations are often biased towards large and unusual prey and may be coloured by observer bias and sometimes by misidentified prey.

Prey remains: I gathered most of the prey remains from five nest sites and their associated plucking stations, after the young had fledged. Thus a bias in favour of prey taken during the second half of the breeding season exists. I also collected prey remains from two of five nests when I visited them once to weigh and band the nestlings 2 weeks before fledging. Ten collections were made from plucking stations near three other nest sites during the incubation period.

The numbers of large prey items found at nest sites such as rabbits, hedgehogs *(Erinaceus europaeus)*, ducks and Pukekos *(Porphyrio porphyrio)* were calculated from the number of skulls, legs and wings recovered. Adult and fledgling Passeriforme feathers were identified by comparing them with specimens from a reference collection. I did not try to distinguish Skylarks *(Alauda arvensis)* from New Zealand Pipits *(Anthus novaeseelandiae)* in prey remains.

Pellets: Harrier pellets consist of the undigested residue of food from the stomach. Bone is readily dissolved by Harrier digestive juices, and so the pellets consist largely of hair, feathers or chitinous insect parts, and often vegetable matter. Misidentified pellets were most unlikely because pellets were collected from trapped birds, nest sites and communal roosts only.

I soaked pellets in water overnight and then teased them apart on a shallow white tray. After macroscopic examination a representative sample of hairs and feathers were mounted in 70% alcohol and examined microscopically. By not examining microscopically every hair and feather from every pellet I probably overlooked a few prey items. Mounted hairs and feathers were identified using the key developed by Day (1966), which identifies mammalian hair to genus or species but feathers to order only. Those feathers I could not classify to species level on macroscopic characteristics were from Passeriformes and Anseriformes. Because Day did not separate hare *(Lepus europaeus)* and rabbit hair on microscopic structure, I examined 182 pellets known to contain hair from either hares or rabbits used as trap bait. I found that pellets containing the hair of hares were markedly paler and so I used this character to distinguish it in pellets. To reduce the bias from contamination of pellets by rabbits and hares used as baits, the frequency of lagomorphs in the diet from this source (pellets from traps) was assumed to be the same as their frequency from all other uncontaminated sources.

Small insects such as ladybirds (*Coccinella* sp.) were found only in pellets that also contained the remains of insectivorous birds, and so these insects were not regarded as occurring in the diet of the Harrier in their own right.

The data of Glading *et al.* (1943) on food presented to captive hawks, including harriers (*Circus* sp.), confirmed that the occurrence of each species in a pellet corresponded roughly with one prey item. I have followed this guideline in estimating numbers of prey in pellets. unless numbers of identifiable parts indicated otherwise. A range of one to four prey species was found in pellets. The results are presented as the percent frequency of each food compared with the total number of items identfied. The prey remains and field observations were combined with the results from the pellet analyses. Schipper (1973) has demonstrated that when data from several sources are combined the results are more comprehensive.

Biomass of food eaten

Prey and carrion of vastly different biomass are considered equal when evaluated only in terms of their frequency in the diet. It is also biased to consider, for example, that all of the weight of an animal such as a 3 kg hare contributes to the diet when only a small fraction of the animal may be eaten. To reduce these biases an estimate of the biomasses of the foods eaten was calculated. The assumptions made below are subject to considerable variation and so only general conclusions have been made concerning the relative importance of classes of animals in the diet.

When fed regularly in captivity, both adult and nestling Harriers consumed about 120 g of meat per day (Redhead 1969). However, hungry Harriers may consume up to 240 g of tissue in one meal, but rarely more than this (Robertson 1978), and so animals larger than 300 g (see below) were considered to be wasted food. Harriers have not been seen to cache prey and so left-over food would be likely to be eaten by another Harrier or another predator. During the breeding season, however, an upper limit of 500 g of useable food was chosen, based on what I have seen a male Harrier carry and what a family of two adults and one or two nestlings might reasonably consume.

In addition to not being able to eat some of the available tissue of large (> 300 g) animals, Harriers did not eat, or regurgitated as pellets, some parts of all animals such as large bones, hair, feathers and gut contents. From feeding trials with captive birds wastage factors were calculated to be: 33% for large (> 300 g) mammals, 20% for large birds, 17% for medium-sized (75-300 g) mammals, 12% for medium-sized birds, 9% for small (< 75 g) mammals and 5% for small birds, fish, frogs and insects (Fox 1977, Baker-Gabb unpublished data). Weights of animals were taken from Fox (1977), Baker-Gabb (1978), Robertson (1978) and specimens in the National Museum of Victoria.

Bird prey counts

Five times per season I recorded the number of passerines observed as I walked a 2.5 km transect through equal areas of open farmland, duneland, pines and raupo. Counts were made early in the morning on fine calm days.

The data from the four vegetation types were weighted to match the proportion of the vegetation types in the study area. They were then combined to give a measure of relative seasonal abundance rather than absolute density of passerines (Emlen 1971).

Live prey and carrion in the diet

Medium-sized (75-300 g) and small (< 75 g) land birds, golden bell frogs *(Littoria aurea)*, large insects, house mice *(Mus musculus)*, brown rats *(Rattus norvegicus)* and juvenile rabbits were classed as live prey, while all sheep *(Ovis aries)*, brush-tailed possums *(Trichosurus vulpecula)* and prions (*Pachyptila* sp.) were classed as carrion. I found ten prions dead in the study area after a summer storm, and so the four prions in the Harriers' summer diet had probably been found dead. Brush-tailed possums are nocturnal and so are available only as carrion.

I could not be sure whether the following species that occurred in the diet were live prey or carrion because I did not see them being taken. Thus, most rabbits, hares, hedgehogs, ducks, Pheasants *(Phasianus colchicus)*, Pukekos and Australian Magpies *(Gymnorhina tibicen)* were placed in a category termed " unknown."

Harriers kill both adult and juvenile rabbits and hares (Buller 1888, Sharland 1932, Stead 1932, Douglas 1970). I have seen them kill juvenile rabbits and eat rabbit and hare carrion.

Although hedgehogs are mainly nocturnal (Brockie 1957), I sometimes saw hedgehogs foraging during the day in all seasons except winter. It is not certain that Harriers can kill hedgehogs, but the occurrence of juvenile hedgehogs in prey remains at nest sites suggests that they may be taken as live prey at this stage. Robertson (1978) saw a juvenile Harrier capture a medium-sized hedgehog during the day, but when the bird was flushed 20 minutes later the hedgehog was curled up and alive. Hedgehogs are frequently recorded as roadside carrion (Brockie 1963, Baker-Gabb 1978, Robertson 1978), and they are often taken by Harriers. Hedgehogs recorded in this study at nest sites were probably not road-killed because the recorded home ranges of the nesting Harriers did not include any public roads. Douglas (1970) found hedgehog remains at nest sites 10 km from the nearest country road.

I have found no evidence in the literature of Harriers killing adult game birds. I have seen them flush ducks, Pheasants and Pukekos more than 100 times, but the birds either successfully defended themselves or evaded the Harrier. However, Harriers do occasionally take

young game birds (W. Pengelly, A. Garrick, *in litt.*) and I have seen them kill 4-month-old Domestic Fowls *(Gallus domesticus)* that had no cover into which to escape. Game birds in pellets and prey remains were therefore placed in the same *unknown* category as hedgehogs and most rabbits and hares.

RESULTS

The results of all four analyses of data are given in Table 1 and summarised in Figures 1 and 2. Of the 477 food items, mammals (46%) were the main food, birds and their eggs (41%) were the next most numerous food, and insects (8%) and fish and frogs (5%) were about equal. In terms of biomass eaten, mammals (71%) were much more important than birds and their eggs (25%) and fish and frogs (4%). Insects contributed less than 0.1%.

Rabbits (17%), hedgehogs (9%), sheep (8%) and house mice (8%) were the most frequently taken mammalian foods; being eaten in all seasons. Brown rats (2%), brush-tailed possums (2%) and hares (0.5%) were recorded infrequently.

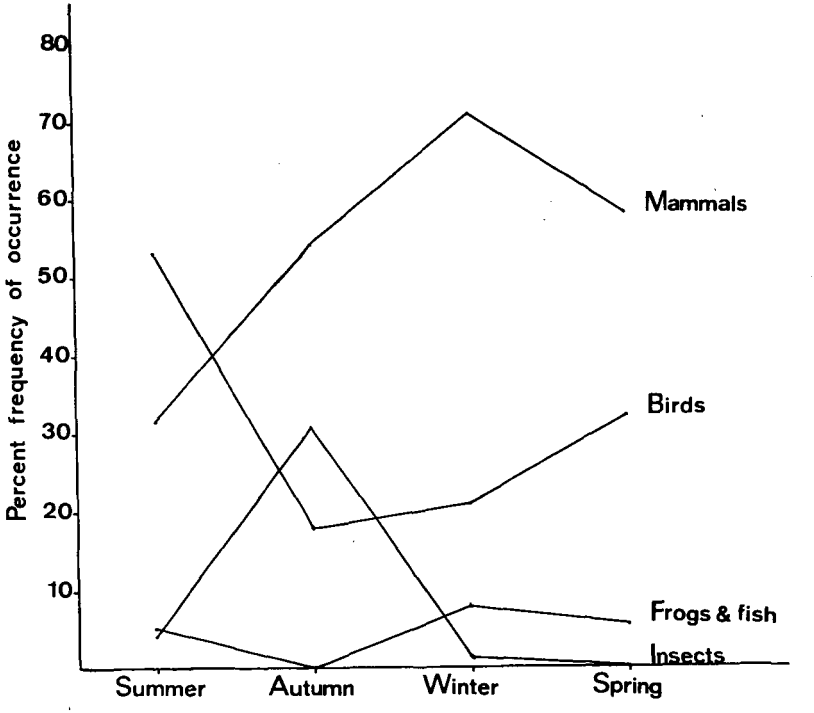

FIGURE 1 — Seasonal occurrence of classes of food in the diet of the Australasian Harrier.

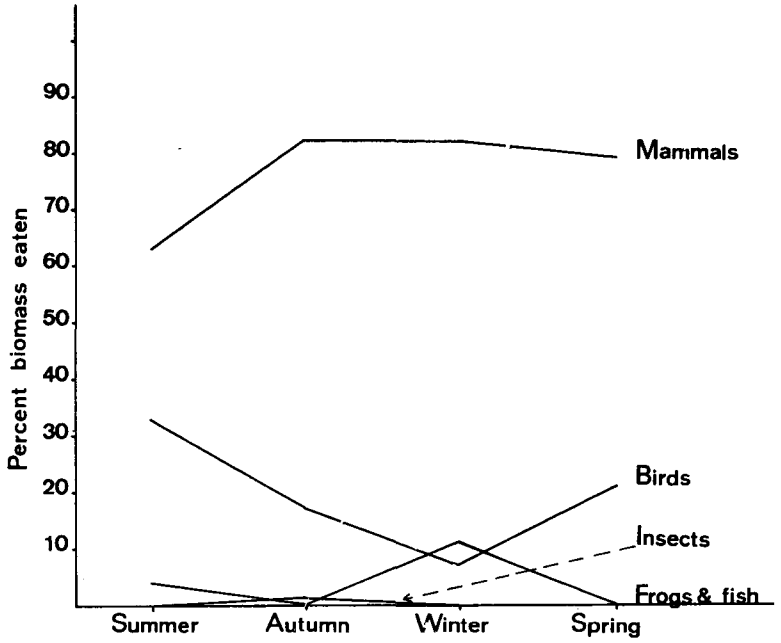

FIGURE 2 — Biomass of classes of food eaten by the Australasian Harrier.

The highest percentage of rabbits was eaten in autumn and winter, when they were probably taken as carrion. I saw rabbit carrion used 11 times in these seasons (compared with only twice in spring and summer), and I also found shotgun pellets and rabbit hair together in two pellets collected in winter. A source of rabbit carrion in the study area was provided by the Manawatu Pest Destruction Council (MPDC) which shot and poisoned rabbits, particularly in winter when control operations are most successful because grass growth is least (N. Bowick *pers. comm.*). During autumn and winter most rabbits were of adult size, whereas in summer 65% (20) of the rabbits collected as prey remains at nest sites and plucking stations were classed as immature from their skull measurements. These immature rabbits were probably taken mainly as prey because both of two fresh carcases examined at nests had haemorrhage marks where the Harrier's claws had punctured the skin.

Hedgehogs occurred fairly regularly in the diet throughout the year, although fewer were taken in spring. The winter records were probably carrion because many die at this time of year from diseases such as pneumonia, or drown while hibernating (Brockie 1957). Some of the remains of 20 hedgehogs found at nest sites may have been live

prey, for skull measurements showed that 40% were juveniles, an age group more easily taken alive.

Most (79%) sheep in the diet were eaten in winter and spring. The high frequency of occurrence of wool in spring (33%) indicates how important sheep carrion is when it is available during the lambing

TABLE 1 — Seasonal diet of the Australasian Harrier

	Summer Dec-Feb		Autumn March-May		Winter June-Aug		Spring Sept-Nov		Totals	
	n[1]	%[2]	n	%	n	%	n	%	n	%
Rabbit	31	12.7	22	25.9	22	23.9	7	12.3	82	17.2
Hare	2	0.8	-	-	-	-	-	-	2	0.4
Hedgehog	20	8.2	10	11.8	12	13.0	3	5.3	45	9.4
Possum	4	1.7	1	1.2	2	2.2	2	3.5	9	1.9
Sheep	5	2.0	3	3.5	11	12.0	19	33.3	38	8.0
Brown rat	-	-	4	4.7	4	4.3	-	-	8	1.7
House mouse	15	6.2	6	7.0	14	15.2	2	3.5	37	7.8
Total mammals	77	31.6	46	54.1	65	70.6	33	57.9	221	46.4
Duck	5	2.0	5	5.9	2	2.2	3	5.3	15	3.1
Pheasant	5	2.0	2	2.4	-	-	3	5.3	10	2.1
Pukeko	6	2.5	-	-	-	-	1	1.7	7	1.5
Prion	4	1.7	-	-	-	-	-	-	4	0.9
Aust. magpie	1	0.4	-	-	-	-	-	-	1	0.2
Blackbird	6	2.5	1	1.2	2	2.2	1	1.7	10	2.1
Starling	2	0.8	-	-	-	-	-	-	2	0.4
Hedge sparrow	19	7.8	-	-	1	1.1	2	3.6	22	4.6
House sparrow	5	2.0	1	1.2	1	1.1	-	-	7	1.5
Skylark/Pipit	5	2.0	-	-	-	-	1	1.7	6	1.3
Yellowhammer	14	5.8	-	-	3	3.3	2	3.6	19	4.0
Greenfinch	6	2.5	-	-	-	-	1	1.7	7	1.5
Chaffinch	4	1.7	-	-	-	-	-	-	4	0.8
Goldfinch	2	0.8	-	-	2	2.2	-	-	4	0.8
Silvereye	1	0.4	-	-	1	1.1	-	-	2	0.4
Grey warbler	1	0.4	-	-	-	-	-	-	1	0.2
Unidentified passerines	43	17.8	4	7.0	5	5.3	1	1.7	53	11.2
Total birds	129	53.1	13	17.7	17	18.5	15	26.3	174	36.6
Eggs	15	6.2	-	-	2	2.2	6	10.5	23	4.8
Frog	6	2.5	-	-	-	-	3	5.3	9	1.9
Carp	2	0.8	-	-	1	1.1	-	-	3	0.6
Eel	4	1.7	-	-	6	6.5	-	-	10	2.1
Total	12	5.0	-	-	7	7.6	3	5.3	22	4.6
Coleoptera	1	0.4	-	-	-	-	-	-	1	0.2
Hemiptera	3	1.2	1	1.2	1	1.1	-	-	5	1.0
Orthoptera	6	2.5	25	29.4	-	-	-	-	31	6.4
Total insects	10	4.1	26	30.6	1	1.1	-	-	37	7.6
TOTALS	243	100.0	85	100.0	92	100.0	57	100.0	477	100.0

[1] n = Estimated number of individuals

[2] % = Per cent of total individuals

season in late winter and spring when stock losses are greatest. In contrast, sheep made up only 2% of the summer diet.

Mice were taken in all seasons, but the highest percentage occurred in winter, and the lowest in spring. Brown rats were recorded only in the autumn and winter diets. The capture rates of these rodents paralleled the pattern of population changes in rodents, whose numbers increase from late summer through to winter, when they decline (Daniel 1978, Fitzgerald 1978).

Of the 138 (29%) passerines in the diet, one was a large (> 300 g) bird, 12 were medium sized (75-300 g) and 125 were small (< 75 g). The summer peak of passerines in the diet (109) corresponds with the peak in relative abundance (Table 2). There was a positive, but non-significant, correlation (Spearman's $r = 0.4$, $p > 0.05$) between the number of passerines counted and the number in the diet.

Of the 36 passerines identified in prey remains from Harrier nest sites, 20 (56%) were nestlings or fledglings, showing that Harriers took advantage of this abundant and vulnerable food source when it became available. Most passerine species which were commonly seen in the study area were represented in the diet; however, six species occurred infrequently. Magpies were available only as carrion. Starlings *(Sturnus vulgaris)* usually foraged in open farmland, which Harriers did not hunt at Pukepuke Lagoon (Baker-Gabb 1978). When they foraged in swampland and duneland in autumn and winter, Starlings moved in flocks, which provide protection from predators (Tinbergen 1951). Silvereyes *(Zosterops lateralis)* and Grey Warblers *(Gerygone igata)* are agile restless birds which remain within or close to cover while foraging in shrubs (Soper 1963). Fantails *(Rhipidura fuliginosa)* and Welcome Swallows *(Hirundo tahitica neoxena)* are unlikely prey because they forage on the wing and Harriers take most of their prey on the ground (Oliver 1955, Baker-Gabb 1978).

Thirty-two game birds, including ducks, Pheasants and Pukekos, comprised 7% of the annual diet. They were identified most frequently in the spring, summer and autumn diets. All 16 game birds in the

TABLE 2 — Average number of passerines counted seasonally along 2.5 km transect

Bird size	Summer Dec-Feb	Autumn March-May	Winter June-Aug	Spring Sept-Nov
Large (> 300 g)	19.0	16.1	12.5	25.0
Medium (75-300 g)	19.0	9.9	11.0	8.5
Small (< 75 g)	163.0	60.5	50.0	102.5

summer diet were identified from prey remains, 15 being adults and one a duckling. The number of game birds in the study area was high. NZ Wildlife Service personnel have recorded the breeding success of ducks in 80 ha of wetlands at Pukepuke Lagoon. During the 9 years from 1970 to 1978 a minimum of 706 duckling broods have been produced, with approximately 700 ducklings hatched each year (A. Garrick *in litt.*). Large numbers of Pukekos bred in the area. Some Pheasants bred, and others were regularly released in the surrounding farmland for sportsmen to shoot.

The 23 eggs in the spring and summer diets included three duck, two Pheasant, two Blackbird *(Turdus merula)*, four Hedge-sparrow *(Prunella modularis)*, five Skylark and seven unidentified eggs.

All 22 frogs, eels (*Anguilla* spp.) and carp were found as prey remains, rather than in pellets. Nine frogs were caught during spring and summer, while three carp and ten eels were recorded in the summer and winter diets.

I did not see many large insects until late summer and they did not occur in nest site pellets or prey remains. Most insects occurred in pellets collected from the communal roost and trapped birds during autumn. The insects in the diet were predominantly orthopterans (6%) and hemipterans (1%).

Live prey and carrion in the diet

Table 3 shows that, excluding the *unknown* category, live prey (77%) was the most numerous food in the annual diet. There was a significant difference between the numbers of live prey and carrion items

TABLE 3 — Live prey and carrion in the diet of the Australasian Harrier

Food	Summer Dec-Feb			Autumn March-May			Winter June-Aug			Spring Sept-Nov		
	n[1]	%[2]	%[3]	n	%	%	n	%	%	n	%	%
Live prey	171	71	33	42	49	8	37	40	11	25	44	8
Carrion	18	7	19	17	20	36	27	29	31	21	37	54
Unknown	54	22	48	26	31	54	28	31	58	11	19	38
Total	243	100	100	85	100	100	92	100	100	57	100	100

[1] n = estimated number of individuals

[2] % = per cent of total individuals

[3] % = per cent of biomass eaten

eaten seasonally ($X^2 = 46.7$, $p < 0.001$), mainly due to the disproportionate numbers eaten during summer. During winter and spring there were approximately equal numbers of live prey and carrion in the diet.

Excluding the *unknown* category, the biomass of carrion eaten in all seasons was more than twice that of live prey, except in summer, when live prey predominated. The *unknown* category accounted for half of the biomass eaten, and it is my opinion that most of this would have been made up of carrion, although this cannot be proved.

DISCUSSION

In summary, large insects, rabbits, hedgehogs and rodents occurred frequently in the autumn diet. These mammals remained important during winter and spring, but large insects were no longer available then. At this time the diet changed to include considerable sheep carrion. In summer, it changed back to live prey, particularly passerines and their eggs and young, and to a lesser extent juvenile rabbits.

Live prey and carrion in the diet

The Harriers at Pukepuke Lagoon drew their food from a wide range of live prey and carrion and they ate greater numbers of live prey than carrion annually. However, in the annual diet the biomass of carrion eaten was greater than that of live prey. In summary, both live prey and carrion were important, with live prey being more so in summer and carrion more so in the other three seasons.

Food availability versus palatability

Redhead (1969) recorded similar trends in species composition in the diet of the Australasian Harrier to those outlined above. He stated, without supporting evidence, that the summer changes were a move from a staple mammalian diet to a preferred one, and that birds, particularly passerines, and their eggs were taken in preference to all other foods available at the time.

In this study the seasonal changes in the diet closely matched seasonal changes in prey densities and vulnerability and in carrion availability. Therefore, I believe that birds took the foods that were available, not what they are supposed to prefer. It has been shown that Harriers made good use of sources of rabbit and sheep carrion, killed inexperienced young mammals and birds in spring and summer, and included birds' eggs and insects in their diet when they were available.

Douglas (1970) provided further support for the availability hypothesis. In his Harper-Avoca study area, hare carrion was unusually abundant in summer. In this season 76% (34 items) of the Harriers' diet was mammalian (56% hare), and only 15% (7) was insect and 9% (4) was avian.

From a series of experiments with carrion baits, Robertson (1980) found that rats and domestic fowl pullets were consistently favoured by Harriers ahead of eels, rabbits and possums. He concluded that, rather than selecting particular species, Harriers chose the smaller (< 300 g) carrion items because they were able to carry them to nearby cover where other Harriers were less likely to disturb them. When rabbit carcases were provided, some with exposed flesh and some with their skin intact, the birds chose to feed from those with flesh readily available.

It is possible that Harriers find hare and rabbit carrion more palatable than possum because, when a choice between these species has been offered, Harriers have nearly always eaten the lagomorphs first (Baker-Gabb 1978; Robertson 1978, 1980; Fennell 1980). These choices may also be influenced by the ease of handling because the thicker skins of possums may be more difficult for Harriers to penetrate.

A considerable body of evidence shows that population density of raptors is limited primarily by food availability in all seasons (Newton 1979) and that raptors hunt where they find a particular prey species at its highest density (Craighead & Craighead 1956, Rusch *et al.* 1972, Schipper 1973). If this was not the case and there was sufficient food for raptors to follow consistently their palatability preferences, population densities of raptors would increase until food availability was once again limiting.

Sampling techniques

From the data of Carroll (1968), Redhead (1968, 1969), Douglas (1970) and Fox (1977), Australasian Harriers in widely separate New Zealand localities have a similar diet to that found in this study. Differences between the studies in the use of particular foods are mainly due to variations in the prey and carrion available in the habitats sampled and to differences in sampling techniques. A lower frequency of frogs, fish and bird nestlings was recorded in these other diet studies, probably because field observations and prey remains were not included. In his study of the diets of three species of harrier, Schipper (1973) also noted that frogs, fish and bird nestlings were recorded at much lower frequencies when field observations and prey remains were not included.

Legal protection

The study area I used was centred on a game management reserve where the number of game birds was high. It follows from my predictions concerning prey and carrion availability that the frequency of game birds in the diet of Harriers would be higher at Pukepuke Lagoon than in most parts of New Zealand. It was in fact higher than the frequency of game birds in the diet (3%) combined from five other studies (Carroll 1968, Redhead 1968, 1969, Douglas 1970, Fox 1977), but it was still low at 7% of the annual diet.

All game birds I recorded in the diet were adults, except for one duckling taken as live prey. Probably most adult game birds were carrion or moribund birds because I saw six (20%) eaten as carrion but no successful attacks. Carrion was available in the form of birds that had died from natural causes, ducks that had died following ingestion of lead shot (Caithness 1974) and game birds that were shot and not retrieved during the shooting season. In the years 1970-1978 an annual average of 616 ducks shot and recovered and 54 shot but not recovered has been recorded at Pukepuke Lagoon (A. Garrick, *in litt.*). Thus, quite apart from the point that Harriers may help to control predators of game birds and their eggs, Stead's (1932) assertion that the presence of large numbers of Harriers is one of the chief difficulties in establishing game birds in open country now seems to be unfounded.

Like Carroll (1968), I can find no first-hand evidence of Harriers attacking and killing lambs or sheep, let alone their causing significant economic losses to sheep farmers. Because six studies from throughout New Zealand have now shown that a minimum of 96% of 1122 food items in the Harriers' diet were either of no economic value or harmful to man's interests, there seems no reason why the Australasian Harrier should not be given the same legal protection in New Zealand as other native brids.

ACKNOWLEDGEMENTS

This paper is based on a section of a MSc degree completed at the Botany and Zoology Department, Massey University, Palmerston North. I would like to thank my two supervisors, L. Gurr (Massey University) and P. Moors (NZ Wildlife Service), for their interest and encouragement throughout the study. I received a travelling expenses grant of $300 from the NZ Wildlife Service. A. Garrick and T. Caithness kindly provided unpublished data on waterfowl numbers at Pukepuke Lagoon. I am grateful to L. Gurr for the unpublished data on bounties paid for Harriers in Otago. I would like to thank Prof. J. M. Cullen, P. Dann and H. A. Robertson for their helpful comments on a draft of this paper.

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SHORT NOTE

ANOTHER NANKEEN NIGHT HERON

The photograph of the juvenile Nankeen Night Heron at Owaka (*Notornis* 28: 218) was responsible for the identification of a previous specimen, observed some years ago but not recognised at the time. The notes of this sighting have been languishing in my files since August 1973 when it was reported by Mr J. A. McCluggage of Pohokura, Taranaki.

Mr McCluggage's description of the bird, seen on his farm, and which remained in the area for some months, tallies with all features of a juvenile Night Heron. Mr McCluggage, who now lives in Thames, has confirmed the identification from the *Notornis* photograph.

It also seems appropriate at this time to document a further apparently unrecorded adult specimen of the Night Heron, which is now in the Taranaki Museum. Unfortunately the only data recorded is that the bird was " shot near Cape Egmont " by Newton King. As a permanent pakeha settlement did not begin in the area until 1881 the specimen is likely to have been taken some time between then and 1927 when King died.

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