INTEGRATED SYSTEM FOR PROTECTION OF BIRDS

REPORT

Monitoring of spring bird migration in the Integrated System for Protection of Birds

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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.

Considering the potentially adverse effects of wind farms on environmental features, notably birds (Abbasi et al. 2014), the Integrated System for Protection of Birds (ISPB) was implemented in 2018 aiming towards systematic monitoring of any potential adverse effects, and their mitigation: primarily including fatalities through collision with rotating turbine blades, disturbance leading to the displacement of birds from feeding, drinking, roosting or breeding sites (effectively a form of habitat loss), and turbines presenting a barrier to flight movements, thereby preventing access to areas via those movements or increasing energy expenditure to fly around the turbine locations (Hötker et al. 2006, Madders & Whitfield 2006, Drewitt & Langston 2008, Masden et al. 2009, 2010, de Lucas et al. 2004, 2008, Ferrer et al. 2012).

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/.

It should be noted that this is the first report dedicated to the spring migration period and the ISPB is a subject of continuous improvement based on the observations and any challenges revealed by the several inherent monitoring protocols.

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

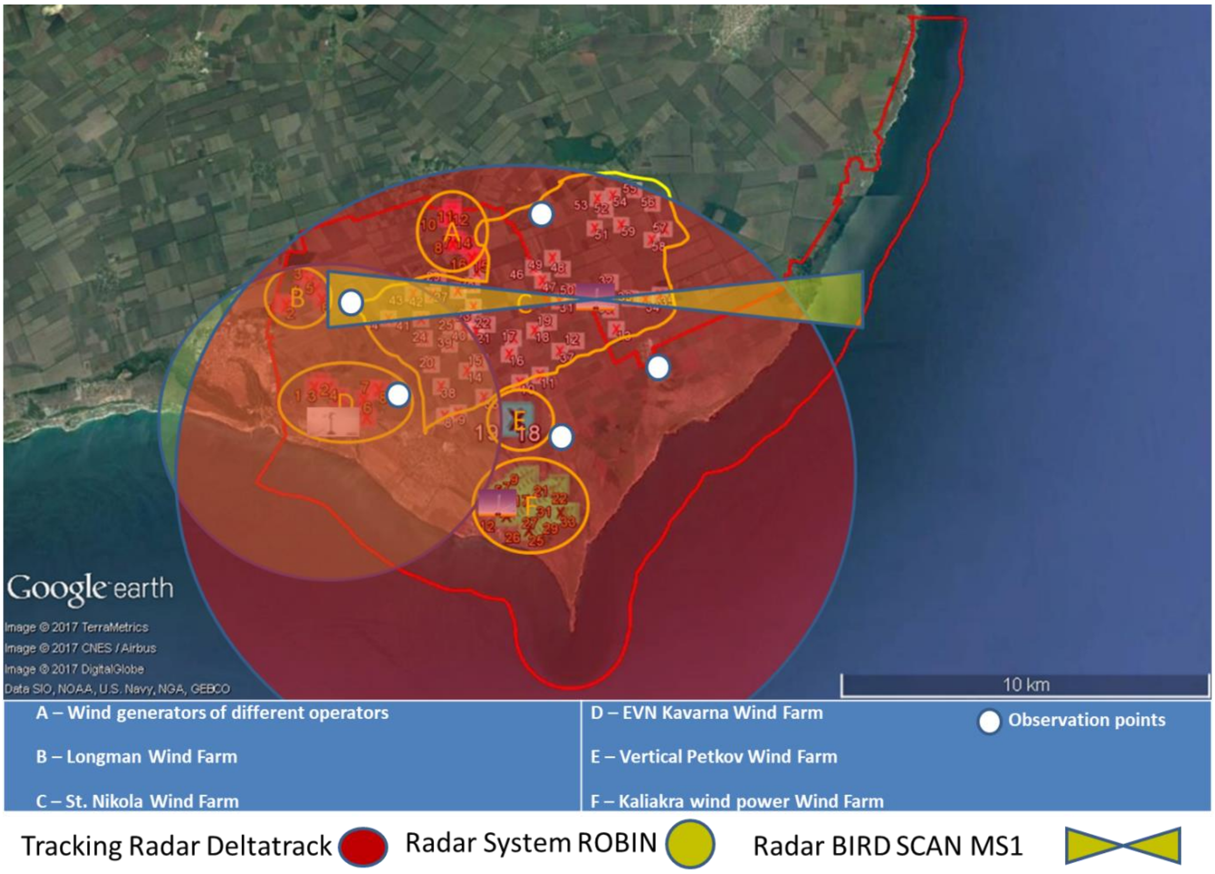


Figure 1. A satellite photo with the location of the wind turbines covered by the ISPB and the boundaries of Kaliakra SPA (shown by the red line), together with the scope of three radar systems.

Birds are one of the most mobile animal groups. In this regard, all bird studies, including the present study, should take into account this mobility. Bird migration is an evolutionary adaptation associated with leaving a part of the geographical range where for at least part of the year natural conditions are not suitable for certain species.

The relationship of birds to space is a source of many basic questions in evolutionary ecology and ornithology. In particular to the present study, the distribution of migratory birds on the Black Sea coast is of significant interest for the development of the wind energy industry in the region.

Seasonal migration of birds is an adaptation to a changing environment. Seasonal migration is an adaptive solution for the use of resources with seasonally unfavorable conditions. By definition, this is a constant process of adaptation to the changing environment. In the adaptation process, birds have developed morphological and physiological features that typically allow long distance flights between breeding sites in temperate zones and wintering sites in tropical and subtropical areas. This adaptation has existed for more than 100 million years and to date has allowed birds to survive global climate change.

There are 409 bird species in the Bulgarian fauna (BUNARCO, 2009 http://www.bunarco.org/files/docs/1385224552_203.pdf). The majority of migrating birds through Bulgaria and Europe are small passerines (Passeriformes) (Hahn et al. 2009). Passerine birds fly mainly at night during migration, at an average height of over 500 m, in a wide front with no visible concentration. These birds are also predominant in the environs of the wind farms subject to this study. Another predominant group involves birds which often rely on rising warm air currents (thermals, or anabatic winds) for a particular kind of flight - soaring. This is an energy-saving way of flying where the birds rise without moving their wings allowing the air currents to lift them upwards, then take a direct flight straight ahead covering long distances and gradually losing height until they reach another zone with warm air. Soaring migrants can also rely on orographic wind energy sources derived from topographic deflections of wind energy. This group of soaring birds includes pelicans, storks, cranes and birds of prey. They are more inclined than passerines to fly during daylight and at an altitude which may bring them into conflict with wind turbines.

All of such species fly across Bulgaria and can be observed anywhere during seasonal migration in spring and autumn (Michev et al. 2012). However, there is a difference in the speed and degree of air temperature at the land and water bodies in particular at the Black Sea coast, which restricts the coastal supply of anabatic winds. The flat topography near this coast also restricts orographic wind energy supply. These differences limit the flying ability of migrating soaring birds. This is why soaring birds prefer to avoid the risk of drift towards the coast and typically fly away from the coastline of the Black Sea, inland, thereby forming a large migratory flow within the Eurasian-East African Flyway (e.g. Bildstein 2006) known as Via Pontica in Bulgaria (Michev et al 2011, 2012) (Fig. 2). This concentration of migratory movements is part of several global migration flyways (Bildstein 2006). The Kaliakra SPA, in the territory of which are located the majority of the wind turbines subject to this study is situated in north-eastern Bulgaria, near the Black Sea. Bird counts listed in previous preconstruction monitoring reports of wind farms from the same territory (e.g.http://www.aesgeoenergy.com/site/images/Supplementary_Information_Report_EN.pdf), and the long term migration observations from the Saint Nikola Wind Farm (SNWF) operation clearly and repeatedly indicated that the wind farms in and around Kaliakra SPA are not situated on the main migration corridor of soaring bird species within Bulgaria (Via Pontica, which is part of a longer corridor on a much larger Eurasian-East African Flyway: Bildstein 2006). The main migration 'highway' obviously lies to the west of Kaliakra SPA and stretches out 80 to 300 km from the coast illustrated in Figure 2 (Michev et al. 2012 http://acta-zoologica-bulgarica.eu/downloads/acta-zoologica-bulgarica/2012/64-1-033-041.pdf, represented in the upper left corner at Fig. 2).

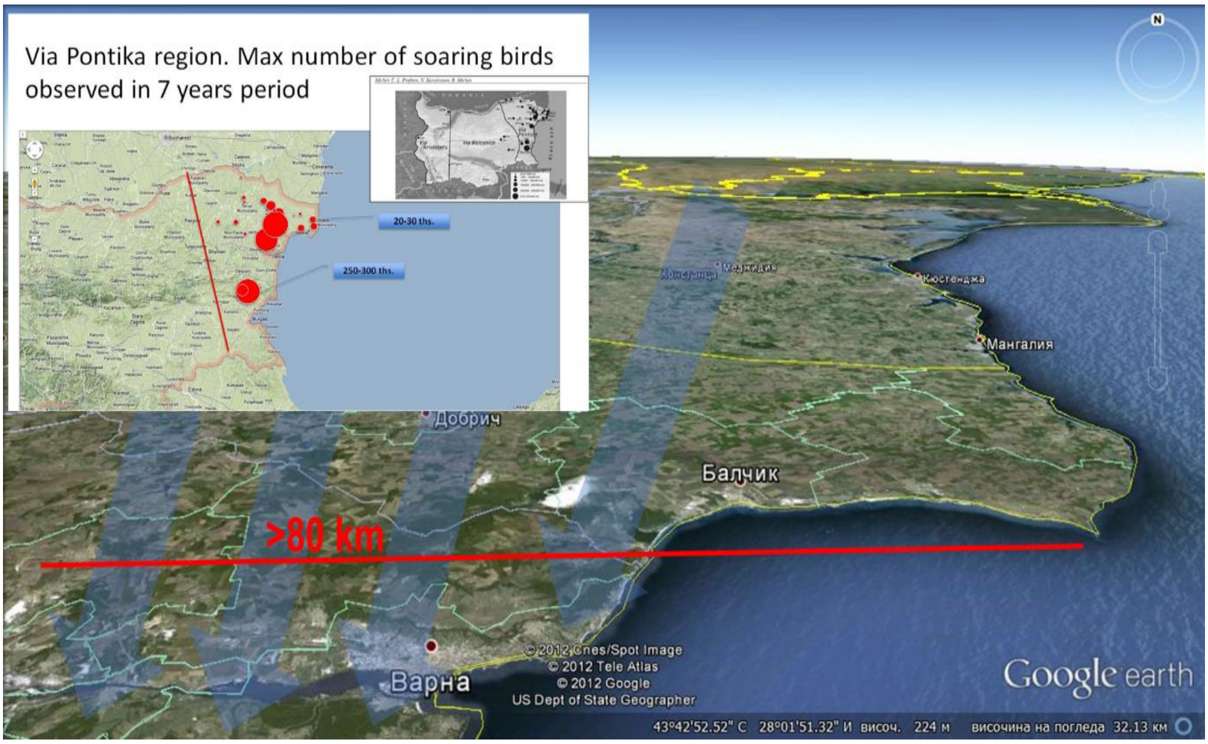


Figure 2. Schematic location of the main migratory flows in the North-East of Bulgaria, known as Via Pontica.

Over the past 8 years, a series of surveys have been carried out at SNWF to investigate the territorial and temporal distribution of mainly autumn migration, wintering and breeding birds, and specifically on the impact of a wind farm on birds: http://www.aesgeoenergy.com/site/Studies.html

There have been very limited studies dedicated specifically to spring migration in Bulgaria as the Spring migration is not a point of interest and importance as described in the preconstruction surveys (http://www.aesgeoenergy.com/site/images/Supplementary_Information_Report_EN.pdf). This is the first systematic report devoted to spring migration within the formulation of ISPB.

In order to provide objective data for the bird risk assessment, this study considers information on the characteristics of spring bird migration within the environs of ISPB to assess and, if necessary, reduce the risk for migrating 'soaring birds' through the study area.

This report covers the period of the spring migration season (15 March to 15 May 2018) and includes observed birds' movements, ordered turbine shut downs on demand, and registered collision fatalities. The collected information was used to assess the impacts of the wind farms within the ISPB on birds; primarily including fatalities through collision with rotating turbine blades, disturbance leading to the displacement of birds and any potential barrier effect.

The spring monitoring is performed following the recommendations from a series of Ministry of Environment and Waters (MOEW) normative documents (including the Kaliakra SPA Order РД-816/2017). Taking into account the geographical location of the terrain and previous observations, we consider that this period is optimal and representative, and the time is most appropriate for carrying out this type of study (http://www.aesgeoenergy.com/site/images/Supplementary_Information_Report_EN.pdf).

Particular attention has been paid to ISPB-target bird species of soaring birds as well as other bird species of conservation significance that are most vulnerable to direct collisions with wind facilities. The target species are defined on the basis of Report "Map of areas with risk for the birds from construction of wind turbine generators", Sofia, 2013 ECONECT (http://natura2000.moew.government.bg/PublicDownloads/Auto/OtherDoc/276299/276299_Birds_120.pdf.) The list may be supplemented or reduced in the course of the implementation of the ISPB.

In the list of the target species the red-breasted goose *Branta ruficollis* is included as required by the MOEW Kaliakra SPA Order РД-816/2017 in line with the recommendation of Bern Convention file T-PVS/Files (2017) 31 (file:///D:/Archive/Wind%20turbines/Калиакра%20СРП/Bern%20Convention%202018%20Kaliakra/Доклади%20коментари%20Ноември%202018/Files31e_2017_Bulgaria_Balchik_Kaliakra_Complainant_Rep.docx.pdf). This is despite substantial empirical evidence from SNWF over many winters that this goose species is not vulnerable to collision (http://www.aesgeoenergy.com/site/Studies.html).

Maps with the observed flocks during the spring monitoring are given later.

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 spring 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 spring 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, 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**

Over 25 years of research in ornithology. Over 85 scientific publications in international ornithological journals. Member of European Ornithologists Union and several other conservation organisations. Winner of the Revolutionary Discovery Award for Ornithology of an American Ornithological Society in 2016 – The Cooper Ornithological Society.

10 years of experience in impact monitoring of wind turbines on breeding, migrating and wintering bird species in the region of Kaliakra. Longtime member of BSPB.

- **Dr. Victor Vasilev -Field ornithologist**

Senior researcher in the Faculty of Biology, University of Shumen.

Member of BSPB and participant in several conservation projects in Bulgaria.

Author of over 20 scientific publications in international journals. Member of BSPB.

- **Dr. Dimitar Dimitrov- Field ornithologist**

Institute of Biodiversity and Ecosystem Research – Bulgarian Academy of Sciences

Author of over 20 scientific publications in international ornithological journals. Member of BSPB .

5 years of experience in impact monitoring in the region of Kaliakra. Member of BSPB.

- **Ivaylo Antonov Raykov - Field ornithologist**

Museum of Natural History, Varna. Member of BSPB. Author of over 20 scientific publications in international journals. 5 years of experience in impact monitoring in the region of Kaliakra. Member of BSPB.

- **Kiril Ivanov 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 7 years of experience in impact monitoring of wind parks in Bulgaria. Member of Balkani NGO for conservation of birds and nature.

- **Yanko Yankov - Field ornithologist**

Student in Biology, University of Shumen. 7 years of experience in impact monitoring of birds in Wind Park projects in NE Bulgaria. Member of BSPB.

- **Nikolay Bunkov - Field ornithologist**

PhD Student in Institute of Biodiversity and Ecosystem Research – Bulgarian Academy of Sciences

- **Boyan Michev – Field ornithologist**

PhD Student in Institute of Biodiversity and Ecosystem Research at the Bulgarian Academy of Sciences, Department of Ecosystem Research, Environmental Risk Assessment and Conservation Biology. Expert in radar ornithology and analysis of the radar data for bird monitoring. Member of the European Network for Weather radar application in ornithology.

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 Waters 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 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).

4.1. Application of radar systems in the ISPB

The three radars could not distinguish between species or higher taxa (e.g. birds, insects), or other aerial features which could produce registrations. They could register these aerial features at considerable height well above the limits of the wind farms' turbines and beyond the visual acuity of the field observers. The radars therefore could not be used to document the traffic of birds through the wind farms, but served as a tool in the ISPB and any subsequent triggering of the TSS under the ISPB, led by the field observers.

The three radars allowed, by the scope of their registration capacity beyond the limits of visual observation, the potential for early alerts of possible incoming birds towards the wind farms. Such possible warnings were used to alert the field observer team to potential ingress of birds in the wind farms by location and direction, thereby enhancing the ISPB and observers' capacity to focus for any need to trigger the TSS under the ISPB.

By nature of their specific identification shortcomings and the substantial distance-detection, however, the radars often provided many false alerts on wind farm ingresses and could also not be used to describe the traffic of birds in and around the immediate vicinity of the wind farms. In that respect the study relied on the field observers: the role of the radars was to alert the field observers to possible ingresses at distance, and thereby enhance their capacity to record such ingresses, should they occur.

Three types of radars integrated into the ISPB were used for monitoring and prevention of bird collisions:

Bird Scan MS1

The radar collects quantitative data and provides information about Migration Traffic Rate of birds through a specific sector where the fixed beam of the radar is directed (Fig. 1). The quality of the data deepens on the distance to the birds and to the size of the migrating birds. In the case of ISPB the maximum distance we have used the Bird Scan MS1 radar is 10 km beam directed from west to east across the main migratory front of seasonal migrations. The data obtained by this radar system allow crude identification of ecological types of birds: for example, passerines, swifts, waders and large birds. The radar data do not allow quantification of bird migration for every bird species observed in the ISPB territory and therefore do not allow any comparison with visual observations.

These data are not used for quantification and analysis of the characteristics of migration.

Deltatrack Radar System

This radar is a tracking radar system which allows detection of a single target or group of targets and tracking of their movements in a range of around 5 km (Fig. 1). It is used in the monitoring as a real time tool for the tracking of already (visually) identified bird targets in the ISPB territory. The radar is not applicable for quantitative analysis of bird migration.

Radar System Robin

This is a 3 D radar system constructed for detection and tracking of moving targets in air volume of around 10 km^3 (https://www.youtube.com/watch?v=-Kb70clGHOQ&t=8s) (Fig. 1). It is a real time tool for tracking of moving targets and in combination with visual observations in the field provides highly reliable data on the distance as well altitudes of birds already detected and identified by the field ornithologists. This radar does not provide quantitative data of migration at a species level because it does not allow species identification.

All three radar systems have been used as tools to assist field observations, detection of potential ingresses, and real time tracking of birds after visual observation through the ISPB during the period of monitoring. The results presented in the report are obtained by simultaneous application of visual observations and radar systems in real time monitoring of ISPB (https://img1.wsimg.com/blobby/go/1a109f6d-5fe3-4ff5-bcf3-17602b59ac27/downloads/1cjddqfou_175924.pdf)

The radar system ROBIN provides 24/7 coverage of a wide area around EVN Kaliakra wind farm (indicated in Figure 1) and ensures automatic shutdown of turbines in case of risk of collision for the birds in the area (https://www.youtube.com/watch?v=-Kb70clGHOQ&t=8s). All quantitative data and analysis of recorded bird numbers are based on the only possible quantification of bird migration of different bird species – the visual observations in the field. Locations of field observation points are presented in Figure 1.

Detailed descriptions of the technical characteristics of the three radar systems integrated within the ISPB are presented on the web site: https://kaliakrabirdmonitoring.eu/

4.2. Ornithological methods

Counts of migrating birds were conducted according to the standard methodology - from an observation point (OP) (stationary points) to an appropriate part of the designated area described above (e.g. Figure 1). Observations of migrating birds refer to hemispheric airspace with the OP as a center and a radius of about 4000 m. The main focus of the observations was pelicans, storks, cranes and birds of prey united in a general ecological group of "Soaring Birds".

In addition to these bird species some non-soaring birds from other taxonomic orders were registered too. The behaviour of birds of prey was recorded in order to evaluate significance of the territory for feeding of these soaring birds.

Visual observations were conducted daily from 8:00 am to 5:00 pm. In days with adverse climatic conditions, observation time was shortened. Observations were recorded in a log, with the daily field data being transferred in the evening to electronic (Microsoft Excel) form, so that the results were transcribed to and stored in standardized and approved Microsoft Excel spreadsheets.

4.3. Protocol for visual observations

Field observations protocol followed Bibby et al. (1992) modified in line with the Bulgarian Ministry of Environment and Water methodology adopted for visual observations in wind parks (https://www.moew.government.bg/static/media/ups/tiny/filebase/Nature/Biodiversity/Preporyki%20Rykowodstwa%20Dokladi/Metodika_VEP.pdf) with the simultaneous observations by three radar Systems (3D Radar System Robin, Fix Beam radar Bird Scan MS1 and tracking radar system) which extended the range of surveillance over the whole ISPB territory (see Fig.1). Observations covered the sky in a semicircle. They were made with optical instruments - each observer had a 10x magnification binocular. All observation points were also equipped with standard telescopes with 20 - 60x magnification, compass, GPS and digital camera as recommended by the specific methodology regulated by MOEW for visual observations of bird migration at wind farms (https://www.moew.government.bg/static/media/ups/tiny/filebase/Nature/Biodiversity/Preporyki%20Rykowodstwa%20Dokladi/Metodika_VEP.pdf

Figure 3. A flock of White pelicans: an illustration of the simultaneous records obtained by every ornithologist in real time, information from Robin Radar System and visual observations.

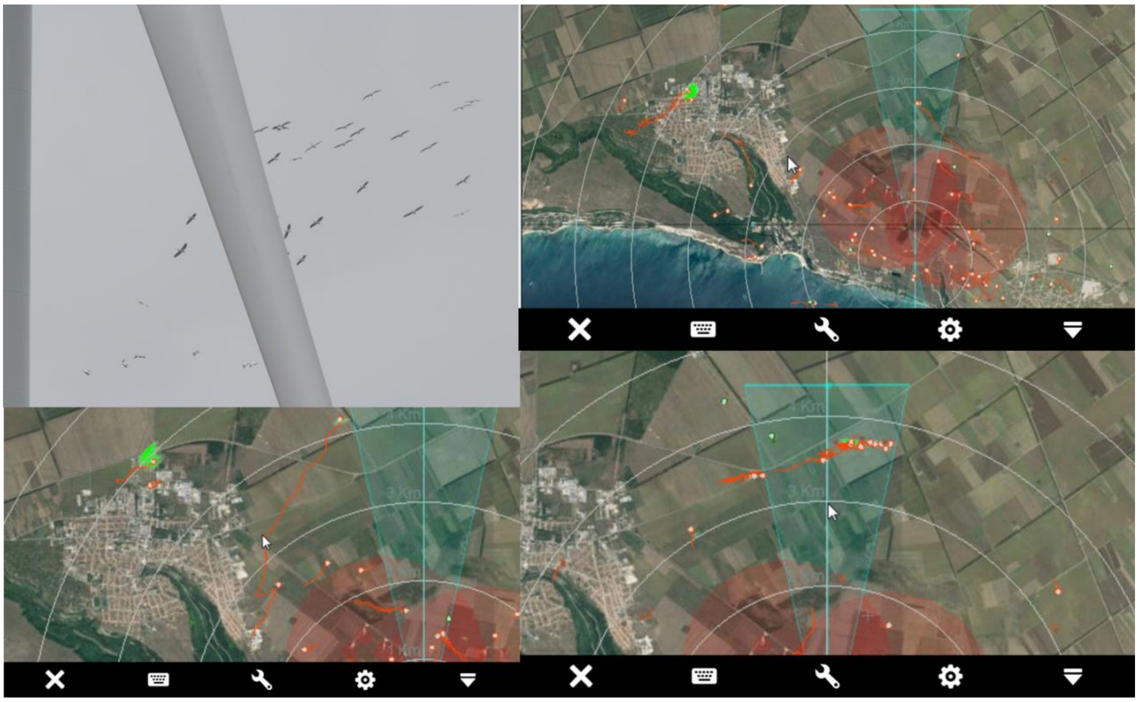


Figure 4. Every single bird and flock of birds from the target bird species were tracked by visual observations and the Robin radar simultaneously.

4.4. Specific Protocol for visual observations

During the observations the following data were recorded:

- Species;
- Number;
- Distance from observer;
- Height;
- Flight direction;
- Behaviour in terms of proximity to wind turbines;
- Additional observations on behaviour;
- Meteorological data;
- Precise position of birds simultaneously detected by the radar and by the observer (used to calibrate the radar to accurately identify the species - Pelicans, Stork, etc.).

4.4.1. Species

All flying birds were identified to species by the field ornithologists and registered. Due to the difficulty of differentiating between some similar species under specific conditions (e.g. poor visibility, long distances, etc.), when exact identification was impossible, all possible species were recorded.

4.4.2. Number of the observed birds

Participants in the survey reported all birds flying within their visual range, regardless of whether it was possible to distinguish between species or a higher taxonomic category (as described in the previous paragraph). When recording data individual birds (or pairs), flocks and their size (number of birds) and species composition were reported. In the case of large flocks, where counting of individual specimens was not possible, a count of 10 bird groups applied to the identity of the majority of the flock was recorded.

4.4.3. Distance to the flocks and trajectory of birds

Simultaneous with the identification of the number of migratory birds, the determination of the flock trajectories and flying single birds were among the important tasks of the study. The 3D Radar System ROBIN was able to determine distance from the radar to the bird and direction of the flight as well as the speed of the bird or flock. The field ornithologists used the information from the screen of the radar which was displayed on his mobile device to validate the observed bird/flock and its trajectory.

Pre-selected field reference points were used to identify the relative horizontal distance of the flying birds from all observation points. The distances to the field reference points were measured in advance in the agricultural area, or such a measurement was carried out using a topographic map. The distance from the observation point was estimated and reported separately for each bird or flock.

4.4.4. Altitude of flight

The height of the flight of each individual bird or flock was determined in altitudinal categories of 50 m. Such categories were used to provide data that could be useful for analysis. These altitude data were also checked by utilizing the ROBIN Radar system after the identity of observed birds was determined.

4.4.5. Flight direction

The direction of the observed flights was determined by taking into account the geographical direction to which the birds were flying as referenced against the location of the observation point. Sixteen possible categories were used to classify the observed geographical flight directions (each category was limited to 22.5 degrees). Again, these data were verified whenever possible using the ROBIN Radar system after the observers had identified the birds to the highest taxonomic level possible (see earlier).

The 16 categories starting from North: N (North), NNE (North-Northeast), NE (Northeast), ENE (East-Northeast), E (East), ESE (East-Southeast), SE (Southeast), SSE (South-

Southeast), S (South), SSW (South-Southwest), SW (Southwest), WSW (West-Southwest), W (west), WNW (West-Northwest), NW (Northwest) and NNW (North-Northwest). Flight direction was reported for each individual bird or flock by observers at units below the 16 categories. However, for the purposes of the analysis, the recorded direction in the database was assigned to one of the 16 compass categories. Directivity ordinances were evaluated using circular statistics (Batschelet, 1981).

4.4.6. Physical characteristics of the environment

Physical factors affecting bird behaviour and potentially affecting the survey data of the studies were taken into account, namely:

- Wind direction
- Wind force
- Air temperature
- Rainfall
- Visibility

The direction and strength of the wind, as well as temperature, were accurately measured and provided for the data analysis by the wind park operators, on the basis of installed anemometers.

Visibility was estimated as the maximum distance in meters at which known permanent geographic landmarks could be seen. For example if the observer could see the buildings of the nearest village A located at 5 km distance, but could not see village B located at 10 km, the visibility was evaluated as 5 km. Visibility data was recorded at the beginning of survey observation sessions as well as at any time within an observation session when a significant change of visibility occurred. Natural phenomena such as fog, light fog and others leading to a deterioration of visibility were also taken into account when data were analysed.

4.4.7. Behaviour of the birds in respect to operating wind turbines and other anthropogenic constructions

These were additional data recorded on the behaviour of birds in relation to wind turbines, such as bypassing or altering flight height. The tracking radar systems were used to assist all detected and identified-to-species target species and flocks of birds (Fig. 4). Data were also collected on the feeding and resting places of migratory birds in the ISPB study area.

4.5. Data registration

All data were entered in a log. They were processed on a daily basis and entered into a database in Excel format. The protocol adopted for primary data processing purposes was a modified version of the Protocol on Birds Risk and Mortality, used by the US National Laboratory for Renewable Energy Sources (Morrison, 1998). Periodic checks to detect collision mortality with wind turbines existing in the ISPB territory were performed under all 114 turbines once per week during the period of spring migration between 15 March and 15 May 2018.

Data registration:

- At the beginning of each observation period, the date and time, the meteorological situation (as described above) and the names of the persons conducting the survey were entered.
- When a bird or a flock of birds was observed, the exact hour and minutes were entered first, then the vernacular species name, the scientific name, the number, the vertical and horizontal distance from the observation point and the flight direction. After the entry of these mandatory data, additional information was recorded such as: the composition of the flock, landing birds with a precise indication of the place of landing, etc. In the event of a change in the values of physical environmental factors or when observing other interesting and / or important phenomena, such changes or phenomena was also entered in the log, when the exact time was indicated.
- Upon completion of the daily records, the exact time, the values of the physical environmental factors and the names of the surveyors were again entered.

5. Results

5.1. Direction of migrating birds

During the spring monitoring, observations were made during all 92 days of the season, with registered migratory, soaring birds being detected over 70 % of the time. For the survey period (March 15 - May 15), a total of 1560 migratory and resident birds (Table 1) were registered:

Table 1. Number of registered birds of all ecological groups by day during the spring migration in the territory covered by ISPB

Period	Number of birds in Spring 2018
15-31 March	882
1-30 April	445
1-15 May	233
Total for the period	1560

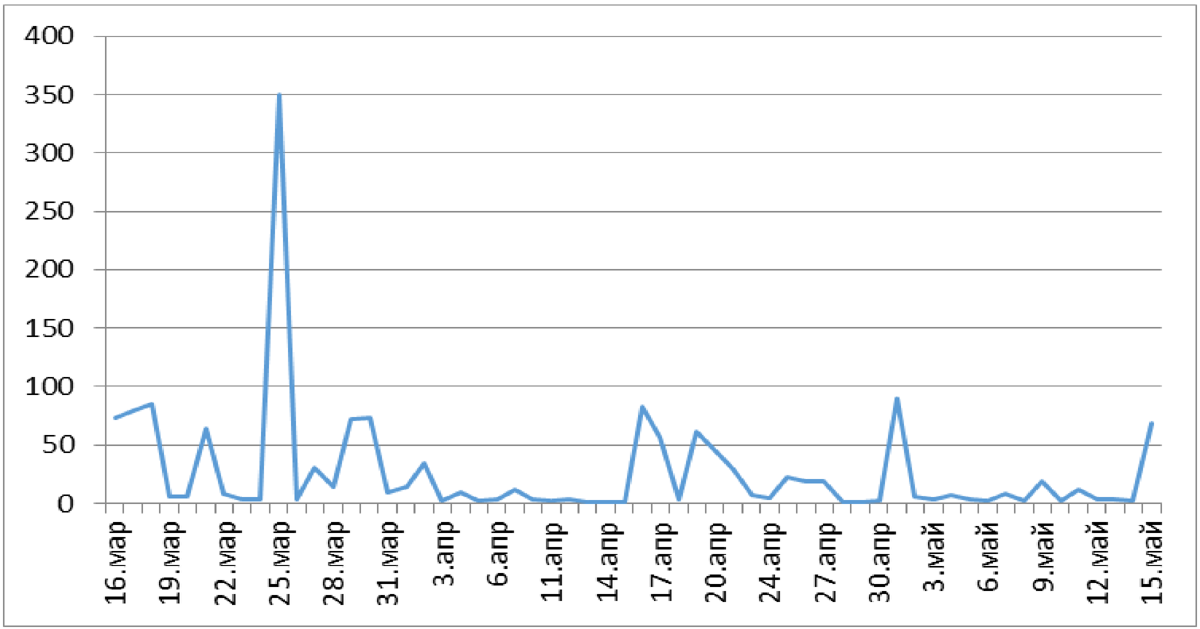


Figure 5. Dynamics of the spring migration of birds in the ISPB territory based on visual observations during the period 15 March - 15 May 2018

The variations in bird numbers were substantial (Figure 5). The low number of migrating birds through the study area, because of the relatively low prevalence of westerly winds in this season, did not allow for an in-depth statistical analysis of the number of birds according to wind direction.

An important parameter for determining the impact of wind turbines on birds is whether or not the general direction of the migration was changed by the presence of the turbines. For birds with registered flight directions, the distribution of directions in spring 2018 is presented in Table 2.

Table 2. Proportion of registered birds by direction during spring migration on the territory of ISPB for the period 15 March - 15 May 2018. In grey are presented observed as expected prevailing for the spring migration migratory directions.

Direction	Percent of birds
ENE	4,90%
N	28,88%
NE	41,91%
NNE	2,82%
NNW	0,34%
NW	5,98%
WNW	0,13%
S	1,75%
SE	0,54%
E	9,00%
SW	2,08%
W	1,68%

The main direction of the flight in the migratory birds of all ecological groups during the 2018 spring migration was N-NE with over 70 % of registered birds. Prevailing wind directions were typical for the season (spring) when the movement of birds through the study area was recorded. Therefore, there was no observed deviation from the seasonal expectation of migratory flight directions which were centered around the north (Table 2). No changes were identified in the migratory directions of the birds due to the proximity to wind turbines being monitored.

5.2. Species composition and number of birds

Relatively few migratory birds were recorded during the spring migration period in the surveyed territory.

Of the total of 1560 birds registered in the course of the study, 1521 individuals were identified to species. The species and number of birds recorded during spring migration is shown in Table 3.

Table 3. Composition and number of registered bird species during the period 15 March - 15 May 2018 in the ISPB territory.

English name	***Latin name***	***Number***
Common swift	*A. apus*	*2*
Alpine swift	*A. melba*	*5*
Northern Goshawk	*A. gentilis*	*1*
Eurasian sparrowhawk	*A. nisus*	*1*
Grey heron	*A. cinerea*	*6*
Squacco heron	*A. raloides*	*1*
Booted eagle	*A. pennata*	*2*
Lesser spotted eagle	*A. pomarina*	*1*
Common buzzard	*B. buteo*	*75*
Long-legged buzzard	*B. rufinus*	*2*
Marsh harrier	*C. aeruginosus*	*23*
Hen harrier	*C. cyaneus*	*8*
Montagu's harrier	*C. pygargus*	*8*
Pallid harrier	*C. macrourus*	*1*
Short-toed snake eagle	*C. gallicus*	*6*
White stork	*C. ciconia*	*81*
Black stork	*C. nigra*	*4*
Mute swan	*C. olor*	*9*
European roller	*C. garrulus*	*4*
Raven	*C. corax*	*2*
Hooded crow	*C. cornix*	*6*
Red-footed falcon	*F. vespertinus*	*21*
Eurasian hobby	*F. subbuteo*	*8*
Peregrine falcon	*F. peregrinus*	*1*
Kestrel	*F. tinnunculus*	*37*

English name	*Latin name*	*Number*
Saker falcon	*F. cherrug*	*1*
Black kite	*M. migrans*	*1*
Common crane	*G. grus*	*62*
Demoiselle crane	*G. virgo*	*25*
Yellow-legged gull	*L. michahellis*	*43*
White-tailed eagle	*H. albicilla*	*1*
Golden oriole	*O. oriolus*	*2*
Common cormorant	*P. carbo*	*601*
White pelican	*P. onocrotalus*	*259*
European honey buzzard	*P. apivorus*	*2*
Grey partridge	*P. perdix*	*2*
European turtle dove	*S. turtur*	*1*
Common tern	*S. hirundo*	*1*
Starling	*St. vulgaris*	*80*
Hoopoe	*U. epops*	*3*
Common shelduck	*T. tadorna*	*35*
European bee-eater	*M. apiaster*	*85*
Northern lapwing	*V. vanellus*	*2*

The most numerous birds in spring in the region were common cormorants (*Phalacrocorax carbo*), white pelicans (*Pelecanus onocrotalus*) and some birds of prey – Buzzards (*Buteo buteo)*, Red-footed falcon (*Falco vespertinus*), Kestrels (*Falco tinnunculus*) and Marsh harriers (*Circus aeruginosus*) (Table 3).

In the spring of 2018, a total of 81 white storks (*Ciconia ciconia*) passed over the surveyed 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 wider western Black Sea region, which also covers a part of north-eastern Bulgaria. According to these values, white storks flying over the Kaliakra area, substantially east of the main migratory path of white storks along the western Black Sea migration corridor, were an insignificant proportion (0.02%) of the Via Pontica population. According to Shurulinkov et al. (2011), an estimate of the total population of White stork *Ciconia ciconia* in SE Bulgaria flying along Via Pontica in spring was 23,358 individuals in their study period. In this respect our observations confirm the low significance of the territory of Kaliakra as part of the migratory corridor for spring migrating white storks along the Via Pontica component of the larger flyway.

Similar numbers of two different crane species - Common and Demoiselle cranes - were seen. Common cranes were recorded for three days in March, and Demoiselle cranes were observed over seven days in April and May. Remarkable was the behaviour of a pair of Demoiselle cranes which stayed in the ISPB area for nearly 30 days between April and May. A pair of these beautiful birds used a temporary pond of surface water for feeding within SNWF without showing any apparent signs of fear of the nearby wind turbines.

Common Kestrels (*Falco tinnunculus*) were the most numerous bird of prey recorded during spring migration. They appeared in the area after mid-April, with the bulk of birds passing through between April 20th and 25th. The proportional contribution to records from the five most commonly recorded raptor species during spring migration 2018 is shown in Figure 6.

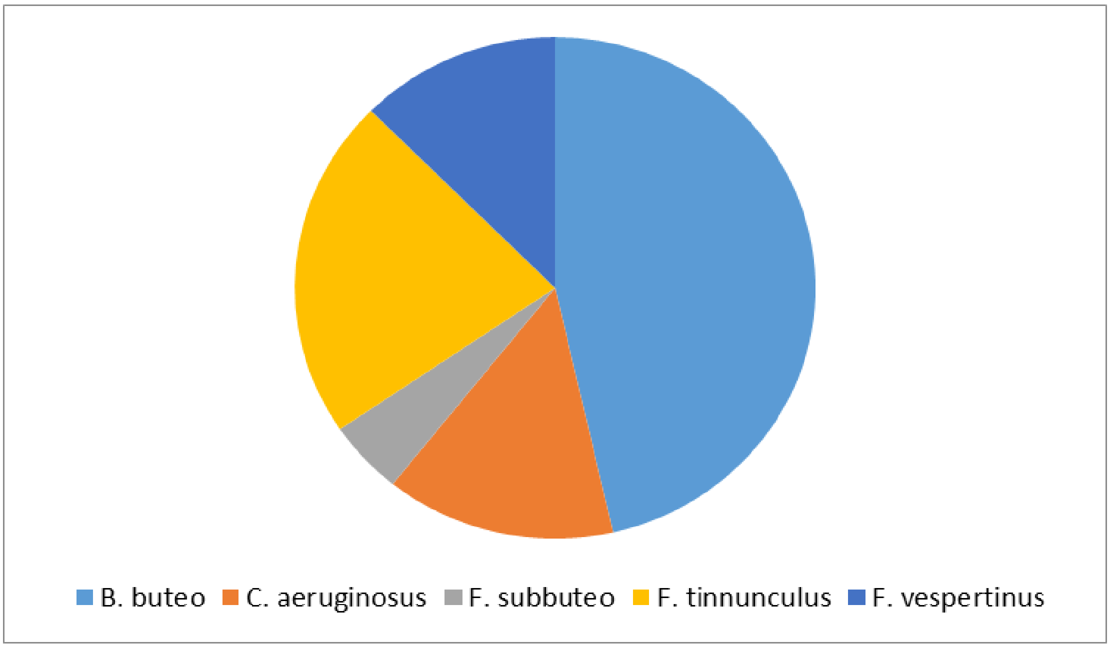


Figure 6. Proportional representations of the five most numerous birds of prey recorded during spring migration 2018.

5.3. Frequency of appearance

During the spring migration in 2018 over the surveyed area, migratory species of soaring birds were noted on an average of 80 % of the days covered by observations in Spring migration. In majority of cases, only one bird, predominantly Falconiformes, some of which are local for the area, was observed. These were mostly Common buzzard (*Buteo buteo*) and Common kestrel. These species were regularly observed to hunt in the area covered by ISPB. Flocks of migratory birds having more than three individuals were observed in only 3 % of the days. In most cases, they were flocks of cormorants. Another more regularly observed species was Red-footed falcon (*Falco vespertinus*). The most frequent migrant during the spring monitoring period was the Common buzzard. The white stork, albeit with a higher number than the other species, was observed on only nine days during the monitoring. Three flocks of White storks (67, 5 and 3 birds) were observed.

5.4. Altitude of flights

Over 70 % of birds were observed to fly at a height of less than 200 m above ground level. No changes in flight height due to the proximity of wind turbines were observed. The distribution of migratory birds in height is shown in Fig. 7.

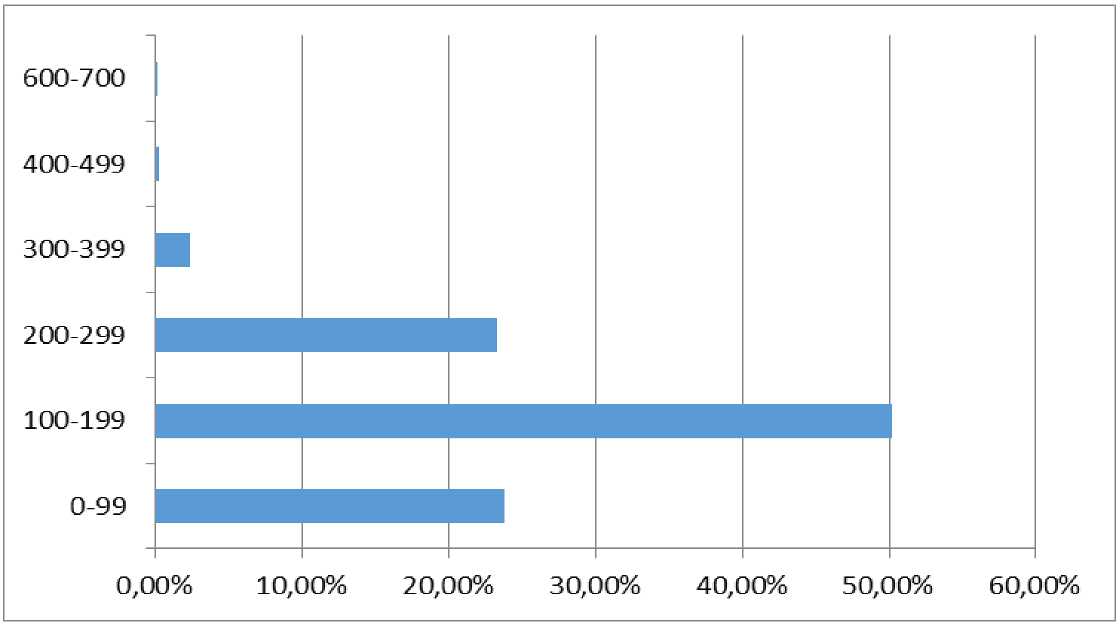


Figure 7. Distribution of Passing Birds by Height

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

As a result of the systematic observations carried out during the whole period of the spring migration a total of 11 stops of individual turbines, groups of turbines or entire wind farms in the territory covered by ISPB were undertaken. 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 ISPB in the Kaliakra study area during the 2018 spring migration of birds.

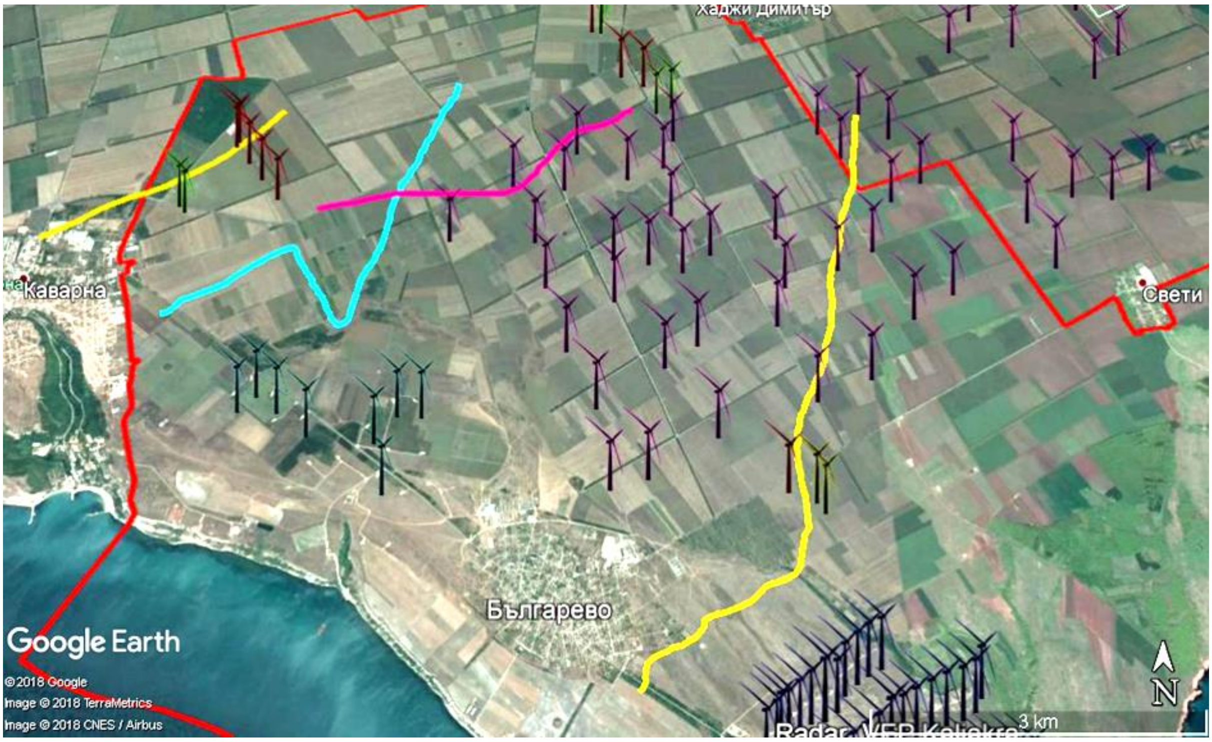
Date	Wind Farm*	Turbine №/ group	Species	Number of birds	Time stopped	Time started
21.03.2018	EVN Kavarna WF	4 turbines	Automatic system	Radar information **	06:06	06:35
30.03.2018	St. Nikola WF	D, C	Common cranes (*Grus grus*)	13	13:07	13:20
02.04.2018	St. Nikola WF	F	White pelicans (*P. onocrotalus*)	19	11:07	11:29
09.04.2018	St. Nikola WF	A	White tailed eagle (*H. albicilla*)	1	12:45	12:58
11.04.2018	St. Nikola WF	B	Demoiselle crane (*G. virgo*)	2	13:25	13:41
18.04.2018	St. Nikola WF	A	Demoiselle crane (*G. virgo*)	2	11:16	11:45
18.04.2018	St. Nikola WF	B	Demoiselle crane (*G. virgo*)	2	12:15	12:48

Date	Wind Farm*	Turbine №/ group	Species	Number of birds	Time stopped	Time started
18.04.2018	St. Nikola WF	B	Demoiselle crane (*G. virgo*)	2	13:23	14:00
18.04.2018	St. Nikola WF	B	Demoiselle crane (*G. virgo*)	2	14:05	14:17
26.04.2018	Kaliakra Wind Power WF	All	Demoiselle crane (*G. virgo*)	12	13:25	13:45

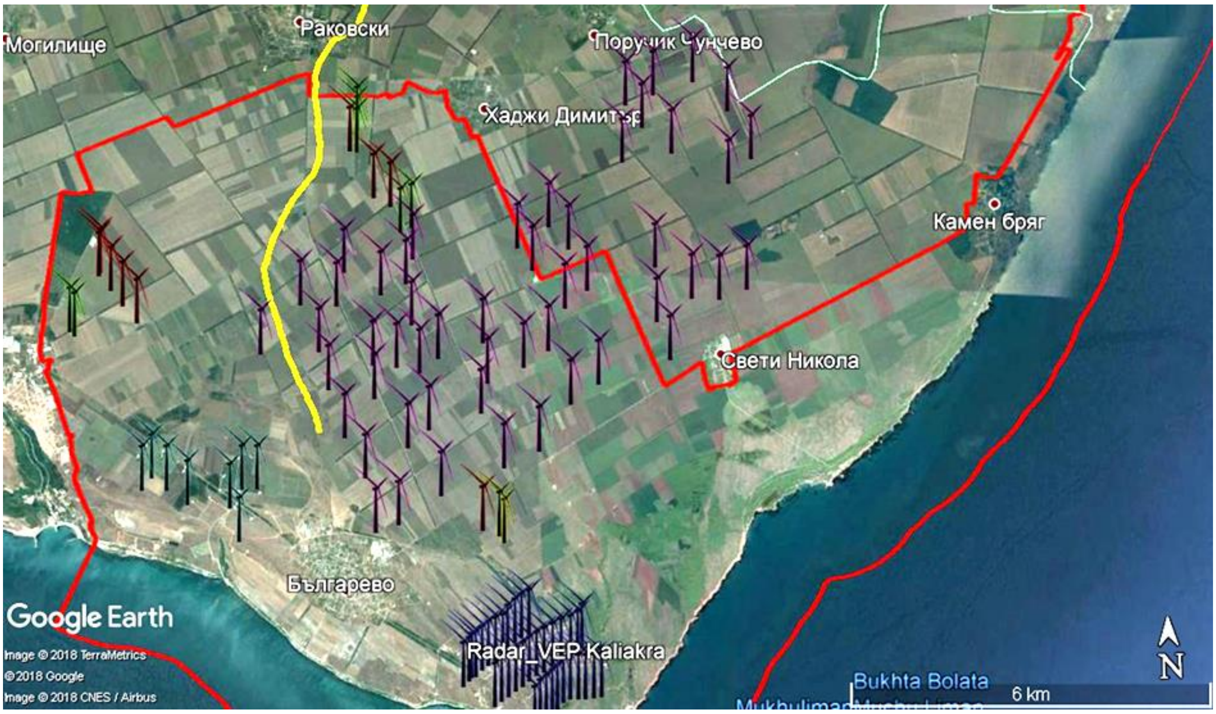
*The location of wind turbines of different wind farms are presented in Figure 1.

** Radar System Robin provides 24/7 automatic shutdown of turbines in case of increased risk for birds.

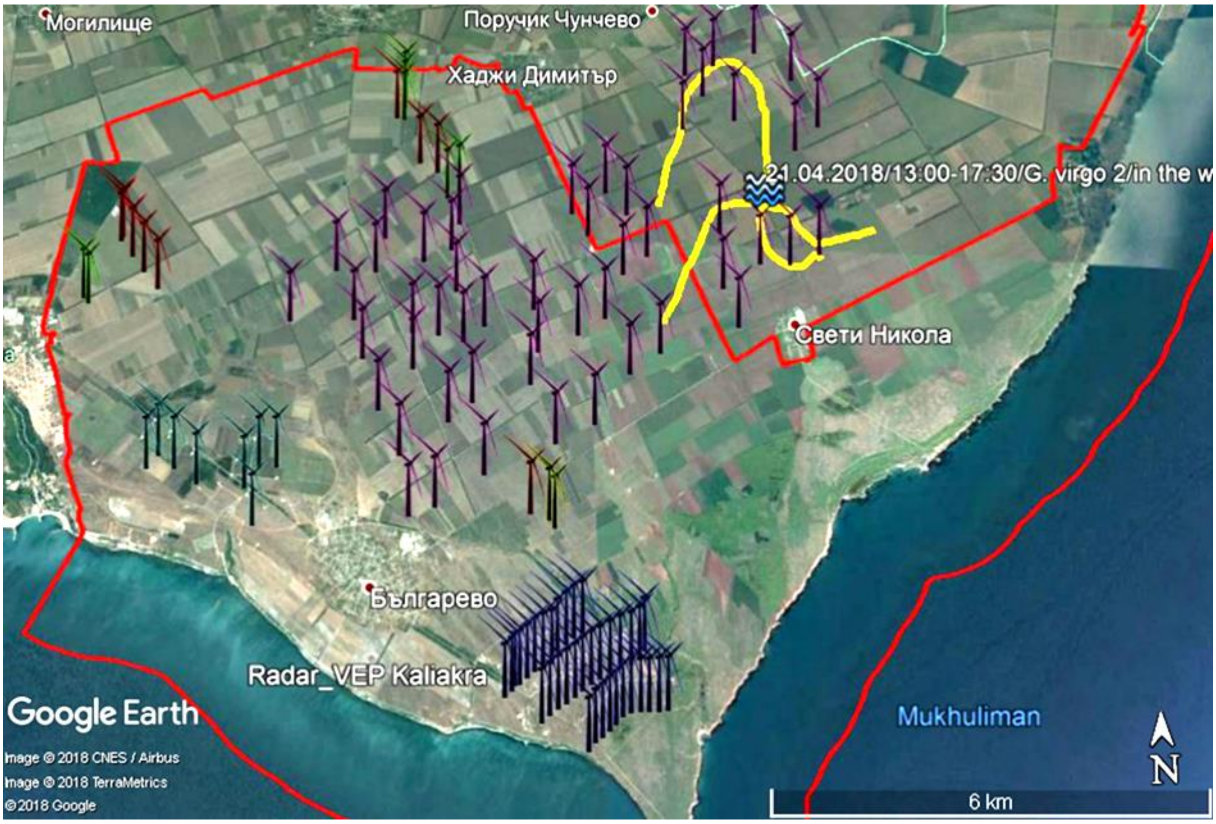
5.6. Observed flocks of target bird species for ISPB as observed in spring migration 2018 in ISPB.



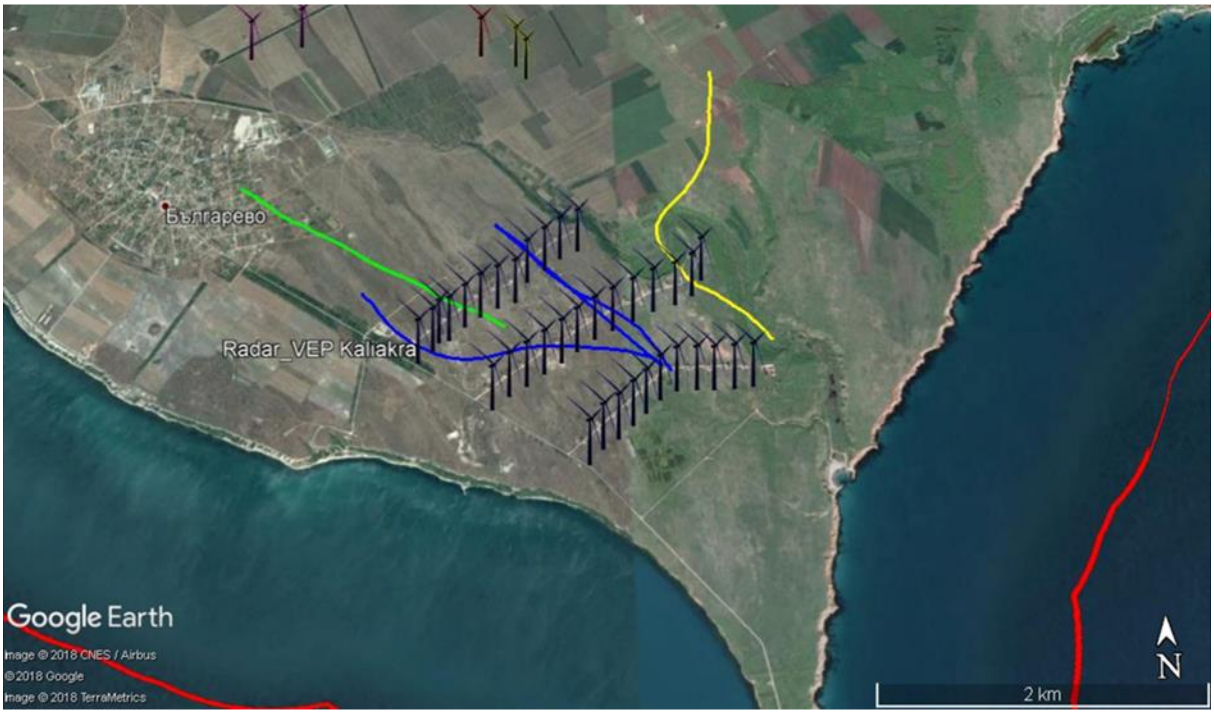
Green - 240 White Pelicans 25.03.2018, Pink - 67 White Stork 25.03.2018, and Yellow – 13 and 48 Common cranes observed 29.03.and 30.03.2018 respectively.



Flock of 19 White pelicans 02.04.2018



In Yellow are shown the movements of 2 Demoiselle cranes, remaining in the area of temporary wetland among the agricultural lands from 18.04.2018 until 21.04.2018



In Yellow are shown the movements of 1 Demoiselle crane on April 24, 2018, in blue movements of a flock of 12 Demoiselle cranes on 26.04 and in a green flock of 4 Demoiselle cranes on 27.04.2018.

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 spring migrating birds, each of the 114 turbines covered by the ISPB programme was checked at least once a week for collision victims. According to previously performed carcass removal and searcher efficiency tests during autumn migration and in winter at SNWF (and repeated in spring 2018 with similar results), this search regime of weekly searches provides for a cost-effective method, which can also be calibrated, to discover any bird strike fatalities which may be of concern. Hence a frequency of four searches per month under every turbine allows estimation of the mortality of the birds from a collision with the turbines in the ISPB. For details, see previous studies of: http://www.aesgeoenergy.com/site/Studies.html

The total number of searches and the distribution of turbine searches is presented in Table 5.

Table 5. Number of turbines searched for collision victims in the territory of ISPB during the period 15 March 15 May 2018. The Code of every turbine use the abbreviation of the wind farm and the number of the turbine. Used in the table abbreviations of wind farms: ABZevs - Zevs Bonus OOD, , Wind Park Kavarna East EOOD, Wind Park Kavarna West EOOD, Millennium Group OOD and Long Man Energy OOD, АВГ - Long Man Invest OOD, ABMillenium group - Windex OOD, AE - AES Geo Energy Ltd, DBГ -Degrets OOD, DC - Disib OOD, E - EVN Kavarna, M - Kaliakra Wind Power, VP - Vertikal-Petkov & Sie SD

Turbine	March	April	May	Total
ABBalgarevo	3	4	2	9
ABГ1	3	5	2	10
ABГ2	3	5	2	10
ABГ3	3	5	2	10
ABГ4	4	5	2	11
ABZevs	2	5	2	9
ABMillenium group	3	4	3	10
ABMillenium group	3	4	1	8
AE10	2	5	2	9
AE11	1	5	2	8
AE12	3	4	2	9
AE13	3	3	2	8
AE14	2	5	2	9
AE15	2	5	2	9
AE16	3	4	2	9
AE17	3	4	2	9
AE18	3	4	3	10
AE19	3	4	3	10
AE20	2	4	2	8
AE21	2	5	2	9
AE22	2	5	2	9
AE23	2	5	2	9
AE24	2	5	2	9
AE25	2	5	2	9
AE26	2	5	2	9
AE27	3	4	2	9
AE28	2	4	2	8
AE29	2	5	2	9
AE31	2	4	2	8
AE32	3	4	2	9
AE33	3	4	2	9
AE34	3	4	2	9
AE35	3	4	2	9
AE36	2	7	2	11
AE37	3	5	2	10
AE38	2	6	2	10
AE39	2	5	2	9
AE40	2	5	2	9
AE41	2	5	2	9
AE42	2	5	2	9
AE43	2	5	2	9
AE44	2	5	2	9
AE45	3	4	2	9
AE46	2	4	3	9
AE47	2	4	3	9
AE48	2	4	3	9
AE49	2	4	3	9
AE50	2	3	2	7
AE51	3	5	2	10

Turbine	March	April	May	Total
AE52	3	5	2	10
AE53	3	5	2	10
AE54	3	5	2	10
AE55	3	5	2	10
AE56	3	5	2	10
AE57	3	5	2	10
AE58	3	5	2	10
AE59	3	5	2	10
AE60	3	3	2	8
AE8	2	4	2	8
AE9	2	5	2	9
DBГ1	1	5	2	8
DBГ1HSW250	2	5	2	9
DBГ2	1	5	2	8
DBГ2MN600	2	5	2	9
DBГ3	1	5	2	8
DBГ4	1	4	2	7
DBГ5	3	4	2	9
DC1	3	4	2	9
DC2	3	4	2	9
E00	2	4	2	8
E01	2	5	2	9
E02	1	5	2	8
E04	2	5	2	9
E05	2	5	2	9
E07	1	5	2	8
E08	2	5	2	9
E09	2	4	2	8
M1	3	4	2	9
M10	2	4	2	8
M11	2	4	2	8
M12	2	4	2	8
M13	3	4	2	9
M14	3	4	2	9
M15	3	4	2	9
M16	3	4	2	9
M17	3	4	2	9
M18	3	4	2	9
M19	3	4	2	9
M2	3	4	2	9
M20	3	4	3	10
M21	3	4	3	10
M22	3	4	3	10
M23	3	4	3	10
M24	3	4	3	10
M25	2	4	3	9
M26	2	4	3	9
M27	2	4	3	9
M28	2	5	2	9

Turbine	March	April	May	Total
M29	2	5	2	9
M3	3	4	2	9
M30	2	5	2	9
M31	2	5	2	9
M32	2	5	2	9
M33	2	5	2	9
M34	2	5	2	9
M35	2	5	2	9
M4	2	4	2	8

Turbine	March	April	May	Total
M5	2	4	2	8
M6	2	4	2	8
M7	2	4	2	8
M8	2	4	2	8
M9	2	4	2	8
VP1	3	4	2	9
VP2	3	4	2	9
total	**272**	**510**	**242**	**1024**

Fourteen records of birds' remains were documented during the 1024 searches under individual turbines during the 2018 spring migration of birds in ISPB territory. Most numerous were records of single feathers and groups of feathers (Table 6). There were five records of feather groups and one single feather. Such findings of single feathers as well as groups of body feathers are often remains of hunting and feeding of raptor species in the wind farms.

Table 6. Records of bird remains recorded by 1024 searches under the ISPB study area's turbines during the 2018 spring migration.

Species name	***Feathers***	***Feather***	***Intact***	***Part of the body (wings)***	***Total***
Alauda arvensis			*1*		*1*
Accipiter nisus			*1*		*1*
Asio otus			*1*		*1*
Buteo buteo			*1*	*1*	*2*
Carduelis carduelis				*1*	*1*
Larus sp.	*1*	*1*			*2*
Motacilla alba	*3*				*3*
Perdix perdix	*1*		*1*		*2*
Phylloscopus sp.				*1*	*1*
Grand Total	***5***	***1***	***5***	***3***	***14***

Findings of intact carcasses or parts of bird body caused by physical trauma by a blade-like instrument can be evidence of collision with turbines. The state of one of the intact bodies discovered during the survey period, that of a Eurasian sparrowhawk (*Accipiter nisus*), can be referred to a period preceding spring migration as it probably dated back several months previously, because it was found in a dry, mummified state. Similar conditions related to a recorded European goldfinch (*Carduelis carduelis*) and a warbler of the genus *Phylloscopus* sp., which hindered the exact identification of the causes of death.

Among the confirmed collision victims during the study period were a Skylark, a Common buzzard, Long-eared owl and Grey partridge (Tables 6 & 7). All bird species found as collision victims (Table 7) were not among the target species for ISPB (the target species are listed at https://kaliakrabirdmonitoring.eu/).

No case of collision with the turbines of a target bird species for the period of TSS application in ISPB was registered during the monitoring in spring 2018.

Table 7. Confirmed collision victims and species' conservation status as recorded during the 2018 spring migration period.

English name	***Species name***	***Red Data Book***	***IUCN***
Skylark	*Alauda arvensis*	*Not Listed*	*Least Concern*
Common buzzard	*Buteo buteo*	*Not Listed*	*Least Concern*
Long-eared owl	*Asio otus*	*Not Listed*	*Least Concern*
Grey partridge	*Perdix perdix*	*Not Listed*	*Least Concern*

6. CONCLUSIONS

1) During the monitoring, there were no apparent changes in the main characteristics of the ornithofauna typical for the spring 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 during their spring migration.

3) The migration periods, the species composition, the dynamics in number of birds, the daily activity, the height of the flights, as well as the feeding, resting and sleeping 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, which involved the subject of this study.

4) The data presented in this report confirmed the absence of any adverse impact on sensitive bird species of the order Ciconiiformes, Pelecaniformes, Falconiformes, Gruiformes using migratory ascending air flows (thermals) for movement over long distances.

5) All these species were found to occasionally cross the study site, and their observed behaviour in respect to wind turbines did not indicate major changes which would impact on the energetics of these species during daily movements.

6) The quantitative characteristics of bird migration in the ISPB area during spring 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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