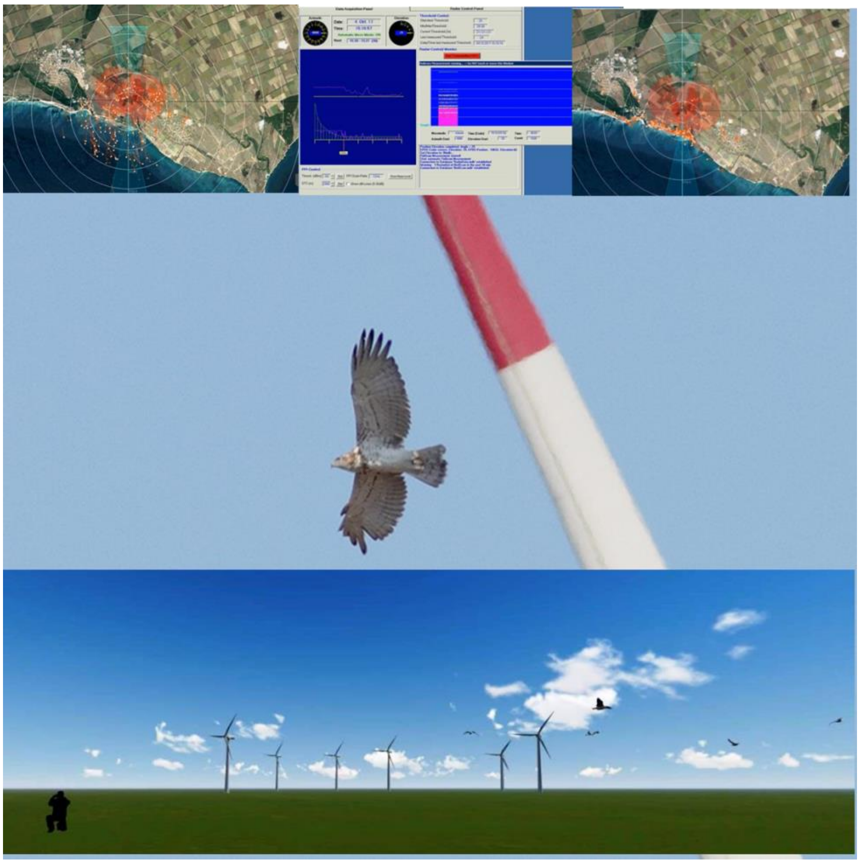
INTEGRATED SYSTEM FOR PROTECTION OF BIRDS

REPORT

Monitoring of the migration of birds through the territory of the Integrated System for Protection of Birds Autumn 2018



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November 2018

Contents

1. Introduction

The present study was commissioned by AES Geo Energy Ltd., Kaliakra Wind Power, EVN Kavarna, Degrets OOD, Disib OOD, Windex OOD, Long Man Invest OOD, Long Man Energy OOD, Zevs Bonus OOD, Vertikal-Petkov & Sie SD, Wind Park Kavarna East EOOD, Wind Park Kavarna West EOOD, and Millennium Group OOD in order to collect and summarize the information about the performance of the Integrated System for Protection of Birds (ISPB) that includes 114 wind turbines, 95 of which are within the Kaliakra SPA BG0002051 and 19 are in the areas adjacent to the protected zone.

The ISPB consists of a combination of radar observations and meteorological data, integrated with field visual observations, which jointly used are essential for the accurate risk assessment and ensure that appropriate action is taken immediately to avoid collision risk. So far as potential adverse impacts of turbine collisions on birds, a Turbine Shutdown System is deployed supported by an Early Warning System.

The monitoring studies are based on the requirements of basic normative and methodological documents as follows: Environmental Protection Act, Biological Diversity Act, Bulgarian Red Data Book, Directive 92/43/EEC for habitats and species, and Directive 2009/147/EC on the conservation of wild birds, Protected Areas Act and Order RD-94 of 15.02.2018 of the Minister of Environment and Waters. Best international practices are also incorporated (T-PVS/Inf (2013) 15: https://rm.coe.int/1680746245). Detailed information on the scope, technical rules and monitoring procedures are publicly available at a dedicated website https://kaliakrabirdmonitoring.eu/.

Figure 1 presents the locations of all 114 wind turbines within the study area covered by the ISPB.

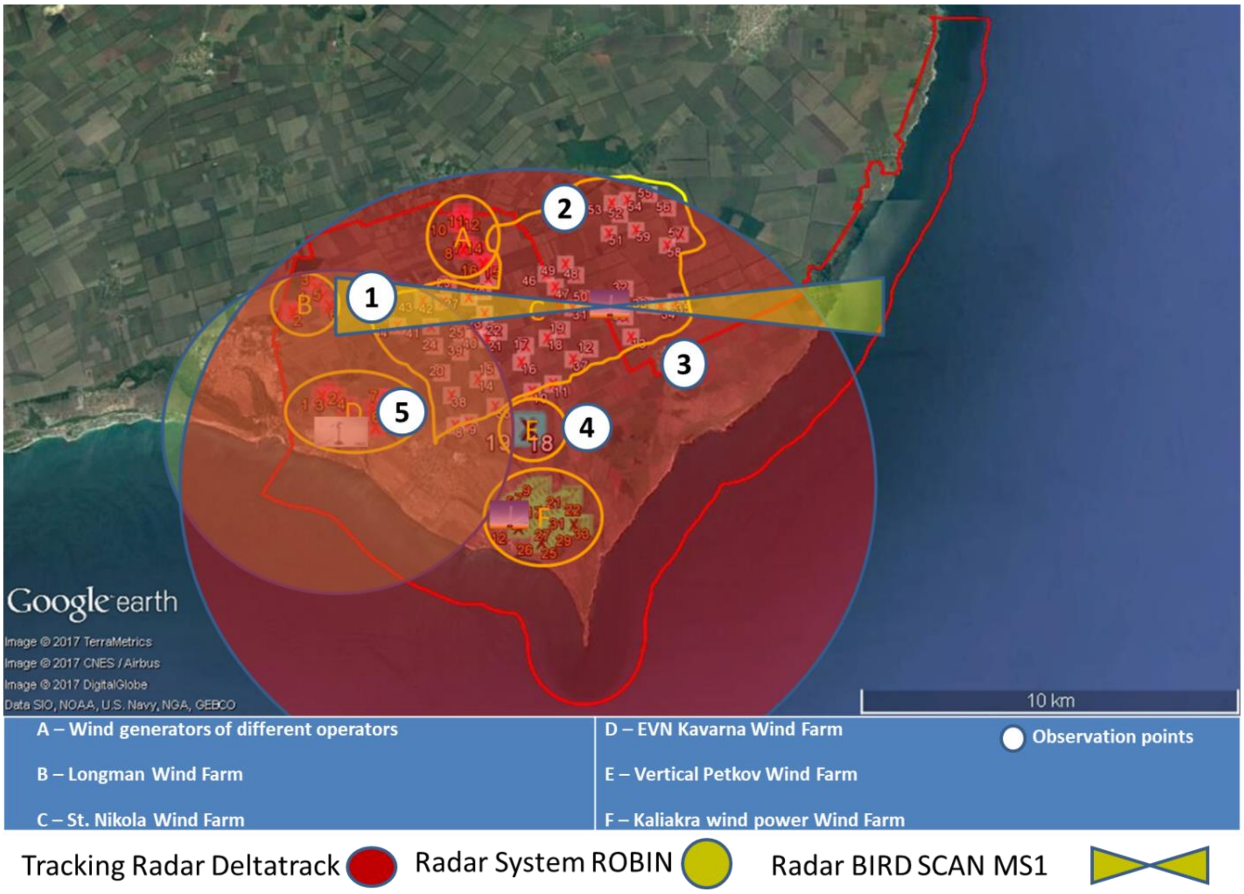

Figure 1. A satellite photo with the location of the wind turbines covered by the ISPB and the boundaries of Kaliakra SPA (shown by the red line), together with the scope of three radar systems.

The recent surveys of bird migration in Bulgaria show that SPA Kaliakra is in the region of the country to the east of a defined migratory route -Via Pontica (Michev et al., 2012 http://acta-zoologica-bulgarica.eu/downloads/acta-zoologica-bulgarica/2012/64-1-033-041.pdf) (Figure 2).

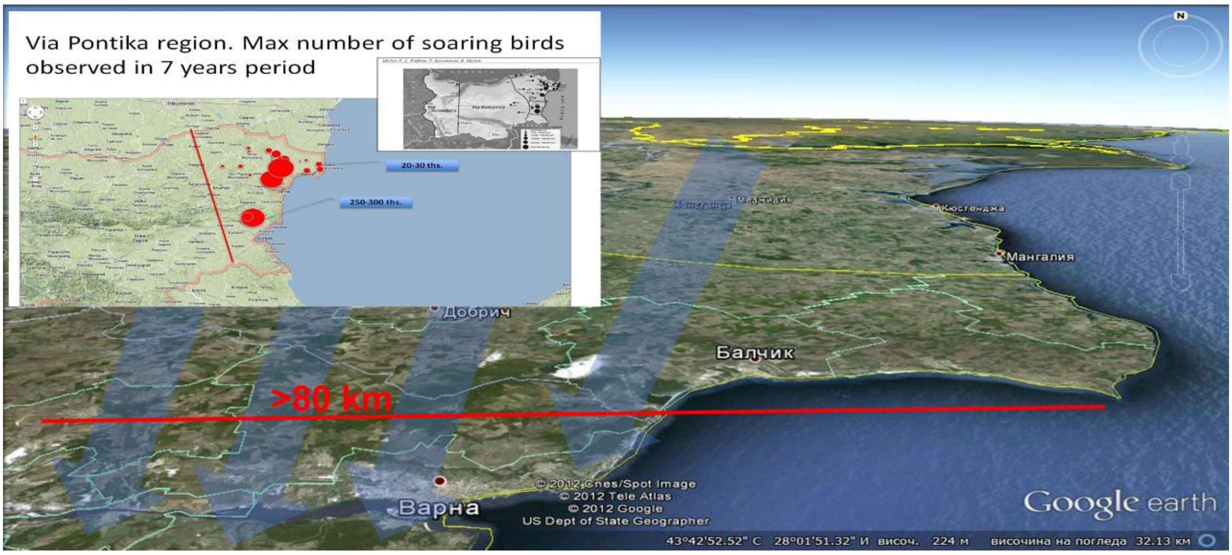

Figure 2. Schematic location of the main migratory flows in the North-East of Bulgaria, known as Via Pontica.

Over the past eight years, a series of studies have been carried out to study migratory, wintering and breeding birds in this area and specifically on the impact of a wind farm on birds: http://www.aesgeoenergy.com/site/Studies.html. These intensive surveys over several years have confirmed further that the study area on the Kailakra Cape is, indeed, away from the main migratory Via Pontica migration corridor. To date, moreover, these surveys found no evidence of significant impacts due to wind turbines on the populations of recorded species.

Under an agreement to establish and operate the ISPB, the ornithofauna was monitored during autumn migration in 2018 on the above-mentioned territory.

This report covers the period of the autumn migration season (01.08 - 31.10.2018). The collected information was used to assess the effectiveness of the application of ISPB in Kaliakra in the autumn of 2018.

Taking into account the geographical location of the site and previous research (Monitoring reports of the Saint Nikola Wind Farm, http://www.aesgeoenergy.com/site/Studies.html), as well as a report published by the MoEW on Nature of the Migration of 42 Birds from the Bulgarian fauna according to the level of modern knowledge http://natura2000.moew.government.bg/PublicDownloads/Auto/OtherDoc/276296/276296_Birds_120.pdf of migration, we consider the period covered in our study as optimal and representative for autumn bird migration of all target for ISPB species.

The study is specifically focused on target species for ISPB which are diurnal migrants. The data for all bird species flying over the territory, deemed as vulnerable to direct collision with wind facilities is presented in the report. Maps showing birds and flocks tracked by radar and visual observers are presented in the report.

2. OBJECTIVES AND TASKS OF THE STUDY

The main objective of this monitoring study is to determine the quantitative characteristics of migratory birds in the area of ISPB during autumn migration, to assess the effectiveness of the TSS applied here, in order to reduce the risk for birds, and to evaluate impact of the wind farms on birds during autumn migration.

During the monitoring, the following characteristics of the bird migration were identified:

1. Migration periods, species composition, changes in the number of birds during the season, daily activity, flight heights, as well as feeding, resting and roosting places of migrant birds passing through the area and observation points.

2. The significance of the territory for feeding birds of prey.

3. Proportion of migrating birds in respect to the western Black Sea migratory flyway - Via Pontica.

The data presented in this report are focused on potentially sensitive soaring birds of the orders Ciconiiformes, Pelecaniformes, Falconiformes, and Gruiformes. This category includes bird species primarily using upward airflows (thermals) for long-range movement during migration.

3. ORNITHOLOGISTS WHO CARRIED OUT THE SURVEY

- **Prof. Dr Pavel Zehtindjiev – Senior field ornithologist**

More than 25 years of research experience in ornithology. Author of more than 85 scientific publications in international journals with an impact on the scientific field of bird biology, ecology and ecosystem conservation. Member of the European Ornithological Union and many nature conservation organizations. Winner of the Revolutionary Discovery Award for the Ornithology of the American Ornithological Society for 2016 - The Cooper Ornithological Society.

10 years of experience in impact monitoring study of wind turbines in the study area.

- **Dr Viktor Vasilev – Field ornithologist**

Senior researcher in the Faculty of Biology, University of Shumen.
Member of BSPB and participant in number of conservation projects in Bulgaria.
Author of over 20 scientific publications in international journals. Member of BSPB.

- **Veselina Raikova - Field ornithologist**

Natural History Museum of Varna. Member of BSPB. Author of more than 10 publications in international scientific journals. 10 years of experience in impact monitoring study of wind turbines in the study area.

- **Ivaylo Raykov - Field ornithologist**

Natural History Museum of Varna. Member of BSPB. Author of over 20 scientific publications in international journals.
Five years of experience in impact monitoring in the region of Kaliakra.

- **Kiril Bedev - Field ornithologist**

Researcher in Institute of Biodiversity and Ecosystem Research at the Bulgarian Academy of Sciences.

Active member of conservation organization Green Balkans. Long term study on migrating birds and biodiversity of Burgas lakes. Author of three articles in Bulgarian Red Data Book. Expertise in biotechnology, conservation biology and environmental monitoring. Over seven years of experience in impact monitoring of wind parks in Bulgaria. Member of Balkani NGO for conservation of birds and nature.

- **Janko Jankov - Field ornithologist**

Student in Biology, University of Shumen. Over seven years of experience in impact monitoring of birds in Wind Park projects in NE Bulgaria. Member of BSPB.

- **Nikolay Velichkov - Field ornithologist**

Field studies of the distribution and number of breeding bird species ENVEKO, Inspection of use of pesticides and pedigrees in the framework of the project "Urgent measures for the protection of the Egyptian Vulture (*Neophron percnopterus*) BSPB”.
Monitoring the migration of birds species composition and the number of nesting fauna 2007-2012 "Ecotan" EOOD. 10 years of experience in impact monitoring study of wind turbines in the study area

- **Rusi Todorov Ivanov - Field ornithologist**

Bulgarian Swiss Program for Biodiversity Conservation - Bourgas Wetlands Project 1998 - 2004 mid-winter census of water birds 1998 - 2005 - BSPB. Monitoring of the ornithofauna of Burgas wetlands - monthly 1998 - 2005 2011 ECOTAN -Monitoring during the breeding season of the Imperial Eagle (*A. heliaca*) - Sladun village. 2011 Monitoring of the flying birds during the autumn migration of the reserve At. lake. ECOTAN. Study of the spatial migration of *L. michahellis* by marking with colored rings. - GICB 2010 - 2018 2011 -2013d Mapping and Determination of the Conservation Status of Natural Habitats and Species - Phase 1, Lot 7 - Determination and Minimization of Risks for Wild Birds. Union Econet - MOEW

- **Jelyazko Dimitrov Dimitrov - Field ornitologist**

Member of BSPB from 31.12.2006 to 31.12.2010. Trained to monitor the severity of collisions of birds with wind turbines.

- **Dimitar Jelyazkov Dimitrov - Field ornitologist**

Student in Biology at Sofia University Kliment Ohridski. Field activities - participation in a number of field studies - monitoring of some important zones on the territory of Bulgaria. (Durankulak lake and the Shabla lake complex (2010 - 2013)) and the Soil Field (2014-2017), regular winter monitoring of waterfowl in Shabla and Durankulak Lake in connection with the

Life + project (2011 - 2017), monitoring of *Spermophilus cittelus* in the reintroduced colony near Kotel (2017), census of cetacean mammals on the northern Black Sea coast with ECO-Nord association., voluntary eye initiatives on reintroduction of the griffon vulture in the Kresna Gorge.

- **Boyan Michev - Field ornitologist**

PhD student at the Institute of Biodiversity and Ecosystem Research - BAS. He works in Risk Assessment and Conservation Biology department. Expert in the use of radars to study bird migration. Member of the European Migration Tracking Network through meteorological radars.

4. MATERIAL AND METHODS

The methodology for ornithological monitoring has been developed in accordance with the methodological guidelines adopted by the National Council on Biological Diversity at the MOEW with Protocol No. 11 of 8 June 2010 and the Order of the Minister of Environment and Water of 15.02.2018 https://www.moew.government.bg/static/media/ups/tiny/filebase/Nature/Biodiversity/Preporyki%20Rykowodstwa%20Dokladi/Metodika_VEP.pdf) for the implementation of TSS in the Protected territories of Natura 2000 network of Bulgaria. Field observation protocols followed Bibby et al. (1992) and Michev et al. (2010 and 2011) and were used to study the spring migration of birds in the territory covered by ISPB in 2018.

In addition, three radar systems were used in conjunction with real time observations by each of the field ornithologists. The range of the radar systems is presented in Figure 1.

The assessment of the effectiveness of the TSS utilizes the methodology developed in the USA (Morrison 1998) for monitoring bird collision with the turbines (and see methods described in http://www.aesgeoenergy.com/site/Studies.html).

All details about the application of the radar systems in the ISPB, ornithological methods, protocol for visual observations, specific protocol for visual observations, bird data and physical characteristics of the recorded environment are given already in a previous report dedicated to spring migration 2018, available at the website of ISPB (https://kaliakrabirdmonitoring.eu/).

5. RESULTS

5.1. Direction of migrating birds

During the autumn monitoring, observations were made during all 92 days of the season. There were a total of 16973 birds of 53 species.

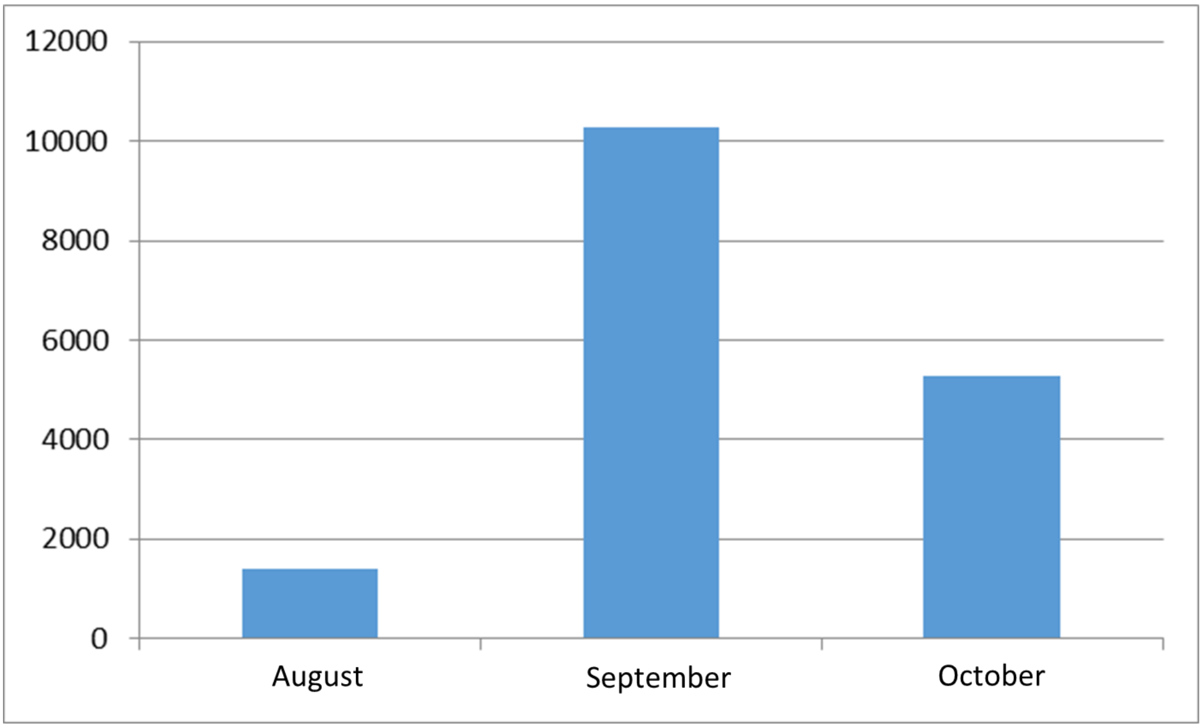

Figure 3. Number of registered birds by months during the autumn migration in the territory of ISPB.

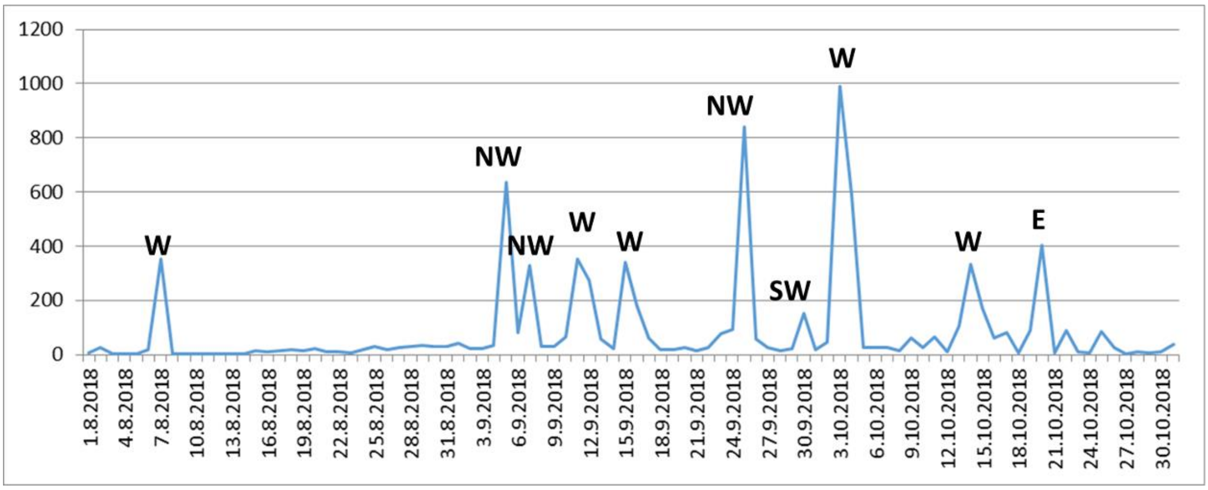

Figure 4. Dynamics of the autumn migration of the flying bird species in the ISPB territory according to visual observations during the period 01 August - 31 October 2018. Letters indicate the direction of wind in days with increased number of migrating birds.

The number of birds in the ISPB study area apparently depended on the direction of the wind in autumn 2018. Of the 10 peak days with intense migratory flights of birds: in nine, westerly winds prevailed, and in only one day with a relatively high number of registered migrants, the wind direction was eastern (Figure 4).

An important parameter for determining the presence of a barrier effect is the degree of circumvention of the territory with operating wind turbines. The recorded flight directions in autumn are presented in Figure 5.

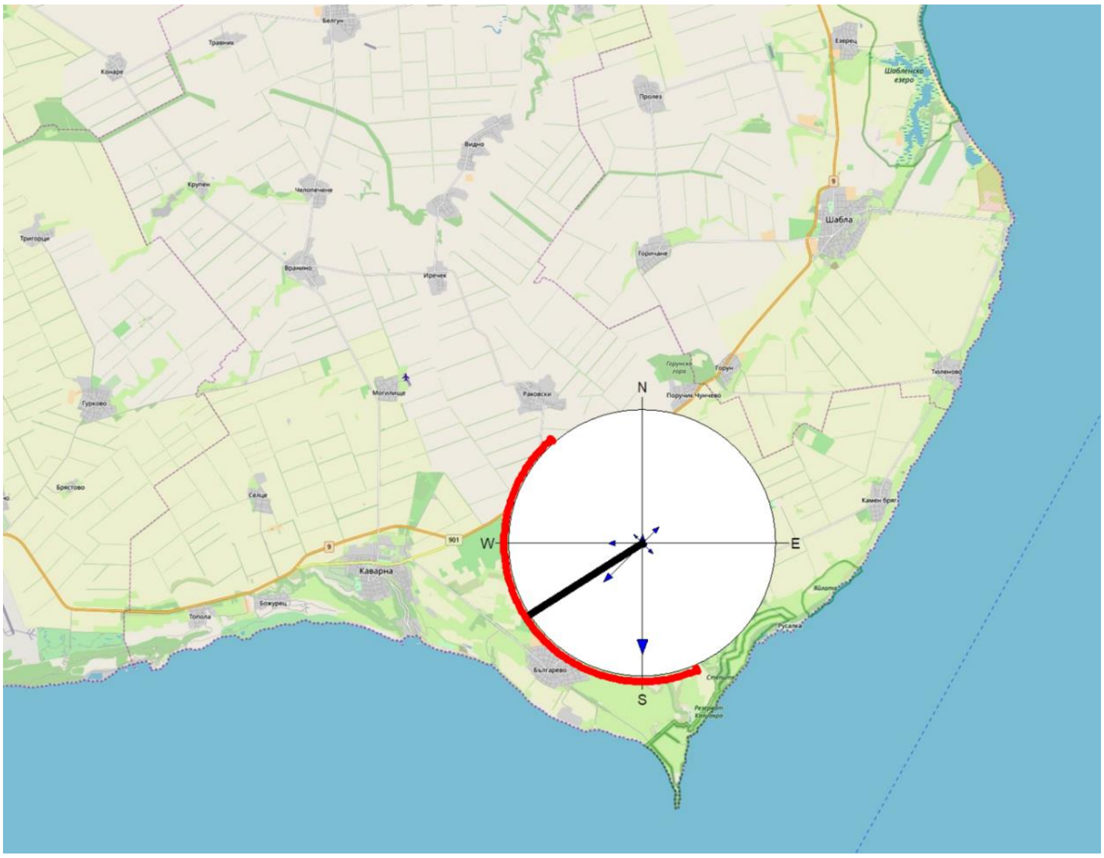

Figure 5. ***Directionality of observed birds (blue arrows), the resultant mean vector of migration (black bar) and standard deviation of the mean vector of migration (red) for all observed flight directions recorded during autumn migration 2018 in ISPB territory.***

The majority of flight directions of the birds during the autumn migration were to the south to southwest, accounting for over 70 % of observed birds. This result corresponds with the guiding line of the Black Sea coast and the specific location of the Kaliakra Cape (Figure 5). All observed directions do not implicate a barrier effect of the operational wind parks located in the same territory. A barrier effect from the wind farms should result in higher deflection of observed directions and higher prevalence of reverse directions, particularly towards the west and north, during autumn migration which was not observed (Figure 5), and has not been observed for several previous years at SNWF (http://www.aesgeoenergy.com/site/Studies.html). This is despite the Kaliakra Cape (and hence the ISPB study area) being effectively a cul-de-sac for the progression of southward migration of many autumn migrants, as evidenced by the considerable data showing this broadly southward route occurs far to the west, away from the Cape and ISPB wind farms, principally involving the Via Pontica as part of a wider flyway (Figure 2).

5.2. Species composition and number of birds

Observations during the monitoring from 1 August to 31 October 2018 recorded 16973 individual birds which were assigned to 53 bird species. The recorded number of individuals according to species during autumn migration is shown in Table 1.

Table 1. Composition of species and number of registered birds over the period 01 August to 31 October 2018 in the ISPB territory.

Species name	*Number*
A. brevipes	*309*
A. gentilis	*1*
A. nisus	*242*
A. cinerea	*21*
A. purpurea	*2*
A. pennata	*30*
A. pomarina	*232*
B. buteo	*2642*
B. rufinus	*58*
B. lagopus	*3*
C. aeruginosus	*442*
C. cyaneus	*37*
C. pygargus	*88*
C. macrourus	*8*
C. gallicus	*94*
C. ciconia	*451*
C. nigra	*54*
C. garrulus	*1*
C. corax	*15*
C. cornix	*6*
C. monedula	*35*
C. frugilegus	*14*
C. oenas	*44*
C. palumbus	*1200*
F. vespertinus	*472*
F. subbuteo	*48*
F. peregrinus	*4*

Species name	*Number*
F. tinnunculus	*272*
F. cherrug	*2*
F. columbarius	*2*
F. eleonorae	*3*
M. migrans	*71*
M. milvus	*2*
M. alba	*414*
M. apiaster	*2963*
M. calandra	*1430*
G. grus	*100*
G. virgo	*13*
L. michahellis	*234*
L. fuscus	*1*
H. albicilla	*1*
H. rustica	*1000*
P. carbo	*576*
P. onocrotalus	*2021*
P. apivorus	*801*
P. haliaetus	*17*
P. leucorodia	*5*
P. roseus	*1*
P. perdix	*10*
R. riparia	*76*
St. vulgaris	*400*
V. vanellus	*4*
E. garzetta	*1*

The most numerous migrating birds in the autumn of 2018 in the region were common buzzards (*Buteo buteo*) and white pelicans (*Pelecanus onocrotalus*) with over 2,000 individuals of each species (Table 1). Bee-eaters (*Merops apiaster*) were also numerous with over 2,900 individuals registered during the autumn migration period. Third, with around 1,000 individuals per species were barn swallow (*Hirundo rustica*), calandra lark (*Melanocorypha calandra*), and wood pigeon (*Columba palumbus*), flocks of which were recorded feeding in the ISPB during the autumn migration in 2018.

In autumn 2018, over 451 white storks (*Ciconia ciconia*) and 54 black storks (*C. nigra*) passed over ISPB territory. The European nesting population of the white stork is estimated to be between 180,000 and 220,000 pairs, with about 80% of the species migrating along the western Black Sea flyway (Via Pontica), covering a region of northeastern Bulgaria. Our results confirm that white storks flying over the Kaliakra area have a negligible number (0.02% of the Via Pontica population) and the area remains east of the main migratory route of white storks along the western Black Sea migration flyway. The remaining registered bird species were also observed in low numbers. The proportions of the most numerous birds of prey species using the ISPB area recorded during autumn migration are shown in Figure 6.

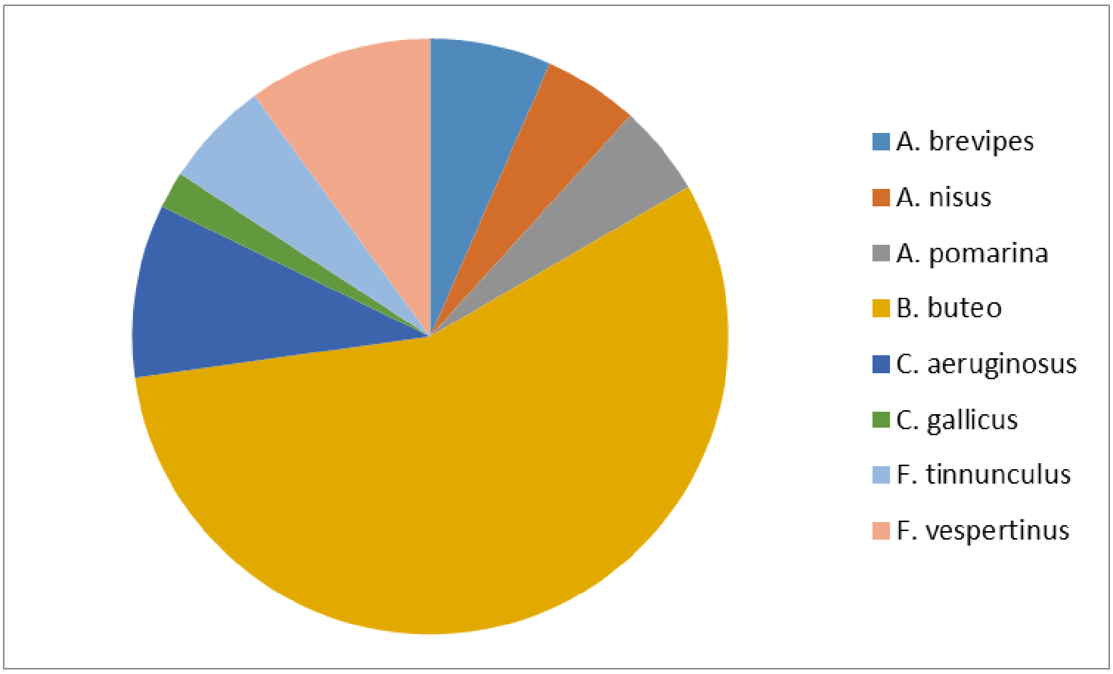

Figure 6. ***Proportional representations of the eight most numerous birds of prey recorded during autumn migration 2018.***

5.3. Frequency of appearance

During the autumn migration of 2018, the common buzzard, honey buzzard (*Pernis apivorus*), red-footed falcon (*Falco vespertinus*) and marsh harrier (*Circus aeruginosus*) were recorded with the highest frequency for birds of prey in ISPB territory. The sparrowhawk (*Accipiter nisus*) and the common kestrel (*Falco tinnunculus*) were the next most frequently registered birds of prey in the area. All other bird of prey species appeared episodically in the ISPB area in autumn 2018.

The white pelican, the species with the highest recorded number, of over 2,000 individuals, was observed in a short period during the monitoring season.

The appearance of the observed species in different parts of the ISPB study area does not obviously indicate avoidance of the locations with operating wind turbines. This supposition is reached by virtue of the observed frequency of appearance of every species by observation points, indicated in location by Figure 1, on data presented in Table 2.

Table 2. Number of days with appearance of the most numerous soaring bird species across every observation point during the period of autumn monitoring in ISPB territory in autumn 2018.

Opservation point	OP1	OP2	OP3	OP4	OP5
Species					
A. brevipes	11		10	13	16
A. nisus	34		36	95	28
A. pomarina	18		9	21	17
B. buteo	80	4	75	78	80
B. lagopus			1	1	1
B. rufinus	15	1	15	9	10
C. aeruginosus	83	4	70	99	116
C. ciconia	1	4	10	2	3
C. cyaneus	15		1	9	8
C. gallicus	10	3	17	16	24
C. garrulus	1				
C. macrourus	3		1	2	2
C. nigra	5		3	5	3
F. columbarius				1	1
F. eleonore				2	1
F. subbuteo	13		21	4	6
F. tinnunculus	44	5	45	51	29
F. vespertinus	44		18	54	21
P. apivorus	15		27	17	17
P. onocrotalus	7		12	9	2

The diurnal activity of birds recorded in autumn 2018 in the ISPB is shown in Figure 7.

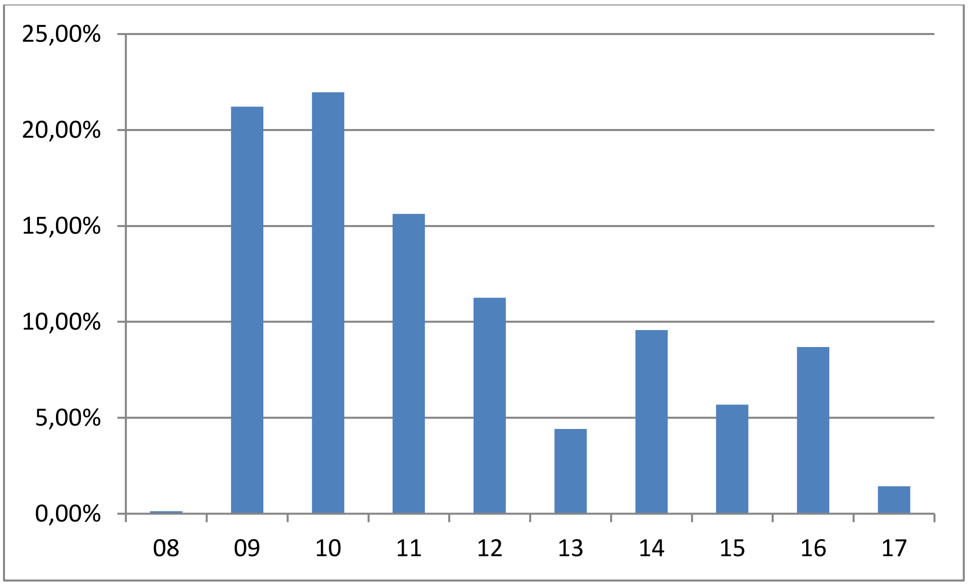

Figure 7. The dynamics of the presence of birds by hour of the day in the ISPB territory in the autumn of 2018.

5.4. Altitude of birds

Over 50 % of birds flew across the ISPB territory with operating wind farms at an altitude of less than 200 m above ground level which does not indicate substantial disturbance of the birds in flight height. Aside from deflection of flight directions (covered earlier), any other potential barrier (or macro-displacement) effect would result in significant increase of the flight altitudes which would provide for expected flights over the zone of rotating turbines i.e. over 200 m above the ground. Observed flight altitudes did not indicate such an increase of flight altitude of migrating birds over the rotors of the turbines in ISPB territory. The distribution of all migratory birds in flight altitude (above ground level) is shown in Figure 8 and by species, on range of records, in Table 3.

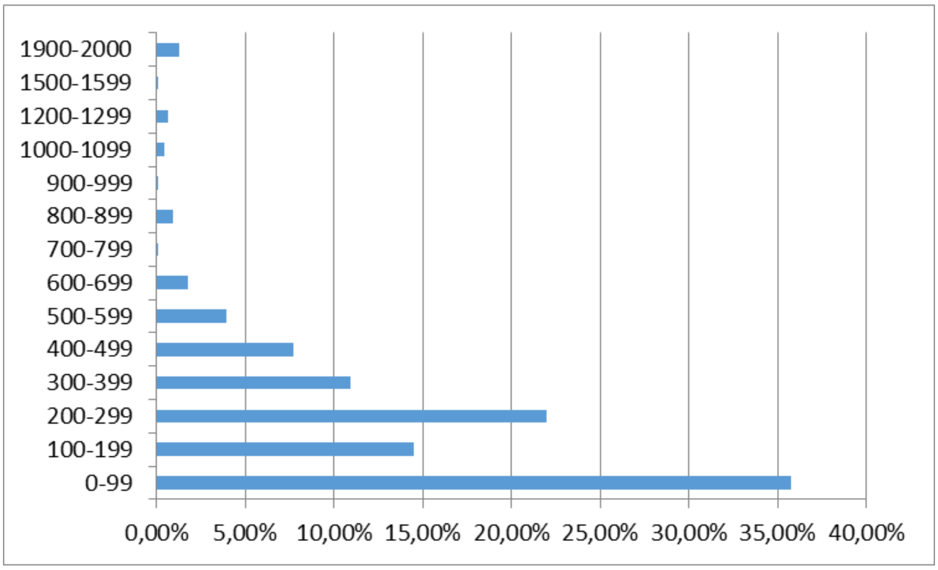

Figure 8. Distribution of migratory birds passing through the ISPB territory by altitude (above ground level).

Table 3. The altitudinal range in which each bird species was registered during the autumn migration monitoring 01 August - 31 October 2018 in the ISPB area.

species	min. altitude	max. altitude
A. brevipes	1	2000
A. cinerea	150	500
A. gentilis	150	150
A. nisus	1	1000
A. pennata	20	400
A. pomarina	90	1200
A. purpurea	100	100
B. buteo	1	1000
B. lagopus	50	200
B. rufinus	1	800
C. aeruginosus	1	1000
C. ciconia	3	800
C. corax	10	200
C. cornix	15	50
C. cyaneus	1	600
C. frugilegus	80	200
C. gallicus	3	600
C. macrourus	1	300
C. monedula	40	50
C. nigra	150	500
C. oenas	100	100
C. palumbus	200	250
C. pygargus	1	800
F. cherrug	10	200

species	min. altitude	max. altitude
F. columbarius	*1*	*5*
F. eleonorae	*50*	*100*
F. peregrinus	*150*	*300*
F. subbuteo	*1*	*600*
F. tinnunculus	*1*	*1000*
F. vespertinus	*1*	*800*
G. grus	*100*	*500*
H. albicilla	*400*	*400*
H. rustica	*10*	*100*
L. fuscus	*150*	*150*
L. michahellis	*50*	*150*
M. alba	*3*	*20*
M. apiaster	*10*	*600*
M. calandra	*2*	*50*

species	min. altitude	max. altitude
M. migrans	*10*	*800*
M. milvus	*150*	*150*
P. apivorus	*50*	*1500*
P. carbo	*20*	*800*
P. haliaetus	*50*	*500*
P. leucorodia	*300*	*300*
P. onocrotalus	*10*	*600*
R. riparia	*50*	*150*
S. vulgaris	*10*	*50*
V. vanellus	*40*	*40*
E. garzetta	*400*	*400*
G. ciconia	*200*	*200*
G. virgo	*500*	*500*

5.5. Ordered and automatic wind turbine stops during the autumn 2018 migration period

As a result of the simultaneous observations of five constantly attended observation points with assistance from three radar systems (Figure 1) during the whole period of the autumn migration, a total of 10 stops of single turbines, groups of turbines or entire wind farms in the ISPB study area (Table 4). The stop orders given to the engineers on duty were executed in a timely manner, thus avoiding any collision risk of birds passing through the territory. Detailed information on the duration of these stops is given in Table 4.

Table 4. Data for ordered and automatic stops of wind turbines as a result of the application of EWS in and around Kaliakra SPA during the autumn migration of birds in 2018.

Date	Wind Farm	Turbine code №/ Group	Species	Number of birds	Time stop	Time restart
05.09.2018	*SNWF*	*D*	*P. apivorus*	*17*	*16:14*	*16:20*
05.09.2018	*KWP*	*all*	*P. onocrotalus*	*17*	*16:46*	*16:56*
06.09.2018	*KWP*	*all*	*P. onocrotalus*	*13*	*16:17*	*16:56*
10.09.2018	*SNWF*	*B*	*C. ciconia*	*7*	*9:31*	*9:41*
12.09.2018	*SNWF*	*C*	*P. onocrotalus*	*17*	*10:25*	*10:33*
12.09.2018	*SNWF*	*E*	*P. onocrotalus*	*13*	*10:33*	*10:44*
12.09.2018	*SNWF*	*B*	*P. haliaetus*	*2*	*13:30*	*13:41*
12.09.2018	*SNWF*	*D*	*P. haliaetus*	*2*	*13:33*	*13:41*
12.09.2018	*SNWF*	*C*	*P. haliaetus*	*2*	*13:36*	*13:41*
3.10.2018	*KWP*	*B*	*P. onocrotalus*	*550*	*09:19*	*09:36*

5.6 Ilustrative examples of recorded movements of target bird species in ISPB study area during the autumn 2018 migration period.

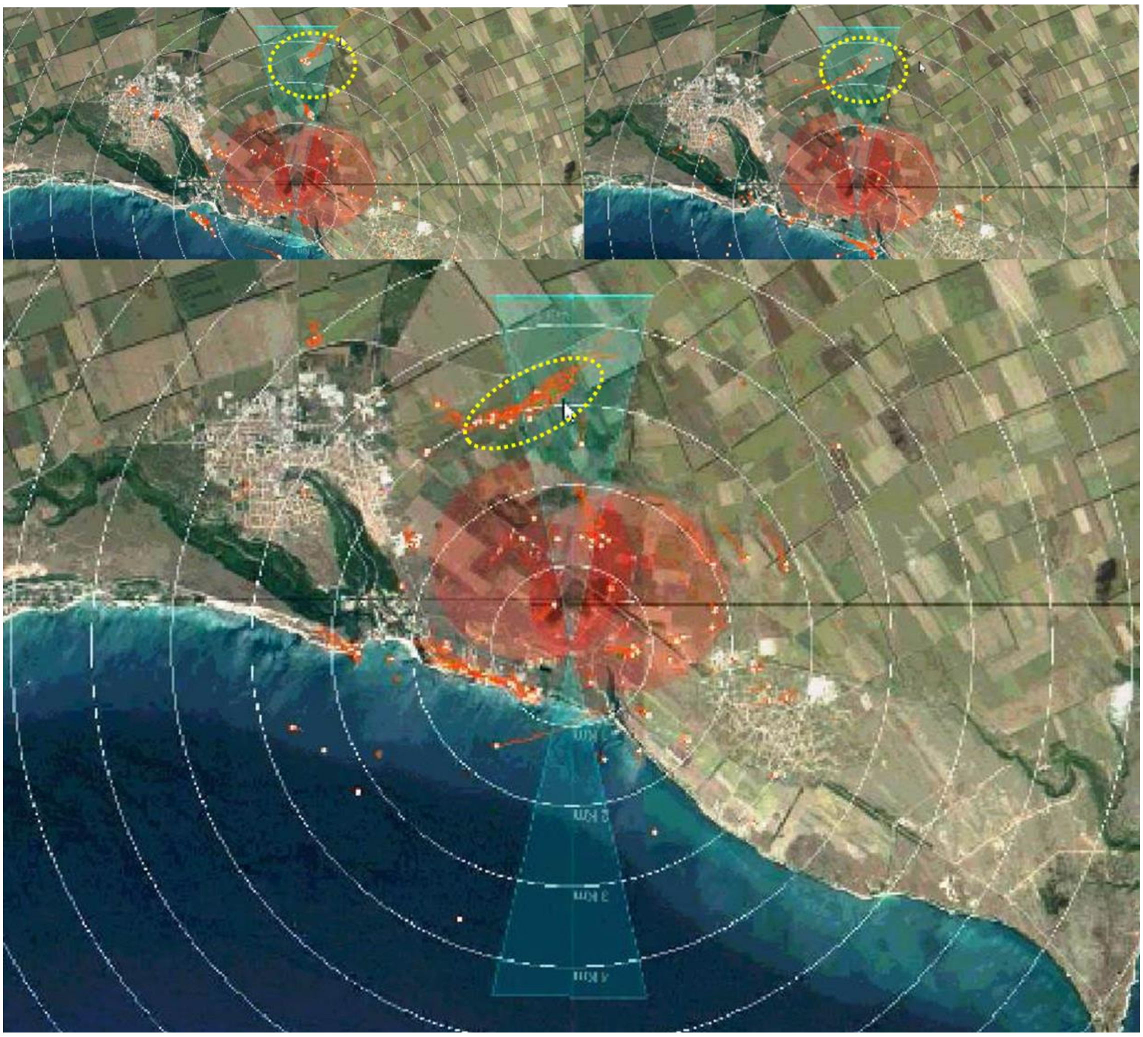

Figure 9. An example of a ROBIN radar screen tracked by 17 pink pelicans on 09 September 2018

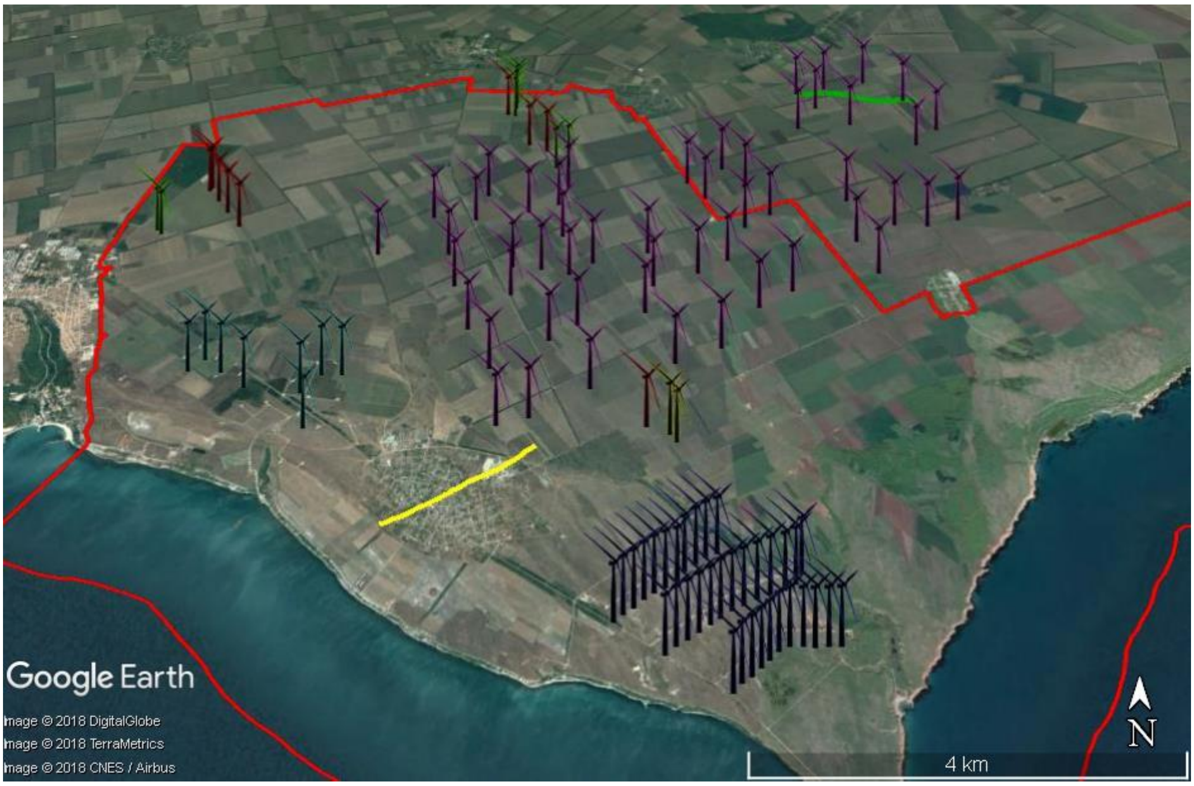

Figure 10. Registered in August 2018, flocks of birds in the ISPB territory: 25 white storks (yellow) and 13 Demoiselle cranes (green)

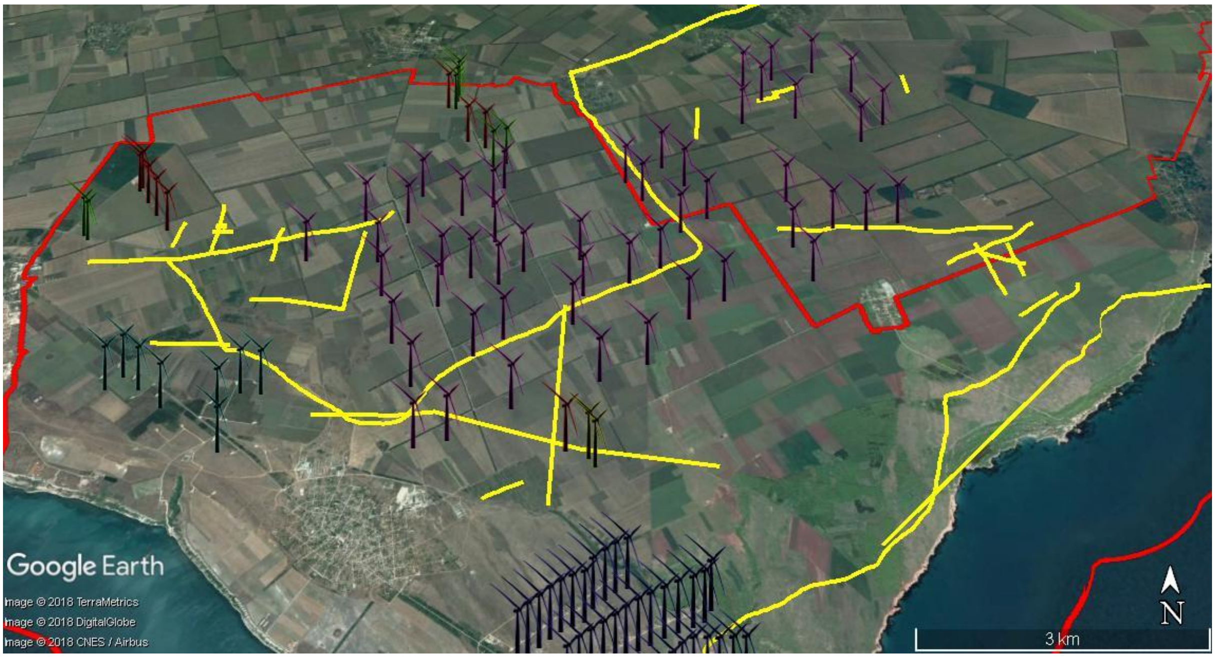

Figure 11. Registered in September 2018, flocks of birds in the territory of ISPB (detailed data about the number of birds and species in the flocks are already published in the weekly bulletins at the web site of ISPB https://kaliakrabirdmonitoring.eu)

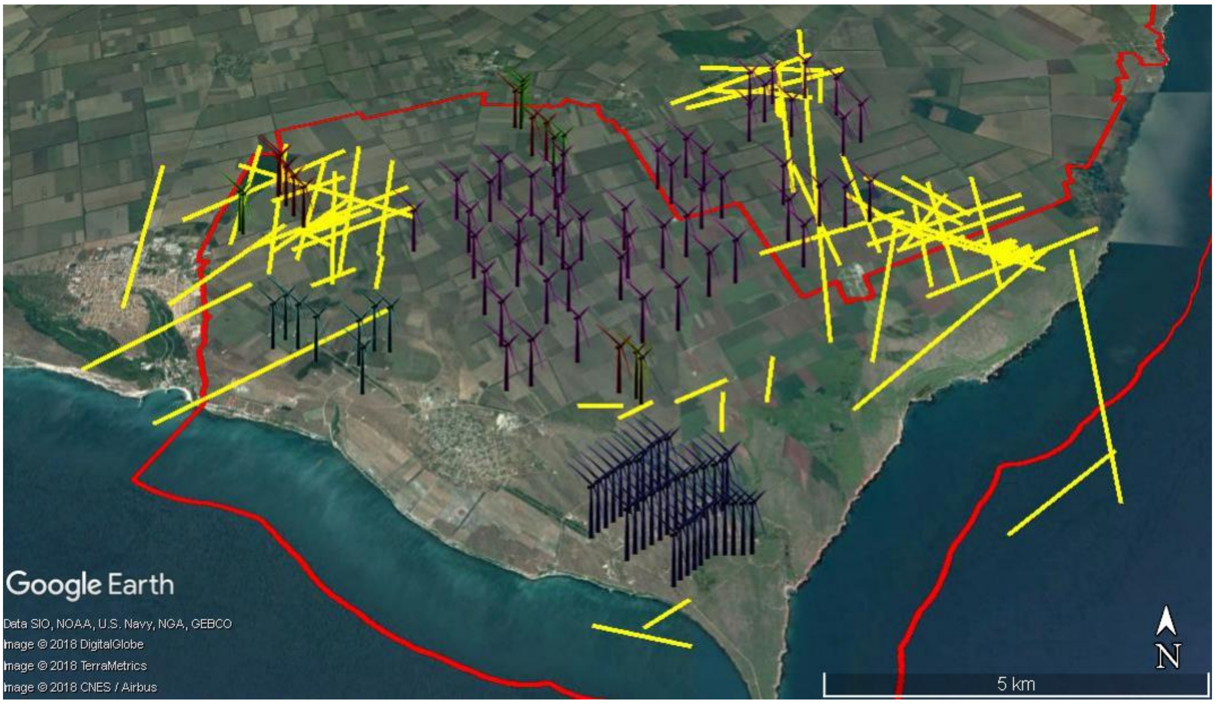

Figure 12. Registered in October 2018, flocks of birds in the ISPB territory (detailed data about the species and number of birds in the flocks are already published in weekly bulletins at the web site of the ISPB https://kaliakrabirdmonitoring.eu

5.7. Analysis of the recorded additive mortality caused by wind turbines on the bird populations passing through the ISPB territory.

In order to check the effectiveness of the ISPB to prevent collisions of migrating birds, the immediate environs of the 114 turbines covered by the ISPB programme was searched at least once a week for collision victims during the autumn 2018 migration monitoring period. It is well known that in the search for victims of collision with working wind turbines searchers do not detect all dead birds for several reasons. The main factors for this lack of detection are the effectiveness of the searcher (the searchers fail to find all the dead birds) and the removal / disappearance of the dead birds before they can be discovered by the searcher. Knowledge of these two potential biases can significantly improve the assessment of mortality due to collision in operating wind farms in conjunction with the protocol for searching of collision victims, including their frequency.

To describe such corrections and their potential influence on the raw data from searches under turbines, field experiments were undertaken in the ISPB territory in autumn 2018. These were the latest of several such exercises undertaken previously within SNWF (see: http://www.aesgeoenergy.com/site/Studies.html).

According to previously performed carcass removal and searcher efficiency tests during autumn migration and in winter at SNWF, a search regime of weekly searches provided for a cost-effective method, which can also be calibrated on the potential for missed carcasses, to discover any bird strike fatalities which may be of concern (by way of species deemed as targets: Introduction; and other materials referenced). Hence a frequency of four searches per month under every turbine allowed preliminary estimation of the mortality of the birds from any collision with the turbines in the wider study area later delineated by the ISPB. These previous studies can facilitate estimation of bird mortality from collision with the turbines in the Kaliakra SPA under all 114 wind turbines included in the ISPB. For details of these previous studies at SNWF which lies within the wider ISPB territory, see: http://www.aesgeoenergy.com/site/Studies.html

A further experiment was nevertheless conducted in the autumn of 2018 to check the basic search periodicity and the scale of potential biases, and to reference the comparable results obtained in previous research at SNWF. This experiment was initiated due to the expansion of the territory beyond the limits of SNWF where previous experimental trials had been conducted, and when the ISPB study area included a greater variety of habitats and a correspondingly larger number of scavengers removing carcasses of collision victims. The propensity for scavenging of carcasses can also change over time, regardless of any habitat or locational differences; or any differences in searcher detectability due to habitat under turbines.

On October 12, 2018, under five turbines: AE29, AE41, E00, M2, M35, 26 fresh chicken carcasses were placed randomly without knowledge of the four searchers. All carcasses were reviewed by a veterinarian prior to placement who confirmed that they were not carriers of diseases (as required under legislation). The five turbines were selected at random and subsequently were placed in different habitats in the ISPB territory.

Experiment on searcher efficiency: autumn 2018

All four ornithologists searching for dead birds in ISPB participated in the experiments for efficiency of searches. Searchers had no information about the exact location of the carcasses or the number of carcasses placed around every turbine, but were notified that they were being tested prior to the searches and that the surroundings of the five turbines constituted the test area.

Search protocols under the experimental provisions were the same as those used for basic and routine searches around turbines for collision casualties; so that transects of 20 m intervals were traversed over an area of 200 x 200 m around each turbine during each search.

The results of searcher efficiency from searches the day after carcass placements are presented in Table 5.

Table 5. Summary of searchers' efficiency

Turbine	*Number of chickens*	*Searcher 1*	*Searcher 2*	*Searcher 3*	*Searcher 4*
AE29	*5*	*3*	*3*	*0*	*1*
AE41	*6*	*4*	*3*	*3*	*2*
E00	*6*	*4*	*2*	*6*	*4*
M2	*5*	*3*	*2*	*3*	*4*
M35	*4*	*3*	*1*	*3*	*3*
Mean efficiency estimated in %		*65,4*	*47,8*	*65,2*	*60,9*

Previous similar trials were conducted at SNWF in autumn 2009, 2010 and 2014, with an efficiency which ranged between 72.0 % and 89 %. In 2018 the efficiency test (Table 5) repeated practically the same protocol. The white coloured chickens of the same age and size were located under five turbines (Table 5) randomly selected from within 114 wind generators of ISPB. The plots were investigated in the first day for efficiency of every of the searchers. After this first day the experimental plots with experimental carcasses were investigated every day. The plots have been searched every day until the last dead body in our experiment disappeared from the searched plots. Given the several potential influential factors on efficiency (e.g. searcher experience/skill and – notably – habitat being searched) and that these metrics are inevitably low in sample size in such exercises, it is difficult to justify any further analysis. The mean efficiency in the autumn 2018 trial, however, apparently revealed efficiency across all searchers of 60 % which was reduced from the previous trials' results at SNWF.

Nevertheless, since these trials function to calibrate potential mortality rates from searches for strike fatalities through blade collision then because both searcher experience/skill and the habitat searched were correspondingly representative then this tends to remove a need for such further analysis. This tendency is based on the low sample size which could be applied to any potential influential factor on efficiency. As noted later, however, such analysis is pointless if the raw data from searches under turbines continue to show that there are few if any collision victims of target species to which the search biases could apply.

The different results from the trials across years, however, should require for more tests in the future in order to evaluate further the relatively lower searcher efficiency in the much bigger territory of ISPB in respect to a part of this territory tested previously (SNWF) (see next section). Such trials should also be matched in terms of the applicability, so far as records of any target species being recorded as collision victims under the routine searches under all ISPB turbines for such victims. If, as persistently recorded for SNWF over many years and in the wider ISPB study area in autumn 2018, there continues to be no indication of any threatening fatality rates through turbine colisions to target species' populations then checks on biases through further searcher efficiency/carcass removal trials may become increasingly moot. Such checks should continue under constant review, however, as part of the wider agreed programme (Introduction).

Experiment on the removal rate: autumn 2018

All 26 hen carcasses were located under five randomly selected turbines in ISPB territory on 14 of October 2018. The carcasses started to disappear (be removed e.g. by scavengers) within the first day of the experiment (Table 6). The removal of carcasses varied between turbine locations but was much faster than established in previous experiments (2009, 2010, 2014 autumn monitorings of SNWF). Overall, at day three after placement 50 %, of the carcasses remained, and at day 9 all of the carcasses had disappeared.

The time of disappearance of the carcasses in autumn 2018 experiment varied depending on the location of the five turbines, with most disappearing after the second day of placement (Table 6).

Table 6. Periodicities for scavenging or removal of carcasses in autumn 2018

Days of the experiment	*Turbine AE29*	*Turbine AE41*	*Turbine E00*	*Turbine M2*	*Turbine M35*
1st day	*5*	*6*	*6*	*5*	*4*
2nd day	*2*	*4*	*6*	*3*	*4*
3rd day	*2*	*4*	*2*	*3*	*2*
4th day	*2*	*0*	*2*	*1*	*1*
5th day	*2*	*0*	*2*	*0*	*1*
6th day	*2*	*0*	*2*	*0*	*1*
7th day	*2*	*0*	*2*	*0*	*1*
8th day	*0*	*0*	*1*	*0*	*1*
9th day	*0*	*0*	*0*	*0*	*0*

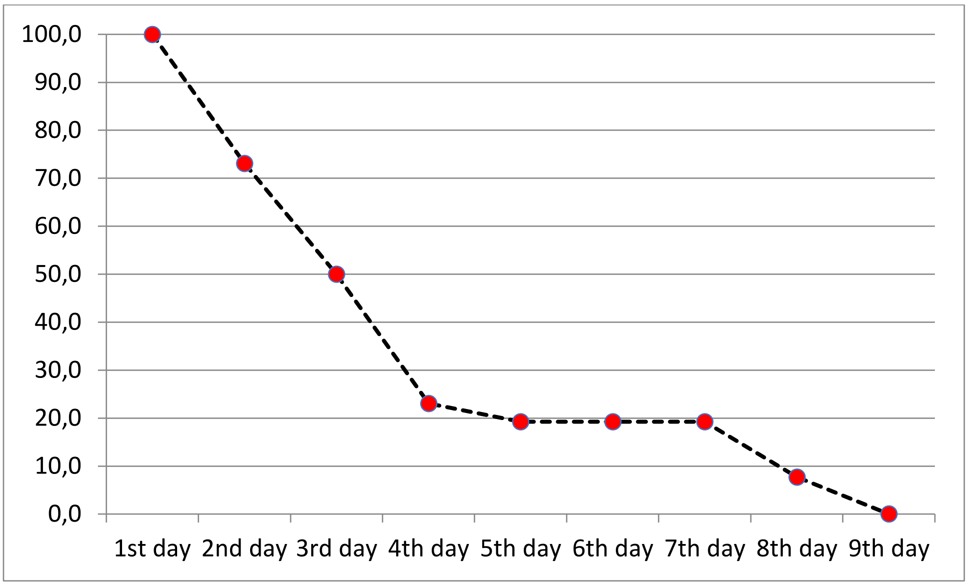

Figure 13. Removal rate by days during the experiment in autumn 2018.

The autumn 2018 experiment showed higher scavenging (or otherwise removal) rate of carcasses in the ISPB in comparison to those previously estimated in experiments conducted only in agricultural fields around SWWF. It could be explained by the abundant scavengers in the variable steppe habitats which have now been included in the ISPB. While previous comparable trials covered a much smaller territory and habitat diversity the current test is more representative for the territory of ISPB including open steppe habitats and a variety of shrubland outside the agricultural fields. The difference, however, may also be due to annual changes in alternative food supplies for scavengers, independent of the change in the experimental study area: hence the need for more studies, noted earlier.

Taking into account the results of the searchers efficiency which varied between 47 and 65 percent of the experimentally allocated dead chickens and a relatively higher scavenging rate, we have maintained a searching frequency of once per week on each of 114 turbines protected in the territory of ISPB. This frequency is the same as applied in previous monitoring periods in a part of the territory (SNWF) and allows comparision of the results in the long-term. Despite the higher scavenging rate discovered by the 2018 experiment we decided to keep the frequency of the searches at seven days. Practically, this allows coverage with the available resources of experienced ornithologists across all the 114 turbines included in ISPB. Even with a decrease in searcher efficiency and increased scavenging rate, this frequency of seven days is also sufficient to allow the estimation of the ‘real’ mortality, via analyses noted later.

Additionally, to date there has been no indication of any target species’ population being remotely affected by collision mortality, as revealed by the numerous weekly searches under all the turbines in SNWF, and more recently in autumn 2018 within the wider ISPB study area. An increased frequency of search effort may be suggested superficially by the autumn 2018 trials with 26 chickens. That superficial indication, however, would only be valid if there was any substantive data from collision fatality data on which any potential search biases should or could apply.

To date, there are no indications of any substantive collision fatality estimates to which corrective factors through searcher efficiency or carcass removal could reasonably apply. In other words, correcting fatality-zeroes is analytically fraught, and will not contribute towards or much-alter the basic finding – undertaken with a relatively frequent search regime of 7 d under every turbine, with no individual of a target species being found as a collision casualty, to date.

Some may argue that there is some circularity in this view, such that if the basic search regime is insufficiently frequent to record collision fatalities of target species, then they will not be recorded. However, this argument can be dismissed in this programme because of the basic necessity for the number of fatalities which would have to be recorded to create an adverse population impact for the target species. The recording of such a fatality level is well within the realms of the search programme, and any potential biases (even if detection of fatalities may be slightly lowered by the autumn 2018 searcher/removal trial).

Hence, on a level of collision fatality which may impact target species' populations then, regardless of discovery biases (as documented), this level should be evident from the monitoring procedures in place and therefore should be detected (see next subsection). At that detection point then corrections for biases become relevant. That detection point has yet to be reached and so there is no need to change the basic 7 d search protocol. That periodicity should continue to be under review, nevertheless, based on recorded collision fatalities and the continued need to track changes in searcher efficiency and carcass removal across the wider ISPB study area, in the highly unlikely event of substantially increased collision fatalities for target species.

Implications for adjusted mortality rate and search interval

Smallwood (2007) presented an equation which can be used to adjust observed ('raw' turbine search) estimates of collision mortality rates to account for searcher efficiency, carcass removal and inter-interval search timings. The estimator of adjusted mortality rate, M_a, is as follows:

$M_a = c \,/\, (t \times p \,/\, I)\ (e^{I/t} - 1 \,/\, e^{I/t} - 1 + p)$ .... (equation 1) where c is average number of carcasses observed per year (i.e. observed or raw mortality rate), t is the mean number of days for carcass removal, p is observer efficiency rate, and I is the search interval in days.

This result inferred that slightly more collision casualties would be found in 2014 than in the years of the previous two trials in 2009 and 2010 (Table 7). This is largely because of the increased carcass persistence rate (t, mean number of days for carcass removal) in 2014. Bringing this 2014 rate to the rate found in 2010, for example, gives an adjusted mortality (M_a) of 20.1 under a 7 d search interval (i.e. twice the hypothetical 'observed' unadjusted mortality of 10).

The results from the 2018 trial (Table 7) confirms earlier commentary in this report that in expanding the searcher efficiency trial to more turbines across the wider ISPB study area this may indicate that the detection of collision fatalities may be reduced under the basic search protocol. As also noted, earlier, however, this potential reduction in detection of collision fatalities through search biases can be moot (if nevertheless worth tracking by future trials) when there is no conceivable basis from the search regime's records of fatalities that any target species' population could be adversely affected.

Table 7. Calculated values of adjusted mortality rates using the results of the SNWF searcher efficiency and carcass removal trials in 2009, 2010 and 2014 and ISPB in autumn 2018 applied to equation 1, given a hypothetical unadjusted mortality of 10 collision victims and a 7 d search interval. The mean number of days for carcass removal (t) and observer efficiency rate (p) from the trials are also shown.

Carcass and year	*t*	*p*	*Unadjusted mortality Mu*	*Adjusted mortality Ma*
Hen 2009	*5.3*	*0.73*	*10*	*22.9*
Pigeon 2009	*4.45*	*1.0*	*10*	*19.8*
Hen 2010	*6.0*	*0.895*	*10*	*18.3*
Hen 2014	*9.66*	*0.787*	*10*	*16.0*
Hen 2018	*4*	*0.6*	*10*	*38.3*

The results in autumn 2018 from the searches under turbines across the ISPB study area (Table 7) and the conservation status of species from the few individuals recorded as collision fatalities (Table 9) did not indicate that there was any substantial threat to any of the target species. Not least, also, that there was any need to change the search regime to a greater frequency.

The total number of searches per turbine is presented in Table 8.

Table 8. Number of checks for victims of collision in the territory of ISPB in Kaliakra SPA during the period 01 August 31 October 2018

turbine	Aug.	Sept.	Oct.	total
ABBalgarevo	4	4	4	12

turbine	Aug.	Sept.	Oct.	total
АВГ1	3	5	4	12

turbine	Aug.	Sept.	Oct.	total
ABГ2	3	5	4	12
ABГ3	3	5	4	12
ABГ4	3	5	4	12
ABMillenium group	6	6	5	17
ABMillenium group Micon	2	2	3	7
AE10	4	4	4	12
AE11	4	4	4	12
AE12	4	4	5	13
AE13	4	4	5	13
AE14	3	5	4	12
AE15	3	5	4	12
AE16	4	4	4	12
AE17	4	4	4	12
AE18	4	4	5	13
AE19	4	4	5	13
AE20	3	5	4	12
AE21	4	4	4	12
AE22	4	4	4	12
AE23	4	4	4	12
AE24	3	5	4	12
AE25	3	5	4	12
AE26	4	4	4	12
AE27	4	4	4	12
AE28	4	4	4	12
AE29	3	5	4	12
AE31	4	4	5	13
AE32	4	4	5	13
AE33	4	4	5	13
AE34	4	4	5	13
AE35	4	4	5	13
AE36	3	5	4	12
AE37	4	4	5	13
AE38	3	5	4	12
AE39	3	5	4	12
AE40	3	5	4	12
AE41	3	5	4	12
AE42	3	5	4	12
AE43	3	5	4	12
AE44	3	5	4	12
AE45	4	4	4	12
AE46	4	4	5	13
AE47	4	4	5	13
AE48	4	4	5	13
AE49	4	4	5	13
AE50	4	4	5	13
AE51	4	4	13	21
AE52	4	4	4	12
AE53	4	4	4	12
AE54	4	4	4	12
AE55	4	4	4	12
AE56	4	4	4	12
AE57	4	4	4	12
AE58	4	4	4	12
AE59	4	4	4	12
AE60	4	4	5	13
AE8	3	5	4	12
AE9	3	5	4	12
DBГ1	3	5	4	12
DBГ1HSW250	3	5	4	12
DBГ2	3	5	4	12
DBГ2MN600	3	5	4	12
DBГ3	4	5	4	13
DBГ4	4	4	4	12
DBГ5	4	4	4	12
DC1	4	4	4	12
DC2	4	4	4	12
E00	4	4	5	13
E01	3	5	4	12
E02	3	5	4	12
E04	3	5	4	12
E05	3	5	4	12
E07	3	5	4	12
E08	3	5	4	12
E09	4	4	4	12
M1	3	4	4	11
M10	4	4	4	12
M11	3	4	4	11
M12	4	4	5	13
M13	4	4	5	13
M14	4	4	5	13
M15	4	4	5	13
M16	4	4	5	13
M17	4	4	5	13
M18	4	4	5	13
M19	4	4	5	13
M2	3	4	4	11
M20	4	4	5	13
M21	4	4	5	13
M22	4	4	5	13
M23	4	4	5	13
M24	4	4	5	13
M25	4	4	5	13
M26	4	4	5	13
M27	4	4	5	13
M28	4	4	5	13
M29	4	4	5	13
M3	3	4	4	11
M30	4	4	5	13
M31	4	4	5	13
M32	4	4	5	13
M33	4	4	5	13
M34	4	4	5	13
M35	4	4	5	13
M4	3	4	4	11
M5	3	4	4	11
M6	3	4	4	11
M7	3	4	4	11
M8	4	4	4	12
M9	4	4	4	12
VP1	3	4	4	11
VP2	3	4	4	11
ABZevs	3	5	4	12
Grand Total	**415**	**488**	**506**	**1409**

As a result of 1409 searches under 114 individual turbines between 1 August and 31 October 2018 (Table 8), a total of 18 dead birds of 13 species were identified as being fatalities through collision (Table 9). Individuals found as collision victims did not involve the target ISPB species.

Table 9. Victims of collision with turbines during the autumn migration period in 2018

Species	*Number of birds*	*Red Data Book*	*IUCN*
A. apus	*1*	*Not listed*	*LC*
A. melba	*1*	*Not listed*	*LC*
A. arvensis	*1*	*Not listed*	*LC*
B. buteo	*2*	*Not listed*	*LC*
L.michahellis	*3*	*Not listed*	*LC*
Larus sp.	*1*	*Not listed*	*LC*
M. alba	*1*	*Not listed*	*LC*
M. calandra	*1*	*Not listed*	*LC*
P. perdix	*2*	*Not listed*	*LC*
P. pica	*1*	*Not listed*	*LC*
S. vulgaris	*1*	*Not listed*	*LC*
F. tinnunculus	*2*	*Not listed*	*LC*
E. citrinella	*1*	*Not listed*	*LC*
total	***18***		

6. Conclusions

1) During the monitoring, there were no apparent changes in the main characteristics of the ornithofauna typical for the autumn migration in the whole country and the specific characteristics of the species composition and phenology of bird migration in NE Bulgaria.

2) The results of the monitoring confirmed the relatively low importance of the ISPB territory for the birds flying through it and the absence of negative influence of the operating wind farms on bird populations passing through the ISPB during their autumn migration.

3) The migration periods, the species composition, the dynamics in number of birds, the daily activity, the elevation of flights, as well as the feeding, resting and roosting places of the flying birds passing through the area and the observation points indicated the absence of a barrier effect of the 114 wind turbines covered by ISPB in autumn migration period.

4) The data presented in this report confirmed the absence of impact on sensitive bird species of order Ciconiiformes, Pelecaniformes, Falconiformes, Gruiformes using migratory upward airflows (thermals) to move (soaring) over long distances in autumn migration period.

5) All these species were found during the study to cross the site using suitable habitats without the need to increase their energy losses in their daily movements and to change their migratory strategy in the period of autumn mugration.

6) The quantitative characteristics of bird migration in the ISPB area during autumn 2018, and the absence of mortality among the target bird species allows a continued conclusion that the studied wind farms do not present a risk of adverse impact to migratory birds. The application of the ISPB's safeguards potentially was and can be an ongoing contributory part of the minimal risk posed to birds from wind farms in the Kaliakra region.

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