Habitat Preferences of Lesser Spotted Eagle *Clanga pomarina* Brehm, 1831 in Belarusian Polesie

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Abstract: The main factors affecting the habitat preferences of Lesser Spotted Eagle in the Belarusian part of Polesie have been described. Such data can be used in the development of measures for the protection of this species. We identified the optimal nesting conditions at two levels: within areas of 2 km diameter around the nests (using GIS) (eagle's home range), and within an immediate radius of 200 meters around the nests, where all the vegetation was described. The most important factors in the selection of a home range were the distance to the foraging habitat and the competitive relationships (the distance to the nearest neighbouring Lesser Spotted Eagle nest). Regarding the selection of a nesting site, the main factors were: the size of the nesting tree (tree diameter 66.5 ± 35 cm), the distance between the nest and the hunting ground (0.5 ± 0.2 km), the presence of forest glades and the stand density.

Key words: Lesser Spotted Eagle, habitat preferences, protection, forest, Belarus

Introduction

The Lesser Spotted Eagle *Clanga pomarina* Brehm, 1831 is the most common of all rare protected species in Belarus. It is a protected species in most of the countries within its breeding range, classified as Least Concern in IUCN Red List (BIRDLIFE INTERNATIONAL 2018). The species is distributed from the eastern part of Central Europe to western Russia and from the Baltic region to the southern part of the Balkans and the Caucasus region (DEL HOYO 1994, VÄLI et al. 2004, 2009, MISCHENKO & MELNIKOV 2019, MELNIKOV & MISCHENKO 2019, POIRAZIDIS et al. 2019, DEMERDZHIEV et al. 2019a). A significant part of the European population (23%) is breeding in the Belarusian territory (DOMBROVSKI 2013) where the habitats of eagles are protected by the legislation. In recent decades, studies of the habitat preferences of Lesser Spotted Eagle were carried out in Europe: Latvia (BERGMANIS 2004), Estonia (VÄLI 2003, VÄLI et al. 2017), Lithuania (TREINYS 2004, TREINYS et al. 2009), Poland (MIRSKI 2009, ZUB et al. 2010), Slovakia (DRAVECKY et al. 2015), Greece (POIRAZIDIS et al. 2007, 2019), Bulgaria (DEMERDZHIEV et al. 2019b) and Germany (MEYBURG et al. 2004). The authors identified the main groups of factors influencing the breeding territory selection such as distance and quality of foraging areas, distance to settlements, types of forests, etc. The situation in the different countries is very specific and there is no common solution. Most of the studies on the habitat preferences of Lesser Spotted Eagle in Belarus were incomplete, not covering all the aspects of the factors of significance for the nesting of the species. The habitat preferences of the species were described for the Northern part of Belarus (IVANOVSKI 2012). However, the author did not identify the main factors, influencing the Lesser Spotted Eagle habitat selection and their roles in the species distribution. The Belarusian authorities

implement an active forest policy with large-scale logging, which affects the forest structure. We have no data on the requirements of the Lesser Spotted Eagle with regard to the tree-stand composition and structure. It is of particular importance to take these into consideration for further development of the legal protection of the species and regulation of the logging practices within the species' habitats. In order to identify the habitat preferences of the Lesser Spotted Eagle, our study was aimed at: (1) evaluating the kind of factors influencing the home range selection, and (2) identifying the factors that influence the selection of nesting trees inside the species' home range.

Materials and Methods

The study was carried out in the Belarusian part of Polesie, within the territory of Brest and Gomel Regions. Most of the study area is located in a zone of mixed broadleaf-pine forests; Belovezhskaya

Pushcha is situated in a zone of dark coniferous forests (GELTMAN 1982). The forest cover consists of Scots Pine (*Pinus sylvestris* L.*)*, Hornbeam (*Carpinus betulus* L.) and Common Oak (*Quercus robur* L.). We studied the home range selection within three plots and the nest tree selection within two plots (Fig. 1). These plots harboured transition mires and all of the most common forest formations, which were typical for the region.

Beloozersk plot is located in the south-western part of Belarus (N 52°33' E 25°18'), between Bereza and Ivacevichi districts. It includes the territory of Sporovo Reserve. It is characterized by a large area of drained arable fields bordering large forests. Black alder (*Alnus glutinosa* L.) forests (aged 40-50 years) dominate among the forest formations. Pine, oak, spruce (*Picea* sp.) and birch (*Betula* sp.) forests are located in a mosaic pattern. Wetlands are represented by transition mires, rivers, streams, channels and lakes. The hydrological regime is regulated according to the needs of agriculture and industry (Bereza
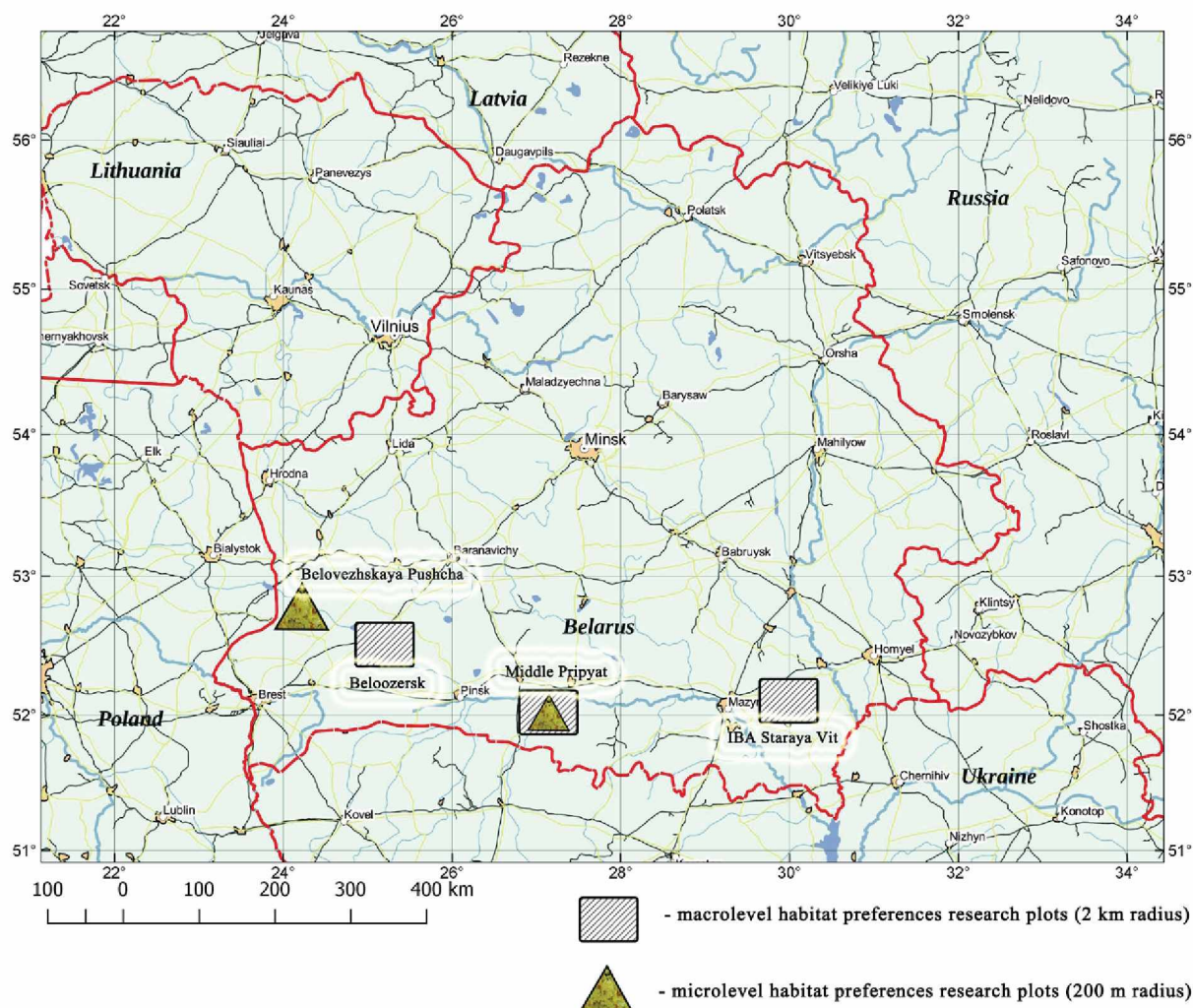

Fig. 1. Location of research plots in Southern part of Belarus

Electro Station). The density of Lesser Spotted Eagle in Beloozersk plot was rather low, estimated at about 4.2 pairs/100 km².

Plot IBA Staraya Vit is located in the south-eastern part of Belarus in Rechitsa and Khoiniki Districts, Gomel Region (N 52°04' E 29°27'). It is one of the biggest mosaic complexes of swampy forests in Belarus, which alternate with small fen mires, wetlands and abandoned fields. Black alder and pine forests co-dominate in the forest formations. The age of certain trees is 120-160 years. Pine and birch forests dominate on elevated sites. The density of Lesser Spotted Eagle was estimated at about 7 pairs/100 km² within Staraya Vit plot.

Middle Pripyat plot is located in the southern part of Belarus (Brest Region, Stolin District, N 52°05' E 27°03') in Middle Pripyat Reserve. The surveyed area is the valley of the Pripyat River. It includes two natural complexes: a) a floodplain of the Pripyat River with meadows, wetlands and floodplain forests; b) a floodplain terrace with alder and broadleaf forests. Black alder (aged 40-50 years), hornbeam and oak (aged 85-100 years) forests dominate in the forest formations. Extensive and moderately high spring floods are typical of its hydrological regime. The duration of the floods varies from 40-45 days to 2-3 months. This plot harbours lots of drained fields, grasslands and meadows. The northern part of the plot is represented by natural floodplain areas and a reconstructed drainage system. The Lesser Spotted Eagle inhabits only the southern part of the surveyed area at a density of 8 pairs/100 km².

Belovezhskaya Pushcha National Park (N 52°44' E 24°10') is located in the south-western part of Belarus. Pine forests are more common within this plot, compared to Middle Pripyat. Broadleaf-pine forests with oaks, spruce and alder forests are also found within the national park. Belovezhskaya Pushcha is the last remaining large forest tract in the southern part of Belarus, where the spruce still has relatively high phytocoenotic resistance, not much different from the spruce forests of the northern part of Belarus (GELTMAN & ROMANOVSKI 1971). The forests of Belovezhskaya Pushcha are still rather undisturbed, representing a relict forest. The density of Lesser Spotted Eagle was rather high in this territory, up to 12 pairs/60 km² (DOMBROVSKI 2013).

The area of each surveyed plot was more than 100 km². We applied the method of visual observation through binoculars and telescopes from a series of points spaced at 2–3 km from each other and located at a distance of 500–1,000 m from the edge of the forest, in order to map the home ranges of Lesser Spotted Eagle pairs (DOMBROVSKY 1998). GIS maps

of forest management units were used to describe the factors within areas of 2 km radius around the nests (n = 29). The home ranges of the species include areas of 2 km around the nests (LÕHMUS & VÄLI 2004, VÄLI et al. 2004, TREINYS 2004, TREINYS et al. 2017), where the nests are usually situated near the centre of the territory (VÄLI et al. 2017). We used random points within the same surveyed areas as control samples (n = 60). All used 19 variables describing the Lesser Spotted Eagle home ranges were tested for intercorrelations: forest area, mires, pine forests, spruce forests, oak forests, black alder forests, other broadleaf forests, other small-leaved forests, farmlands, glades, felling areas, ponds, the length of roads, channels, hunting grounds, roads, settlements, distance to the nearest nest and number of nests of other Lesser Spotted Eagles, falling within a territory of 2 km radius. We assumed that when (*r*) coefficient of a pair of correlated variables is > 0.7 one of the variables would be removed and the other one would be kept in the subsequent analysis. Since there was no strong intercorrelation between the tested variables (r = 0.18-0.7), we used all of them in the subsequent analyses. We studied the habitat preferences in two aspects: differences in the nesting habitat at different distances from the nest (to determine the size of the nesting habitat, necessary for Lesser Spotted Eagle) and differences between the nesting habitat and a random place in the forest, used as a control sample. We described all the trees growing along the transects in order to reveal the preferences of Lesser Spotted Eagle with regard to its nests (n = 12). We covered 4 transects from each nesting tree (to the North, South, West and East), 10 meters wide and 150 meters long (up to 200 meters in Middle Pripyat), split in sections of 50 m: 0-50 m – experimental (around the nest), then 50-100 m and 100-150 m as a control distance. We also described 13 random points around trees potentially suitable for nesting, applying the same method, covering 50 meters long transects, used as a control group. These were trees of the same species and diameter, as the nesting trees, but situated in different sub-compartments of the forest. We used standard methods to collect data (ANDREEVA et al. 2002). The factors described along the transects were as follows: tree species, tree diameter at 1.3 m height, underwood height, density and stage of development, presence and size of glades, forest paths, felling areas, roads and their exploitation (abandoned or in use). The height of the trees was calculated through the formula, based on the diameter of the tree (MIROSHNIKOV et al. 1980). The coefficient of the stand density was calculated as a ratio of the sums of tree stems areas to

a standard area of normal forest: CSD= ΣGc / ΣGst, where ΣGc is a sum of cross-sections of the explored part of the forest, and ΣGst is a sum of cross-sections in a standard forest (MIROSHNIKOV et al. 1980). We united all the data related to the transect sections for every 50 meters of transects in each direction (0-50 m, 50-100 m etc.). To assess the impact of every factor, we estimated the differences between the Lesser Spotted Eagle home range and the control area using a Mann–Whitney U test (due to the nonparametric type of data). All data are presented with median and interquartile range (IQR).

Results and Discussion

The analysis of the criteria used by the Lesser Spotted Eagle in the selection of a home range (2 km radius around the nest) in the three surveyed areas revealed significant differences (p < 0.05) between the home range and the control area related to the following factors: area of mires, ratio of spruce forests, presence of glade, distance between the nest and the nearest hunting ground. Other factors didn't show significant differences between the territories and the control area (Table 1).

The distribution of tree formations within the home range of the Lesser Spotted Eagle is shown in Fig. 2.

We would like to note a certain inaccuracy in the GIS-data on the forest management practices. It may be one of the reasons why the analysis didn't show any significant differences compared to the control sample. We did not find significant differences between the territories and the control sample in the farmland area (Fig. 3).

It could be explained by the availability of quantitative data of farmland lacking qualitative parameters. Different types of farmland may provide different amount of food for the Lesser Spotted Eagle, which determines the differences in the
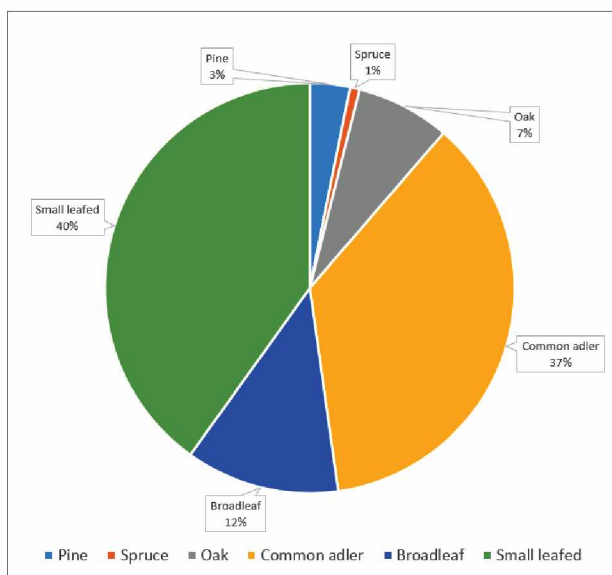

Fig. 2. Forest formations in radius of 2 km around Lesser Spotted Eagle nests (N = 29).

Table 1. Mean value and impact of factors in Lesser Spotted Eagle home range and control area

| Factor	Breeding territories	Control	p
Total forest ratio, %	55.4±21.4	63.86±35.26	0.3282
Total mire ratio, %	1.05±1.68	2.46±2.79	0.0003
Pine forest, %	1.75±3.14	4.63±6.33	0.1092
Spruce, %	0.41±1.57	1.93±1.98	<0.0001
Oak, %	6.96±5.23	9.33±6.87	0.5383
Common alder, %	21.98±19.16	52.12±9.96	0.9529
Broadleaf, %	6.69±14.45	12.31±12.86	0.1967
Small leafed, %	62.20±27.22	19.67±15.42	0.2115
Farmland ratio, %	21.45±27.02	36.09±35.3	0.5001
Glade, %	1.30±1.13	0.38±0.57	0.0004
Felling, %	0.09±0.13	0.19±0.17	0.2633
Length of roads, km	2.93±2.2	2.89±2.08	0.8661
Distance to nearest road, km	0.85±1	0.96±0.7	0.1730
Area of water, ha	2.5±3.3	3.1±2.3	0.1735
Length of channels, km	2±3.5	2.4±2.3	0.1958
Number of nests of LSE inside the 2 km buffer	0.97±0.87	1.5±0.95	0.0657
Distance to nearest LSE nest, km	1.8±0.98	1.47±0.75	0.3031
Distance to nearest settlement, km	3.3±1.4	3.3±1.5	0.8994
Distance to nearest hunting place, km	0.5±0.2	1.34±1.02	0.0099
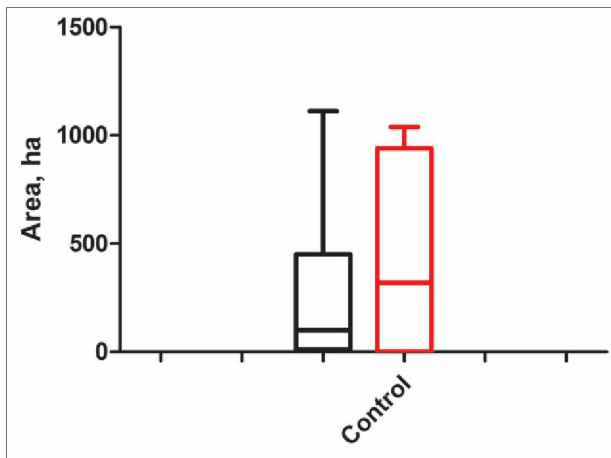
Fig. 3. The area of farmland, included in breeding territory of Lesser Spotted Eagle (2 km around the nest) (Box – median and interquartile range, whiskers form min to max, N = 29)
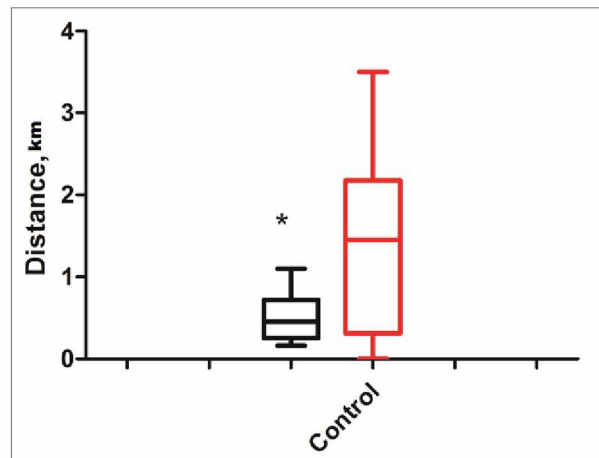

Fig. 4. Distance between the nest of Lesser Spotted Eagle and nearest place for hunting (Box – median and interquartile range, whiskers form min to max, N = 29)

density of predatory birds feeding in the same area. We identified a significant difference between the species' home range and the control area with regard to the distance between the nest and the nearest hunting ground: the Lesser Spotted Eagle prefers nesting at 0.5 ± 0.2 km from the forest edge, while in the control area this distance is 1.3 ± 1 km (Fig. 4).

It can be very useful in terms of energy saving during flights between the nest and the hunting ranges and increases the chances to safely bring food to the nest and avoid attacks by other birds of prey, nesting in the forest. The same result was obtained in Poland (ZUB et al. 2010). It is known, that the Lesser Spotted Eagle can use glades as hunting grounds (VÄLI at al. 2017). The analyses have shown that the area of glades within the Lesser Spotted Eagle home range is significantly larger (median 10.5 IQR 4.2 – 28.40) than in the control area (median 0.635 IQR 0 – 11.6). This can indirectly confirm the role of glades in Lesser Spotted Eagle home range selection.

The analysis of the preferences in nesting site selection did not show any significant differences between the transects near the nest (0-50 m), the remote ones – up to 200 m from the nest, and the control ones, with regard to the tree species, the diameter and the height of the trees. The analysis showed some regularity in the selection of the nesting tree. We excluded from the analysis those tree species which were not used by the Lesser Spotted Eagle for nesting (as crabapple, hornbeam etc.). The analysis was carried out separately in Middle Pripyat (MP) and Belovezhskaya Pushcha (BP) because of the great difference between these forests. In Middle Pripyat, there are no spruce forests and the Lesser Spotted Eagle nests on oak and black alder.
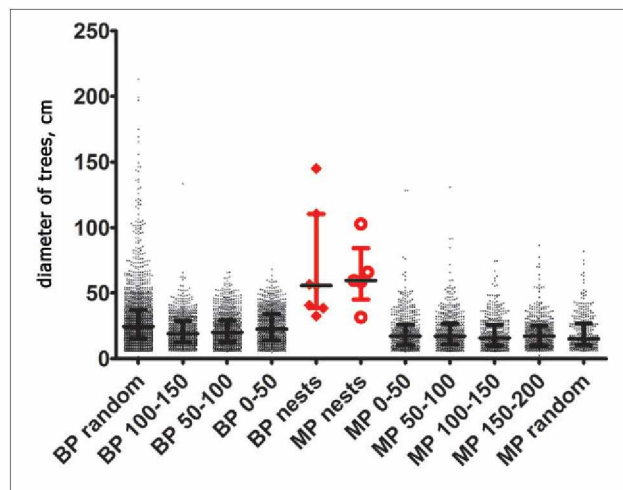

Fig. 5. Distribution of trees around nests of Lesser Spotted Eagle in Belovezhskaya Pushcha (BP) Middle Pripyat (MP) and control (Line at median and interquartile range, N = 12)

In Belovezhskaya Pushcha, we found Lesser Spotted Eagle nests on spruce only despite the great number of oaks and black alder trees. In the Northern part of Belarus spruce forests are more common and the Lesser Spotted Eagle often nests on spruce trees (IVANOVSKI 2012:350). However, we found out that the Lesser Spotted Eagle showed a significant preference for nesting on trees of certain size range, similar in Middle Pripyat and Belovezhskaya Pushcha (Fig. 5).

These were trees of about 57.58 cm (IQR from 39.07 to 93.58) diameter and 19–27 m height, while the tree diameter median in the transects was 23.24 (IQR from 14.00 to 35.97) cm. However, the Lesser Spotted Eagle did not show preferences for the biggest spruce trees. This can be explained by the great
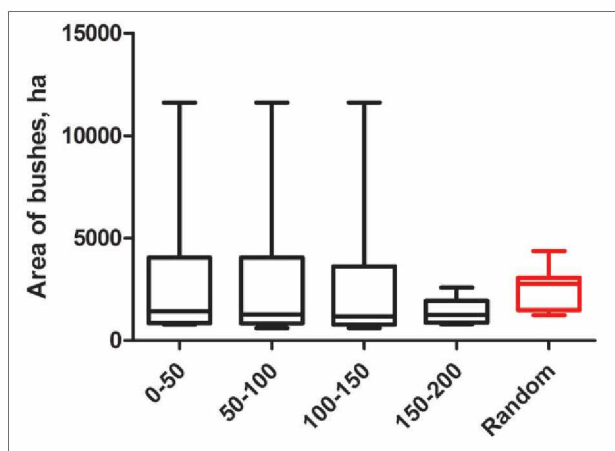
Fig. 6. The area of bushes around nests of Lesser Spotted Eagle (Box – median and interquartile range, whiskers form min to max, N = 12)

height and far from optimal architectonics of the crown of old spruce trees. It is known that the nests of the Lesser Spotted Eagle are located under the canopy of trees, never higher, to secure cover and seclusion (IVANOVSKI 2012: 350). However, the tops of old spruce trees are usually higher than the stand canopy and the lower branches are much bigger, free of needles and less secluded than the crown of spruce trees with Lesser Spotted Eagle nests. We considered the territory around the nest as optimal and calculated the average stand density for the Lesser Spotted Eagle home range. The coefficient of stand density was about 0.7–0.9. We can assume that the implementation of salvage felling and selective logging would not degrade the stand density to less than 0.7. The required measures include development of better legislation on the protection of the Lesser Spotted Eagle and prescription of recommendations on the protection of the Lesser Spotted Eagle home range. The analysis of the shrub vegetation around the nest (cover and seclusion) didn't show any significant differences between the transects around the nest and the remote ones (including the control set, Fig. 6).

The tops of the bushes are much lower than the Lesser Spotted Eagle nest and the presence or absence of shrub vegetation was not a significant factor in our surveyed area. We can conclude that the Lesser Spotted Eagle use primarily the architectonical features of the crown to shelter its nest.

In some cases, foresters refuse to adopt measures for the protection of the Lesser Spotted Eagle nesting habitats because of their felling and timber harvesting intentions. In such cases, it is necessary to find a compromise and agree on certain types of logging, such as selective and sanitary. Our data will

be the basis for finding a compromise with the forest users, allowing certain forestry activities and maintaining the Lesser Spotted Eagle's nesting habitats. It is necessary to determine the limits for salvage felling and selective logging, which are acceptable for the home range and do not worsen the nesting conditions of the Lesser Spotted Eagle.

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