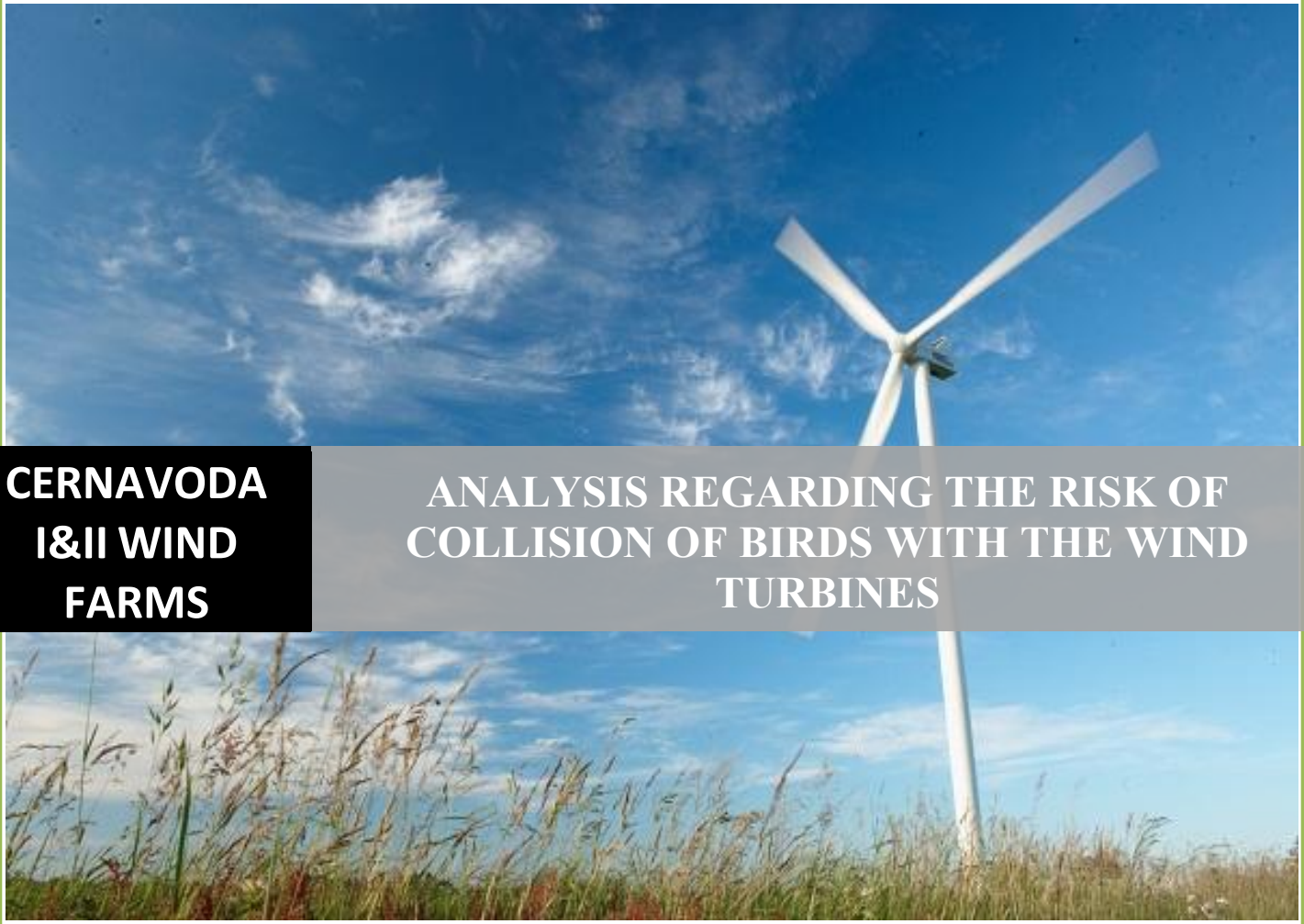

CERNAVODA I&II WIND FARMS

ANALYSIS REGARDING THE RISK OF COLLISION OF BIRDS WITH THE WIND TURBINES

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1. GENERAL DATA

1.1. Introduction

EDP Renewables has developed in the area Mircea Voda, Constanta county, two wind farms with a total power of 138 MW, currently operated by S.C. CERNAVODA POWER S.R.L.

The development of the wind farms was done in accordance with the specific legislation in force, in compliance with European and national regulations regarding the development of this kind of projects.

In terms of compliance with the environmental legislation, for the building of the wind farms was obtained the Environmental Agreement no. 24/29.09.2008 issued by the EPA Constanta, based on the assessment study of the environmental impact, prepared by specialists in the field.

Later, after building the objective, regulating the operation conditions for the wind farms was done by issuing the environmental permit no. 578/29.12.2010.

Both the Environmental Agreement and the Environmental Permit required the monitoring of biodiversity in the area of the wind farms both during its construction and at least during the first year of operation of the wind farms.

S.C. CERNAVODA POWER S.R.L. has achieved this monitoring by means of S.C. Blue Terra Consulting SRL, which has prepared regular reports that were submitted to the beneficiary and the environmental authorities according to the regulatory documents mentioned above.

1.2. General data regarding the analyzed objective

The wind farms developed by EDP in the area of the administrative territory of the Mircea Voda village, Constanta county, has a total power between them of 138 MW and comprises of a total of 46 Vestas V90 turbines with a power of 3 MW each.

Regarding the location of the farm in relation to Natura 2000 sites, the following table indicates the distances to the nearest Natura 2000 sites and their position towards the wind farms.

Natura 2000 Site	Location of the farms in relation to Natura 2000 Site
ROSCI0022 CANARALELE DUNARII	5,7 km East
ROSPA 0039 DUNARE-OSTROAVE	4,8 km East

Regarding the migration routes, as indicated in the impact study, the wind farms is not located on a main migration route, but given the distance of about 5-6 km between the farm and the Danube, it is possible that specimens of birds flying along the Danube River also reach the farm area during their migration.

2. GENERAL DATA REGARDING THE RISK ANALYSIS

2.1. Data and methodologies used for the calculation of the risk analysis

This material represents an analysis of the risk of collision of birds with wind turbines that make up the wind farms from Mircea Voda, Constanta county.

The data used in the analysis are those obtained as a result of the monitoring of the area for 12 months (over the entire year 2011).

The methodology used is based on the pattern developed by Scottish Natural Heritage, that takes into account that, in practice, most birds in their flight are able to detect a wind turbine or an entire farm of turbines and to modify their flight so they can avoid such obstacles.

2.2. Description of the calculation method

The method used for the analyzed wind farms, developed by SNH, aims to estimate the number of collisions of birds with the wind turbines over a period of time. In this case, the period taken into account in this analysis is of one year.

The method is mainly based on the following equation:

Number of birds that can collide with the turbines =
number of birds that fly in the action area of the turbine rotor x
the likelihood that the birds that fly in the action area of the rotors be hit by these

Regarding the number of birds that can collide with the wind turbines, there are two approaches:

A. Birds with regular flights in the area of the wind farms. For the analyzed objective, in this category were included only species observed in migration in the area of the wind farm. These species are shown in Table. 5 of the Report on the monitoring of biodiversity in the wind farms area, prepared for the entire year 2011. The above mentioned report also describes the methods of monitoring the avifauna used during monitoring.
B. Birds frequently using the wind farms area. This category only took into account, from the species of birds identified in the wind farms area, those species whose flights are frequent in the action area of the wind turbine rotor.

In each of the two cases was calculated the likelihood of collision of birds with the wind turbines, according to the methodology described by SNH.

The calculation of the collision risk is presented in further detail for each of the two cases mentioned above.

CASE 1: MIGRATING BIRDS

For this case were considered the species listed in Table 5 of the annual monitoring report, presented in the Table 3 of this material.

For the calculation of the risk of collision were considered all species listed in Table no. 3, though, as the table also emphasizes, not all were observed flying high in the action area of the wind turbine rotor, so in the area with risk of collision. But considering that these species are migratory and have been observed during migration, it has been considered that such specimens can also reach heights that would pose a risk of collision with the turbines.

Regarding the number of birds of each species considered in this case it was considered that it is n x 2, where "n" is the number of birds of each species observed during the entire year and 2 represents the number of regular flights of these birds in the wind farms area (spring migration and fall migration).

In order to calculate the risk of collision of birds in this category with the turbines of the wind farms, according to SNH methodology, the following technical data were also used:

Table no. 1

Input data			Output data		
Farms width (largest width of the farms considered perpendicularly to the predominant flight direction)- fig.1	1	10 km	Risk window	W = l x H	1.500.000 mp
Wind turbine height	H	150m	Risk section	A = N x πR^2	292491mp
No. of turbines that make up the farms	N	46		A/W	0.20
Radius of the turbine rotor	R	45m			

The risk window (W) is a "window", actually a vertical section through the farms whose dimensions are defined as follows:

- Length of the risk window is the largest width of the farms, perpendicularly to the predominant flight direction of birds
- Width of the risk window is the height of the highest turbine of the farms. In our case all turbines have a height of 150 m.

Risk section (A) is the plan area occupied by the action radius of all turbine rotors that make up the wind farms.

Table no. 2: Technical features of the turbines

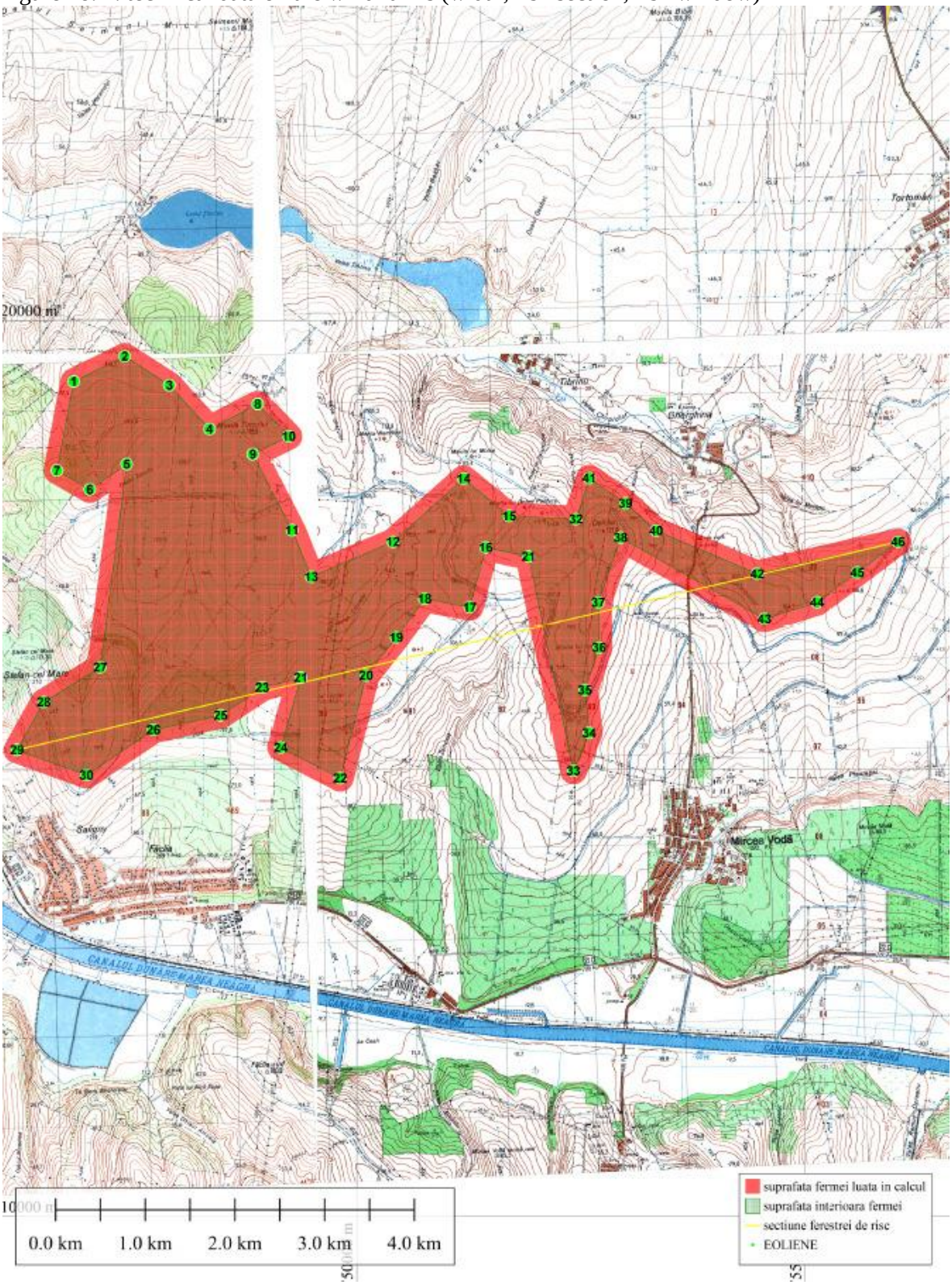
No. of blades	3
Tower height	105m
Blade length	45m
Maximum blade width	3.5m
Maximum angle of slope of the blade	30^0
Rotor diameter	90m
Rotation period	3.72 sec.
Rotor depth	4.4 m

Table no. 3: birds in migration observed in the wind farms area over the entire year 2011

Run. No.	Scientific name	Common name	Observation period (month/months)	Number of specimens	Observations
1.	Ciconia ciconia	White stork	05.2011	16 spec.	bird groups (36 spec.); flying height 150-200 m; flying direction: S-N, W
2.	Buteo buteo	The Common Buzzard	03/04/05/10/11.2011	6 spec.	single specimens flying; flying height 120-150 m; flying direction: S-E,N
3.	Buteo rufinus	The Long-legged Buzzard	04/11.2011	3 spec.	single specimens flying; flying height 90-150 m; flying direction: S-E,N
4.	Merops apiaster	The European Bee-eater	04/05/09.2011	25 spec.	single specimens flying; flying height 150-200 m; flying direction: S-W,N.
5.	Coracias garrulus	The European Roller	05.2011	6 spec.	single specimens flying; flying height 50-60m; flying direction: S-E, N.
6.	Upupa epops	The Hoopoe	04/05.2011	5 spec.	single specimens, groups of birds flying; flying height 30-40 m; flying direction: S-N-W.
7.	Alauda arvensis	The Skylark	03/04/05/09/10.2011	84 spec.	single specimens flying; flying height 40-60 m; flying direction: S-E, N.
8.	Hirundo rustica	The Barn Swallow	03/04/05/09.2011	73 spec.	Groups of birds/ single specimens flying (3-5 spec.); flying height 35-40 m;

					flying direction: S-W,E.
9.	Anthus campestris	The Tawny Pipit	04/05.2011	4 spec.	single specimens; flying height 25-30 m; flying direction: E, S-E,W.
10.	Motacilla alba	The White Wagtail	04/05/09/10.2011	80 spec.	single specimens; flying height 20-30m; flying direction: S-W, N.
11.	Lanius collurio	The Red-backed Shrike	05/09.2011	16 spec.	single specimens flying; flying height 40-50m; flying direction: S-W,E.
12.	Lanius minor	The Lesser Grey Shrike	05/09.2011	6 spec.	single specimens flying; flying height 40-50m; flying direction: S-W,E.
13.	Sylvia communis	The Whitethroat	04/05.2011	4 spec.	single specimens flying; flying height 35-40 m; flying direction: S-E, N.
14.	Coturnix coturnix	The Common Quail	04/05.2011	12 spec.	Groups of birds/ single specimens; flying height 40-50 m; flying direction: S-N-W
15.	Fringilla coelebs	The Chaffinch	03/04/05.2011	35 spec.	Groups of birds/ single specimens (2-3 spec.); flying height 40-50 m; flying direction: S-W,E.

Figure no. 1: technical data on the wind farms (width, risk section, risk window)



The following table presents the results on the risk of collision with the farms turbines of birds in migration observed in the wind farms area

Bird species	number of birds	number of birds through the risk window	Length of bird cm	Wingspan cm	way of flying hovering (0) flapping (1)	flying speed m/s	collision likelihood* %	no. of birds with risk of collision without any avoidance activities	avoidance rate**	real risk no. of birds/ year
1	2	3	4	5	6	7	8	9	10	11
	n	nxA/W	L	A				Col. 3 x 8		(1-col.10)xcol.9
Ciconia ciconia	32	6.4	110	200	1	12	14.50	0.928	95%	0.0464
Buteo buteo	12	2.4	46	112	0	17	8.20	0.1968	98%	0.0039
Buteo rufinus	6	1.2	58	142	0	17	8.90	0.1068	98%	0.002136
Merops apiaster	50	10	28	40	1	17	9	0.9	98%	0.018
Coracias garrulus	12	2.4	30	57	1	12	9.10	0.2184	98%	0.004368
Upupa epops	10	2	28	46	1	12	9.00	0.18	98%	0.0036
Alauda arvensis	170	34	18	33	1	9	10.70	3.638	98%	0.07276
Lanius collurio	32	6.4	18	26	1	9	10.70	0.6848	98%	0.013696
Lanius minor	12	2.4	20	27	1	9	10.90	0.2616	98%	0.005232
Anthus campestris	10	2	16	27	1	9	10.50	0.21	98%	0.0042
Motacilla alba	160	32	18	28	1	9	10.70	3.424	98%	0.06848
Sylvia communis	10	2	14	25	1	9	10.40	0.208	98%	0.00416
Coturnix coturnix	24	4.8	18	27	1	9	10.7	0.5136	95%	0.02568
Fringilla coellebs	70	14	15	28	1	17	6.20	0.868	98%	0.01736
Hirundo rustica	146	29.2	19	33	1	17	6.40	1.8688	98%	0.037376

* calculated according to the SNH methodology

** according to the specialized literature

CASE 2: BIRDS FREQUENTLY USING THE WIND FARMS AREA

In the wind farms area, as a result of the avifauna monitoring for one year a total of 43 species of birds were highlighted, which were presented in Table no. 2 of the monitoring report and in Table no. 6 of this material. But among these species only some have been taken into account when calculating the risk of collision, given that many of the species observed fly at heights much lower than the height of the action area of the turbine rotor, where the risk of collision of birds with wind turbines is particularly present.

Thus, the species that were included in the calculation in this case are shown in Table no. 7.

For the calculations the technical characteristics of the turbines, listed in Table no. 2 and the data in the following table were taken into account.

Table no. 5

Input data			Output data		
Surface of the wind farms (farm area)- see fig.1	A	19977796m p	Volume of the farms	$V_w = A \times H$	2996669400 mp
Wind turbine height	H	150m	Volume scanned by the turbine rotor	$V_r = N \times \pi R^2 x(d+l)$	See table no. 7
No. of turbines that make up the farm	N	46			
Radius of the turbine rotor	R	45m			
Length of the turbine rotor	d	4.4 m			
Length of the bird	1	See table no. 7			

The wind farms area (A) was thus considered: area strictly delimited by the wind turbines (cross-hatched area in Fig. 1), plus surface in the close vicinity with a width of 50m, considering that it also enters the range of action of the rotor (area in red, not cross-hatched on the sketch in Fig. 1)

The volume of the farms (V_w), where there is some risk that birds collide with turbines, is the area bounded as described above - A, multiplied by the height of wind turbines -H.

Table no. 6: Data on the monitoring of the avifauna in the Cernavoda I&II wind farms area over the year 2011

Run. No.	Scientific name	Common name	Number of specimens												Phenology	Ecology
			Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.		
1.	*Ciconia ciconia*	White stork					16								Summer Guest (SG)	terrestrial
2.	*Circus cyaneus*	The Hen Harrier		1											Winter Guest (WG)	terrestrial
3.	*Buteo buteo*	The Common Buzzard	2	1	2	1	1		1	1		1	1		Partially migrating (PM)	terrestrial
4.	*Buteo rufinus*	The Long-legged Buzzard				1							2		SUMMER GUEST (SG)	terrestrial
5.	*Falco tinnunculus*	The Common Kestrel	2	1			2		2	1	1	1	2	1	Partially migrating (PM)	terrestrial
6.	*Perdix perdix*	The Grey Partridge	23	15								6	16	14	S	terrestrial
7.	*Phasianus colchicus*	The Common Pheasant	1					3		2			2		S	terrestrial
8.	*Coturnix coturnixâ*	The Common Quail				6	6	6	5						Summer Guest (SG)	terrestrial
9.	*Larus ridibundus*	The Black-headed Gull	23	15	45			34	28				14	16	Partially migrating (PM)	terrestrial
10.	*Larus cachinnans*	The Caspian Gull	12	27	31			18	15				38	17	S	aquatic
11.	*Columba livia domestica*	The Domestic Pigeon	21	16	27			26	18				25	18	S	terrestrial
12.	*Streptopelia turtur*	The European							5	8	7				S	terrestrial

		Turtle Dove														
13.	*Streptopelia decaocto*	The Eurasian Collared Dove	9	7				15	21				8	13	Summer Guest (SG)	terrestrial
14.	*Merops apiaster*	The European Bee-eater				8	9	9	7		8				Summer guest (SG), Passing by (P)	terrestrial
15.	*Coracias garrulus*	The European Roller					6		6		4				Summer Guest (SG)	terrestrial
16.	*Upupa epops*	The Hoopoe				3	2	3	2						Summer Guest (SG)	terrestrial
17.	*Melanocorypha calandra*	The Calandra Lark						4	6				15		Partially migrating (PM)	terrestrial
18.	*Galerida cristata*	The Crested Lark	4	7	6			8		7	6		6	5	Summer Guest (SG)	terrestrial
19.	*Alauda arvensis*	The Skylark			17	11	14	15	12	14	19	23			Summer Guest (SG)	terrestrial
20.	*Hirundo rustica*	The Barn Swallow				10	11	15	23	14	37				Summer Guest (SG)	terrestrial
21.	*Anthus campestris*	The Tawny Pipit				2	2	3	2		3				Summer Guest (SG)	terrestrial
22.	*Motacilla alba*	The White Wagtail				26	5	9	8	6	14	35			Summer Guest (SG)	terrestrial
23.	*Lanius collurio*	The Red-backed Shrike					7	7	6	8	9				Summer Guest (SG)	terrestrial
24.	*Lanius minor*	The Lesser Grey Shrike					3		2	1	3				Summer Guest (SG)	terrestrial
25.	*Pica pica*	The European Magpie	7	14	6	4	5	6	8	4	5	7	8	12	S	terrestrial
26.	*Corvus monedula*	The Jackdaw	18	26	25	16									S	terrestrial
27.	*Corvus*	The Rook	190	150	235	270		35	14	32	45	152	243	235	S	terrestrial

	frugilegus															
28.	*Corvus corone cornix*	The Hooded Crow	24	18	24	17		25	14	15	9	12	6	10	S	terrestrial
29.	*Troglodytes troglodytes*	The Eurasian Wren			2							1			Summer Guest (SG)	
30.	*Sylvia communis*	The Whitethroat				2	2	3		2					Summer Guest (SG)	terrestrial
31.	*Phylloscopus collybita*	The Common Chiffchaff							8	12	15	23			Summer Guest (SG)	terrestrial
32.	*Oenanthe oenanthe*	The Northern Wheatear						8	7	10					Summer Guest (SG)	terrestrial
33.	*Saxicola rubetra*	The Whinchat						1			2				Summer Guest (SG)	terrestrial
34.	*Saxicola torquata*	The Common Stonechat									3	2			Summer Guest (SG)	terrestrial
35.	*Sturnus vulgaris*	The Common Starling	65	25			12		70		32	150	350	160	Partially migrating (PM)	terrestrial
36.	*Passer domesticus*	The House Sparrow	45	36				16	25	21	38	24	25	34	S	terrestrial
37.	*Passer montanus*	The Eurasian Tree Sparrow	26	17				14	28	34	17	31	14	23	S	terrestrial
38.	*Fringilla coelebs*	The Chaffinch	9	14	15	10	10						12	8	Partially migrating (PM)	terrestrial
39.	*Carduelis spinus*	The Eurasian Siskin	5	4									7	8	Partially migrating (PM), Winter Guest (WG)	terrestrial

40.	*Carduelis carduelis*	The European Goldfinch	7	6						7		14	16	9	S	terrestrial
41.	*Carduelis cannabina*	The Linnet	10	8					5		4	13	6	5	Partially migrating (PM)	terrestrial
42.	*Emberiza citrinella*	The Yellowhammer	12	15			8	5	6				7	6	S	terrestrial
43.	*Miliaria calandra*	The Corn Bunting					6	5	4						Partially migrating (PM)	terrestrial

Abbreviations: SG – Summer guest; PM – partially migrating; S - sedentary; WG – winter guest; P – passing by

Table no. 7 summarizes the results regarding the risk of collision with the farms turbines of birds that frequently use the air space of the wind farms over the year.

Bird species	Length of the bird (cm)	Wingspan (cm)	d+l (m)	Vr	No. of birds observed in the farms area	No. of days/year	no. of birds in Vw –N (occupation degree)	Vr/Vw	NxVr/Vw	v (flying speed - m/s	t=(d+l)/v	no. Birds between the rotors	Collision likelihood	no. of birds with risk of collision without any avoidance activities	Avoidance rate	Real risk no. of birds/year
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Buteo buteo	46	112	4.86	1422227.27	11	45	1980	0.000475	0.94	17.00	0.29	3.29	0.08	0.27	0.98	0.01

Merops apiaster	28	40	4.68	1369552.18	41	25	4100	0.000457	1.87	17	0.275	6.81	0.09	0.61	0.98	**0.012**
Coracias garrulus	30	57	4.7	1375404.97	16	15	960	0.000459	0.44	12.00	0.39	1.12	0.09	0.10	0.95	**0.01**
Falco tinnunculus	30	68	4.7	1375404.97	14	45	2520	0.0005	1.16	17.00	0.28	4.18	0.07	0.29	0.98	**0.01**
Pica pica	45	55	4.85	1419300.88	86	61	20984	0.000474	9.94	9.00	0.54	18.44	0.10	1.84	0.95	**0.09**
Corvus Monedula	33	68	4.73	1384184.15	85	20	6800	0.00	3.14	9.00	0.53	5.98	0.10	0.60	0.95	**0.03**
Corvus fragilegus	46	85	4.86	1422227.27	1600	56	358400	0.000475	170.10	12.00	0.41	419.99	0.10	42.00	0.98	**0.84**
Corvus corone cornix	46	90	4.86	1422227.27	174	56	38976	0.000475	18.50	12.00	0.41	45.67	0.10	4.57	0.98	**0.09**
Larus ridibundus	38	91	4.78	1398816.12	175	35	24500	0.00	11.44	12.00	0.40	28.71	0.10	2.78	0.98	**0.06**
Larus argentatus	57	135	4.97	1454417.6	158	35	22120	0.00049	10.74	12.00	0.41	25.92	0.11	2.85	0.98	**0.06**
Alauda arvensis	18	33	4.58	1340288.25	125	40	20000	0.00045	8.95	17.00	0.27	33.20	0.11	3.55	0.98	**0.07**
Hirundo rustica	19	33	4.59	1343214.64	110	30	13200	0.00045	5.92	17.00	0.27	21.91	0.06	1.40	0.98	**0.03**
Sturnus vulgaris	21	36	4.61	1349067.43	864	54	186624	0.00045	84.02	17.00	0.27	309.82	0.07	20.14	0.98	**0.40**

Observations:

- Column 4: d- represents the depth of the turbine rotor, 4.4m (it is highlighted in table no. 2). Column 4 represents the sum between this depth of the turbine rotor and the length of the birds (see column 2);

- Column 6: represents the number of birds of each species observed in the wind farms area, as a result of the monitoring.

- Column 7: represents an estimation of the number of days within a year when the bird species identified after the survey are considered to fly in the farms area. The number of days is estimated according to the number of months when the species was identified in the farm area, according to the data indicated in table no. 6, considering that birds spent on average 4 hours/day in the wind farms area.

- Column 8= col.6 x col.7

- Column 12: represents the time necessary for a bird to fly over the entire distance representing the depth of the rotor

- Column 14: the likelihood was calculated according to the SNH methodology

3. RESULT INTERPRETATION AND CONCLUSIONS

Obviously a risk of collision of birds with the wind turbines exists only when a bird is flying within the rotor sweep area or when it can be affected by the turbulences caused by the rotors.

The behavior during the flight, including the height at which birds fly, varies considerably between species.

Many birds sometimes barely reach the action area of the rotor, while others perform routine flights in these areas and others fly at heights much higher than this area.

There are also various types of flights such as hovering, flying in circles in the air, flying horizontally and vertically, which is characteristic for certain species of birds or certain activities, that may pose different risks of collision. The variation of the visibility conditions during the day or night, or due to weather conditions, is also likely to influence the risk of bird collision with the turbines.

For example, although few data are available, it seems that most collisions that occur are the result of the fact that birds do not notice wind turbines due to poor visibility conditions, rather than of the fact that they cannot avoid a turbine visible.

As far as the analyzed farms are concerned, as shown in tables no. 4 and no. 7, one can notice that all values that emphasize the real risk of collision of birds with the wind turbines (column 11 of Table no. 4 and column 17 of Table no. 7) are subunits, which emphasizes that over a year it is very unlikely that mortality occurs in the populations of birds that cross the wind farms area due to collision with the wind turbines.