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OSPREY AND WHITE-TAILED EAGLE IN NORTHERN BELARUS: ECOLOGICAL NICHE COMPARISON

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In the light of the white-tailed eagle *(Haliaeetus albicilla)* population growth in many European countries we tried to find out how the osprey *(Pandion haliaetus)*, which inhabits mainly the upland bogs of Northern Belarus and have similar to white-tailed eagle ecological niche, behave. Nesting biotopes, nesting trees, the architectonics of nests, as well as food spectra of the osprey and the white-tailed eagle in the Vitebsk region of Belarus were compared in order to identify the principal parameters of their ecological niches. Breeding territories were searched by using the circular plot census method modified by Dombrovski. Descriptions of nest site positions were done using the forest stand maps of local forest management divisions. Forest blocks and particular stands where the nests were situated or suspected to be situated were identified from the maps, and available state survey stand features were used. Diet was studied by standard methods. In the result of Morishita-Horn index calculation, it was shown that the competition between ospreys and White-tailed Eagles might occur during feeding on fish. The other parameters are not overlapped. Species solve this problem by preying on different fish size classes.

Keywords: *osprey, white-tailed eagle, competition, niche overlap, mechanisms of partitioning, Northern Belarus*.

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Introduction. The population estimate for ospreys in Northern Belarus stands at 150-180 breeding pairs and is stable. White-tailed eagle in northern Belarusian Lake Region (Poozerie) represents recently an increasing trend: estimates stand at 25 breeding pairs in 1984 and 45 pairs in 2017. We have studied the Osprey and White-tailed Eagle since.

Osprey. Raised pine bogs are the primary breeding habitat – 91,7% of all nests were found in such habitats. The number of fledglings averaged for 1,86 per active nest (n=81). The breeding success counts for 78,2%.

White-tailed Eagle. All found nest (100%) are located within old pine or mixed forests near large lakes (or lake systems) and fish farm ponds. The number of fledglings averaged for 1,12 per active nest (n=49). The breeding success counts for 83,7 (Tishechkin, Ivanovsky, 1992; Ivanovsky, 1995; Dombrovski, Ivanovski, 2005; Ivanovski, 2017).

The main material was summarized in our monograph «Birds of prey of Belarusian Poozerie» (Ivanovsky, 2012). The given study is the first know analysis of nesting biotopes, nesting trees, the architectonics of nests, and food spectra of White-tailed eagle and Osprey.

Various aspects of Osprey and White-tailed Eagle ecology were studied in Belarusian Poozerie in 1972-2017. In particular, breeding habitats were studied. We discovered that ospreys primarily occupy raised bogs, often far away from feeding water bodies, while eagles used for breeding old pine and mixed forests not far from the lake banks (Ivanovskiy, 2017). In Belarus, White-tailed Eagle nested on the whole territory, while Osprey nests only in Belorussian Lakeland.

To uncover the tightest parameters of the white-tailed eagle and osprey ecological niches, a comparison of nest microhabitats and trees, nest positions, and diet compositions of these two species in Vitebsk Region of Belarus, so-called Belarusian Lake Region (Poozerie), was performed. The information about niches of the species is given in tables 1-5.

Nesting biotopes, nesting trees, the architectonics of nests, as well as food spectra of the Osprey and the White-tailed Eagle in the Vitebsk region of Belarus were compared in order to identify the most demanding parameters of their ecological niches.

The study aimed to uncover the ecological niche parameters relevant to the potential interspecific competition between the species and mechanisms used to lower it. In late XX - early XXI centuries increase of the white-tailed eagle (*Haliaeetus albicilla*) breeding populations was observed, not only in several lake regions (Belarus, Russia, and Poland) (e.g., Mizera, 1999; Ivanovski, 2014b) but even in dry steppes of Kazakhstan and other parts range (Bragin, Bragin, 2018). Naturally, in such a situation, I became interested in how the relationships between two trophic competitors, white-tailed eagles, and ospreys, are changing.

Methods. Study area. Belorussian Lakeland (within the Vitebsk Region) is located in the northern part of the Republic of Belarus. The area of Belorussian Lakeland is nearly 40100 km^2 (Figure 1).

The climate of the region is moderately continental. Belorussian Lakeland is located almost wholly within the oak-dark coniferous forest subzone, which means the predominance of mixed spruce and pine forests with oak incorporation. The forest cover of the region is nearly 34%. The wetlands occupy nearly 9% of the territory and are represented by three types, raised bogs, transitional and lowland mires. The territory of the region belongs mostly to the basin of the Western Dvina River (81 %). The hydrographic network is well developed and includes a high number of lakes (nearly 2800). The density of the river network is 45 rivers per 100 km^2. Lakes occupy 2,5% of the area; their total area is 900 km^2.

Data acquisition. Data were collected in Belarusian Poozerie during the field seasons of 1972-2017. Standard techniques (Hardey et al. 2006) were used to study the nesting ecology.

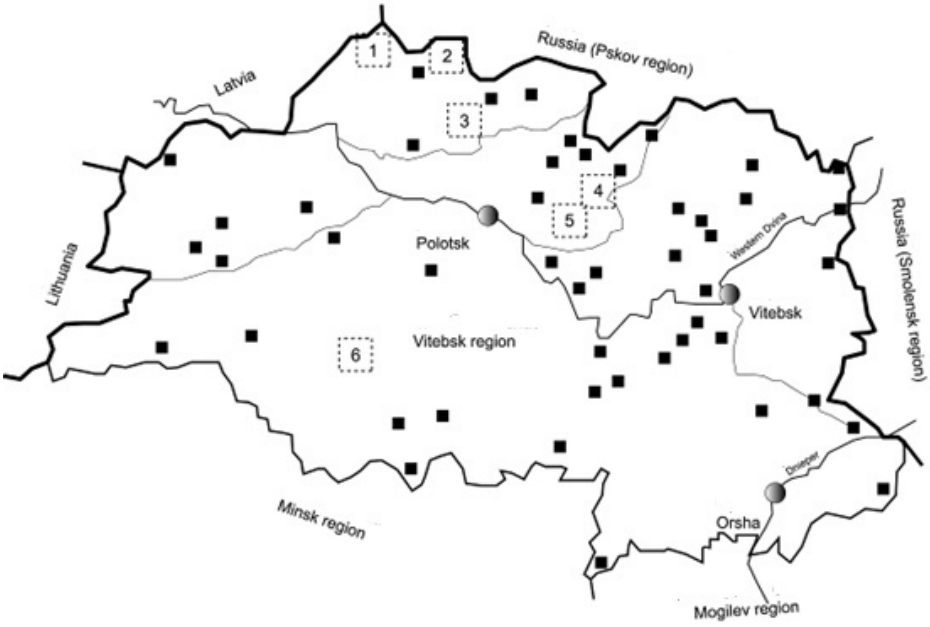

Figure 1 - Belarusian Lakes (Poozerie) Research Region
Research locations: 1 - Osveya, 2 – «Red Bor», 3 – «Falcon», 4 – «Koziany», 5 – «Obol», 6 – «Golubitskaya Pushcha»; ■ - places of 1-3-day excursions

Breeding territories were searched by using the circular plot census method modified by Dombrovski (1998). Higher trees, most often spruces and pines, were used for the eagle spotting in forests. Individual platforms made of thick plywood were put next to the bowl near the treetops, and an observer visually searched the area using binoculars. In winter, aerial searches from low flying airplanes and helicopters were used.

The classification of microhabitat is performed on the base of I.D. Yurkevish et all. (Yurkevish, Golod, Aderikho, 1979).

Data on the diet of white-tailed eagles and ospreys were obtained by:

(1) Analysis of pellets. These were gathered either under perches near the known nests (as well as under the nests themselves), or under the roosting sites well known from the visual observations.

(2) Analysis of food brought to the nest.

The material collected was analyzed as follows. The hair piles of mammalian prey from pellets and remnants were microscopically examined via cross-sections (Debrot et al. 1982, Teerink 1991). Other components

were analyzed using the published keys of feathers and bones of birds (Böhme 1977, März 1987, Brown 1999).

To obtain the percentage of food biomass consumed (hereafter, %BC), the number of prey individuals was multiplied by the mean body mass of that prey (Pucek 1981; Sidorovich, 2011).

Ecological niche widths for every parameter was calculated according to Levins (1968). The modified equation for the calculation of the Levins' index looks as follows:

$$B=1 / (p_1^2 + p_2^2 +\ldots+p_n^2),$$

where p_i – part of a given resource in the particular parameter of the ecological niche. The value of the Levins' index will be higher; the higher are the numbers of resources used and the evenness of their proportions in the entire resource specter. Niche width for a particular ecological parameter calculated in such a way is a relative index, i.e., is used only for a comparison between different species. Overlaps of particular dimensions of ecological niches between two species were calculated according to Morishita-Horn equation (Krebs, 1998):

$$D_{MH} = 2(\sum p_{ij}*p_{ik}) / (\sum p_{ij}^2+\sum p_{ik}^2),$$

where p_{ij} and p_{ik} – proportions of particular resources in ecological niches of eagles and ospreys. Values of $D_{MH} \geq 0,6$ were considered as ecologically and statistically relevant.

Student's t-test was used for the comparisons of mean values; G-criterion of maximal likelihood was used to compare the differences between proportional values (Sokal, Rolf, 1995).

Information about other assessed characteristics is missing here: “Nesting biotopes, nesting trees, the architectonics of nests”. The nesting habitat was studied in the area of 50 m around the nest in accordance with maps of forestry institutions. The species of the nesting tree and its height were determined in each case. We also determined the architectonics of the nest and its position on the tree.

***Results and discussion*.** Niche breadths and overlaps were calculated for nesting biotopes, nesting trees, the architectonics of nests, as well as food spectra.

Nest microhabitat (considered as a habitat composition within the 50 m radius around a nest, Ivanovski, 2017) niche breadth was 3.034 in osprey, and 3,937 in white-tailed eagle (Table 1), an overlap for that parameter was 0,195, much lower than the threshold value of 0.6. Therefore, there is no competition along this niche dimension.

On the other side, it cannot be positively stated that raised bogs are optimal habitats for osprey. At a study site on the Kola Peninsula (northwestern Russia), ospreys not always occupy optimal habitats in attempts to minimize contacts with the dominant white-tailed eagles (Ganusevich, 1991).

Ospreys build nests almost exclusively on pines, only one nest out of 90 known ones (98,9%) was built on the spruce with a broken top, 31.6% of the known nest were built on dead trees. Ospreys mostly use a single nest per territory (58.3%), although 30,6% pairs used two nests, 8.3% had three and 2,8% – five. No clear trends in the number of nests used per territory were recovered. I can only speculate that the number of nests used by a particular pair reflects, on one side, availability of the perfectly suitable (emerging, with a flat top) trees at the breeding site and, on the other, individual behavioral patterns in nest tree choice of a given pair.

Table 1 – Structure of nest microhabitats of osprey (n=90) and white-tailed eagle (n=73) in Belarusian Poozerie

Nest microgabitat type	Osprey %	Eagle %
Scattered higher pines over raised bog	46,7	0
Forest island within open wetland	31,5	15,4
Narrow forested ridge within open wetland	8,7	0
Forested 'peninsula' within open wetland	4,3	15,4
Forested open wetland edge	4,3	0
Tall pine forest away from open wetland	0	38,4
Clear-felling edge in the forest	0	23.1
Lake coastline	2,2	0
Single tree within clear-felling	2,2	7,7
TOTAL	100	100
G-test	186,6 (p<0,0001)	
Niche breadth	3,034	3,937
Niche overlap	0,195	

Contrary to the ospreys, white-tailed eagles primarily (60%) build their nests concealed within dense forests, 200–300 m away from open areas (lakes, open wetlands, clear-fellings), and only 40% of the nests were built on large open trees. Some of the nest trees were situated near roads (one was built in an abandoned cemetery 400 m from a village edge) and were open enough to be seen from a long distance. Large white-tailed eagle nests are usually built in upper crown parts of old trees and are sitting on thick major lateral branches, near the trunk or in its major fork (34,4% for both categories). Third of the nests (31,2%) were situated on treetops as in osprey, but they were positioned lower than the tops of the surrounding tree and were mostly (3/4) covered by the neighboring crowns. Statistics of nest tree position for both species are given in Tables 2 and 3.

Niche breadth on the 'nest tree species' dimension is 1,037 in osprey and 1,901 in white-tailed eagle, niche overlap on this parameter is critical 0,877 (Table 2). To uncover mechanisms allowing the species to reduce the competition in that respect, one should look at the data on nest height. In

osprey, nests are built from 4-26 m above the ground, 12,5±0,55 m on average (n=90). In white-tailed eagles, they are from 12-27 m above the ground, 17,5±0,59 m on average (n=73), the difference is statistically significant (Student's t=6,199, p=0,001). Furthermore, ospreys build the overwhelming bulk of their nests in raised bog pine stands. Full-grown pine trees in this habitat are not tall and thick enough in comparison with pines in upland forests to support bulky eagle nests. Only occasionally, white-tailed eagles may occupy osprey nests, but only ones built on tall, upland forest pine trees. So, potential nest tree conflict between the species is solved by way of the use of trees of different stature.

Table 2 – Nest tree species used by ospreys (n=90) and white-tailed eagle (n=73)

Nest tree species	Osprey %	Eagle %
Pine – *Pinus silvestris*	98,9	67,4
Aspen – *Populus tremula*	0	26,6
Spruce – *Picea abies*	1,1	2,0
Black Alder – *Alnus glutinosa*	0	2,0
Birch – *Betula pubescens*	0	2,0
TOTAL	100	100
G-test	48,2 (p<0,0001)	
Niche breadth	1,037	1,901
Niche overlap	0,877	

Table 3 – Nest position on the tree for ospreys (n=90) and white-tailed eagles (n=73)

Nest position	Osprey %	Eagle %
On lateral branches near the trunk	0	34,4
In a fork of the trunk	0	34,4
On the tree top	100	31,2
TOTAL	100	100
G-test	133,3 (p<0,0001)	
Niche breadth	1,0	2,994
Niche overlap	0,468	

Niche breadths along the 'nest position on the tree' dimension are 1.0 in osprey (n=90; all nest are on treetops) and 2,994 in white-tailed eagle (n=73) (Table 3), niche overlap is 0,468, well below the critical threshold. It should be noted that ospreys have more problems in finding a suitable tree for a nest building. First, such a tree has to be taller than neighboring ones. Second, it has to possess a convenient 'flat' crown top. Third, a tree has to be mature enough to support a relatively large osprey nest. Perhaps, this is one of the reasons why the maximal distance from the nest to the hunting

habitat is 15 km in ospreys and 4 km in eagles.

In the Belarusian Lake region (Poozerie), some cases of almost colonial breeding of osprey 5-15 km from fish farms were recorded. However, breeding success in such 'colonies' is low, since it is hard to find in the middle of raised bog a tract of 5-8 suitable pine trees able to support massive nests which tend to fall during heavy rains and storms.

Table 4 – Comparative analyses of osprey (n=321) and white-tailed eagle (n=335) breeding season diets in terms of the biomass consumed

Prey items	Osprey %	Eagle %
Small fish up to 50 g	2,6	1,6
Larger fish havier than 50 g	95,4	42,9
Mustelidae spp.	0	0,7
Fox, Racood Dog, Badger	0	2
Carrion	0	1,7
Small birds (up to thrush size)	0,8	0
Mediem-sized and large birds	1,2	51,1
Niche breadth	1,05	2,24
Niche overlap	0,61	

Both species hunt over rivers, lakes, and fish farm ponds. I have identified 321 osprey prey items and 335 prey items in the white-tailed eagle diet.

Kovaliov (1958) reported on the existence of a linear relationship between body length, body weight, and lower jawbone dimensions of European freshwater fishes. So, I used measurements of fish *operculum* and *dentale* bones collected at feeding stations and perches to estimate prey fish body sizes and weights using the published conversion tables (Kovaliov, 1958; Häkkinen, I978). Prey weights were estimated for 163 fish specimens in an osprey diet and 136 fish prey items in a white-tailed eagle diet.

For example, I measured the mandibles of pikes caught by ospreys (n=40) and white-tailed eagles (n=60). The differences between mean bone lengths appeared to be statistically different (Student's $t=3,259$, $p<0,01$). The arithmetic mean sizes of pikes' lower mandibles from osprey's prey are 50,2±4,69 mm, and from white-tailed eagle's is prey 71,4±6,15 mm.

Table 4 provides the data on diets of ospreys and white-tailed eagles in terms of biomass consumed. It is clear from this Table that osprey, a specialized piscivore (98% of consumed biomass comes from fish), may feel competitive pressure from the ornitho-ichthyophagous eagles (44% of fish in diet); dietary niche overlap between the species is 0,61. So, the question arises what the compromise these two species find while partitioning their trophic niches.

Both species have identical to some degree requirements towards nesting conditions and feeding habitats. They also have a similar hunting technique, grasping prey out of water. These factors give some background to suspect the presence between these species of so-called complicated heterocompetition (Ivlev, 1955), which exhibits itself in the mutual impact by the competitors in the way of scaring each other, directly fighting for food, creation of mutual interferences and disturbances. Observed cases of eagle cleptoparasitism on ospreys support this idea.

Table 5 – Fish in osprey and white-tailed eagle diets (after Ivanovski, 2012)

Prey species	Osprey %	Eagle %
Pike – *Esox lucius*	29,2	27,5
Tench – *Tinca tinca*	0,9	0,6
Bream – *Abramis brama*	25,6	9,3
Perch – *Perca fluviatilis*	12,4	3,3
Cyprinidae sp.	2,8	0
Ide – *Leuciscus idus*	0,9	0
Crucian Carp – *Carassius carassius*	0,9	0
Pisces spp.	23.6	12,6
Total	96,3	53,3

Detailed analysis of osprey and white-tailed eagle food spectra, as well as comparison of fish prey item weights, reveals that a substantial lowering of the trophic competition between the species is achieved through the use of different prey size classes. An osprey feeds on relatively small (mean weight 243 g) and physiologically more active, always alive fish. Eagles not only feed on larger fish (mean weight 700 g) but also prey on sick, 'sleepy,' poorly moving and/or dead fish.

If one looks at the dietary spectra at the prey species level (Table 5), there is no high similarity in terms of fish species used and their proportions in the diet (Ivanovski, 2012; Table 5). It should also be noted that eagles hunt more on large lakes, while osprey uses smaller lakes and forest rivers more often.

The above-cited study of Ganusevich (1991) reports that in the Kola Peninsula, ospreys are forced to hunt on oligotrophic lakes, while eagles control all fish-rich water bodies.

Therefore, lowering of the dietary competition between osprey and a white-tailed eagle in Belarusian Poozerie is achieved by the hunting fish of different weight categories.

Conclusion. My study allows suggesting that currently, despite some tensions in the relationships between osprey and the white-tailed eagle, the population increase in the latter species does not affect the population state of osprey in Belarusian Poozerie. However, the current

situation can not be projected in the future if the local white-tailed eagle populations will keep increasing.

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СКОПА И ОРЛАН-БЕЛОХВОСТ В СЕВЕРНОЙ БЕЛОРУССИИ: АНАЛИЗ ЭКОЛОГИЧЕСКИХ НИШ

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В последние десятилетия во многих европейских странах увеличилась численность орлана-белохвоста (*Haliaeetus albicilla*), естественно возник вопрос, как поведёт себя в этих условиях скопа (*Pandion haliaetus*), главный трофический конкурент орлана. С целью выявления наиболее напряженных параметров их экологических ниш было проведено сравнение «гнездовых выделов», гнездовых деревьев, архитектоники гнёзд, а также спектров питания скопы и орлана-белохвоста в Витебской области Белоруссии. Исследования показали, что с экологических и статистических позиций конкуренция между скопой и орланом возможна при добыче рыбы. Сравнительное изучение трофических ниш этих видов показывает, что ослабление пищевой конкуренции между этими видами достигается путем

использования различных размерных групп видов-жертв. Скопа добывает относительно мелкую (средний вес 243 г) и физиологически более активную, всегда живую рыбу. Орлан же, кроме того, что добывает более крупную рыбу (средний вес 700 г), в подавляющем большинстве случаев нападает на больную, снулую, малоподвижную рыбу или же подбирает мертвые экземпляры. Проведённое исследование позволяет говорить о том, что, несмотря на определённые «натянутые» отношения между скопой и белохвостом, рост численности орлана-белохвоста не повлияет на состояние популяции скопы Белорусского Поозерья.

Ключевые слова: *скопа, орлан-белохвост, перекрытие параметров экологических ниш, адаптационные механизмы уменьшения конкуренции, Северная Белоруссия.*

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