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Food niches of sympatric Marsh Harriers *Circus aeruginosus* and Hen Harriers *C. cyaneus* on the Dutch coast in winter

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Analysis of pellets collected from adjacent communal winter roosts of Marsh Harriers *Circus aeruginosus* and Hen Harriers *C. cyaneus* on an extensive saltmarsh in the southwest Netherlands showed highly significant differences between the diets of the two species. Marsh Harrier diet showed no change throughout January, February and March. They specialized on ducks, which were about half of their prey numerically and more important by weight. Although Marsh Harriers sampled other prey, this remained at a low level and showed no seasonal response to the availability of young lagomorphs. Hen Harriers occupied the niche of a generalist predator, having a broader diet and responding to the presumed changes in availability of prey with diet shifts. In November, about half of their prey items were passerines but these declined in importance in December, and small mammals rose. The proportions of both small mammals and birds fell in February and March, due to increasing dependence on young lagomorphs. Diet overlap between the two species was greatest in January and declined in February and March.

The winter diets of sympatric Marsh and Hen Harriers *Circus aeruginosus* and *C. cyaneus* have never been compared. Schipper *et al.* (1975) studied the hunting behaviour of Marsh and Hen Harriers in winter in Flevoland (central Netherlands), and Schipper (1973) gave data on the winter diet of Hen Harriers but could not determine the diet of Marsh Harriers quantitatively there, as the species was scarce.

We found a substantial roost of Marsh Harriers in the far southwest of the Netherlands, at a point about 150 km south of the northern boundary of the wintering range of the species according to Cramp & Simmons (1980). The roost was adjacent to a substantial roost of Hen Harriers and so provided an ideal opportunity to compare the winter diets of the two species by analysis of pellets collected from their roosting forms. Unlike the mixed roosting described in Zijlstra (1987), the two species roosted quite apart, in different habitats, and only rarely were individuals of one species seen to join the roost of the other. The risk of contamination of samples of pellets of one species by pellets of the other was therefore minimal.

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ROOST SITES AND CATCHMENT AREA

The harrier roosts were situated on Het Verdronken Land van Saeftinghe, a former reclaimed polder lost to the sea. The lower parts of this 2850-ha saltmarsh were dominated by sea club-rush *Scirpus maritimus* favoured by roosting Hen Harriers, sea aster *Aster tripolium*, sea couch grass *Agropyron pungens* and sea arrow-grass *Triglochin maritima*. The higher parts, especially in the less saline east affected by the freshwater output of the river Schelde, had common reed *Phragmites australis* beds where the Marsh Harriers roosted from about November to March. In autumn, a larger number of Marsh Harriers used Saeftinghe for roosting but were more spread out over the marsh.

Upriver, at Antwerp, there were reedy margins and rough wasteland awaiting development at the edges of industrial areas. Inland of the marsh the terrain was mainly large clay polder fields with scattered farmhouses and small villages. Fields were separated by grassy dykes, ditches or rows of poplar trees, and in winter they were left ploughed or were seeded with winter cereals or grass. Gamebirds were released at one point adjacent to the marsh.

Observation of the harriers leaving the roosts in the morning and on the marsh during the day showed that the Marsh Harriers tended to remain on the marsh, but most of the

Hen Harriers left the marsh to hunt elsewhere. This is consistent with the findings of Zijlstra (1987), who found that Marsh Harriers hunted in marsh and Hen Harriers hunted in 'bush scrub farmland'.

SEX AND AGE COMPOSITION OF THE ROOSTS

Counts at the Marsh Harrier roost peaked at 33 individuals (February) in the 1990–1991 winter and at 31 (December) in 1991–1992. A few adult females were identified on the counts but no adult males. Most of the birds appeared to be juveniles. In Flevoland, Zijlstra (1987) found that nine Marsh Harriers in female (brown) plumage occurred for every one in male plumage but made no comment on the sex or age of the brown birds.

Counts at the Hen Harrier roost peaked at between 40 and 60 individuals in three of the four winters (1988–1989 to 1991–1992) in which we collected pellets. About 11% were grey (adult and sub-adult) males. This is a low proportion compared to an average of about 18% in the Netherlands (G. van Duin, Hen Harrier Winter Roost Survey). The high proportion of birds in ringtail plumage (brown plumage of females of all ages and immature males) was similar each winter, which would not necessarily have been the case if largely immature birds were involved since their numbers might have been expected to vary according to fluctuations in the annual breeding success of the species. Few ringtails at the roost were recognized as immature males by size. At least some immature Hen Harriers can be distinguished from adult females by subtle plumage characteristics, but poor viewing conditions at the roost did not allow us to use these methods.

METHODS

Pellets were collected from the Hen Harrier roost in all four winters from 1988–1989 to 1991–1992. Collection was less regular after 1989–1990, due to the roost frequently moving into inaccessible areas. Attempts at collecting pellets from the Marsh Harrier roost failed before 1991, due to the difficulty of locating the settling areas in the dense reeds, but pellets were collected in January, February and March 1991 and in February and March 1992. On occasion, few pellets were found, because they had apparently dropped through the sparse, stiff stems of sea club-rush on which the Hen Harriers often roosted or had been washed away by high tides.

The pellet contents were analysed by R.C. The contents were washed and dried. Plumage and bill parts were matched to a reference collection, which gave a high success rate in identifying prey to species. However, where too little plumage was present to allow macro identification but downy barbules were present, the plumage was examined microscopically and identified to order, using the key in Brom (1986). It was assumed that all the black plumage from rails found in the pellets was from Moorhens *Gallinula chloropus* rather than Coots *Fulica atra* because Moorhens were common in the dykes on nearby farmland, Coots were not common nearby and white undertail coverts and partly white flank feathers (Moorhen only) occurred in some of the pellets. The plumage of partridges, Pheasants *Phasianus colchicus* and pigeons was often almost completely digested, and so care was needed with the pellets suspected of containing these. They exhibited a characteristic foamy consistency when dissolved in water. More than one passerine of the same species in a pellet was recorded when more than one of the same bill part occurred. Otherwise, all the plumage in a pellet from a species, or sex of a species if distinguishable, was counted as one individual.

The count of small mammals in each pellet was taken as the highest of left jaws, right jaws, skulls or pairs of upper or lower incisors (single incisors left over were counted as one further individual). Hair and bones occurring on their own were counted as from one individual. Small mammals were identified to species by their teeth from the keys in Corbett & Ovenden (1980) and Yalden & Morris (1990). Missing upper second molars of voles caused difficulties in separating common vole *Microtus arvalis* from field vole *M. agrestis*, and in such cases these were put into a 'vole spp.' category. Field voles comprised only 4% of the voles identified to species. Where no teeth occurred in pellets, samples from the fur were checked microscopically for the readily recognizable characteristics of shrews (constrictions in hairs and scales protruding on one side), but no shrew remains were found.

The larger mammals were identified by matching the medulla of guard hairs to the illustrations in Teerink (1991). Occurrence of remains in a pellet was taken as one individual. It was not possible to separate rabbit *Oryctolagus cuniculus* from brown hare *Lepus capensis* because of the very similar structure of their hair. Very few other large mammals occurred in the area.

Prey frequency in the diet was taken as the number of individuals found in the pellets. An alternative method would have been to count the number of pellets in which each prey species was registered. This would have given almost the same results for the Marsh Harrier pellets, only one of which was found to contain more than one individual of the same prey species. However, the alternative method would have greatly reduced the proportion of voles in the Hen Harrier diet, as remains of more than one individual regularly occurred in the same pellet, whereas no species of small passerine did.

The data were not converted to prey weights because weights could not be ascertained for the partial consumption of the larger bird and mammal prey. However, the differences in mass of prey of different classes must of course be borne in mind when considering the nutritional importance of each prey class and interpreting the results.

Prey were grouped in the classes shown in Tables 1 and

Table 1. *Total numbers and percentages by class of prey items identified in pellets collected from the Marsh Harrier roost at Saeftinghe*

	Month/winter		
	January 1990–1991	February 1990–1991 & 1991–1992	March 1990–1991 & 1991–1992
No. pellets	48	61	61
No. prey items	74	85	84
Prey class			
Ducks and geese	49%	51%	54%
Gamebirds	4%	0%	2%
Rails	15%	8%	6%
Waders	0%	5%	3%
Pigeons	4%	8%	10%
Small passerines	8%	4%	2%
Unidentified birds	3%	5%	1%
Lagomorphs	8%	4%	10%
Small mammals	8%	14%	12%
Fish	1%	1%	0%

2 for the purposes of statistical analysis, although these were pooled when necessary to meet rules for expected frequencies. Chi-squared tests of homogeneity were carried out to test whether data from the same month each year should be pooled. A lack of homogeneity was found for the December, February and March Hen Harrier data, so Hen Harrier data were not pooled, other than in Appendix 2. The Marsh Harrier data were found to be not significantly heterogeneous throughout, so data for all years were pooled.

Diet breadth (B) was calculated using Levins' (1968) formula:

$$B = 1/\Sigma\, p_i^2$$

where p_i is the proportion of the diet in the prey class i. Because the study was of two species which used the same prey classes (except fish, which was exclusive to Marsh Harrier but occurred in only two pellets and did not affect the results), values of B calculated each month for each species are directly comparable between both months and species and vary from 1 to n, where n is the number of prey classes in the diet and higher values indicate a broader diet.

Diet overlap (O) was calculated using the formula in Pianka (1973):

Table 2. *Total numbers and percentages by class of prey items identified in pellets collected from the Hen Harrier roost at Saeftinghe*

		Percentage of prey class								
Month/winter	Total n	Ducks and geese	Gamebirds[1]	Rails	Waders	Pigeons	Small[2] passerines	Unidentified birds	Lagomorphs	Small[3] mammals
November										
1989–1990	44	11	—	5	—	—	59	—	5	20
1990–1991	46	7	7	9	4	2	45	—	4	22
December										
1988–1989	153	14	2	4	6	3	19	1	2	49
1989–1990	57	5	18	3	5	2	39	5	2	21
1990–1991	51	6	—	6	8	10	35	—	2	33
January										
1988–1989	161	9	12	11	4	3	17	4	1	39
1989–1990	46	2	15	9	9	—	20	2	6	37
1991–1992	61	21	5	13	5	3	21	2	7	23
February										
1988–1989	43	7	7	5	2	5	5	2	35	32
1989–1990	18	—	6	6	—	—	22	—	27	39
1991–1992	94	19	2	12	3	2	11	1	35	15
March										
1988–1989	29	—	—	—	3	—	—	—	83	14
1991–1992	76	5	4	7	5	3	4	4	47	21

[1] Galliformes.
[2] Up to and including thrush-sized passerines.
[3] Voles, mice, shrews, Common Rat *Rattus norvegicus* and Muskrat *Ondatra zibethicus*.

$$O = \Sigma\, p_{ij} \cdot p_{ik} / \sqrt{\Sigma\, p_{ij}^2 \cdot \Sigma\, p_{ik}^2}$$

where p_{ij} and p_{ik} are the proportions prey class i comprised of the diets of the jth and kth species (Hen Harrier and Marsh Harrier, respectively). Values of diet overlap range from 0 (no overlap) to 1 (complete overlap).

RESULTS

Totals of 243 Marsh and 879 Hen Harrier prey items were identified, in 170 and 641 pellets, respectively (Tables 1 and 2, Appendices 1 and 2). Comparing frequencies of classes of prey, highly significant differences were found between the overall diets of Marsh Harrier (1990–1991 and 1991–1992 pooled—see Methods) and Hen Harrier (1991–1992) in each of the three months, January ($\chi^2_5 = 16.3$, $P < 0.01$), February ($\chi^2_6 = 43.8$, $P < 0.001$) and March ($\chi^2_5 = 58.0$, $P < 0.001$). This was due to the high proportions of ducks and geese in the Marsh Harrier diet throughout, of small passerines and small mammals in the Hen Harrier diet in January and of lagomorphs in the Hen Harrier diet in February and March.

Chi-square contingency analysis of prey item frequency by month in the four classes (small passerines, other birds, lagomorphs and small mammals) showed highly significant variation in the Hen Harrier diet overall ($\chi^2_{36} = 396$, $P < 0.001$), but not in the Marsh Harrier diet ($\chi^2_4 = 3.7$, n.s.). Inspection of the contingency table for Hen Harrier showed that the greatest contributions to χ^2 were from the high proportions of small passerines in November 1989 and 1990, high proportion of small mammals in December 1988 and low proportions of lagomorphs in December 1988 and January 1989 but high proportions in March 1989 and March 1992.

Measures of diet breadth (Table 3) showed that the Hen Harriers always had a broader diet then the Marsh Harriers, except in March 1988–1989 when they specialized on lagomorphs. Measures of diet overlap (Table 3) showed that this decreased progressively from January to March.

Numerically, ducks and geese (principally ducks) made up about half the Marsh Harrier diet throughout January, February and March (Table 1, Appendix 1) but were even more important when their mass is taken into consideration. Small mammals were the second most numerous element in the diet overall, closely followed by rails.

The Hen Harriers took a wide spectrum of prey throughout (Table 2, Appendix 2). Numerically, passerines constituted about half of the prey items in November and small mammals (mainly voles) about 20%. Fewer passerines were found in December 1988 and each January, when small mammals were the largest class of prey. Lagomorphs were the largest class in two out of three winters in February and in two out of two winters in March, with virtually all other classes being correspondingly reduced.

Lead shot was found in five Hen Harrier pellets containing duck, Pheasant and pigeon remains, and in three Marsh Harrier pellets containing duck and Pheasant remains. Lead shot has previously been reported in harrier pellets by Baker-Gabb (1981) and Bavoux *et al.* (1990).

Table 3. *Measures of diet breadth (Levins 1968) and diet overlap (Pianka 1973) for Hen Harriers and Marsh Harriers at Saeftinghe (see Methods for formulae)*

	November	December	January	February	March
Diet breadth					
Marsh Harrier 1990–1991 pooled	—	—	3.52	3.25	3.08
Hen Harrier					
1988–1989	—	3.12	4.55	4.07	1.42
1989–1990	—	4.27	4.61	3.53	—
1990–1991	3.61	3.88	—	—	—
1991–1992	—	—	5.92	4.81	3.48
Diet overlap					
1990–1991 and 1991–1992 pooled	—	—	0.76	0.60	0.35

DISCUSSION

Competition between Marsh and Hen Harriers for hunting space resulted in the less manoeuvrable Marsh Harrier being excluded in all eight encounters observed by Zijlstra (1987) in the harsh winter of 1978–1979. Interspecific competition is generally acknowledged to reduce niche size in competing species and encourage niche separation. We found from both observation and the prey found in pellets that Marsh Harriers hunted mainly over the marsh, whereas Hen Harriers hunted more widely. Niche separation was therefore being exhibited with regard to hunting. The Marsh Harrier has proportionately shorter wings and tail than the Hen Harrier and is slower and less manoeuvrable. However, it has longer tarsi, thought to be an adaptation to reach deep into tall marsh vegetation (Nieboer 1973), and Schipper *et al.* (1975) found that the slower Marsh Harrier preferred to hunt over taller vegetation, probably because this gave it more opportunity for surprise.

The proportions of ducks and geese in Marsh Harrier pellets ranged from 49% to 54% (Table 1) and are similar to the 56% of ducks found by Schipper (1973) in Marsh Harrier pellets from the Camargue (south France). Bavoux *et al.* (1990), however, found only ten ducks in 410 Marsh Harrier bird prey items identified in Charente-Maritime (west France), and mammals represented nearly 60% of prey/pellet records there. Larger mammals such as coypu *Myocastor coypus* and rabbit featured significantly, but up to 55% of their mammal prey/pellet records were voles. Schipper *et al.* (1975) suggested that because of its larger size, the Marsh Harrier

cannot afford to specialize in voles until their density reaches the threshold where hunting effort is rewarded by adequate prey biomass. We believe that the threshold for the smaller Hen Harrier is lower, enabling it to be more sensitive to changes in density of small prey species and to occupy the niche of a generalist predator. This is supported by both the shifts in diet and the greater diet breadth of the Hen Harrier at Saeftinghe (Table 3). Note that the difference in diet breadth would have been still greater had the data been converted into prey weights.

Our data show no seasonal shifts in the diet of the Marsh Harriers, in contrast to frequent shifts in the Hen Harrier diet. The greater nutritional requirements of the larger Marsh Harrier may restrict it to wintering at sites where a stable source of food is available throughout the winter, in this case in the form of duck on a marsh where their hunting technique was effective. The ability to winter so far north may have important survival value; migration presumably poses risks which the less experienced juvenile Marsh Harriers predominating at Saeftinghe are avoiding.

Saeftinghe is an important wintering site for the Greylag Goose *Anser anser* and the White-fronted Goose *A. albifrons*. The occurrence of geese in the diet as carrion is therefore not surprising. The Marsh Harrier has proportionately more powerful feeding apparatus than the Hen Harrier, enabling it to feed more easily at large carcasses and compete better with other scavengers. However, we do not know how many of the ducks were moribund or fed on as carrion. Wildfowl shooting was banned on the marsh after 1988–1989, which may have reduced the availability of disabled ducks, but Schipper's (1973) observations in the Camargue suggested that Marsh Harrier attacks on ducks (mainly Teal *Anas crecca* and Mallard *A. platyrhynchos*) were invariably on disabled or sick birds.

The Hen Harriers fed more on ducks and geese than was found in any other study, but much less than the Marsh Harriers. Diet overlap was greatest in midwinter (Table 3), largely due to the duck and rail components of the prey. However, it would have been lower had the data been converted to prey weights.

In wildfowl counts by Castelijns *et al.* (1991 and unpubl.), the four most numerous species of duck at Saeftinghe were Wigeon *Anas penelope*, Mallard, Teal and Pintail *A. acuta*, the only duck species identified in the harrier pellets. Although the smaller Hen Harriers might have been expected to take more of the smaller Teal, there was no significant difference between the mixes of the commonest three ducks taken by both species of harrier (χ^2_2 = 1.3, n.s.); Hen and Marsh Harriers, respectively, took 51% and 54% Wigeon, 24% and 17% Teal, and 25% and 29% Mallard. However, in the wildfowl counts (November to March in the four winters 1988–1989 to 1991–1992), the proportion of Wigeon ranged from 79% to 89% of the three most numerous species of duck, Teal 1% to 5% and Mallard 9% to 19%. The significant differences between these percentages and those we found in the harrier diets may be due to bias in the wildfowl counts, with the Wigeon in large, easily counted flocks, and disproportionate predation on Teal and Mallard by both Hen and Marsh Harriers because they were more dispersed and could be surprised in ditches and longer vegetation.

The small proportion of Skylarks *Alauda arvensis* in the Hen Harrier diet at Saeftinghe is striking, since the Skylark is the most frequent passerine in midwinter diets of Hen Harriers in England (Clarke & Palmer 1987, Clarke 1988, Clarke *et al.* 1988) and northern France (Clarke & Tombal 1989). However, those areas attract higher proportions of adult male Hen Harriers than does Saeftinghe, and the diets there overall contained a higher proportion of passerines. In Scotland, Marquiss (1980) found that males took mainly small passerines and females larger prey in winter and that there was a corresponding preference for different habitats by each. Other than in November, the prey taken at Saeftinghe was predominantly voles or lagomorphs, both of which may reflect the larger females' less agile hunting abilities. However, Collopy & Bildstein (1987) warned against making generalizations about agile birds being harder to catch than mammals, since the structure of different habitats can make certain species more vulnerable. The passerine most frequently taken at Saeftinghe by Hen Harriers in November was the Starling *Sturnus vulgaris*. Starlings are an infrequent winter prey in England (Clarke & Palmer 1987, Clarke 1988 and unpubl., Clarke *et al.* 1988) other than on the Wash (Lincolnshire), where they are probably taken on saltmarsh. They were also taken in quantity in a coastal situation with extensive saltmarsh on Terschelling (north Netherlands) (Schipper 1973). The large numbers of Robins *Erithacus rubecula* taken by the Hen Harriers at Saeftinghe in December and January are remarkable. However, the very open farmland forming the catchment area for the roost is not rich in small birds, except for Robins around the farmsteads.

The timing of the shifts to lagomorphs by the Hen Harriers at Saeftinghe in February and March indicates that these were probably largely young animals. A similar swing towards lagomorphs has been found in England in early spring (Clarke 1988 and unpubl.).

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REFERENCES

Baker-Gabb, D.J. 1981. The diet of the Australasian Harrier (*Circus approximans*) in the Manawatu-Rangitikei Sand Country, New Zealand. Notornis 28: 241–254.

Bavoux, Ch., Burneleau, J., Cuisin, J. & Nicolau-Guillaumet, P. 1990. Le Busard des roseaux *Circus a. aeruginosus* en Charente-Maritime

(France). 111—Alimentation en période internuptiale. Alauda 58: 221–231.
Brom, T.G. 1986. Microscopic identification of feathers and feather fragments of Palearctic birds. Bijdragen tot de Dierkunde 56: 181–204.
Castelijns, H., Maebe, J. & van de Wiel, A. 1991. Vogels in Saeftinghe in het winterhalfjaar. Het Vogeljaar 39: 267–274.
Clarke, R. 1988. The diet of Hen Harriers roosting in Wicken Fen. Cambridgeshire Bird Rep. 62: 52–58.
Clarke, R. & Palmer, D. 1987. The diet of Hen Harriers roosting on a Breckland heath. Suffolk Birds 36: 71–75.
Clarke, R. & Tombal, J.-Ch. 1989. Régime alimentaire du Busard Saint-Martin *Circus cyaneus* utilisant des dortoirs dans les cultures en Cambrésis. Le Héron 22: 77–80.
Clarke, R., Combridge, M.C. & Combridge, P. 1988. The diet of Hen Harriers roosting in the New Forest. Hampshire Bird Rep. 1987: 78–82.
Collopy, M.W. & Bildstein, K.L. 1987. Foraging behavior of Northern Harriers wintering in southeastern salt and freshwater marshes. Auk 104: 11–16.
Corbett, G. & Ovenden, D. 1980. The Mammals of Britain and Europe. London: Collins.
Cramp, S. & Simmons, K.E.L. 1980. Handbook of the Birds of Europe, the Middle East and North Africa, Vol. 2. Oxford: Oxford University Press.
Levins, R. 1968. Evolution in Changing Environments. Princeton: Princeton University Press.
Marquiss, M. 1980. Habitat and diet of male and female Hen Harriers in Scotland in winter. Br. Birds. 73: 555–560.
Nieboer, E. 1973. Geographical and ecological differentiation in the genus *Circus*. Unpubl. PhD thesis, University of Amsterdam.
Pianka, E.R. 1973. the structure of lizard communities. Ann. Rev. Ecol. Syst. 4: 53–74.
Schipper, W.J.A. 1973. A comparison of prey selection in sympatric harriers (*Circus*) in Western Europe. Gerfaut 63: 17–120.
Schipper, W.J.A., Buurma, L.S. & Bossenbroek, P.H. 1975. Comparative study of hunting behaviour of wintering Hen Harriers *Circus cyaneus* and Marsh Harriers *Circus aeruginosus*. Ardea 63: 1–29.
Teerink, B.J. 1991. Hair of West-European Mammals. Cambridge: Cambridge University Press.
Yalden, D.W. & Morris, P.A. 1990. The Analysis of Owl Pellets. London: The Mammal Society.
Zijlstra, M. 1987. Bruine Kiekendief *Circus aeruginosus* in Flevoland in de winter. Limosa 60: 57–62.

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APPENDIX 1

Number of prey items identified in Marsh Harrier pellets

		Jan	Feb	Mar	Total
Birds					
	Goose spp.	5	2	4	11
	Wigeon *Anas penelope*	12	21	18	51
	Teal *A. crecca*	1	5	10	16
	Mallard *A. platyrhynchos*	12	6	10	28
	Pintail *A. acuta*		3		3
	Duck spp.	6	7	3	16
	Pheasant *Phasianus colchicus*	2		2	4
	Gamebird (Galliformes sp.)	1			1
	Water Rail *Rallus aquaticus*	1			1
	Moorhen *Gallinula chloropus*	10	7	5	22
	Snipe *Gallinago gallinago*		1	1	2
	Woodcock *Scolopax rusticola*			1	1
	Wader sp.		3		3
	Pigeon sp.	3	7	9	19
	Pipit sp.	1			1
	Tit sp.	1			1
	Starling *Sturnus vulgaris*	1		1	2
	Greenfinch *Carduelis chloris*	1			1
	Redpoll *C. flammea*		1		1
	Reed Bunting *Emberiza schoeniclus*	2	1	1	4
	Small passerine sp.		1		1
	Bird spp.	2	4	1	7
Mammals					
	Lagomorph	6	3	8	17
	Common vole *Microtus arvalis*		1		1
	Vole spp.		2		2
	Muskrat *Ondatra zibethicus*	1		5	6
	Common rat *Rattus norvegicus*	2	2	3	7
	Harvest mouse *Micromys minutus*		3	1	4
	Mouse sp.		1		1
	Small mammal spp.	3	3	1	7
Other					
	Fish	1	1		2
	Total	74	85	84	243

APPENDIX 2

Number of prey items identified in Hen Harrier pellets

Prey species	Nov	Dec	Jan	Feb	Mar	Total
Birds						
Goose spp.		1	2	1		4
Wigeon *Anas penelope*	3	13	10	5	3	34
Teal *A. crecca*	1	5	3	7		16
Mallard *A. platyrhynchos*	2	1	9	4	1	17
Pintail *A. acuta*		1	1	1		3
Duck spp.	2	7	4	3		16
Grey Partridge *Perdix perdix*	1	1	5	2	2	11
Pheasant *Phasianus colchicus*	1	12	24	4		41
Gamebird (Galliformes spp.)	1				1	2
Water Rail *Rallus aquaticus*	1	2	7	4	1	15
Moorhen *Gallinula chloropus*	5	9	22	10	4	50
Golden Plover *Pluvialis apricaria*				1		1
Lapwing *Vanellus vanellus*			1			1
Snipe *Gallinago gallinago*	1	13	7		4	25
Woodcock *Scolopax rusticola*	1					1
Wader spp.		3	5	3	1	12
Pigeon spp.	1	10	7	4	2	24
Skylark *Alauda arvensis*	2	6	3	1		12
Pipit spp.	4	5	3	1	1	14
Wren *Troglodytes troglodytes*	3	3	2			8
Dunnock *Prunella modularis*	2	3	6			11
Robin *Erithacus rubecula*	2	18	15	2	1	38
Fieldfare *Turdus pilaris*		1				1
Song Thrush *T. philomelos*	1		1		1	3
Redwing *T. iliacus*		1		1		2
Thrush spp.	1	1				2
Blue Tit *Parus caeruleus*	2	1	3			6
Great Tit *P. major*		1	2			3
Tit spp.		2	1			3
Starling *Sturnus vulgaris*	12	7	2	3		24
Sparrow spp.	7	5	1	2		15
Greenfinch *Carduelis chloris*	6	4	3	3		16
Linnet *C. cannabina*		3				3
Reed Bunting *Emberiza schoeniclus*	5	3	6	2		16
Corn Bunting *Miliaria calandra*		1	1	1		3
Small passerine spp.		4	1			5
Bird spp.		5	8	2	3	18
Mammals						
White-toothed shrew *Crocidura* sp.		1				1
Lagomorph	4	5	9	53	60	131
Bank vole *Clethrionomys glareolus*		1	1		1	3
Field vole *Microtus agrestis*			2	1	1	4
Common vole *M. arvalis*	6	33	34	7	12	92
Vole spp.	6	48	37	13	2	106
Muskrat *Ondatra zibethicus*				1		1
Common rat *Rattus norvegicus*	1		8	4		13
Wood mouse *Apodemus sylvaticus*		3	3	1	1	8
Harvest mouse *Micromys minutus*	3	3	2	1	1	10
Small mammal spp.	3	15	7	7	2	34
Total	90	261	268	155	105	879