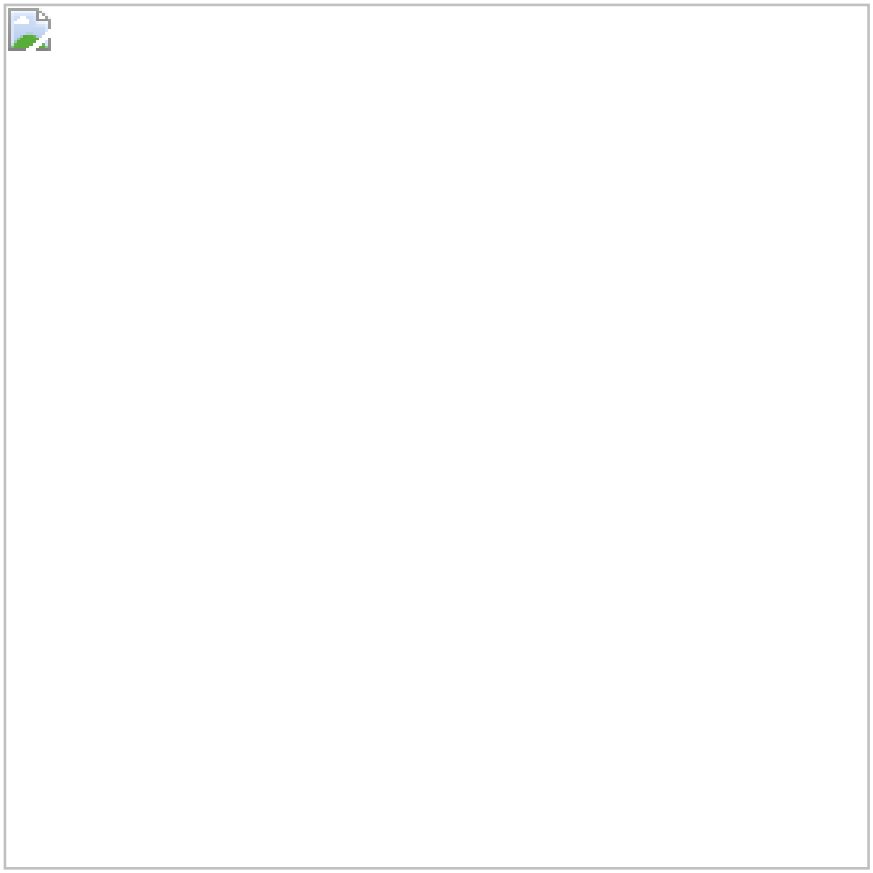

Breeding Populations and Diets of the Sparrowhawk Accipiter nisus and the Hobby Falco subbuteo in the Wigry National Park (Ne Poland)

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Breeding populations and diets of the Sparrowhawk *Accipiter nisus* and the Hobby *Falco subbuteo* in the Wigry National Park (NE Poland)

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Abstract. In 1990–1995, 12–15 pairs of Sparrowhawks (9.1/100 km^2) and 7–9 pairs of Hobbies (5.6 pairs/100 km^2) inhabited the forest-lakeland area of the Wigry National Park (NE Poland). The diet composition of the two species was studied by the analysis of pellets and prey remains. Sparrowhawks fed on birds (97% of prey items, 99% of food biomass), especially *Turdus* spp., *Parus* spp. and *Fringilla coelebs*. Hobbies consumed birds (52% of prey, 94% of biomass) and insects (43% of prey, 1% of biomass). Sparrowhawks specialized in forest birds, positively selecting *Parus* spp., *Turdus* spp., *Picidae* and *Ficedula* spp. Hobbies hunted mainly birds of open habitats (*Alauda arvensis*) and woodland (*Anthus trivialis*).

Key words: Sparrowhawk, *Accipiter nisus*, Hobby, *Falco subbuteo*, diet, prey selection

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INTRODUCTION

The Sparrowhawk was widely studied in Great Britain (Newton & Marquiss 1982, Newton 1986, 1991, Newton et al. 1997a, 1997b, Cresswell 1995, 1996), Fennoscandia (Frimer 1989a, 1989b, Gotmark 1995, Gotmark & Post 1996, Selås 1997, Solonen 1997), and Spain (Manosa & Oro 1991). Studies on the Hobby were fewer — from Netherlands (Bijlsma 1980), and Germany (Fiuczynski 1988, Arbeitsgruppe Greifvögel Nordrhein-Westwalen der GRO, WOG 1996). In Poland, data on distribution and densities of Sparrowhawks and Hobbies were collected by Sosnowski (1991), Czuchnowski (1993), Rzępała & Mitrus (1995), Chmielewski et al. (1996), and Pugacewicz (1996). Diet composition of the two raptors was only reported from the Białowieża Primeval Forest in eastern Poland (Jędrzejewska & Jędrzejewski 1998).

STUDY AREA

The Wigry National Park, located in the Suwałki-Augustów Lakeland of NE Poland (WNP, 53°58′–54°10′N, 23°–23°15′E), covers 150 km^2. The area is fairly flat. Forests cover 63% of WNP area, lakes 19%, and farmland 15%. Forests are dominated by pine *Pinus sylvestris* (80% of forested area), spruce *Picea abies* (12%), black alder *Alnus glutinosa* (3%), birch *Betula verrucosa* (3%) and oak *Quercus robur* (2%). Forest plantations and young forests cover 9% of the forested area. Stands 21–40-years old cover 24%, stands 41–60 years old — 16%, those 61–80 years old — 18%, and old stands (80–100 years) — cover 16%. Forests older than 100 years grow on 17% of the area.

METHODS

In 1989–1995, the nests of raptors and Ravens *Corvus corax* in the whole WNP were searched for. Older stands were combed from November till June. In spring and summer (April–September), all observations of raptors were mapped. The nests found were checked (from the ground) 1–2 times during the breeding season.

Prey remains (235 of the Sparrowhawk and 60 of Hobby) and pellets (10 of Sparrowhawk and 24 of the Hobby) were collected under the occupied nests and plucking posts in 6 breeding territories

of Sparrowhawks (in April–July 1989–1995) and 2 territories of Hobbies (in July–August 1992–1993). Diet composition (prey identified by feather, bone, hair, and exoskeleton remains) was expressed as percentage of prey specimens and percentage of food biomass. Biomass was calculated by multiplying the number of prey specimens by the average body mass of a given species (from Busse 1990). Food niche breadth (B) was calculated according to Levins (1968):

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

where p_i is a fraction of each of the prey groups (birds, mammals, insects) in the total number of prey or biomass consumed. Index of food niche overlap between the two species was calculated after Pianka (1973):

$$\alpha_{ij} = \Sigma(p_{ia}\, p_{ja})\, [(\Sigma p_{ia}^2)(\Sigma p_{ja}^2)]^{1/2}$$

where a_{ij} is the overlap between predators i and j, p_{ia} is the fraction of ath prey in the total biomass consumed by ith predator, p_{ja} is the fraction of ath prey in the total biomass consumed by jth predator. Index α varies from 0 (exclusive food niches) to 1 (identical niches).

In 1996, the species composition and densities of birds community in WNP were estimated. Censuses were done on 13 plots (in total 210 ha), representing various habitats, 4–7 times on each plot between April and July. The plots covered 71 ha of forests (deciduous, mixed, and coniferous stands aged 40–120 years) and 139 ha of open areas (fields, meadows, open marsh). Mean density of forest birds was 55 pairs/10 ha, and that in open areas 50 pairs/10 ha. The censuses in 1996 were preceded by regular faunistic observations and pilot surveys of birds in 1989–1994 (Zawadzka & Zawadzki 1995). The results of the earlier pilot surveys and the censuses in 1996 indicated that both the species structure of bird communities and their densities were fairly stable during the study.

Species composition of birds captured by Sparrowhawks and Hobbies was compared with that of the available bird community and Ivlev's selectivity index D (modified by Jacobs 1974) was calculated:

$$D = (r - p)/(r + p - 2rp)$$

where r is a fraction of a given prey in predator's diet, and p is a fraction of that prey in the living community. D varies from -1 (complete avoidance of prey) to 1 (maximum positive selection); 0 is random selection (or opportunistic feeding).

RESULTS

Sixteen nesting territories of Sparrowhawks and 9 territories of Hobbies were found in WNP. Breeding densities were determined for 1990–1995, when all territories were known. Each year 12–15 territories of Sparrowhowk were occupied, on average 13.7 ± 1.2, i.e. 8–10 ± 0.8 breeding pairs per 100 km^2 of the whole area, and 12.7–15.9 ± 1.3 pairs per 100 km^2 of the forested area. The nearest neighbour distance (NND) between occupied nests varied from 1.2 to 2.8 km, on average 1.9 ± 0.6 km. Based on NND (calculated on forest area), we roughly estimated that the average size of Sparrowhawks' breeding territories was about 2.8 km^2. Nests of Sparrowhawks were located in the forests, 0.31 to 1.61 km from the nearest open area (mean 0.74 ± 0.38 km). Sparrowhawks nested in stands from 38 to 45 years old.

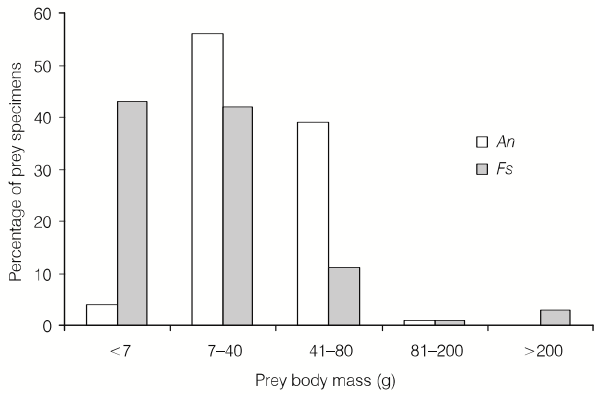

Fig 1. Prey body mass identified in the diets of Sparrowhawks (*An*) and Hobbies (*Fs*).

In 1990–1995, 7–9 (mean 8.3 ± 0.8) breeding territories of Hobbies were occupied i.e. 4.7–6.0 (mean 5.6 ± 0.5) pairs per 100 km^2 of the whole area, and 7.4–9.5 (mean 8.8 ± 0.8) pairs per 100 km^2 of the forested area. The NND between occupied nests ranged from 2.75 to 5.3 km, on average 3.91 km (SD = 1.08, n = 9). Rough estimate of the size of breeding territory would thus be 12 km^2. Eight nests of Hobbies were located in the forest, 0.08 to 0.72 km from the nearest open area, on average 0.36 km (SD = 0.22, n = 8). The ninth nest was found in a small woodlot 200 m away from forest. Hobbies most often nested in nests of

Table 1. Diet composition of the Sparrowhawk in the breeding seasons of 1989–1995. + denotes < 0.05%

Species	Prey items		Biomass	
	N	%	g	%
Dendrocopos major	8	3.1	560	6.4
Dendrocopos minor	1	0.4	20	0.2
Dendrocopos sp.	3	1.2	120	1.4
Alauda arvensis	2	0.8	70	0.8
Anthus trivialis	6	2.4	120	1.4
Anthus sp.	1	0.4	20	0.2
Motacilla alba	1	0.4	21	0.2
Erithacus rubecula	4	1.6	60	0.7
Turdus merula	3	1.2	210	2.4
Turdus philomelos	75	29.5	3750	43.0
Turdus viscivorus	1	0.4	80	0.9
Turdus sp.	2	0.8	120	1.4
Sylvia sp.	2	0.8	40	0.5
Phylloscopus sp.	3	1.2	21	0.2
Ficedula hypoleuca	8	3.1	112	1.3
Ficedula sp.	1	0.4	14	0.2
Parus ater	1	0.4	10	0.1
Parus caeruleus	6	2.4	60	0.7
Parus major	24	9.4	480	5.5
Parus sp.	6	2.4	90	1.0
Garrulus glandarius	2	0.8	350	4.0
Pica pica	1	0.4	200	2.3
Sturnus vulgaris	4	1.6	320	3.7
Fringilla coelebs	32	12.5	640	7.3
Coccothraustes coccothraustes	4	1.6	220	2.5
Emberiza citrinella	7	2.7	210	2.4
Undetermined small birds	37	14.5	740	8.5
Birds total	245	96.4	8658	99.2
Microtus sp.	1	0.4	32	0.4
Undetermined small rodent	1	0.4	25	0.3
Mammals total	2	0.8	57	0.7
Odonata	1	0.4	1	+
Coleoptera	4	1.6	4	0.1
Elateridae	2	0.8	2	+
Invertebrates total	7	2.8	7	0.1
Total	254	100	8722	100
Breadth of food niche (*B*)	1.1		1.0	

Table 2. Diet composition of the Hobby in the breeding seasons of 1992–1993. + denotes <0.05%.

Species	Prey items		Biomass	
	N	%	g	%
Perdix perdix	1	0.9	400	12.5
Columba palumbus	1	0.9	475	14.8
Columba sp.	1	0.9	450	14.1
Cuculus canorus	1	0.9	100	3.1
Apus apus	1	0.9	40	1.2
Alauda arvensis	6	5.6	210	6.6
Hirundo rustica	3	2.8	54	1.7
Anthus trivialis	5	4.6	100	3.1
Anthus sp.	1	0.9	20	0.6
Saxicola rubetra	1	0.9	15	0.5
Erithacus rubecula	2	1.8	30	0.9
Phoenicurus phoenicurus	1	0.9	20	0.6
Turdus merula	3	2.8	210	6.6
Turdus philomelos	7	6.5	350	11.0
Sylvia sp.	1	0.9	20	0.6
Parus major	1	0.9	20	0.6
Parus sp.	1	0.9	15	0.5
Sturnus vulgaris	1	0.9	80	2.5
Fringilla coelebs	2	1.8	40	1.2
Pyrrhula pyrrhula	1	0.9	25	0.8
Emberiza citrinella	2	1.8	60	1.9
Undetermined small bird	14	12.9	280	8.8
Birds total	57	52.3	3014	94.2
Clethrionomys glareolus	1	0.9	20	0.6
Undetermined small rodent	3	2.8	75	2.3
Undetermined small mammal	1	0.9	50	1.6
Mammals total	5	4.6	145	4.5
Odonata	4	3.7	4	0.1
Apidae	3	2.8	3	0.1
Vespidae	2	1.8	2	0.1
Nymphalidae	1	0.9	1	+
Coleoptera	23	21.1	23	0.7
Phyllobius sp.	4	3.7	1	+
Melolontha sp.	2	1.8	2	0.1
Elateridae	2	1.8	2	0.1
Carabidae	3	2.8	3	0.1
Geotrupes sp.	2	1.8	2	+
Undetermined insect	1	0.9	1	+
Invertebrates total	47	43.1	44	1.3
Total	109	100	3203	100
Breadth of food niche *(B)*	2.2		1.1	

Ravens (89% of cases). Only once Hobby occupied on old nest of the Goshawk *Accipiter gentilis*.

The diet of Sparrowhawks in WNP was composed mainly of birds (97% of prey, 99% of biomass) with minor additions of mammals and insects (Table 1). The mean body mass of prey was 34 g. Among at least 21 species of birds captured by Sparrowhawks, thrushes *Turdus* spp., tits *Parus* spp., Chaffinch *Fringilla coelebs* and woodpeckers *Picidae* dominated — they made up 70.5% of food biomass. Sparrowhawks captured predominantly small (body mass 7–40 g) and medium-sized birds (41–80 g), which constituted, respectively, 56% and 39% of the prey (Fig. 1). As much as 95% of the specimens and 86% of the biomass taken by Sparrowhawks were species living in forest.

The diet of Hobbies was more diversified, but also dominated by birds, which contributed 52% to the number of prey specimens and 94% to food biomass (Table 2). Hobbies frequently captured

insects (43% of prey), which, however, added very little (1%) to the total biomass consumed. The mean body mass of Hobby's prey was 29 g. Among 19 species of birds identified as Hobby's prey, thrushes, Skylarks *Alauda arvensis* and Tree Pipits *Anthus trivialis* were most common. Very small (body mass < 7 g) and small (7–40 g) animals dominated (85%) among prey captured by Hobbies (Fig. 1). However, occasionally taken large birds (Partridge *Perdix perdix*, Woodpigeon *Columba palumbus*) made up a significant portion of food biomass (Table 2). Hobbies were predominantly hunters of open habitats, where they captured 72.5% of their prey specimens (57% of food biomass).

In the two raptors species, percentage distributions of prey in classes of body mass differed significantly ($G = 60.6$, $df = 4$, $p < 0.001$).

Hobby's food niche was twice as broad as that of the Sparrowhawk by number of prey specimens, but only slightly wider by food biomass (Tables 1 and 2). Food niches of the two raptors overlapped nearly completely (Pianka's index $\alpha = 0.999$), when calculated for 3 major groups of prey. This was due to the dominance of bird biomass in their diets.

Heavily relying on birds as they were, the two raptors specialised on different species of birds. Sparrowhawks positively selected tits, thrushes, woodpeckers, Starling *Sturnus vulgaris*, flycatchers *Ficedula* spp., and Yellowhammer *Emberiza citrinella* (Table 3). Chaffinch, the most common forest bird, was captured roughly proportionally to their occurrence (or slightly less so), and very small birds (warblers *Phylloscopus* spp., Goldcrest *Regulus regulus*) were avoided. The prey preferences of Hobbies (though based on a fairly small sample) were different. Skylarks, Tree Pipits, and thrushes were taken more often than could have been expected from their shares in the living communities of birds (Table 3). However, the selection of thrushes by Hobby was analysed on a small sample. Most of the common forest birds were strongly avoided by Hobbies.

Table 3. Selection of bird species by Sparrowhawks and Hobbies from the available community of birds in WNP. n — number of prey items identified, (%) — % in bird community, D — Ivlev's selectivity index. Statistically significant non-random choice of prey: *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$. Homogeneity of percentages: $G = 6.8–36.6$, $df = 1$.

Species	(%)	Sparrowhawk		Hobby	
		% prey	D	% prey	D
Forest birds:		n = 184		n = 25	
Fringilla coelebs	22.4	17.4	-0.16	8.0	-0.54*
Parus spp.	14.3	16.8	0.10	8.0	-0.31
Phylloscopus spp.	11.9	1.6	-0.79*	0	-1**
Regulus regulus	5.2	0	-1	0	-1
Turdus spp.	4.7	44.0	0.88***	36.0	0.84***
Anthus trivialis	3.6	3.3	-0.04	20.0	0.74**
Erithacus rubecula	3.2	2.2	-0.19	8.0	0.45
Picidae	2.3	6.5	0.49	0	-1
Ficedula spp.	2.3	4.9	0.37	0	-1
Garrulus glandarius	2.2	1.1	-0.34	0	-1
Other species	27.9	2.2		20.0	
Birds of open habitats:		n = 24		n = 18	
Hirundidae	10.9	0	-1**	16.7	0.24
Sylvia spp.	10.3	8.3	-0.12	5.5	-0.33
Acrocephalus spp.	7.5	0	-1**	0	-1
Emberiza spp.	5.6	29.2	0.75**	11.1	0.36
Passer spp.	4.8	0	-1	0	-1
Sturnus vulgaris	3.7	16.7	0.68*	5.5	0.20
Alauda arvensis	3.5	8.3	0.43	33.3	0.86***
Parus caeruleus	1.1	25.0	0.94***	0	-1
Other species	52.6	12.5		27.9	

Table 4. Population densities (pairs/100 km^2) of Sparrowhawks (An) and Hobbies (Fs) in various localities of Poland, against the forest cover (%) of plots studied.

Region	Plot (km^2)	Forest cover	Pairs/100km^2		Source
			An	Fs	
Niepołomice Forest (S Poland)	106	100%	3.3	4.4	Czuchnowski (1993)
Słonne Hills (SE Poland)	513	61%	3.5	1.2	Ćwikowski et al. (1998)
Spała Forest (Central Poland)	216	65%	2.3	7.4	Sosnowski (1991)
Kryńszczak Forest (EC Poland)	97	90%	5.1	4.1	Rzępała & Mitrus (1995)
Mazowsze (Central Poland)	110	5-23%	0.5	0.5	Chmielewski et al. (1996)
Białowieża Forest (E Poland)	620	90%	16.7	2.6	Pugacewicz (1996)
Równina Bielska (E Poland)	343	5%	3.5	1.2	Pugacewicz (1997)
Wigry National Park (NE Poland)	150	63%	9.1	5.6	This paper

DISCUSSION

Compared to other localities in Poland, Wigry National Park harboured dense populations of Sparrowhawks and Hobbies (Table 4). The densities of the Sparrowhawk, which prefers spruce for nesting, have varied in Poland from 2.3 to 16.7 pairs/100 km^2 (Table 4). The highest densities were recorded in north-east Poland, where coniferous forests with abundant spruce predominate. Multiple regression analysis showed that Sparrowhawk densities increased significantly from south-west to north-east and positively correlated with percentage forest cover. Longitude (L) and forests (F) were most important factors explaining 77% of the observed variation in Sparrowhawk densities in Poland: $Y = -63.667 + 0.093F + 2.869L$ ($R^2 = 0.77$, $n = 8$, $p = 0.026$).

Densities of the Hobby were fairly stable throughout various Polish woodlands (1.2–7.4 pairs/100 km^2), except for Mazowsze in Central Poland (0.5 pairs/100 km^2). Variation in the densities of Hobby throughout Poland were related neither to forest cover nor to geographical location (multiple regression analysis, $n = 8$, $p > 0.1$).

In all study sites in Europe, birds dominated (93–99%) the diets of Sparrowhawks (Newton 1986, Frimer 1989a, Manosa & Oro 1991, Solonen 1997, Jędrzejewska & Jędrzejewski 1998). A few dozen species of birds were identified as Sparrowhawk's prey, but usually mere 5–7 species dominated heavily and formed 38–60% of food biomass. In WNP, most Sparrowhawk prey were animals of body masses between 7 g and 80 g. Similar size classes of optimal prey of Sparrowhawk were reported from southern Finland (Solonen 1997), Scotland (Newton 1986), and Spain (Manosa & Oro 1991). Sparrowhawk's preferences for various bird species were also investigated in southern Finland (Solonen 1997) and eastern Poland (Jędrzejewska & Jędrzejewski 1998). Similarly to our findings, these two studies revealed that Sparrowhawks specialized on forest birds. Also, the species of birds positively selected from the available communities were largely the same on a wide geographic scale: tits, flycatchers, Song Thrushes *Turdus philomelos*, and Greenfinches *Carduelis chloris* in S Finland; tits, thrushes, woodpeckers, and Jays *Garrulus glandarius* in E Poland, and tits, woodpeckers, thrushes, and Starlings in NE Poland. Also birds avoided by Sparrowhawks were the same in various geographic localities and comprised numerous but very small species such as *Phylloscopus* spp. and Goldcrests (Solonen 1997, Jędrzejewska & Jędrzejewski 1998, this study).

All studies on the diet of Hobby documented that birds and flying insects were the most frequently captured prey, although the latter contributed very little to the Hobby's food biomass (Golodushko 1960, Cramp & Simmons 1980, Génsbol & Thiede 1986, Fiuczynski 1988, Jędrzejewska & Jędrzejewski 1998). Again, among a few dozen species of birds captured by Hobbies, mere 3–5 species dominated. Invariably, most of the birds captured by Hobbies were species of open areas, with Swallows *Hirunda rustico*, Skylarks, and pipits often dominating in woodlands (W Belarus — Golodushko 1960, E Poland — Jędrzejewska & Jędrzejewski 1998, NE Poland — this study), and Sparrows *Passer domesticus*, Swifts *Apus apus*, and Swallows in cultivated habitats (Netherlands — Bijlsma 1980; Berlin, Germany — Fiuczynski 1988).

Translated by Dr. Bogumiła Jędrzejewska

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STRESZCZENIE

[Liczebność populacji lęgowej i skład pokarmu krogulca i kobuza w Wigierskim Parku Narodowym]

W latach 1990–1995 badano obszar 150 km^2. Zebrano wypluwki i szczątki zdobyczy w 6 rewirach lęgowych krogulca i 2 — kobuza. Ofiary identyfikowano na podstawie piór, kości, włosów oraz fragmentów pancerzyków i łusek okrywowych. Oszacowano biomasę pokarmu mnożąc liczbę ofiar przez średnią masę osobniczą danego gatunku. Szerokość nisz pokarmowych oceniono według Levinsa (1968), a wskaźnik nakładania się nisz według Pianki (1973). Preferencje obydwu gatunków drapieżników wobec ptaków porównano przy zastosowaniu wskaźnika selekcji Ivleva (Jacobs 1974). Danych o strukturze zgrupowań ptaków leśnych oraz ptaków terenów otwartych dostarczyły liczenia awifauny przeprowadzone w 1996 r. (4–7 razy na 13 powierzchniach próbnych).

W poszczególnych latach stwierdzono 12–15 (średnio 13.7) rewirów lęgowych krogulca. Zagę-

szczenie tego gatunku wynosiło 9.1 par/100 km^2 powierzchni Parku, a szacunkowa wielkość rewiru lęgowego — 2.8 km^2. Krogulec gnieździł się w oddaleniu od brzegu lasu. Liczebność kobuza oceniono na 7–9 (średnio 8.3) par lęgowych, zagęszczenie — na 5.6 par/100 km^2, a rewir lęgowy obejmował ok. 12 km^2. Kobuz gniazdował blisko brzegu lasu, najczęściej zajmował puste gniazda kruka (89% przypadków).

Głównym składnikiem pokarmu krogulca były ptaki leśne (Tab. 1), najczęściej drozdy, sikory, zięby i dzięcioły. Średnia masa ofiary wynosiła 34 g. W pokarmie kobuza dominowały ptaki środowisk otwartych (ponad 70% ofiar i 50% biomasy pokarmu), najczęściej drozdy, skowronek, świergotki (Tab. 2). Bardzo licznie chwytane owady miały znikomy udział w biomasie pożywienia. Średnia masa ofiary wynosiła 29 g.

Szerokość niszy pokarmowej oceniana dla frekwencji ofiar była u kobuza dwukrotnie większa niż u krogulca, natomiast szerokości niszy oceniane dla biomasy pokarmu były u obydwu gatunków niemal równe (Tab. 1 i 2). Nisze pokarmowe kobuza i krogulca, oceniane na podstawie udziału biomasy 3 grup pokarmu (ssaków, ptaków i owadów), pokrywały się niemal całkowicie ($\alpha = 0.999$).

Do preferowanych ofiar krogulca w stosunku do ich ogólnego udziału w miejscowej awifaunie należały sikory, drozdy, dzięcioły, szpak, muchołówki i trznadel. Zięba była wyławiana proporcjonalnie do jej liczebności w środowisku. Kobuz preferował skowronka, świergotki i drozdy (Tab. 3). Rzadko chwytał ptaki typowo leśne.

Zagęszczenia kobuza w Polsce wahają się w różnych lasach Polski od 1.2 do 7.4 par/100 km^2, z wyjątkiem Mazowsza, gdzie są niższe (0.5 par/100 km^2). Zasiedlający przeważnie drągowiny świerkowe krogulec ma stosunkowo niskie zagęszczenia na południowym zachodzie Polski (gdzie przeważają lasy liściaste), a wyższe na północnym wschodzie, w lasach z dużym udziałem świerka (Tab. 4).

Dane z piśmiennictwa europejskiego są zgodne z wynikami badań w WPN. W pokarmie krogulca dominują ptaki o masie od 7 g do 80 g (ponad 90% ofiar). Drapieżnik ten preferuje ptaki żyjące w lesie, unikając bardzo małych ofiar (np. mysikrólik, gatunki z rodzaju *Phylloscopus*). Źródła te podają też, że kobuzy licznie chwytają ptaki, najczęściej z terenów otwartych oraz latające owady.

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