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BREEDING BIOLOGY OF ROOK (CORVUS FRUGILEGUS) IN THE HUMAN TRANSFORMED STEPPE ECOSYSTEMS (THE CASE OF BOTIEVO WIND FARM)

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The article gives a space-structural characteristic of rook (Corvus frugilegus) nesting places in the territory of Botievo wind farm (Zaporizhzhia region). The distribution of the rook colonies around the territory, the structure of the colonies, the dependence of the location of the nests on the height, diameter, condition and species composition of tree and shrub plantings are analyzed and studied. The types and methods of the localization of nests in the trees and their quantitative characteristics are highlighted. The consortium relations of the rook and the risks associated with living near existing wind turbines are described.

In 2015 some eight colonies were found: 2 medium (51-100 nests) and 6 large (101-500 nests) ones. All the colonies were located in the forest belts, mainly represented by locust trees *Gleditsia triacanthos* (7 colonies) and in the mixed forest consisting of the mulberry *Morus sp.*, maple *Acer*, black locust *Robinia pseudoacacia,* and locust trees (1 colony). The area occupied by colonies had a four-fold difference between 977-3994 m^2, while the number of the rook nests fluctuated in a seven-fold range - 52-343 nests.

Analysis of different indicators describing the structure of the rook colonies revealed certain dependence between the breeding area and the number of the occupied trees (r = 0.97); the breeding area and the number of nests (r = 0.60); the number of nests in the colony and the closeness of the trees in the forest belts (r = 0.91); the number of nests and the number of the occupied trees (r = 0.74), the height of the tree and the nest on it (r = 0.64). The characteristic of the location of nests in different rows of the forest belt revealed the shift of the density of the occupation of trees in large colonies to one of the outer rows, where there were 26.0-27.5 percent of all the nests.

Typology and localization of rook nests in the trees has 11 options of the location. The type of the location of nests near the trunk of the tree dominated (57.4 percent of trees and 64.5 percent of all nests). It is shown that rooks demonstrate the plasticity of the nesting behaviour to the changing environmental conditions.

Keywords: Rook (Corvus frugilegus), Zaporizhia region, wind farm, nesting area, colony structure, spatial distribution, colony.

Colonial nesting is a testing ground for the development of many biological problems: the theory of evolution and understanding of the factors of microevolution, the development of the social problems of adaptability and sustainability of space-ethological structure of populations, the functioning of ecosystems and the role of species in ecosystems (Belgard, 1951; Zubakin, 1971). This type of breeding promotes better protection from predators, the stability of groups during the breeding period, ensures the successful feeding of the chicks in a nest distance from the forage.

Rook (*Corvus frugilegus* L., 1758) is one of the most common and numerous species of the family Corvidae (Passeriformes) (Stepanyan, 2003). Areal of rook covers almost the entire territory of the Europe, except for the extreme northern areas and most of the Apennine and Iberian peninsulas (Italy, Spain, Portugal); up to the 66 N the birds do not nest (Hagemeijer, Blair, 1997). Rooks also nest in southern Siberia, Kazakhstan and Central Asia, Middle East, Amur region, in Asia Minor, Iran, in the north of Mongolia, China, Korea, North India, except in those treeless countries, areas of steppes, deserts and high mountains (Dementiev et al., 1954).

To date, it was performed several studies on the characteristics of the breeding biology of rooks and other birds in the areas of WPS (Wind Power Station) activities, but they are generally considered the peculiarities of biology in the key negative WPS impact on clutch size and breeding success, and almost did not focus on the spatial features of nest building and qualitative composition of species for nesting substrates. Most of the work is connected with research and breeding biology of predatory birds, waterbirds, and meadow birds (de Lucas et al, 2004; Hale et al, 2014; Gue et al, 2013).

Basically, the studies of the environmental characteristics of Corvidae in the vicinity of WPS area were limited to monitoring cases of bird deaths from collisions with wind power structures. Thus, for example, there are about forty death cases of Hooded crows and Ravens in the United States and Germany (de Lucas et al., 2007). In another study (Carette et al., 2009) there was examined the impact of windfarm to the Raven occurrences, without consideration of the environmental features of the life cycle of birds.

The main objective of this study was to investigate the structural and spatial features of colonial nesting of Rooks in the conditions of anthropogenically modified steppe ecosystems in the territory of the Botievo WPS in the Azov district of Zaporozhye region, as well as to clarify the level of threat from working WPS turbines on the Rooks, being the most numerous bird species over there.

Materials and Methods

Golf Botievo WPS (8.5 by 4.8 km) is located between the villages of Primorsky Posad and Botiev Azov district of Zaporozhye region (46,631915 N 35,796653 E), the South-Eastern side of the steep shores of the Azov Sea (Fig. 1).

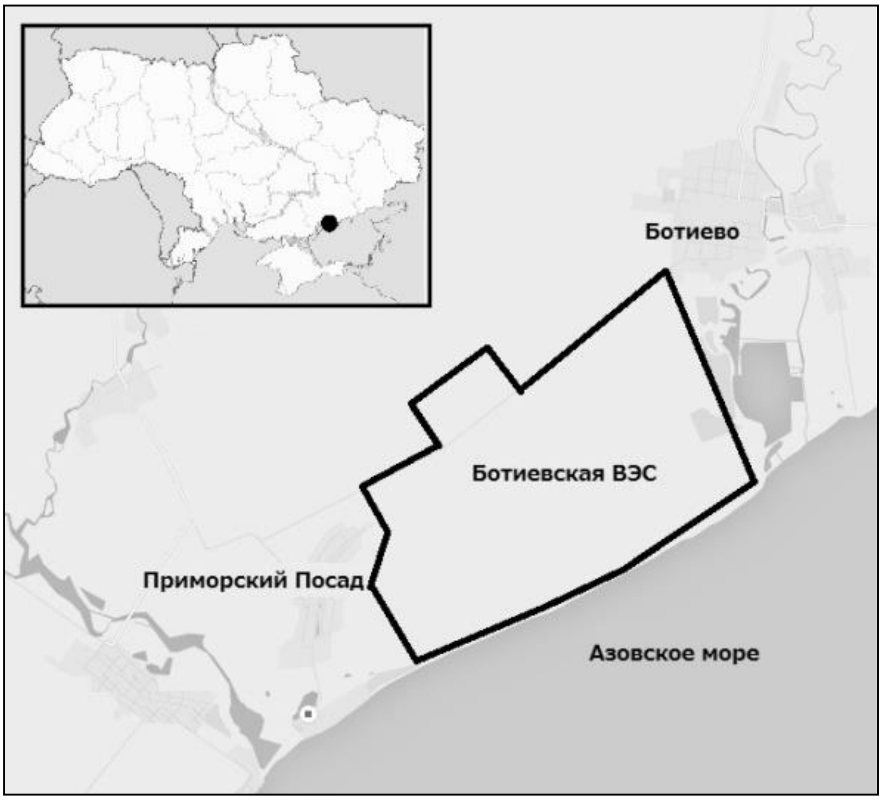

Figure 1. The research area

Average height above sea level has a bias to the North-East (30 m) and to the South-West (5 m). Some 65 wind turbines aggregate here have total installed capacity of 200 MW (Fig. 2). Each wind turbine has a height of central support of 96 m with a length of blades of 56 meters, so taking into account the foundation and wind turbine they provide a maximum height of about 160 m. The distance between the wind turbines ranges from 470 to 700 meters. All units are situated exclusively within the forest belts, leaving farmland free to economic activity.

The basic data were collected on the territory of Botievo windfarm, located in the Azov district of Zaporozhye region, during the Rooks breeding season (from late February to mid-June of 2013-2015). Studies have been carried out during daylight hours and counted to more than 270 hours of hiking routes of about 320 km.

Basic techniques for collecting and processing field ornithological observations have been adapted for wind power sites (Annenkov et al, 2013; Gorlov et al., 2914; Gorlov, Siohin 2014). The surveys in Rook nesting settlements were carried out in the early stages of colony formation (late February - early March), when there was no dense vegetation. With the observation points that are evenly covered the entire area of wind stations we recorded the concentrations of birds, registered regular feeding flights, fixed the elements nest-building behavior (collecting of nesting material, territorial conflicts, courting partners, etc.), which allowed to locate the areas of potential colony location. Then we build transects along main forest belts, which led to the precise fixation of Rook settlements, as well as give us the information on all the species composition of bird nesting within the wind farm.

The line transect method is a one-visit survey, in which the birds are counted along a transect with an average length of 5–6 km. The census is carried out in June in the early morning, when the singing activity of birds is highest. In the line transect method a 50 m wide main belt along the walking line and a supplementary belt outside the main belt are separated. The supplementary belt consists of all the birds observed outside the main belt (Järvinen & Väisänen 1976, Järvinen *et al.* 1991, Väisänen *et al.* 1998, Virkkala 2004).

Densities of bird species were calculated on the basis of observations on the whole survey of belt including both main and supplementary belts (Järvinen & Väisänen 1975). In the density calculation the species-specific correction coefficients were used. These coefficients vary according to the proportion of main belt observations towards the whole survey belt observations. The species-specific correction coefficient takes into account the different detectabilities and audibilities of different species (Järvinen & Väisänen 1983). In the Finnish line transect, densities of species based on the observations in the censuses are calculated in standard units of pairs/km^2

The density of a species (D, pairs/km^2) based on the Finnish line transect census was calculated as:

$D = K \times N/L$, (1)

where K = species-specific correction coefficient, N = number of observations of a species on the whole survey belt, and L = transect length (in km). The species-specific correction coefficient (K) was calculated as (Järvinen & Väisänen, 1983):

$K = 40 - 40 \sqrt{(1- p)}$, (2)

where p = proportion of main belt observations (range 0–1); for details of the calculations, see Järvinen (1976) and Järvinen & Väisänen (1975, 1976, 1983).

The correction coefficients used in this study were calculated on the basis of line transect data collected from protected areas in Ukraine in the steppe and forest-steppe vegetation zones.

We used binoculars (10X) for field surveys and the mapping was done using Garmin GPS 78S map navigator; the tree height and neat altitudes located thereon were measured by a laser range finder, altimeter NICON Forestry 550 (measuring error: ± 0,5 m at a distance of up to 10 m, ± 1 m at a distance of more than 100 m.). We numbered each tree, fixed its position in the ranks of the colony, measured the distance to the nearest tree and its neighboring rows, determined the type of tree trunk diameter (cm) in the surface layer, the tree height (m), the number of nests in the same tree. Each slot was numbered with registration of fixed location on a tree, the height of buildings above ground (m), the distance between adjacent slots (m).

Tree layout were constructed for each colony used by birds and nests layout on every tree. The method of foot bypass colonies on the periphery with a GPS-navigator, followed by transfer of the track as a KML-based content in Google Earth, the exact area of the settlements were established (Matsyura et al., 2013). At the same time we registered the Rook density, the presence of shrub layer and percentage of cover grass cover (Brygadirenko, 2006; 2013)

Statistical data processing was carried out by MS Excel and Statsoft Statistica 6.0. Evaluation of linear relationship closeness was performed by correlation analysis, while using Pearson's correlation coefficient.

There were six Rook colonies on territory of Botievo WPS in the shelter belts. All forest plantations were relatively of the same age (40-50 years) and were surrounded by agricultural land (Fig. 2).

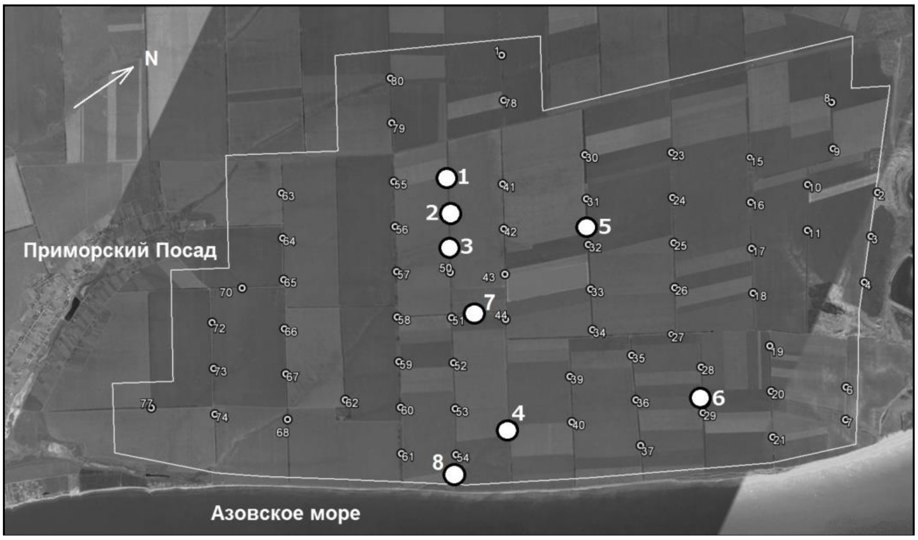

Figure 2. Rook colonial settlements on the Botievo WPS area
(17 - number of wind turbine, 1 – Rook colonies)

The natural woody vegetation was absent in the research area. Wood species were presented exclusively like artificial plantations (belts) in agricultural lands, along the roads and like small artificial forests. The most common part of the artificial tree plantations was the Locust (Robinia pseudoacacia L.), we also registered Ash-leaved Maple (Acer negundo L.), Tatarian maple (A. tataricum L.), Elm (Ulmus carpinifolia Rupp. Ex. G. Sucrow), Honey Locust (Gleditsia triacanthos L.), White mulberry (Morus alba) and very rarely Crimean pine (Pinus pallasiana). The average age of trees was 40-50 years. The fits toddlers were practically absent. Most of the plantations were in extremely poor condition and almost all of them went to the coppice of have a low site class and efficiency as a result of logging, fires and drought.

STRUCTURE OF COLONIAL SETTLEMENTS

We used the mhe method of colonies peripheral surveys with a GPS-navigator, followed by transfer of the track as a KML-file in the Google Earth that contributed to establish the precise area of the colonial settlement. We simultaneously described the crown density, presence of shrub layer and percentage of grass cover. From the number of nests and number of occupied trees in each colony we obtained final results presented in Table 1.

Table 1. Parameters of Rook colonies (Botievo WPS, 2015).

Colony number	Number of nests	Area, m2	Number of occupied trees	Canopy density, %
1	52	1014	28	30
2	210	2083	63	60
3	343	3488	115	75
4	52	977	22	35
5	158	3994	112	60
6	143	1562	45	50
7	134	2973	71	60
8	167	1047	34	50
Average	**157,4**	**2142,3**	**61,3**	**52,5**

Analyzing Table 1, we concluded that the area in various colonies had a four-fold difference between the extreme meanings (977-3994 m2), while the number of Rook nests ranged sevenfold (52-343). This could be explained by different condition of shelterbelts, when the increasing in area of the colony does not necessarily lead to an increase in the number of trees suitable for nest building. The presence of logging sectors, fields, and dead trees reduces the total number of birds, even with an increase in settlement areas (Table. 2). The patterns of tree usage by Rooks has big variation. The percentage of occupied tree by Rook nests was the same in all the studied colonies (Table 3). The whole area of the Rook colony and the number of occupied trees have the highest correlation (r = 0,97) that proved high compactness in the colonies, where almost all suitable trees were occupied by the birds (Fig. 3).

Territory of Botievo WPS includes 30 agricultural fields, the longest sides of which are oriented from northwest to southeast. Traditionally, all fields in the south of Ukraine are bordered with artificial plantations in the form of five-row belts. All 6 Rook colonies are located precisely in the long forest belts (Fig. 2).

When determining the tree priorities towards Rook nesting according to the class of the belts it revealed that the colony number 5 (which was built in the 4 types of trees) is mainly engaged in four series with a relatively uniform density of nests. Colony number 2 (210 tress), number 3 (343 trees), number 6 (143 trees), number 7 (134 trees), and number 8 (167 trees) occupied all five rows, and had a clear shift density from occupied trees to one of the outer rows of shelterbelts in which there were 26-27,5% of all nests.

Table 2. Nest distribution patterns in the shelters of WPS in 2015.

Colony number		Tree rows in shelter 1	2	3	4	5	Total
1	Nests	15	5	12	3	17	52
	Trees	8	3	4	2	11	28
	Nests per tree	2.25	1.67	3	1.5	1.55	1.86
2	Nests	72	28	39	48	23	210
	Trees	12	12	11	21	7	63
	Nests per tree	6	2.33	3.6	2.3	3.3	3.3
3	Nests	75	24	23	51	170	343
	Trees	30	10	8	19	48	115
	Nests per tree	2.5	2.4	2.9	2.7	3.5	2.98
4	Nests	9	4	14	16	9	52
	Trees	6	3	5	4	4	22
	Nests per tree	1.5	1.3	2.8	4	2.25	2.36
5	Nests	31	53	32	37	5	158
	Trees	22	35	23	28	4	112
	Nests per tree	1.4	1.5	1.4	1.3	1.25	1.41
6	Nests	56	9	24	30	24	143
	Trees	14	3	8	13	7	45
	Nests per tree	4	3	3	2.3	3.4	3.18
7	Nests	25	28	27	23	31	134
	Trees	11	16	20	12	12	71
	Nests per tree	2.3	1.8	1.35	1.9	2.6	1.9
8	Nests	44	25	18	13	67	167
	Trees	8	5	4	6	11	34
	Nests per tree	5.5	5	4.5	2.2	6.1	4.9
Total	Nests	327	176	189	221	346	1259
	Trees	111	87	83	105	104	490
	Nests per tree	3	2	2.3	2.1	3.3	2.6

Interestingly, from the 16 that had more than 10 Rook nests each only two trees were in the middle (2nd and 3rd) row, and the rest - in the outer row.

The trees with a maximum number of nests (15, 17, and 22) were also located in the first row of the colonies. The average number of nests in the same tree was also the highest in the external row in the colonies 2, 3, 6, 7, and 8 (6.0; 3.5; 4.0; 2.6 and 6.1 nests per tree, respectively). Note that these were the colonies with the highest number of birds. This can be explained by proper conditions of approach and departure bird flights to/from the nest (which is important in the period of fledging) and unimpeded inspection of colony neighborhoods, which increases the degree of collective Rook security.

The average number of nests per tree was the highest in the third (middle) row in the smallest colonies - 1 and 4 (52 nests).

Table 3. Forest shelter parameters in Rook colonies of WPS, 2015.

Colony number		Tree row in shelter					Total
		1	2	3	4	5	
1	Number of occupied tress	8	3	4	2	11	28
	Number of non-occupied trees	1	1	4	4	1	11
	Number of logged trees	2	6	5	5	2	20
2	Number of occupied tress	12	12	11	21	7	63
	Number of non-occupied trees	5	8	3	2	3	21
	Number of logged trees	5	11	13	14	14	57
3	Number of occupied tress	30	10	8	19	48	115
	Number of non-occupied trees	10	15	6	11	4	46
	Number of logged trees	34	46	51	42	22	195
4	Number of occupied tress	6	3	5	4	4	22
	Number of non-occupied trees	1	1	3	2	1	8
	Number of logged trees	5	8	6	6	5	30

5	Number of occupied tress	22	35	23	28	4	112
	Number of non-occupied trees	10	12	18	9	0	49
	Number of logged trees	30	42	40	59	143	314
6	Number of occupied tress	14	3	8	13	7	45
	Number of non-occupied trees	2	0	4	2	4	12
	Number of logged trees	5	6	2	1	5	19
7	Number of occupied tress	9	18	20	14	10	71
	Number of non-occupied trees	8	4	5	6	6	29
	Number of logged trees	15	10	7	11	15	58
8	Number of occupied tress	7	5	6	7	9	34
	Number of non-occupied trees	3	3	1	3	4	14
	Number of logged trees	7	9	10	6	4	36
Total	Number of occupied tress	108	89	85	108	100	490
	Number of non-occupied trees	40	44	44	39	23	190
	Number of logged trees	103	138	134	144	210	729

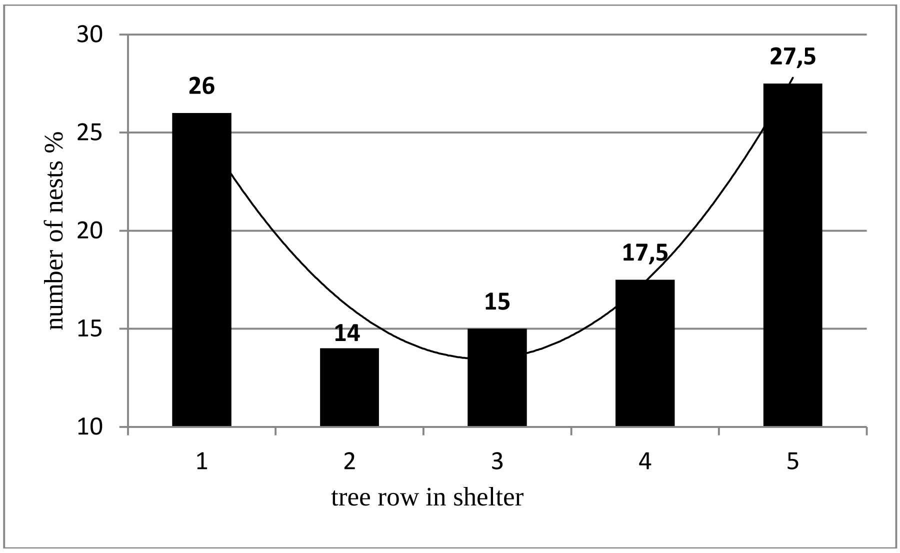

Figure 3. Breeding density in Rook colonies in shelters of Botievo WPS

In more detail the nesting density is presented in Table 2, 3 and in Fig. 3.

We also found another very close relationship between the number of nests in the colony and the proximity of forest belt (r = 0,91). The birds prefer to nest in shady woodland belt, with has dense canopy. Apparently, thus increasing the safety from possible air predators.

We suppose that by increasing the number of the occupied tree also grows the number of nests as the Rooks has capacity to build more than one nest on a suitable tree (up 22 to nests per tree).

Describing the height of Rook nests, we noted that they depend on the composition, age and condition of tree plantations in the forest belt on the background of a certain level of the anthropogenic disturbance.

Table 4. Degree of association of twin factors in Rook colonies (Botievo WPS, 2015).

Twin factor		**Correlation index**
colony square	number of occupied trees	0.97291
nest number	colony square	0.59964
nest number	canopy density. percent	0.9073
nest number	number of occupied trees	0.74182

Table 4 shows that the average height of trees in Rook colonies is 10.5 m (lim: 4.6-16.3), the nests were built in the average height of 7.1 m (lim: 2.2-12.4). We found proof in literature data there were cases of nest building at the height up to 30 meters.

Table 5. Tree measurements and nest heights in Rook colonies (Botievo WPS, 2015).

Measurement	n	average	min	max	C_v
Basal diameter. cm	1259	19.8±7.59	5.4	45.9	38.4
Tree height. m	1259	10.5±1.98	4.6	16.3	18.8
Nest altitude. m	1259	7.1±1.84	2.2	12.4	26.0

In all eight colonies the Rook nests were located higher, the more was the altitude of tree on which they were built (r = 0.64).

Height of Rook nests did not depend on the basal diameter in colonies formed on Robin trees (r = 0.26), though the direct high dependence (r = 0.70) was detected in colony number 5, with the location of nests on 4 tree species (Fig. 4). The closest relationship was registered for the nests located on maple and acacia, to a lesser extent - on the mulberry and honey locust, which in our opinion was determined by the presence of lateral branches at low altitudes suitable for nest building.

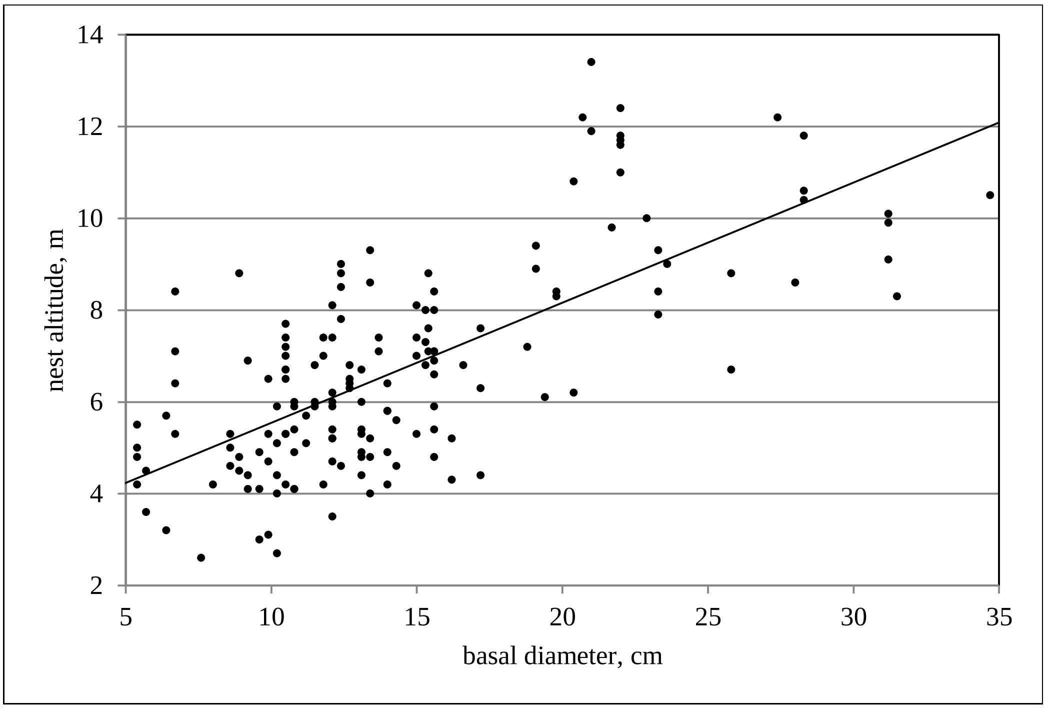

Figure 4. Basal diameter vs Rook nest height in colony 5 (158 nests)

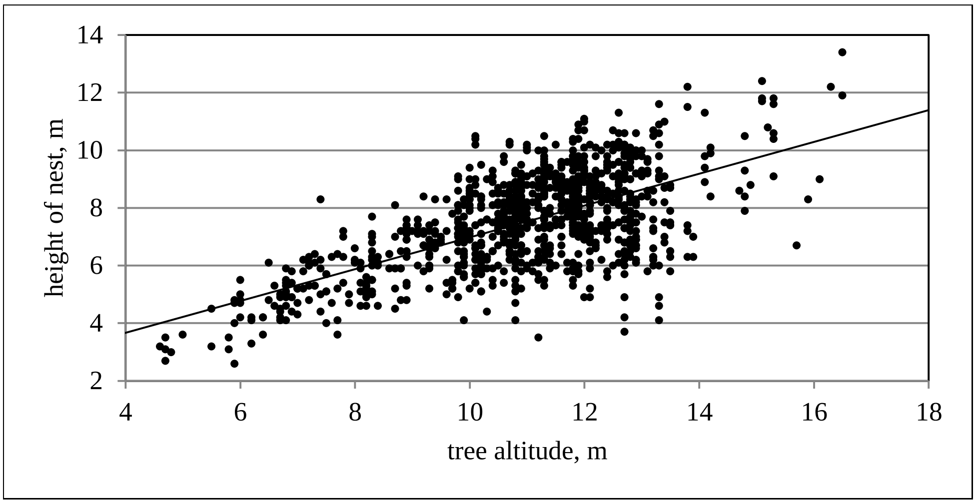

Figure 5. Tree and nest altitudes in Rook colonies of Botievo WPS in 2015 (1259 nests)

Number of nests per tree varied from 1 to 22, on average 2.6 (n = 1259) and was dependent on the type of tree and its crown shape (Figure 6.). The percentage of singular breeding birds did not exceed 50, amounting up to 44.7% of all settlements, which is comparable with the Rook capacity to build from 2 to 5 nests on one tree - 229 trees or 46.7%. There were 42 trees with more than 5 Rook nests (8.6%).

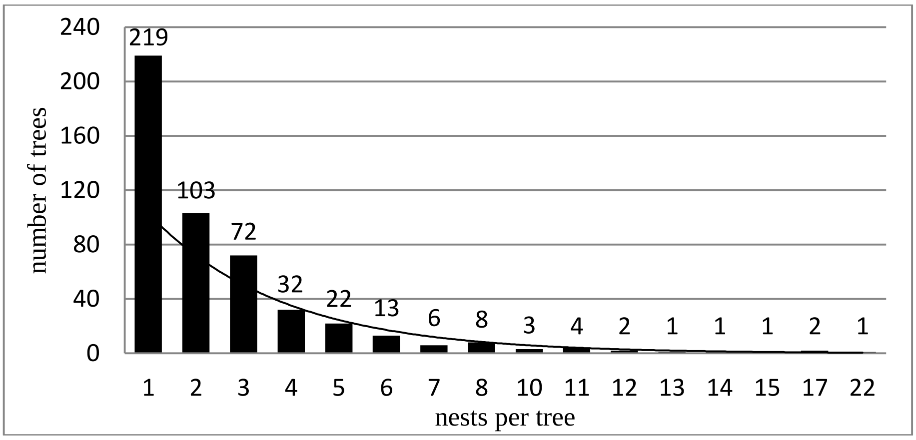

Figure 6. Number of Rook nest per tree in colonies of Botievo WPS in 2015

When identifying the dependence of the number of nests in one tree on tree height and basal diameter, we founded the direct correlation with the latter index (r = 0.37), that could be explained by more spreading crown of trees with large basal diameter (Fig. 7).

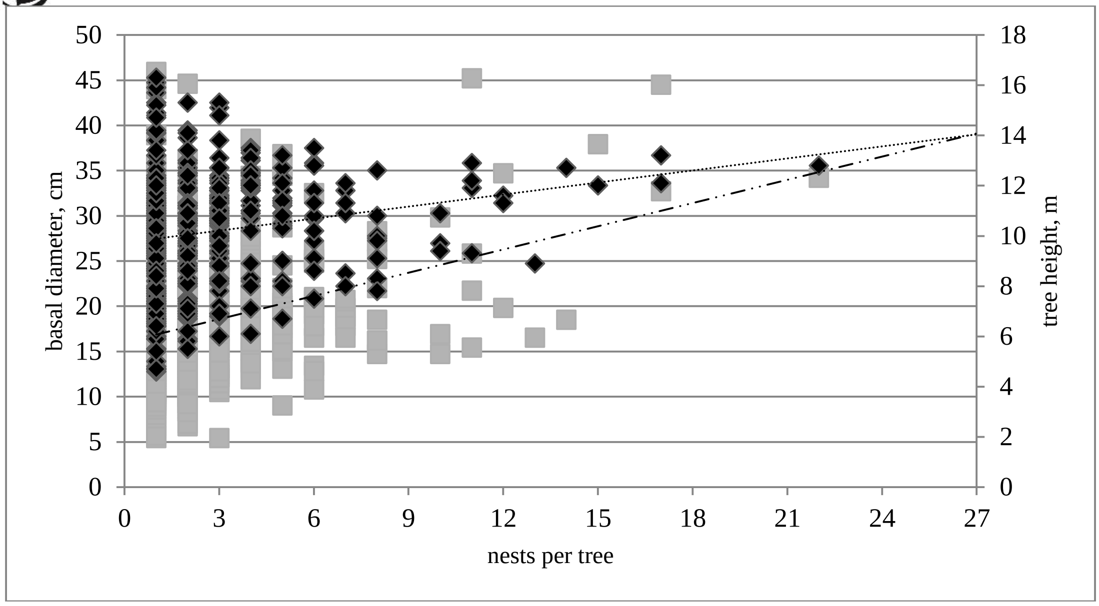

Figure 7. Number of nest per tree towards basal diameter and height

PATTERNS OF NEST DISTRIBUTION ON THE TREE CROWN

There are several patterns of Rook nest distribution in the crown of the tree. About of 44.7% of Rooks in all six colonies have only one nest per the same tree that we considered to be a single nest pattern. The rest of the bird occupied the trees, building from 2 to 22 nests (mass nesting on the same tree). The birds built the nests inside the crown, on the primary and secondary lateral branches, and on the top of the trees (sometimes wind-broken). There have been mixed variants of nest distribution. Schematically, the main types and patterns of the nests in the trees shown in Fig. 8, and their quantitative characteristics are given in Tables 5 and 6.

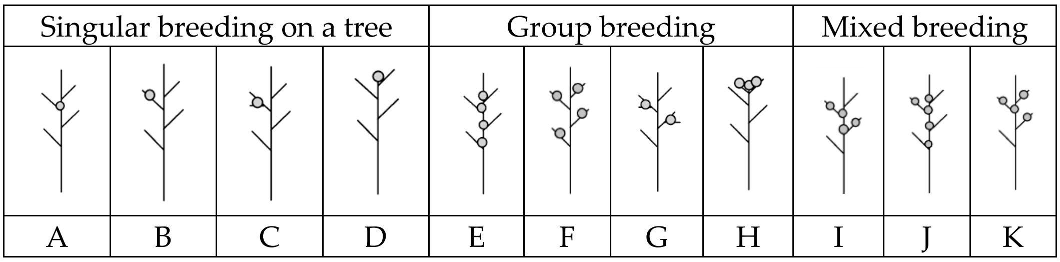

Figure 8**.** Patterns and variants of the nest distribution on the trees
A – single, tree stem; B – single, primary lateral branch; C - single secondary lateral branch; D – single, top of the tree; E – mass, tree stem; F – mass, primary lateral branch; G – mass, secondary lateral branch; H – mass, top of the tree; I - mixed with an equal amount of nests on the stem and lateral branches; J - mixed type with dominance of stem nests; K - mixed type with dominance of the nests on the lateral branches.

Table 6. Rook nest distribution patterns in tree crown (8 colonies, Botievo WPS, 2015).

Type	Rook colonies																Total	
	1	%	2	%	3	%	4	%	5	%	6	%	7	%	8	%	nests	%
A	25	48,2	155	73,8	261	76,1	35	67,3	82	51,9	84	58,7	67	50	103	61,7	812	64,5
B	12	23	27	12,9	45	13,1	2	3,8	13	8,2	29	20,3	31	23,1	29	17,3	188	14,9
C	12	23	23	10,9	26	7,6	12	23,1	54	34,2	24	16,8	28	20,9	33	19,8	212	16,8
D	3	5,8	5	2,4	11	3,2	3	5,8	9	5,7	6	4,2	8	6	2	1,2	47	3,8
Nests	**52**		**210**		**343**		**52**		**158**		**143**		**134**		**167**		**1259**	
Variant	**4**		**4**		**4**		**4**		**4**		**4**		**4**		**4**		**4**	

Note: Patterns and variants of nest distribution – see Fig. 8.

Table 7. Tree parameters according to Rook nest distribution patterns and variants (colonial settlements of Botievo WPS, 2015).

	Rook colonies																Total	
***Pattern**	**1**	%	**2**	%	**3**	%	**4**	%	**5**	%	**6**	%	**7**	%	**8**	%		%
A	8	28,5	16	25,4	22	19,1	3	13,6	44	39,3	7	15,6	15	21,1	0	0	115	23,5
B	1	3,6	0	0	3	2,6	0	0	4	3,6	1	2,2	8	11,3	1	2,9	18	3,7
C	3	10,7	3	4,8	2	1,7	3	13,6	23	20,5	0	0	5	7,1	0	0	39	7,9
D	3	10,7	5	7,9	11	9,6	2	9,1	9	8	6	13,3	8	11,3	2	5,9	46	9,4
E	4	14,3	17	27	42	36,5	7	31,8	11	9,8	13	28,9	15	21,1	9	26,5	118	24,1
F	2	7,1	2	3,2	2	1,7	0	0	1	0,9	0	0	3	4,2	2	5,9	12	2,5
G	1	3,6	3	4,7	4	3,5	1	4,6	6	5,4	2	4,4	4	5,6	1	2,9	22	4,5
H	1	**3,6**	1	1,6	5	4,4	0	0	0	0	3	6,7	0	0	0	0	10	2
I	0	0	3	4,7	4	3,5	1	4,6	6	5,4	3	6,7	3	4,2	5	14,7	25	5,1
J	1	3,6	11	17,5	14	12,2	3	13,6	3	2,7	4	8,9	3	4,2	9	26,5	48	9,8
K	4	14,3	2	3,2	6	5,2	2	9,1	5	4,4	6	13,3	7	9,9	5	14,7	37	7,5
Trees	**28**		**63**		**115**		**22**		**112**		**45**		**71**		**34**		**490**	
Variants	**10**		**10**		**11**		**8**		**10**		**9**		**10**		**8**			

Note: for patterns and variants see Fig. 8

DISCUSSION

The rook show high breeding plasticity in anthropogenic landscapes. Choosing a place for nesting is determined by the presence and power of the limiting factors, some of which are reflected in the table 7. Analysis of the results revealed that the most powerful were sufficiently large distance from the center of the colonies to the office of Botievo WPS (3240-6630 m), brightly lit at night, and to the nearest settlement (2720-4655 m). However, the presence of highway and secondary traffic load exerted less effect because Rook colonies were located 409-3720 m from them. In a large range of values ranged along the gradient "colony center-seaside," which, apparently, is not determinative when choosing nesting sites. Suffice it to long distances to the nearest freshwater pond (2340-5235 m), say small rooks communication with him, even though we repeatedly observed large groups of birds in numbers that are on the banks of fish breeding ponds. The most unexpected was the construction and use of perennial colonies of rooks in the immediate vicinity of the constantly rotating and makes a noise of wind turbines (the nearest colony located 20 and 78 m). Note also that the number of slots is not the lowest in these colonies (tab. 6).

Birds and wind turbines.

For a more detailed study of the threat of bird collisions with blades and wind turbines supports us in 2013-2015 additional special studies related to the areas of scrutiny were held adjacent to the wind turbines for the search for evidence of birds hit by moving parts of the wind turbine.

There were 30 wind turbines operating at the beginning of the autumn migration in 2013 and during our expedition trips in October, there were about 55 (depending on the degree of completion of the second stage). At the beginning of 2014, some 65 wind turbines were put into operation. During each our check-out for not less than 25% of the wind turbines, which ranged from 8 to 17 (there were 5 compulsory monitoring stations, and the rest were visited by choice) that allowed to hold a valid extrapolation of the results to the entire area of the wind farm.

The inspection area around the wind turbine is equal to its maximum height and was 160-170 m; this equal to the area of about 9 hectares. The choice of monitoring areas affect not only the location of installations (along the road, at the coastal cliffs and in the middle of a wind farm), but the situation with the harvest and state farmland. Preference was given to the fields with the missing grass, fields with stubble and arable land. To reduce the factor of predation by foxes, feral cats and dogs the surveys were doing in the early morning.

During the period of the autumn expeditions in 2013 we examined 47 sites (8 in August, 10 in September, 14 and 15 October), in 2014 - 33 (10 March, 10 April, 5 May and 8 October) and in 2015 - 17 sites (March-May). In 2015 special attention was paid to siting wind turbines located in the proximal vicinity of the Rook colonies. The total area of inspected areas in 2013-2015 was about 900 hectares.

As a result, we did not find any dead birds, body parts, feathers, deformation or contamination of the blades or other evidence of collision of birds with wind turbines. Poll wind farm workers and local residents also did not mention the cases of birds falling under the blades of wind turbines.

An interesting fact is that we registered 6 colonies within the wind park, and only 2 colonies in close proximity. Taking into account the absolutely similar habitat characteristics for all study area (agricultural fields separated by forest belts), was could state that the area of Botievo WPS had greater attraction for nesting Rooks than its surroundings. This is probably can be explained by the existing regime of protection areas, which reduces the disturbance, and also the fact that since 2010 the shelterbelt is protected against quite common illegal logging.

Thus, we can state that the threat to the Rooks from operating WPS was practically absent.

CONCLUSIONS

Spatial distribution and structure of rook colonial settlements in the territory of Botievo Wind Power Station caused by number of limiting factors.

Thus, the birds formed eight colonies, among them we registered: no very small (up to 10 trees) and small (11-50 trees) colonies, 2 medium (51-100 trees), 6 large (101-500 trees) in 2015. All these colonies were located in forest with domination of Robin locust (7 colonies) and the mixed forest stand of mulberry, maple, honey locust, and locust (1 colony).

The area in the various colonies had a four-fold difference between the extreme values (977-3994 m2), while the number of Rook nests ranged sevenfold (52-343). Analysis of the different indicators that describe the structure of the Rook colony revealed some dependence: between bird abundance and the number of occupied trees (r = 0.97); space colonies and the number of nests (r = 0.60); the number of nests in the colony and the closeness of the stand in the forest belt (r = 0.91); and the number of slots occupied trees (r = 0.74), the height of the tree and it nests (r = 0.64). The location of nests in different shelterbelts identified the shift of density classes of trees in large colonies to one of the outer rows, in which there were 26.0-27.5% of all nests.

Typology and localization of Rook nests in the trees has 11 accommodation options. We registered the dominated accommodation nests in a tree trunk (57.4% of the trees and 64.52% of all nests). Colonial settlement of Rook in shelter belts on the territory of Botievo WPP form specific conditions and form the interspecies communication with other birds. So, in the old nests of Rooks we surveyed other nesting birds: Kestrel and Merlin. In all eight colonies of Rook we met from 5 to 11 related species of nesting birds. In the colonies, located in the forest belt of Locust with rooks greeted 5-8 species of birds in the colony number 5, built on 4 kinds of trees, a variety of birds reached 12 species.

Table. **Spatial patterns of Rook colonies on the Botievo WPS plots in 2015.**

Colony number	Number of nests	Distance from tne colony center (m):					
		WPS office	water reservoir	route	village	seaside	wind turbine
1	52	3240	5120	409	2750	3470	600
2	210	3290	5020	820	2720	2920	595
3	343	3390	4495	1020	2720	2635	605
4	52	4870	4490	975	4050	640	630
5	158	4840	3480	1077	3915	2870	78
6	143	6630	2340	730	4655	780	20
7	134	3865	4595	1935	3170	1965	217
8	167	4725	5235	3720	3935	147	246
Average	**157.4**	**4356.3**	**4346.9**	**1335.8**	**3489.4**	**1928.4**	**373.9**

We did not identify the facts of the negative impact of operating wind turbines on birds from autumn 2013 to June 2015. Thus, Rooks with a complex spatial and structural organization of colonial nesting communities play an important role in the formation of relationships of biocenotic in forest steppe zone and demonstrate the plasticity of nesting behavior in anthropogenically transformed landscape.

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