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The Comparison of the Winter Diet of Long-Eared Owl Asio otus in Two Communal Roosts in Lublin Region (Eastern Poland) According to Selected Weather Conditions

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Abstract. The survey was conducted in two test areas in Wólka Kątna and Zemborzyce in Eastern Poland in winter 2012/2013. The winter diet of Long-eared Owl *Asio otus* in the test areas differed significantly. In Zemborzyce the Levins food niche breadth index and the Wiener-Shannon biodiversity index were strongly correlated with the average temperature and the snow depth, and not correlated with the precipitation. In Wólka Kątna no correlation was found. No correlation between the weather factors and the number of each prey species was found, except the Tundra Vole *Microtus oeconomus* in Zemborzyce, which occurrence in owls' pellets was positively correlated with the temperature and negatively correlated with the snow depth. Seven factors describing the owls' diet was chosen: average number of prey in one pellet, average number of prey per bird per day, share of *Arvicolidae* and *Muridae* in prey number and prey biomass, and the biomass of prey per bird per day. The share of *Arvicolidae* in biomass negatively correlated with the precipitation on the Zemborzyce test area and no other dependency between diet factors and weather conditions was found.

Key words: Long-eared Owl, winter diet, *Asio otus*, weather

Introduction

The Long-eared Owl *Asio otus* is the second numerous owl in Poland (SIKORA *et al.*, 2007). The fact of forming communal roosts in winter, where many birds rest together, makes the species one of the best known in aspect of diet during non-breeding season (HOLT, 1997; ŻMIHORSKI, 2005; BIRRER, 2009; DZIEMIAN *et al.*, 2012; KITOWSKI, 2013). Fewer papers treat about the effect of weather factors on the birds' activity and the food composition in different types of habitat (CANOVA, 1989; RUBOLINI *et al.*, 2003; ROMANOWSKI & ŻMIHORSK,I 2008). In case of more frequent weather anomalies, the knowledge of their impact on birds may be important in understanding their ecology and for better protection (KUNDZEWICZ & JUDA-REZLER, 2010).

The aim of present study was to survey and compare the effect of selected weather conditions on the diet of Long-eared Owl on two test areas in Eastern Poland.

Material and Methods

Pellets of Long-eared Owl were collected from two communal roosts in Lublin Region, Eastern Poland – Wólka Kątna (51°10'56 N, 22°32'16" E) and Zemborzyce (51°25'35" N, 22°16'49" E) (Fig 1). In both cases, communal roosts were located on pines and the pellets were gathered from under those trees at intervals of 6 to 19 days. Habitat in which birds were roosting differed between the test areas. In Wólka Kątna, the roosting trees were located on the edge of the small forest patch surrounded by agricultural landscape. The area of the patch was 0.3 km², and the distance to the field, where birds could hunt was less than 50 meters. In Zemborzyce, the communal roost was also placed in the middle of the forest edge, between the forest and the artificial lake. The area of the forest was 13.7 km², and the distance to the open space suitable for birds to hunt was over 1000 meters.

Fig. 1. Test areas in Eastern Poland: 1 – Wólka Kątna, 2 – Zemborzyce.

In Wólka Kątna the pellets were collected 10 times, in Zemborzyce 9 times during the period of the survey. The pellets were prepared for analysis by standard methods (RUPRECHT *et al.*, 1998). The number of vertebrate prey species was determined on the basis of skulls, mandibles, teeth, and bone remains (PUCEK, 1984; KITOWSKI *et al.*, 2005). Due to the high degree of fragmentation of some remains, preventing species identification, some prey was grouped, like *Microtus, Apodemus* etc. (Tab. 1, Tab. 2). The prey biomass was estimated as in literature (KITOWSKI, 2013).

The weather data was received from the Institute of Meteorology and Water Management (IMGW), from meteorological stations in Radawiec near Lublin and from Puławy (IMGW, 2013). For analysis, the data of daily precipitation, daily average temperature and snow cover were taken. Each part of data was averaged for the period between subsequent pellet gatherings.

The analyzes included correlations between weather conditions and average number of prey in one pellet, prey number and biomass per bird per day, and the share of *Arvicolidae* and *Muridae* in prey number and biomass during each interval. The correlation between each prey taxon and the weather conditions was also analyzed.

The width of the food niches of owls was estimated using the formula by LEVINS (1968):

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

where pi is the proportion of the prey category *i* in the total biomass of the owl's diet.

Shannon-Wiener biodiversity (H) indices were calculated for trophic diversity at species levels using the next formula (KREBS, 1994):

$$H = -\Sigma [Pi \log (Pi)].$$

Both indexes were analysed to check the correlation with weather conditions.

To compare the test areas, prey was grouped into two families – *Arvicolidae* and *Muridae*, and the "*Other*" group for avian prey, including also reptile and insects, both found once in the survey. The 2×2 Chi-square test was used for *Arvicolidae* and for *Muridae* in number and biomass of prey, to compare the communal roosts (Tab.1). The *Other* group wasn't compared, due to the low number of prey.

All statistical analysis was conducted at significance level α = 0.05. Spearman's correlation was used to examine the dependence of each factor, and Mann-Whitney U test was used to compare the data from different test areas.

Results

In total, 237 prey items were selected from pellets in Zemborzyce test area and 461 in Wólka Kątna. The owls' diet differed significantly between the test areas (Tab. 1).

In almost every control on both gathering places, the Common vole *Microtus arvalis* was the most numerous prey species. In two cases, in pellets collected on the Zemborzyce test area, the most numerous taxon was Tundra vole *Microtus oeconomus*. Other taxa occurred in the lower number and had a lower share in the biomass (Tab. 1).

Table 1. The winter food composition of Long-eared Owl on communal roosts in Wólka Kątna and Zemborzyce in Eastern Poland

	Species	%N		%B	
		Wólka Kątna	**Zemborzyce**	**Wólka Kątna**	**Zemborzyce**
Arvicolidae	*Microtus arvalis*	55.70%	66.59%	51.03%	65.45%
	Microtus oeconomus	22.36%	3.04%	28.04%	4.08%
	Microtus subterraneus	1.27%	2.60%	1.04%	2.29%
	Clethrionomys glareolus	1.27%	5.21%	1.04%	4.58%
	Microtus spp.	2.95%	3.25%	3.28%	3.87%
Muridae	*Apodemus*	6.75%	9.98%	7.33%	11.61%
	Apodemus agrarius	0.42%	0.43%	0.35%	0.38%
	Sylvaemus	0.84%	1.52%	0.83%	1.61%
	Muridae spp	1.27%	4.34%	1.10%	4.04%
	Mus musculus	0.42%	0.65%	0.32%	0.52%
	Micromys minutus	2.11%	1.74%	0.81%	0.72%
Other	*Aves*	3.80%	0.65%	4.58%	0.84%
	Insecta	0.42%	0.00%	0.02%	0.00%
	Reptilia	0.42%	0.00%	0.24%	0.00%
Chi-square test	*Arvicolidae*	$\chi^2 = 0.67$	p = 0.413	$\chi^2 = 36.13$	p<0.0001
	Muridae	$\chi^2 = 5.03$,	P = 0.025	$\chi^2 = 155.03$	p<0.0001

Table 2 The correlation between the Levin's index and the Wiener-Shannon index, and selected weather factors on test areas in Wólka Kątna (W) and Zemborzyce (Z) in Eastern Poland (Spearman test).

Spearman correlation			temperature (˚C)		precipitation (mm)		snow cover (cm)	
			R	p	R	p	R	p
Levin's index	W	2.40 (SD = 0.89)	-0.310	0.384	0.055	0.881	0.411	0.237
	Z	2.61 (SD = 0.79)	**0.850**	**0.003**	0.100	0.798	**-0.683**	**0.042**
Wiener-Shannon index	W	1.11 (SD = 0.32)	-0.248	0.489	-0.006	0.987	0.251	0.483
	Z	1.17 (SD = 0.31)	**0.817**	**0.007**	0.067	0.864	**-0.750**	**0.020**

The occurrence of individual taxa on both test areas did not correlate with selected weather conditions, except the Tundra vole, which occurrence in pellets from Zemborzyce test area was positively correlated with the temperature (Spearman test, R = 0.729, p = 0.026) and negatively correlated with the snow cover (Spearman test, R = -0.763, p = 0.017). The Wiener-Shannon H index and the Levin's B index were count for each interval on both test areas. There was no significant difference in these factors between the test areas (Mann-Whitney U test, U = 35, p = 0.438 for the Levin's index and U = 38, p = 0.596 for the Wiener-Shannon index). In Wólka Kątna none of the indexes were correlated with the weather factors. In Zemborzyce the food niche breadth and the biodiversity index were strongly, positively correlated with the temperature and negatively with the snow cover, which is presented in Table 2.

On the communal roost in Zemborzyce, the only factor, which was correlated with the weather conditions (R=-0.667, p=0.050), was the share of *Arvicolidae* in the total prey biomass. Other factors were not correlated with weather. In Wólka Kątna none of factors studied was correlated with weather. The selected weather conditions did not also influence on the functioning of the owls' digestive system, which is illustrated by lack of differences in the number of prey individuals per pellet (Table 3).

Table 3. The dependency of Long-eared Owls' diet factors on the selected weather conditions on test areas in Eastern Poland (W – Wólka Kątna, Z – Zemborzyce)

		temperature (˚C)		**precipitation (mm)**		**snow cover (cm)**	
	Test area	R	p	R	p	R	p
Number of prey in pellet	Z	-0.238	0.570	0.476	0.233	0.048	0.911
	W	0.200	0.606	-0.050	0.898	-0.239	0.444
Number of prey/day/individual	Z	0.042	0.915	0.435	0.242	-0.050	0.898
	W	0.115	0.751	-0.539	0.107	-0.460	0.181
%N *Arvicolidae*	Z	-0.133	0.732	-0.500	0.170	0.017	0.966
	W	0.006	0.987	-0.333	0.347	-0.325	0.359
%B *Arvicolidae*	Z	-0.100	0.798	**-0.667**	**0.050**	-0.017	0.966
	W	0.091	0.803	-0.103	0.777	-0.337	0.340
%N *Muridae*	Z	0.250	0.516	0.250	0.516	0.067	0.864
	W	-0.006	0.987	0.333	0.347	0.325	0.359
%B *Muridae*	Z	0.250	0.516	0.250	0.516	0.067	0.732
	W	0.006	0.987	0.030	0.934	0.264	0.461
Biomass/day (g)	Z	0.133	0.732	0.350	0.355	-0.283	0.460
	W	0.139	0.701	-0.564	0.090	-0.472	0.168

Discussion

The Long-eared Owl is mentioned as a typical feeding-specialist, mostly hunting small rodents, especially voles *Arvicolidae* (KITOWSKI *et al.*, 2005; ROMANOWSKI & ŻMIHORSKI, 2008). The present study corresponds with these results and is similar to other data from Eastern Poland (DZIEMIAN *et al.*, 2012; STASIAK *et al,*. 2012; KITOWSKI, 2013).

Analyzing the Levin's B index and the Shannon-Wiener H index we obtained the values similar to the data from other test areas in Eastern Poland. The values of the niche breadth obtained in Wólka Kątna (1.64 to 4.20), and in Zemborzyce (1.43 to 3.95), was corresponding to the other results which were comprised between 1.10 and 5.87 (KITOWSKI *et al.*, 2005; ŻMIHORSKI, 2005; DZIEMIAN *et al.*, 2012; STASIAK *et al.*, 2012; KITOWSKI, 2013). The biodiversity H index was also corresponding with other data from the area of the research (STASIAK *et al.*, 2012).

Like in other surveys, the majority of the birds' prey were species connected with large open areas like fields and meadows (*Microtus arvalis, M. oeconomus*, etc.), while forest species (e.g. *Myodes glareolus*) were occasionally hunted (WIJNANDTS, 1984; BIRRER, 2009). The low number of forest species could not be expected in the Zemborzyce test area, because of the long distance from the owls' communal roost to the nearest open space. Birds used for hunting rather the distant open space, than the forest nearby. Earlier survey on correlation between Long-eared Owls' diet and weather conditions, conducted on Zemborzyce test area (which is being used by the species as a communal roost each year for a long time), is less accurate than present study, because of only four pellet gatherings in two years of the research. The relationship between the owls' diet and the weather conditions shown in mentioned study (WIĄCEK *et al.*, 2011), was confirmed in this paper, as the Wiener-Shannon and Levin's indexes did differ according to the temperature and the snow cover. Also in Northern Italy, the temperature did affect on the food niche breadth index, while no correlation between birds' diet and rainfall was found (RUBOLINI *et al.*, 2003). The opposite to presented results can be found in the survey conducted in Central Poland, where the Levin's index differed according to the precipitation factor only (ROMANOWSKI & ŻMIHORSKI, 2008), in our survey such correlation wasn't found. In opposite, in Wólka Kątna, the niche breadth and the biodiversity index didn't differ in aspect of weather conditions, which can be explained by the fact of easy access to different landscapes – fields, meadows, forest patch, human settlements and the ecotone.

The snow cover is mentioned as an important weather aspect in the literature. This is because of the owls' specialization to catching they prey on the ground. Some small mammals, especially voles move rather under the snow cover, which makes them more difficult to hunt in case of the cover's larger thickness (CANOVA, 1989; GALEOTTI & CANOVA, 1994; DZIEMIAN *et al.*, 2012). *Muridae* are being found rather over the snow, which usually causes the increase of their participation in the number and the biomass of the birds' prey, while the share of *Arvicolidae* decreases (ROMANOWSKI & ŻMIHORSKI, 2008; DZIEMIAN *et al.*, 2012). In presented study this didn't take place, as none of the diet factors (share of both main prey groups) was dependant on weather. Also the increase of the share of birds in owls' diet, noted in other studies (CANOVA, 1989), has not been observed in this survey, while birds were occasional prey on both surveyed test areas. In presented research the precipitation factor meant also rainfall and snowfall, and on the Zemborzyce test area this factor was strongly, negatively correlated with the share of *Arvicolidae* in prey biomass. The survey conducted in Western Poland, this factor affected the food niche breadth, but not the share of any species or group of species.

The small amount of Long-eared owls' diet factors correlated with selected weather conditions suggests the high stability of the birds' diet in the area of the research, but lower in the forest habitat. The differences between the test areas mean the species can adapt to the different habitat, and maintain the diet stable. The specialization in feeding or in habitat preferences can provide the species to be more exposed to habitat changes. In case of other owl species, the high degree of association with the specific habitat factors can provide birds to disappearance from the previously held area (KITOWSKI & STASIAK, 2013). This fact should provide to further research of this aspect of the owls' diet.

Conclusions

1. The diet of Long-eared Owl in two surveyed test areas differed significantly.
2. On Zemborzyce test area the food niche breadth and the biodiversity index were correlated with the temperature and the snow depth, while in Wólka Kątna no such correlation was found.
3. The only diet factor correlated with the weather was the number of *Arvicolidae* on Zemborzyce test area.
4. The diet of Long-eared Owl in Eastern Poland was stable in the time of the survey.

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