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Feeding habits of the Black Kite *Milvus migrans*, Red Kite *Milvus milvus*, White-tailed Eagle *Haliaeetus albicilla* and Lesser Spotted Eagle *Aquila pomarina* in Wigry National Park (NE Poland)

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Abstract. The study was conducted in the years 1989–1993. The Black Kite fed primarily on birds and fish, Red Kite — on birds, mammals and carrion. The White-tailed Eagle preyed almost exclusively on birds and fish, and the Lesser Spotted Eagle on small mammals, birds and frogs. The White-tailed Eagle was the most specialized species. Its food niche breadth was smallest among the studied species and food taken in water habitats accounted for 95% of its diet. The Black Kite had the widest food spectrum in terms of the frequency of prey while the Red Kite — in terms of the biomass consumed. The mean body mass of prey specimens taken by the White-tailed Eagle was 578 g, by the Red Kite — 235 g, the Black Kite — 230 g, and the Lesser Spotted Eagle — 34 g. The food niches of both Kites and the White-tailed Eagle strongly overlapped. The smallest overlap was between the food niches of the two Eagles and between the Lesser Spotted Eagle and the Black Kite.

Key words: Diet composition, food niche, birds of prey, Wigry National Park

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INTRODUCTION

In Poland, the Black Kite *Milvus migrans*, Red Kite *Milvus milvus*, White-tailed Eagle *Haliaeetus albicilla* and Lesser Spotted Eagle *Aquila pomarina* are not numerous species, with the number of pairs from 400 of the Kites and White-tailed Eagle to about 1700 of the Lesser Spotted Eagle (unpubl. data of Komitet Ochrony Orłów 1998). These birds nest in forests near water and wetlands. Except the Lesser Spotted Eagle, they reach low densities (Komitet Ochrony Orłów 1995). The diet composition of the Kites, White-tailed Eagle and Lesser Spotted Eagle in Europe is known fairly well (Palasthy & Meyburg 1973, Cramp & Simmons 1980, Fisher 1984, Gensbol & Thiede 1986, Ortlieb 1989, Veiga & Hiraldo 1990). However, there are only few data from Poland (Mrugasiewicz 1984, Waclawek et al. 1998, Mizera

1999). A detailed study of mutual trophic relationships in the bird of prey community was conducted only in Białowieża Primeval Forest (Jędrzejewska & Jędrzejewski 1998).

The purpose of this study was to determine the diet composition and the degree of food competition of the Black Kite, Red Kite, White-tailed Eagle and Lesser Spotted Eagle in Wigry National Park.

STUDY AREA

Wigry National Park (= WNP, 53°58'–54°10'N, 23°00'–23°15'E; 151 km²), situated in the Suwałki-Augustów Lakeland, includes northern part of Augustów Forest and the Wigry Lake. Forests cover 63% of the Park area, lakes — 19% and farmland — 15%. For-

ests are dominated by Scotch pine *Pinus silvestris* (80% of tree stands area) and Norway spruce *Picea abies* (12%). Black alder *Alnus glutinosa* stands 3%, birch *Betula verrucosa* — 3% and oak *Quercus robur* — 2%. Young forests and forest plantations cover 26% of the area, whears old tree stands (> 80 yrs) — 22%.

MATERIAL AND METHODS

In the winter and spring, the nests of birds of prey were searched in old tree stands of the Park. All the nests of birds of prey and Raven *Corvus corax*, known from previous years had been checked. Sites of observation of the studied species were marked on a map. In the years 1989–1993, 15–25 days were spent on searching for occupied nests each year. In the years 1994–1998, only a breeding site of the White-tailed Eagle was checked.

Pellets and prey remains were collected from nests and nearby areas beneath during 2–7 breeding seasons (Table 1) from April through July. Diet composition was estimated quantitatively by identifying eaten prey

1984, Busse 1990). So one meal of carrion was equivalent to 90 g in the Black Kite, 100 g in the Red Kite, and 500 g in the White-tailed Eagle.

The food niche breadth (B) was calculated according to Levins (1968): $B = 1/\sum p_i^2$, where p_i is a fraction of each prey group (mammals, birds, fish, carrion, amphibians, insects) in the total biomass or the number of prey items consumed. With six groups of prey taken for calculations, index B would vary from 1 (the narrowest niche) to 6 (the broadest niche possible). The index of food niche overlap between the two species was calculated after Pianka (1973): $\alpha_{ij} = \sum (p_{ia} \times p_{ja}) \times [(\sum p_{ia}^2) \times (\sum p_{ja}^2)]^{-1/2}$ where α_{ij} is the overlap between predators i and j , p_{ia} is the fraction of a th prey in the total biomass consumed by i th predator, p_{ja} is the fraction of the a th prey in the total biomass consumed by the j th predator. Index α varies from 0 (exclusive food niches) to 1 (identical niches).

The G-test for the homogeneity of percentages was used to analyse the frequency distribution of prey grouped in classes of body mass. The assumed null hypothesis was of 1:1:1 (Sokal & Rohlf 1981).

Table 1. Study data on four raptor species investigated in Wigry National Park (NE Poland). *Mmg* — *Milvus migrans*, *Mml* — *Milvus milvus*, *Hal* — *Haliaeetus albicilla*, *Aqp* — *Aquila pomarina*.

Parameter	Raptor species			
	<i>Mmg</i>	<i>Mml</i>	<i>Hal</i>	<i>Aqp</i>
Period	1990–91	1989–93	1991–98	1989–92
N studied broods	2	8	6	4
N pellets	24	174	114	139
N prey specimens in pellets	51	297	191	272
N prey remains	54	234	108	21
Total number of prey specimens	105	531	299	293
Total biomass of prey consumed (kg)	22.0	111.1	172.2	10.0

items from the found remains (feathers, hair, skeletons, scales etc.). In the case of remains found in both pellets and food remains, double counting of prey items was avoided by assuming the lowest probable number of individuals eaten. The biomass of consumed food was computed by multiplying the number of prey items by their body mass. The mean mass of mammals were taken from Goszczyński (1974), and the mean mass of birds from Busse (1990). The mass of fish were calculated from the sizes of scales and parts of skeletons. The biomass of eaten carrion was determined under the assumption that the bird ate it in the amount of its daily food needs, that is, about 10% of its body mass (Fisher

During the study, the habitat selectivity was estimated based on the observation of preying birds. The way and place of preying and — if possible — the kind of food eaten was determined. The distance of the feeding ground from the nest was noted.

Thirty-five observations of the Black Kite, 103 of the Red Kite, 27 of the White-tailed Eagle and 42 of the Lesser Spotted Eagle were recorded. Another method to estimate the habitat selectivity was based on the analysis of the degree of utilization of a given habitat from the percent share of the food taken there. All raptors prey was divided into species taken from open areas, from forest and from water habitats. The Mole *Talpa europaea*, Brown Hare *Lepus europaeus*, Common Rat *Rattus norvegicus*, domestic hen, Partridge *Perdix perdix*, pigeons *Columba* spp., Sky Lark *Alauda arvensis*, corvids (but without Jay *Garrulus glandarius* and Nutcracker *Nucifraga caryocatactes*), frogs *Rana* spp., and carrion of farm animals were considered prey

from open areas. Forest prey included Red Squirrel *Sciurus vulgaris*, Weasel *Mustela nivalis*, Hazel Grouse *Bonasa bonasia*, Woodcock *Scolopax rusticola*, thrushes *Turdus* spp., Hawfinch *Coccothraustes coccothraustes* and carrion of the Roe Deer *Capreolus capreolus*. The Musk Rat *Ondatra zibethicus*, Water Vole *Arvicola terrestris*, waterfowl (*Anatidae*, *Laridae*), Coot *Fulica atra* and fish came from water habitats. The results of both methods were then compared.

RESULTS

Diet composition

Black Kite. Twenty-three species of prey, belonging to six prey groups, were registered in the diet (Table 2). The most common prey were birds, primarily water species: the gulls and ducks. The second important group of food was fish. Small mammals and carrion of the larger mammals supplemented the diet.

Table 2. Diet composition of the Black Kite (data from pellets and prey remains). *B* — index of the food niche breadth, "+" — < 0.05%.

Species	N	% N	Biomass consumed (g)	% biomass
<i>Talpa europaea</i>	4	3.7	320	1.4
<i>Sciurus vulgaris</i>	1	1.0	300	1.4
<i>Arvicola terrestris</i>	1	1.0	80	0.4
<i>Rattus norvegicus</i>	1	1.0	250	1.1
Undetermined small mammals	7	6.5	350	1.6
Total Mammals	14	13.2	1300	5.9
<i>Anas platyrhynchos</i>	3	2.8	2400	10.9
<i>Anas</i> sp.	3	2.8	2100	9.5
Domestic hen	3	2.8	3000	13.5
<i>Fulica atra</i>	1	1.0	600	2.7
<i>Larus ridibundus</i>	5	4.8	1375	6.2
<i>Larus</i> sp.	4	3.8	1000	4.5
<i>Columba livia</i>	1	1.0	420	1.9
<i>Columba</i> sp.	1	1.0	450	2.0
<i>Alauda arvensis</i>	1	1.0	35	0.2
<i>Turdus philomelos</i>	2	1.9	100	0.5
<i>Turdus</i> sp.	2	1.9	120	0.6
<i>Garrulus glandarius</i>	1	1.0	175	0.8
<i>Pica pica</i>	3	2.9	600	2.7
<i>Sturnus vulgaris</i>	1	1.0	80	0.4
Undetermined medium-sized birds	10	9.6	600	2.7
Total Birds	41	39.3	13055	59.1
<i>Rana</i> sp.	2	1.9	30	0.2
Total Amphibians	2	1.9	30	0.2
<i>Rutilus rutilus</i>	11	10.5	1350	6.2
<i>Scardinius erythrophthalmus</i>	1	1.0	100	0.5
<i>Abramis brama</i>	6	5.6	1200	5.4
<i>Esox lucius</i>	4	3.8	1600	7.2
Undetermined fish	9	8.5	2100	9.5
Total Fish	31	29.4	6350	28.8
Coleoptera	2	1.9	2	+
Total Invertebrates	2	1.9	2	+
<i>Felis catus</i>	1	1.0	90	0.4
<i>Canis familiaris</i>	1	1.0	90	0.4
<i>Sus domesticus</i>	2	1.9	180	0.8
Carrion of mammals	11	10.5	990	4.4
Total Carrion	15	14.3	1350	6.0
Total	105	100%	221 kg	100%
B	3.6		2.3	

Red Kite. Thirty-nine species, belonging to six prey groups, were found in the food (Table 3). Birds accounted for almost half of all prey. The share of mammals was also significant. Relatively high share

of carrion in the diet followed from eating dead animal bodies and from scavenging on thrown-away remainders after the slaughter.

Table 3. Diet composition of the Red Kite (data from pellets and prey remains). *B* — index of the food niche breadth, after Levins (1968), "+" — < 0.05%.

Species	N	% N	Biomass consumed (g)	% biomass
1	2	3	4	5
<i>Talpa europaea</i>	5	0.9	400	0.4
<i>Lepus</i> sp.	10	1.9	10000	9.0
<i>Lepus</i> sp. juv.	1	0.2	200	0.2
<i>Sciurus vulgaris</i>	5	0.9	1500	1.3
<i>Ondatra zibethicus</i>	11	2.1	7700	6.9
<i>Arvicola terrestris</i>	10	1.9	800	0.7
<i>Microtus</i> sp.	10	1.9	320	0.3
<i>Rattus norvegicus</i>	17	3.2	4250	3.8
<i>Mustela nivalis</i>	1	0.2	85	0.1
Undetermined small mammals	78	14.6	3900	3.5
Undetermined medium-sized-mammals	2	0.4	400	0.4
Total Mammals	150	28.2	29555	26.6
<i>Anas platyrhynchos</i>	7	1.3	5600	5.0
<i>Anas</i> sp.	7	1.3	4900	4.4
<i>Aythya</i> sp.	1	0.2	600	0.5
<i>Perdix perdix</i>	3	0.6	1200	1.1
Domestic hen	20	5.6	15000	13.5
<i>Fulica atra</i>	8	1.5	4800	4.3
<i>Vanellus vanellus</i>	4	0.8	600	0.5
<i>Scolopax rusticola</i>	1	0.2	300	0.3
<i>Larus ridibundus</i>	9	1.7	2475	2.2
<i>Larus</i> sp.	9	1.7	2250	2.0
<i>Columba livia</i>	4	0.8	1680	1.6
<i>Columba palumbus</i>	2	0.4	950	0.8
<i>Columba</i> sp.	10	1.9	4500	4.1
<i>Turdus merula</i>	6	1.1	420	0.4
<i>Turdus pilaris</i>	3	0.6	210	0.2
<i>Turdus philomelos</i>	1	0.2	50	+
<i>Turdus</i> sp.	18	3.3	1080	1.0
<i>Garrulus glandarius</i>	17	3.2	2975	2.7
<i>Pica pica</i>	1	0.2	200	0.2
<i>Nucifraga caryocatactes</i>	1	0.2	200	0.2
<i>Corvus monedula</i>	8	1.5	1600	1.5
<i>Corvus frugilegus</i>	18	3.3	8100	7.3
<i>Corvus corax</i>	1	0.2	1100	1.0
<i>Coccothraustes coccothraustes</i>	4	0.8	220	0.2
<i>Emberiza citrinella</i>	1	0.2	30	+
Undetermined medium-sized-birds	91	17.1	5460	4.9
Total Birds	255	48.0	66500	59.9
<i>Rana</i> sp.	9	1.7	135	0.1
Total Amphibians	9	1.7	135	0.1
<i>Rutilus rutilus</i>	4	0.7	800	0.7
<i>Abramis brama</i>	1	0.2	500	0.5
<i>Esox lucius</i>	3	0.6	1000	0.9
Cyprinidae	2	0.4	700	0.6
Undetermined fish	9	1.7	2700	2.4
Total Fish	19	3.6	5700	5.1

1	2	3	4	5
<i>Melolontha</i> sp.	4	0.8	4	+
Coleoptera	2	0.4	2	+
Total Invertebrates	6	1.2	6	+
<i>Canis familiaris</i>	2	0.4	200	0.2
<i>Felis catus</i>	1	0.2	100	0.1
<i>Ovis aries</i>	4	0.8	400	0.3
<i>Sus domesticus</i>	3	0.6	300	0.3
<i>Capreolus capreolus</i>	1	0.2	100	0.1
Refuse from slaughter-house	6	1.1	600	0.5
Carrion of domestic animals	7	1.3	700	0.6
Carrion of undetermined mammals	58	10.9	5800	5.2
Domestic hen	10	1.9	1000	1.0
Total Carrion	92	17.3	9200	8.3
Total	531	100%	111.1 kg	100%
B	2.8		2.2	

White-tailed Eagle. There were 24 species of prey, among which the most numerous group were birds and the next — fish. They accounted together for over 95% of prey in terms of both the number of items and their biomass. The share of mammals and carrion was insignificant (Table 4).

Lesser Spotted Eagle. In the diet 18 species of animals were found (Table 5). Mammals accounted for more than half of all prey. The share of birds was relatively high. The Lesser Spotted Eagle caught numerous frogs and insects but they had small share in the biomass of the food. Fish and carrion were not found in its diet.

Size of prey

Among the studied birds of prey, the White-tailed Eagle caught the largest prey while the Lesser Spotted Eagle — the smallest. Preys of both Kite species were characterized by intermediate biomass (Table 6). The most pronounced difference between the body mass of prey from various systematic groups was found in the case of the Black Kite. Differences between the mass of mammals, birds, and fish caught by the White-tailed Eagle and the Red Kite were small (Table 6).

In the diet of the Black Kite, prey items with mass 101–500 g were the most numerous. The Red Kite caught the most often prey with mass 1–100 g and 101–500 g. The body mass of the Lesser Spotted Eagle's prey in most cases did not exceed 100 g. Vertebrates with mass over 500 g dominated in the diet of the White-tailed Eagle (Fig. 1). Frequency distributions of prey grouped in classes of body mass differed statistically between all the raptor species studied (from 21.8 to 235.7, $df = 2$,

$p < 0.001$ in pairwise comparisons, G-test for homogeneity of percentages).

Foraging habitats

The Black Kite got most of its food in water habitats (Table 7). It preyed on the forest edge, on the lakes or on farmlands. Many observations referred to the birds in an open habitat where the Kite was seen patrolling a busy road segment or picking up carrion of animals run over by vehicles. During the breeding period Black Kites were seen up to 4 km away from the nest.

The Red Kite got the food primarily in open areas. Over half of prey in terms of both the number of items and the biomass comes from this habitat. The Red Kite was the raptor the most strongly connected with anthropogenic habitat. Dumping grounds located near human settlements were an essential source of its food. Lakes were another important feeding area for this raptor. More than one-fourth of all prey came from there (Table 7). Preying Red Kites were observed in all types of WNP's habitats. They were seen generally in a patrol flight over open areas near forest edge and over the lakes (Table 7). Red Kites were also observed flying low over areas of slaughter-houses and picking up the food from an urban dumping ground about 10 km away from the nest. During preying on the rodents the Red Kite often was on the watch on single trees in farmlands.

The White-tailed Eagle was a raptor very strongly connected with the lakes. It got the food almost exclusively in water habitat (Table 7). Almost all observations of White-tailed Eagles referred to birds preying on the lakes, a river or sitting on trees growing

Table 4. Diet composition of the White-tailed Eagle (data from pellets and prey remains). *B* — index of the food niche breadth, "+" — < 0.05%.

Species	N	% N	Biomass consumed (g)	% biomass
<i>Erinaceus concolor</i>	1	0.3	200	0.1
<i>Lepus europaeus</i>	3	1.0	3000	1.7
<i>Sciurus vulgaris</i>	1	0.3	300	0.2
<i>Microtus</i> sp.	1	0.3	30	+
Undetermined mammals	2	0.8	1000	0.6
Total Mammals	8	2.7	4530	2.6
<i>Podiceps cristatus</i>	2	0.8	1400	0.8
<i>Podiceps cristatus</i> pull.	1	0.3	200	0.1
<i>Cygnus olor</i> pull.	2	0.8	1000	0.6
<i>Anas platyrhynchos</i>	9	3.0	7200	4.2
<i>Anas</i> sp.	27	9.0	18900	11.0
<i>Aythya fuligula</i>	5	1.6	3500	2.1
<i>Aythya</i> sp.	3	1.0	2100	1.2
<i>Buteo buteo</i>	1	0.3	1000	0.6
<i>Bonasa bonasia</i>	2	0.8	840	0.5
Domestic hen	1	0.3	1000	0.6
<i>Fulica atra</i>	132	44.1	79200	46.0
<i>Columba palumbus</i>	1	0.3	475	0.3
<i>Turdus</i> sp.	3	1.0	180	0.1
<i>Garrulus glandarius</i>	1	0.3	175	0.1
Undetermined medium-sized-birds	1	0.3	200	0.1
Undetermined big birds	6	2.0	3000	1.7
Total Birds	197	65.9	120370	70.0
<i>Rutilus rutilus</i>	4	1.3	600	0.3
<i>Scardinius erythrophthalmus</i>	1	0.3	150	0.1
<i>Abramis brama</i>	33	11.0	17900	10.4
<i>Anquilla anquilla</i>	8	2.6	4800	2.8
<i>Perca fluviatilis</i>	10	3.3	4500	2.6
<i>Esox lucius</i>	8	2.6	5200	3.0
Undetermined small fish	3	1.0	600	0.3
Undetermined medium-sized-fish	21	7.0	10500	6.1
Undetermined big fish	2	0.8	2000	1.2
Total Fish	90	30.1	46250	26.8
Odonate	1	0.3	1	+
Total Invertebrates	1	0.3	1	+
Egg of ducks	1	0.3	40	+
Total Eggs	1	0.3	40	+
<i>Canis familiaris</i>	1	0.3	500	0.3
<i>Capreolus capreolus</i>	1	0.3	500	0.3
Total Carrion	2	0.8	1000	0.6
Total	299	100%	1722 kg	100%
<i>B</i>	1.9		1.8	

near the banks of water bodies. The White-tailed Eagle preyed up to 15 km away from the nest but the most often within a radius of about 5 km. It was the only species that such common preying of a pair was observed.

The Lesser Spotted Eagle preyed in open areas and in forest. Prey caught on the fields or meadows dominated in its food (Table 7). The Lesser Spotted Eagle was observed primarily in open areas. While preying, the bird circled over a field or a meadow, sat on a

Table 5. Diet composition of the Lesser Spotted Eagle (data from pellets and prey remains). *B* — index of the food niche breadth.

Species	N	% N	Biomass consumed (g)	% biomass
<i>Talpa europaea</i>	14	4.8	1120	11.1
<i>Lepus europaeus</i> juv.	1	0.3	200	2.0
<i>Clethrionomys glareolus</i>	1	0.3	20	0.2
<i>Ondatra zibethicus</i>	1	0.3	700	7.0
<i>Arvicola terrestris</i>	3	1.0	240	2.4
<i>Microtus oeconomus</i>	3	1.0	126	1.3
<i>Microtus arvalis</i>	8	2.8	160	1.6
<i>Microtus</i> sp.	18	6.2	576	5.8
<i>Apodemus flavicollis</i>	1	0.3	30	0.3
<i>Apodemus</i> sp.	1	0.3	25	0.3
Muridae	1	0.3	25	0.3
Undetermined small rodents	94	2.1	2350	23.4
Undetermined small mammals	3	1.0	150	1.5
Undetermined medium-sized-mammals	1	0.3	200	2.0
Total Mammals	150	51.2	5922	59.2
<i>Perdix perdix</i>	1	0.3	400	4.0
Domestic hen juv.	1	0.3	500	5.0
<i>Columba palumbus</i>	1	0.3	475	4.7
<i>Dendrocopos major</i>	1	0.3	70	0.7
<i>Alauda arvensis</i>	1	0.3	35	0.3
<i>Turdus philomelos</i>	2	0.7	100	1.0
<i>Garrulus glandarius</i>	2	0.7	350	3.5
<i>Corvus corax</i> pull.	1	0.3	500	5.0
Undetermined small birds	35	11.9	700	7.0
Undetermined medium-sized birds	6	2.1	360	3.6
Total Birds	51	17.4	3490	34.8
<i>Rana</i> sp.	36	12.3	540	5.4
Total Amphibians	36	12.3	540	5.4
Coleoptera	56	19.1	56	0.6
Total Invertebrates	56	19.1	56	0.6
Total	293	100%	100 kg	100%
B	2.9		2.1	

branch of a tree growing on forest edge or walked on the ground, collecting insects and frogs. Preying Lesser Spotted Eagle were met up to 4 km away from the nest. However, more than 50% of the observations comes from the distance not more than 1 km.

Food niche overlaps

The food niches of studied species overlapped to various degrees, but all the raptors fed at least in half on the same kind of food. The food niches of the Black Kite and White-tailed Eagle overlapped the most (Table 8). Water birds and fish prevailed in the diet of both species but in the case of the White-tailed Eagle the domination of these food groups was much

stronger. The niches of both Kites and of the Red Kite and White-tailed Eagle and also of the Red Kite and Lesser Spotted Eagle also overlapped to a large degree. The food niches of both Eagles and those of the Black Kite and Lesser Spotted Eagle were the most separated (Table 8).

DISCUSSION

The diet of the all studied birds of prey is characterized by relatively large variability dependent on the habitat conditions. Both Kites feed on mammals, birds, fish, and carrion. Locally they supplement the

diet with amphibians, reptiles, and invertebrates. Data from literature shows that proportions of particular food groups in various areas vary (Cramp & Simmons 1980, Delibes & Garcia 1984, Gensbol &

Spain, a high share of carrion (30–55%) was found in the winter food of the Red Kite (Garcia et al. 1998).

Water birds and fish dominate in the White-tailed Eagle's diet. The share of both groups is variable and ranges from several to 90%. In some areas, carrion is also an essential component of the food (Cramp & Simmons 1980, Fischer 1984, Gensbol & Thiede 1986, Waclawek et al. 1998, Mizera 1999). In Pisz Forest, fish accounted for 74%, and birds for 22% of the White-tailed Eagle's prey (Waclawek et al. 1998). In WNP, the White-tailed Eagle caught birds much more often than fish.

Table 6. Average body mass (g) of preys (carrion excluded), taken by four raptor species studied.

Raptor species	Mammal	Bird	Fish	Total prey
<i>Milvus migrans</i>	94	318	205	230
<i>Milvus milvus</i>	197	261	300	232
<i>Haliaeetus albicilla</i>	566	611	514	578
<i>Aquila pomarina</i>	39	68	–	34

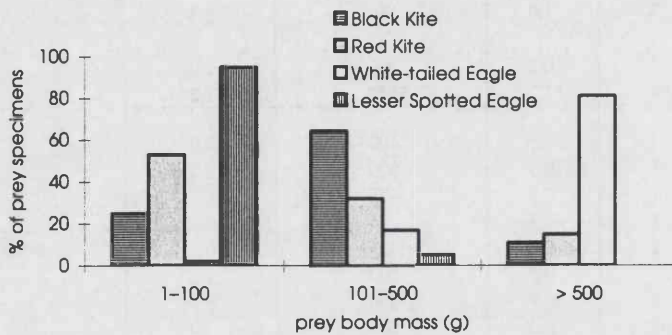


Fig. 1. Percentage frequencies of prey specimens, captured by four raptor species in Wigry National Park, in 3 classes of body mass.

Thiede 1986, Ortlieb 1989, Veiga & Hiraldo 1990, Blanco & Hiraldo 1992, Jędrzejewska & Jędrzejewski 1998). In south-western Spain and in Białowieża Primeval Forest, similarly as in this paper, the share of water species in the diet of the Black Kite was found higher than in the diet of the Red Kite (Veiga & Hiraldo 1990, Jędrzejewska & Jędrzejewski 1998). In the food of the Black Kite and Red Kite in Białowieża Primeval Forest carrion did not appear at all (Jędrzejewska & Jędrzejewski 1998), while it was an essential component of the food of both species in WNP. In

The Lesser Spotted Eagle feeds on small rodents, birds, reptiles, amphibians, and insects (Palasthy & Meyburg 1973, Cramp & Simmons 1980, Gensbol & Thiede 1986). Shares of particular food groups vary. In Białowieża Primeval Forest, small mammals accounted for 27–35% of the food biomass, birds — 30%, reptiles — 5%, frogs — 3–5% (Jędrzejewska & Jędrzejewski 1998). In Pisz Forest, mammals accounted for 62% (including voles — 20% and mole — 11%), birds — 34%, reptiles — 3% of the biomass of the Lesser Spotted Eagle's food (I. Mirowski, unpubl. data). Similar proportions of the main food groups were found in region of Mazowsze, Central Poland (I. Mirowski, unpubl. data).

All studied species use diversified ways of preying and getting the food, observed also in WNP: patrol flight, sit-and-wait tactic, and walking on the ground in a search for less timid prey (Gensbol & Thiede 1986, Mebs 1998). Numerous researchers published information about preying of White-tailed Eagles in pairs (Fischer 1984, Giergielewicz 1985, Gensbol & Thiede 1986, Mizera 1999). The Red Kite, Black Kite and

Table 7. Percentage of prey in diets (% PD) of four raptors from three habitats compared with the percentages of observations of birds (% Ob) hunting in those habitats. NP — number of prey specimens found in pellets and prey remains; NOb — number of observations; D:Ob — mean difference between analysis of diet composition and visual observations.

Raptor species	NP	NOb	Open areas		Lake		Forest	
			% PD	(% Ob)	% PD	(% Ob)	% PD	(% Ob)
<i>Milvus migrans</i>	86	35	27	(55)	66	(36)	7	(9)
<i>Milvus milvus</i>	289	103	52	(77)	28	(15)	20	(8)
<i>Haliaeetus albicilla</i>	295	27	2	(5)	94	(95)	4	(0)
<i>Aquila pomarina</i>	78	42	84	(93)	4	(0)	12	(7)
D:Ob (SD)			+16 (12)		-12 (13)		-6 (4)	

White-tailed Eagle sometimes use kleptoparasitism (Cramp & Simmons 1980, Fischer 1984, Ortlieb 1989). Taking the food from other birds species was not seen in Wigry National Park.

Table 8. Food niche overlaps of the four raptor species studied.

Pair of species	<i>M. milvus</i>	<i>H. albicilla</i>	<i>A. pomarina</i>
<i>Milvus migrans</i>	0.880	0.991	0.528
<i>Milvus milvus</i>	X	0.878	0.816
<i>Haliaeetus albicilla</i>		X	0.502

The Black Kite preys predominately in open areas or over water (Gensbol & Thiede 1986, Mebs 1998). The Red Kite preys in open areas, readily uses places of throwing out food waste and dumping grounds. It eats animals killed by cars and farming machines. It gets its food up to 10–15 km away from the nest (Ortlieb 1998).

The White-tailed Eagle preys almost exclusively on water bodies. It can search for food up to 20 km away from the nest (Mebs 1998, Mizera 1999). However, it was found in Germany that the maximal distance between the nest and the main feeding ground was 3 km, even if White-tailed Eagles preyed also 6–11 km away from the breeding place (Gensbol & Thiede 1986).

The Lesser Spotted Eagle searches for the food in open wetlands or in the fields (Pugacewicz 1996, I. Mirowski unpubl. data). In Białowieża Primeval Forest, the Lesser Spotted Eagle preyed generally in wet meadows, river valleys and on forest edges. The birds preyed within a radius of 3 km from the nest. However, single observations referred to birds bringing the food from the distance of over 6 km (Pugacewicz 1996). In region of Mazowsze, Lesser Spotted Eagles preyed not more than 3 km away from the nest (I. Mirowski unpubl. data).

Application in this study of two assessment methods of using the habitats by raptors (Table 7) allowed determining the real habitat selectivity. The results of both assessment methods were consistent only for the White-tailed Eagle. For the Kites and Lesser Spotted Eagle observations performed in open areas overestimated the degree of usage of this habitat due to better visibility of preying birds and more often penetration of this habitat by an observer. Observations of preying birds on the lakes and in forest led to underestimate the share of food from these habitats in the diet (Table 7). It was the result of strong restrictions on the field of vision in the forest and the possibility of performing observations only from

the bank of a lake. The way of using the habitat of birds of prey in WNP is similar to the results of observations published by another researchers.

Among the raptors studied in Wigry National Park, the White-tailed Eagle was the most specialised species. This bird used for preying only one habitat and had the narrowest food niche. Maybe the food niche breadth of the White-tailed Eagle was slightly underestimated due to classifying by the author food eaten as carrion as preyed birds or fish. According to numerous researchers, the White-tailed Eagle generally eats carrion in winter, but it can also feed on carrion during the breeding period (Cramp & Simmons 1980, Fischer 1984, Mizera 1999).

The Black Kite, Red Kite and Lesser Spotted Eagle were opportunists with respect to their feeding habits. Their food niche breadth in terms of the number of prey items was in WNP much higher than in the case of the White-tailed Eagle. The differences in the niche breadth in terms of the food biomass between the White-tailed Eagle and the other raptors were not very high. In WNP, the food niches of both Kite species and the White-tailed Eagle overlapped considerably. The food niche of the Lesser Spotted Eagle was more separated. Its prey items were much smaller and less timid than in the case of the other raptors. Contrary to the Kites and White-tailed Eagle, the Lesser Spotted Eagle did not prey on the lakes. According to Jędrzejewska & Jędrzejewski (1998) in Białowieża Primeval Forest (where the Kites and Lesser Spotted Eagles nested) the niches of the Red Kite and Lesser Spotted Eagle coincided the most, next the niches of the Red and Black Kites. The niches of the Black Kite and Lesser Spotted Eagle overlapped the least.

The raptors in WNP compensated for the strong coincidence of their food niches by space separation of the feeding grounds. They preferred catching of prey with different body size, proficiency of moving, and timidity. The birds used various strategies to get the food.

Translated by Dr Artur Mikitiuk

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STRESZCZENIE

[Zwyczajne żerowiskowe kani czarnej, kani rudej, bielika i orlika krzykliwego w Wigierskim Parku Narodowym]

Badania prowadzono w okresie 2–7 lat w sezonie lęgowym (tab. 1). Szukano zajętych gniazd ptaków drapieżnych i kontrolowano je. Analizowano resztki pokarmu i wypluwki znalezione w gniazdach i na ziemi. Skład pokarmu oznaczano ilościowo, identyfikując spożyte ofiary na podstawie znalezionych resztek (piór, sierści, szkieletów, łusek). Przy oznaczaniu biomasy zjedzonej padliny założono, że ptak zjadał ją w ilości równej dobowemu zapotrzebowaniu pokarmu, czyli ok. 10% masy ciała (Fisher 1984, Busse 1990, Pielowski 1996). Przyjęto, że jednorazowa konsumpcja padliny dużych kręgowców wynosiła 90 g dla kani czarnej, 100 g dla kani rudej oraz 500 g dla bielika.

Obliczono szerokość nisz pokarmowych badanych gatunków ptaków drapieżnych oraz oceniono stopień ich nakładania się. Wskaźnik szerokości niszy pokarmowej (B) obliczano wg Levinsa (1968): $B = 1/\sum p_i^2$, gdzie p_i jest udziałem każdej z 6 wyróżnionych grup pokarmu (ssaków, ptaków, ryb, padliny, płazów i owadów) w łącznej liczbie ofiar oraz w całkowitej biomase konsumowanego pokarmu. Dla wyróżnionych 6 grup wskaźnik B może przyjmować wartości od 1 (najwęższa nisza) do 6 (najszerza możliwa nisza).

Wskaźnik nakładania się nisz pokarmowych dwóch gatunków był obliczany wg Pianki (1973): $\alpha_{ij} = \sum (p_{ia} \times p_{ja} \times [(\sum p_{ia}^2) \times (\sum p_{ja}^2)]^{-1/2}$, gdzie α_{ij} jest wskaźnikiem nakładania się nisz pomiędzy gatunkiem i oraz gatunkiem j , p_{ia} jest udziałem a -tej grupy ofiar w łącznej biomase pokarmu i -tego gatunku gatunku drapieżnika, p_{ja} jest udziałem a -tej grupy ofiar w łącznej biomase pokarmu j -tego gatunku drapieżnika. Wskaźnik α przyjmuje wartości od 0 (nisze pokarmowe odrębne) do 1 (nisze pokarmowe identyczne).

W trakcie badań obserwowano żerujące ptaki, określano sposób i miejsce polowania oraz oddalenie

żerowiska od gniazda. Przeprowadzono ocenę wybiórczości środowiskowej opartą na udziale w pokarmie ofiar, chwytanych w środowisku polnym, leśnym i wodnym.

W pokarmie kani czarnej stwierdzono 23 gatunki ofiar. Najczęstszą zdobyczą były ptaki, następnie ryby (tab. 2). W pożywieniu kani rudej wystąpiło 39 gatunków ofiar. Blisko połowę wszystkich zdobyczy stanowiły ptaki. Istotny był udział w diecie ssaków oraz padliny (tab. 3). Bielik polował na 24 gatunki ofiar, wśród których najliczniejszą zdobyczą były ptaki, następnie ryby (tab. 4). W pokarmie orlika krzykliwego stwierdzono 18 gatunków zwierząt. Ponad połowę wszystkich ofiar stanowiły ssaki (tab. 5).

Największe ofiary chwycił bielik, najmniejsze orlik krzykliwy. Pośrednią wielkość miały zdobycze kani rudej i czarnej (tab. 6). Najliczniejsze ofiary kani czarnej miały masę 101–500 g, kani rudej: 1–100 g, następnie 101–500 g. Masa zdobyczy bielika najczęściej przekraczała 500 g, a orlika krzykliwego — wynosiła mniej niż 100 g (ryc. 1).

Kania czarna największą część pokarmu zdobywała nad wodą (tab. 7). Żerowała w odległości do 4 km od gniazda. Kania ruda żerowała przede wszystkim na terenach otwartych (tab. 7). Chętnie wykorzystywała wysypiska śmieci i odpadków. Zdobywała pokarm w odległości do 10 km od gniazda. Bielik polował wy-

łącznie nad jeziorami lub rzeką (tab. 7). Obserwowano wspólne polowanie pary ptaków. Bieliki żerowały w odległości do 15 km od gniazda. Orlik krzykliwy zdobywał pokarm na terenach otwartych oraz w lesie (tab. 7). Żerował w odległości do 4 km od gniazda, jednak najczęściej nie dalej niż 1 km.

Najmniejszą szerokość niszy pokarmowej stwierdzono u bielika. Szerokości nisz pokarmowych pozostałych ptaków drapieżnych były zbliżone.

Nisze pokarmowe badanych ptaków drapieżnych, oceniane pod względem biomasy głównych ofiar, nakładały się co najmniej w połowie (tab. 8). Najsilniejsze pokrywanie się nisz stwierdzono u kani czarnej i bielika. W dużym stopniu pokrywały się także nisze obydwu kań oraz kani rudej i bielika. Najbardziej rozdzielone były nisze pokarmowe bielika i orlika oraz kani czarnej i orlika (tab. 8). Najsilniej wyspecjalizowanym gatunkiem był bielik. Kania ruda i czarna oraz orlik krzykliwy były gatunkami oportunistycznymi pod względem sposobu odżywiania.

Silne pokrywanie się nisz pokarmowych ptaki drapieżne w WPN kompensowały rozdzielaniem przestrzennym żerowisk. Preferowały chwytanie ofiar różniących się rozmiarami ciała oraz sprawnością poruszania się i płochliwością. Wykorzystywały różnorodne strategie zdobywania pokarmu.



Admiss

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