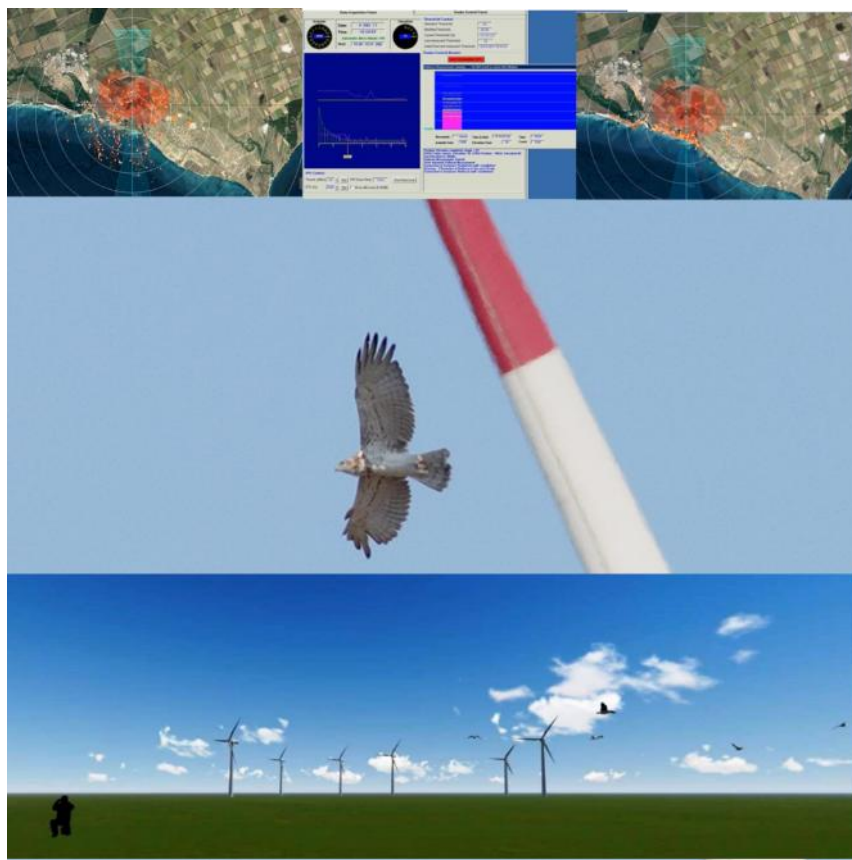




INTEGRATED SYSTEM FOR PROTECTION OF BIRDS

REPORT

Monitoring of the migration of birds through the territory of the Integrated System for Protection of Birds, Autumn 2025



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CONTENTS

1. INTRODUCTION.....	3
2. OBJECTIVES AND TASKS OF THE STUDY	5
3. ORNITHOLOGISTS WHO CARRIED OUT THE SURVEY	5
4. MATERIAL AND METHODS.....	6
5. RESULTS.....	6
5.1. SPECIES COMPOSITION AND NUMBER OF BIRDS	6
5.2. FREQUENCY OF APPEARANCE.....	12
5.3. DIRECTION OF MIGRATING BIRDS.....	14
5.4. ALTITUDE OF BIRDS	15
5.5. ORDERED WIND TURBINE STOPS DURING THE AUTUMN MIGRATION PERIOD.....	16
5.6. OBSERVED FLOCKS OF TARGET BIRD SPECIES FOR ISPB AS DOCUMENTED IN AUTUMN MIGRATION 2025.....	17
5.7. ANALYSIS OF THE RECORDED ADDITIVE MORTALITY CAUSED BY WIND TURBINES ON THE BIRD POPULATIONS PASSING THROUGH THE ISPB TERRITORY.....	21
6. CONCLUSIONS.....	23
REFERENCES	24

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, Millennium Group OOD and Mark Energy OOD in order to collect and summarize the information about the performance of the Integrated System for Protection of Birds (ISPB) that includes 115 wind turbines, 95 of which are within the Kaliakra SPA BG0002051 and 20 are in the areas adjacent to the protected zone (Figure 1).

Detailed information on the scope, technical rules and monitoring procedures are publicly available at a dedicated website (https://kaliakrabirdmonitoring.eu/Methodology_of_ISPB) as well as in seven previous reports on autumn migration in 2018, 2019, 2020, 2021, 2022, 2023 and 2024 respectively

([https://kaliakrabirdmonitoring.eu/Report Autumn Bird Migration, 2018](https://kaliakrabirdmonitoring.eu/Report_Autumn_Bird_Migration,_2018;);
[https://kaliakrabirdmonitoring.eu/Report Autumn Bird Migration, 2019](https://kaliakrabirdmonitoring.eu/Report_Autumn_Bird_Migration,_2019;);
[https://kaliakrabirdmonitoring.eu/Report Autumn Bird Migration, 2020](https://kaliakrabirdmonitoring.eu/Report_Autumn_Bird_Migration,_2020;);
[https://kaliakrabirdmonitoring.eu/Report Autumn Bird Migration, 2021](https://kaliakrabirdmonitoring.eu/Report_Autumn_Bird_Migration,_2021;);
[https://kaliakrabirdmonitoring.eu/Report Autumn Bird Migration, 2022](https://kaliakrabirdmonitoring.eu/Report_Autumn_Bird_Migration,_2022;);
[https://kaliakrabirdmonitoring.eu/Report Autumn Bird Migration, 2023](https://kaliakrabirdmonitoring.eu/Report_Autumn_Bird_Migration,_2023;);
[https://kaliakrabirdmonitoring.eu/Report Autumn Bird Migration, 2024](https://kaliakrabirdmonitoring.eu/Report_Autumn_Bird_Migration,_2024)).

Figure 1 presents the locations of all 115 wind turbines within the study area covered by the ISPB.

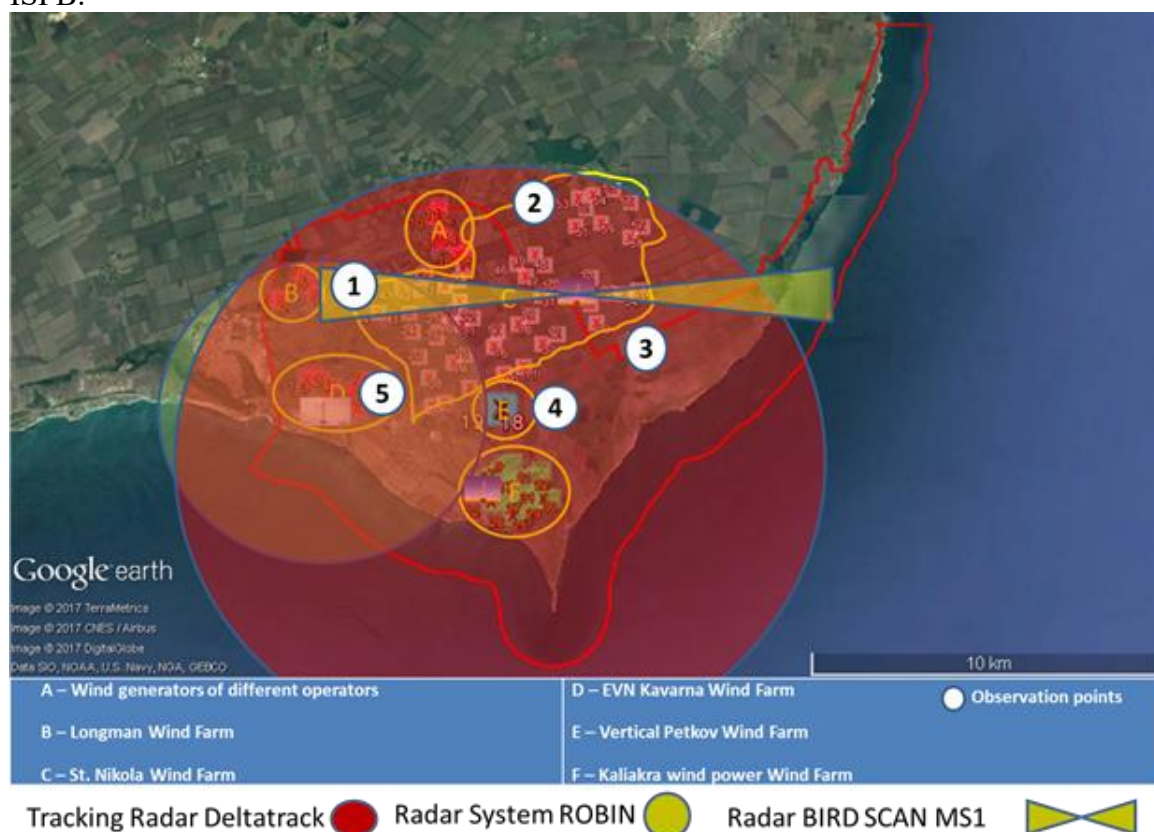


Figure 1. A satellite photo with the location of the wind turbines covered by the ISPB and the boundaries of Kaliakra SPA (shown by the red line), together with the scope of three radar systems.

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: “... *relatively big number of studied*

sites in the last years allows drawing a line, which connects the sites with most numerous soaring migrants along Via Pontica: VP20 Slaveevo, VP8 Izvorsko, VP4 Bryastovets and Burgas”. (Michev et al., 2012 <http://acta-zoologica-bulgarica.eu/downloads/acta-zoologica-bulgarica/2012/64-1-033-041.pdf>) (Figure 2).



Figure 2. Orientation of vantage points with strongest aggregations of birds during autumn migration along the core axis of Via Pontica according to data from Michev et al. (2012)

Over the past sixteen 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 Kaliakra Cape is, indeed, away from the main migratory Via Pontica migration corridor. To date, moreover, these surveys have found no evidence of significant impacts due to wind turbines on the populations of recorded and target species.

Under an agreement to establish and operate the ISPB, the ornithofauna was monitored during autumn migration in 2018, 2019, 2020, 2021, 2022, 2023, 2024 on the above-mentioned territory and reports are published at <https://kaliakrabirdmonitoring.eu/>.

This report covers the eighth autumn migration season (01.08 - 31.10.2025) in ISPB territory. The collected information was used to assess the effectiveness of the application of ISPB in Kaliakra in the Autumn of 2025.

Taking into account the geographical location of the site and previous research (monitoring reports from 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 of migration https://natura2000.egov.bg/PublicDownloads/Auto/OtherDoc/276296/276296_Birds_120.pdf, we consider the period covered in our study as optimal and representative for autumn bird migration of all target ISPB species (page 1 point 2.2.Target Bird Species <https://kaliakrabirdmonitoring.eu/Methodology of ISPB>).

The study is specifically focused on target ISPB species which are diurnal migrants. The data for all bird species flying over the territory, deemed as vulnerable to direct collision with wind energy facilities, are presented in this report.

2. OBJECTIVES AND TASKS OF THE STUDY

The main objectives of this monitoring study are to determine the quantitative characteristics of migratory birds in the area of ISPB during autumn migration, to assess the effectiveness of the Turbine Shutdown System (TSS) applied here, in order to reduce the risk of collision mortality for target birds, and to evaluate the impact of the wind farms on birds during autumn migration.

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

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 study territory for feeding birds of prey.
3. Proportion of migrating birds in respect to the Western Black Sea migratory flyway - Via Pontica.

3. ORNITHOLOGISTS WHO CARRIED OUT THE SURVEY

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

More than 35 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.

Over 18 years of experience in impact monitoring study of wind turbines in the study area.

➤ **Veselina Raikova - Field ornithologist**

Natural History Museum of Varna. Member of BSPB. Author of more than 10 publications in international scientific journals. Over 15 years of experience in impact monitoring study of wind turbines in the study area.

➤ **Hristo Gardov – Field ornithologists**

Experienced biologist, participant in number of field studies of birds as part of many conservation projects. BSPB active member. Member of The Wildlife Conservation Society (WCS) and member of the management of the organization.

➤ **Nikolay Yordanov – Field ornithologists**

PhD student at Institute of Biodiversity and Ecosystem Research at the Bulgarian Academy of Sciences. Master student in Sofia University, Faculty of Biology. Two years of experience in monitoring soaring birds in preconstruction stage of WF projects. Responsible for Radar application in the field survey of birds.

➤ **Svetoslav Stoianov - Field ornithologist**

Bachelor in Biology diploma from Shumen University. Participant in numerous conservation projects of BSPB – BirdLife Bulgaria. Midwinter counts of waterfowl birds in Bulgaria and white stork census expert. Monitoring the migration of birds species composition and the number of nesting fauna 2007-2012 "Ecotan" EOOD. Over 15 years of experience in impact monitoring study of wind turbines in the study area.

➤ **Jelyazko Dimitrov Dimitrov - Field ornithologist**

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

➤ **Vasil Panayotov Dimitrov - Field ornithologist**

Trained to monitor the severity of collisions of birds with wind turbines. Representative of local conservation organization in Balgarevo, Kavarna.

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/Preporaki%20Rykwodstwa%20Dokladi/Metodika_VEP.pdf) for the implementation of TSS in the Protected territories of Natura 2000 network of Bulgaria. Field observation protocols being part of the technical rules followed Bibby et al. (1992) and Michev et al. (2010, 2011) and were used to study the autumn migration of birds in the territory covered by ISPB.

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

The assessment of the effectiveness of the Turbine Shutdown System (TSS) utilizes the methodology developed in the USA (Morrison 1998) for monitoring bird collision with the turbines (and see methods described in [https://kaliakrabirdmonitoring.eu/Methodology of ISPB](https://kaliakrabirdmonitoring.eu/Methodology%20of%20ISPB)).

All details about the application of the radar systems in the ISPB, ornithological methods, generic protocol for visual observations, site-specific protocol for visual observations, bird data records' collation, and physical characteristics of the study area were given before in the Methodology of ISPB, as well as in previous reports dedicated to spring and autumn migration 2018, 2019, 2020, 2021, 2022, 2023 and 2024 are available from the web site of ISPB <https://kaliakrabirdmonitoring.eu/Reports>.

5. RESULTS

5.1. Species composition and number of birds

The monitoring from 1 August to 31 October 2025 recorded 51362 individual birds, assigned to 57 bird species. For comparison, the total number of observed birds of all species in 2018, 2019, 2020, 2021, 2022, 2023 and 2024 were 16973, 11105, 12079, 22983, 26437, 42983 and 13594 respectively. Comparisons of the observed monthly number of birds in eight consecutive migratory seasons are presented in Figure 3.

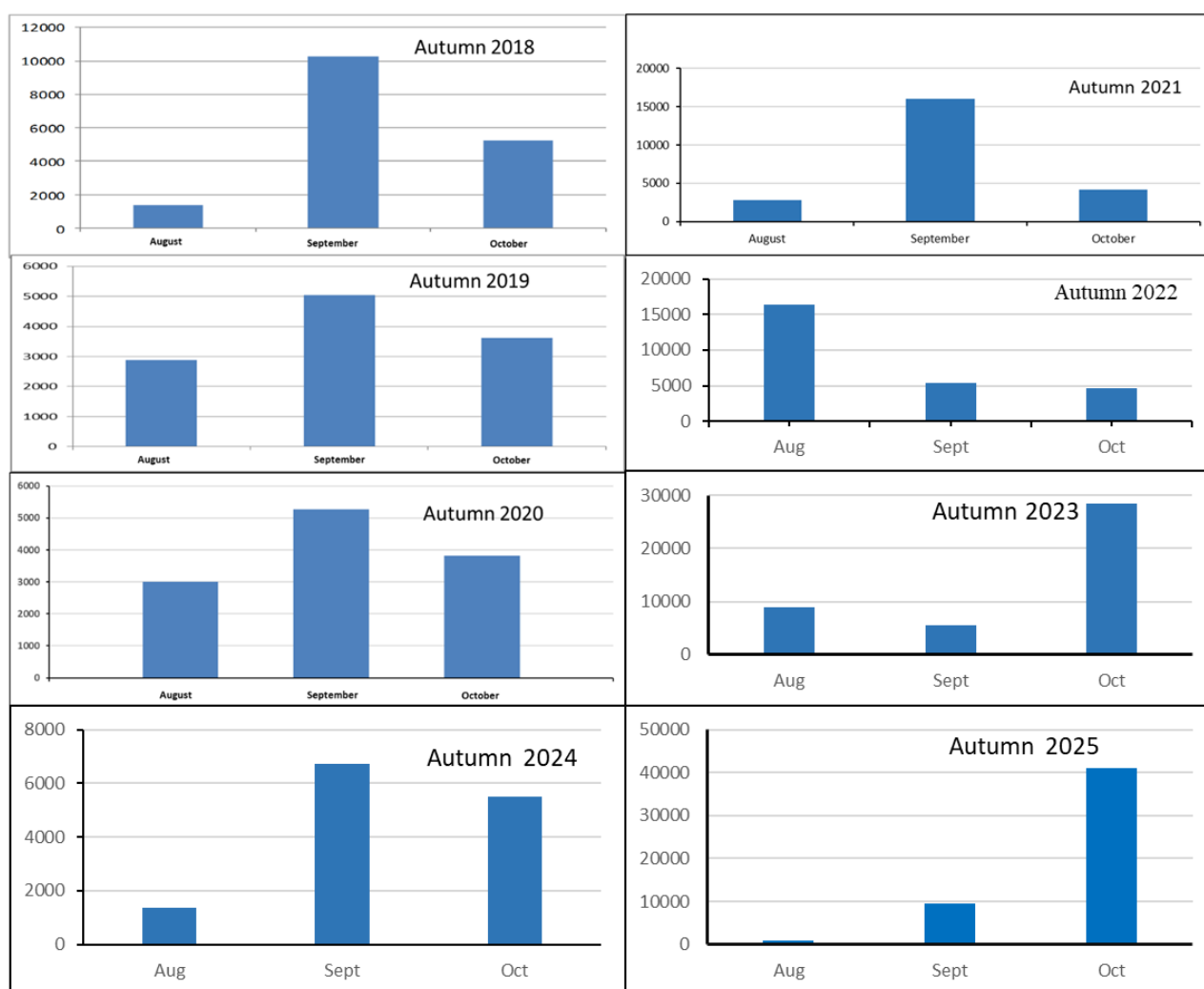


Figure 3. Number of registered birds by months during the autumn migration period in the territory of ISPB in 2018, 2019, 2020, 2021, 2022, 2023, 2024 and 2025.

The number of birds in the ISPB study area apparently depended on the direction of the wind in autumn. The strong correlation of wind direction in the region and number of birds observed in the ISPB territory (Kalikara area) is supported by the direct comparison of days with westerly winds and number of birds registered for the whole season, in eight consecutive years 2018, 2019, 2020, 2021, 2022, 2023, 2024 and 2025 (Figure 4).

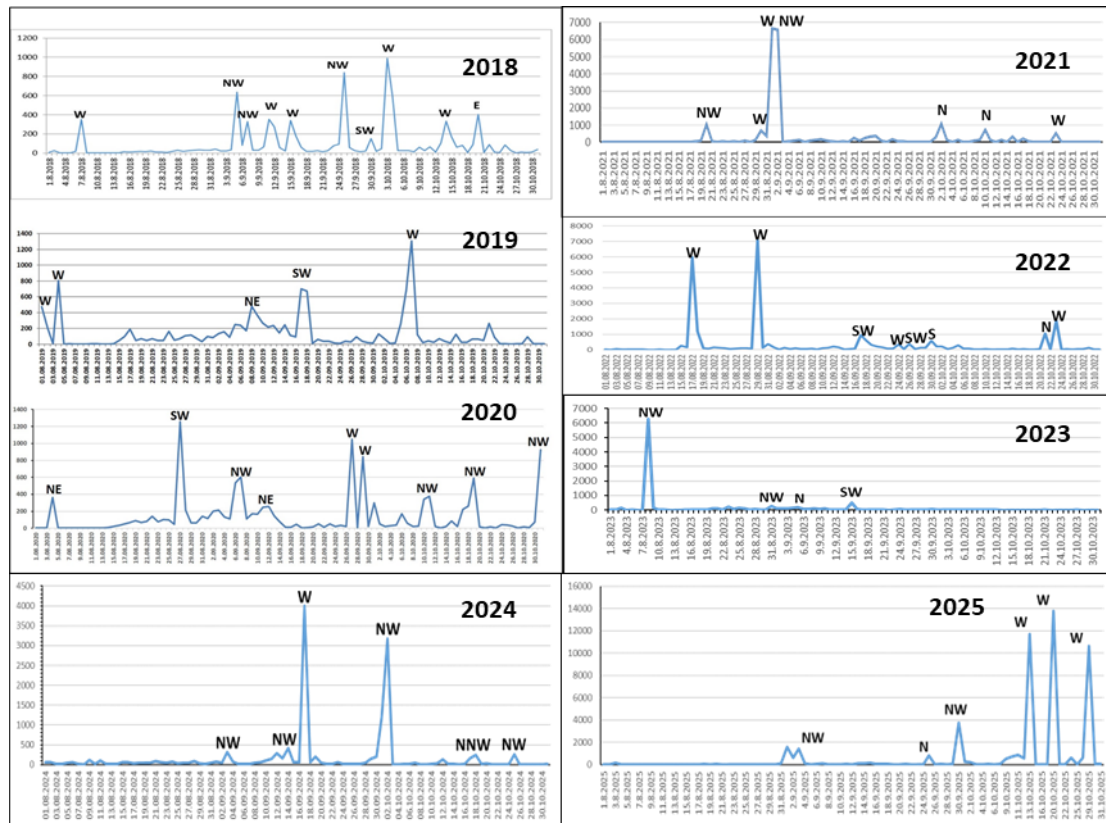


Figure 4. Dynamics of the autumn migration of soaring bird species in the ISPB territory according to visual observations during the autumn migration in 2018, 2019, 2020, 2021, 2022, 2023, 2024 and 2025. Letters above spikes indicate the direction of wind in days with increased numbers of migrating birds.

This pattern in the number of birds recorded in Kaliakra in respect to westerly wind directions in autumn was confirmed in many previous studies at the St. Nikola Wind Farm (SNWF) which forms a major part of the ISPB territory (see reports <http://www.aesgeoenergy.com/site/Studies.html>).

The numbers of individuals recorded by species during autumn migration in eight autumn seasons are shown in Table 1.

Table 1. Composition of species and number of registered birds over the period 01 August to 31 October 2018, 2019, 2020, 2021, 2022, 2023, 2024 and 2025 in the ISPB territory

Species name	Autumn 2018	Autumn 2019	Autumn 2020	Autumn 2021	Autumn 2022	Autumn 2023	Autumn 2024	Autumn 2025
<i>A. alba</i>	0	0	0	5	0	0	1	0
<i>A. brevipes</i>	309	123	110	194	175	32	77	122
<i>A. gentilis</i>	1	5	8	1	9	1	4	3
<i>A. nisus</i>	242	185	244	150	144	79	106	142
<i>A. cinerea</i>	21	8	37	49	3	0	5	100
<i>A. clanga</i>	0	1	0	0	0	0	0	0
<i>A. otus</i>	0	0	0	0	1	0	0	0
<i>A. purpurea</i>	2	0	0	1	0	1	0	0
<i>A. pennata</i>	30	15	40	17	31	0	0	17
<i>A. nipalensis</i>	0	0	1	0	0	0	0	0
<i>A. heliaca</i>	0	0	2	1	1	2	0	0
<i>A. melba</i>	0	35	0	0	0	0	3	70
<i>A. monachus</i>	0	0	0	0	0	0	0	1
<i>A. apus</i>	0	100	0	0	88	128	21	0
<i>B. buteo</i>	2642	1980	2965	615	720	387	1215	782
<i>B. oedicnemus</i>	0	0	0	0	0	1	73	0
<i>B. rufinus</i>	58	13	45	8	35	22	5	29

<i>Species name</i>	<i>Autumn 2018</i>	<i>Autumn 2019</i>	<i>Autumn 2020</i>	<i>Autumn 2021</i>	<i>Autumn 2022</i>	<i>Autumn 2023</i>	<i>Autumn 2024</i>	<i>Autumn 2025</i>
<i>B. lagopus</i>	3	1	15	0	2	0	0	0
<i>C. albus</i>	0	8	3	0	0	0	0	0
<i>C. aeruginosus</i>	442	180	264	202	321	115	117	103
<i>C. caeruleus</i>	0	0	0	0	0	30	0	0
<i>C. canorus</i>	0	0	0	0	0	1	2	1
<i>C. chloris</i>	0	0	0	0	0	15	0	0
<i>C. cyaneus</i>	37	15	16	18	11	1	7	5
<i>C. pygargus</i>	88	28	60	27	53	29	23	18
<i>C. pomarina</i>	232	29	22	27	124	18	114	68
<i>C. macrourus</i>	8	5	13	6	9	5	2	10
<i>C. gallicus</i>	94	50	59	63	67	38	48	29
<i>C. ciconia</i>	451	1557	1137	12859	14249	6386	6	1660
<i>C. clanga</i>	0	0	0	0	2	0	0	0
<i>C. nigra</i>	54	7	13	17	39	1	793	161
<i>C. garrulus</i>	1	37	3	14	8	1	11	7
<i>C. corax</i>	15	27	21	13	15	9	9	14
<i>C. cornix</i>	6	8	0	0	21	67	5	49
<i>C. coturnix</i>	0	0	0	1	0	0	1	1
<i>C. monedula</i>	35	0	0	0	37	107	7	304
<i>C. frugilegus</i>	14	0	0	0	119	8	37	626
<i>C. olor</i>	0	0	0	5	0	0	0	0
<i>C. oenas</i>	44	14	0	0	48	0	0	3
<i>C. crex</i>	0	1	0	0	0	0	13	0
<i>C. palumbus</i>	1200	2	0	500	1002	2002	7	26747
<i>D. urbica</i>	0	0	0	0	0	200	50	0
<i>E. calandra</i>	0	0	0	0	57	0	0	0
<i>E. garzetta</i>	1	0	0	0	0	0	0	0
<i>E. rubecula</i>	0	0	0	0	0	8	0	20
<i>F. coelebs</i>	0	0	0	0	0	153	0	4161
<i>F. colchicus</i>	0	0	0	0	0	2	0	0
<i>F. vespertinus</i>	472	149	1215	397	19	7	599	71
<i>F. subbuteo</i>	48	46	38	34	55	38	23	38
<i>F. peregrinus</i>	4	0	1	3	1	0	0	0
<i>F. tinnunculus</i>	272	161	176	94	311	176	127	101
<i>F. cherrug</i>	2	0	0	0	0	0	0	0
<i>F. columbarius</i>	2	2	1	0	0	1	0	0
<i>F. eleonora</i>	3	1	0	0	0	2	0	0
<i>F. parva</i>	0	0	0	0	0	0	1	11
<i>M. cinerea</i>	0	0	0	0	0	1	0	0
<i>M. migrans</i>	71	19	20	28	30	5	112	307
<i>M. milvus</i>	2	0	2	1	0	0	0	1
<i>M. alba</i>	414	0	0	0	0	120	0	1830
<i>M. apiaster</i>	2963	4314	3737	2374	4375	2623	1975	2321
<i>M. calandra</i>	1430	0	0	0	0	42	0	0
<i>M. striata</i>	0	0	0	0	0	0	1	0
<i>G. grus</i>	100	4	0	251	18	0	0	27
<i>G. gallinago</i>	0	0	0	0	4	0	0	0
<i>G. glandarius</i>	0	0	0	0	0	0	0	16
<i>G. virgo</i>	13	0	0	1	0	0	0	0
<i>G. fulvus</i>	0	0	1	1	2	0	6	0
<i>L. canus</i>	0	0	0	0	0	2000	439	0
<i>L. michahellis</i>	234	62	0	626	1119	2141	705	482
<i>L. melanocephalus</i>	0	0	0	450	1800	33	0	1410
<i>L. collurio</i>	0	0	0	0	0	0	1	0
<i>L. cachinnans</i>	0	0	1	0	0	0	0	0
<i>L. excubitor</i>	0	1	0	0	0	0	1	0
<i>L. fuscus</i>	1	0	0	1	0	0	0	0

Species name	Autumn 2018	Autumn 2019	Autumn 2020	Autumn 2021	Autumn 2022	Autumn 2023	Autumn 2024	Autumn 2025
<i>C. ridibundus</i>	0	0	0	35	0	0	0	76
<i>N. nycticorax</i>	0	12	0	0	0	0	0	0
<i>O. oenanthe</i>	0	0	0	0	0	2	0	0
<i>O. oriolus</i>	0	0	0	0	0	0	2	0
<i>H. minutus</i>	0	0	0	45	0	0	0	0
<i>H. albicilla</i>	1	1	1	0	0	0	0	0
<i>H. pennatus</i>	30	15	40	17	31	4	24	0
<i>H. rustica</i>	1000	86	1000	200	0	400	176	3900
<i>P. carbo</i>	576	512	332	319	114	118	189	325
<i>P. collybita</i>	0	0	0	0	0	1	2	235
<i>P. phoenicurus</i>	0	0	0	0	0	0	3	10
<i>P. onocrotalus</i>	2021	1243	0	1449	695	128	6211	4385
<i>P. crispus</i>	0	1	8	2	5	0	0	20
<i>P. apivorus</i>	801	9	96	1852	371	32	60	160
<i>P. haliaetus</i>	17	12	3	8	7	1	5	1
<i>P. leucorodia</i>	5	1	6	0	10	1	0	0
<i>P. ochrurus</i>	0	0	0	0	0	0	2	20
<i>P. roseus</i>	1	0	0	0	102	0	0	0
<i>P. sibilatrix</i>	0	0	0	0	0	1	0	0
<i>P. perdix</i>	10	25	0	0	0	24	0	12
<i>R. riparia</i>	76	0	0	17	0	210	25	0
<i>S. borin</i>	0	0	0	0	0	0	1	0
<i>S. communis</i>	0	0	0	0	0	0	1	0
<i>S. curruca</i>	0	0	0	0	0	0	2	0
<i>S. decaocto</i>	0	0	0	0	5	3	11	0
<i>S. nisoria</i>	0	0	0	0	0	0	1	0
<i>S. spinus</i>	0	0	0	0	0	30	0	10
<i>S. turtur</i>	0	0	0	0	3	2	8	0
<i>S. rubetra</i>	0	0	0	0	0	5	4	0
<i>S. torquatus</i>	0	0	0	0	0	0	0	3
<i>St. vulgaris</i>	400	0	360	0	0	24970	95	150
<i>V. vanellus</i>	4	0	2	0	0	0	0	0
<i>U. epops</i>	0	0	0	2	0	6	0	5
<i>T. ferruginea</i>	0	8	0	0	0	0	10	0
<i>T. troglodytes</i>	0	0	0	0	0	0	10	7
<i>T. nebularia</i>	0	0	0	0	0	1	0	0
<i>T. philomelos</i>	0	0	0	0	0	4	0	175

The most numerous migrating birds in Autumn 2025 were Common wood pigeons (*Columba palumbus*) with over 26000 individuals registered.

Among the soaring birds, the most numerous recorded birds were Great white pelicans (*Pelecanus onocrotalus*), White storks (*Ciconia ciconia*) and Common buzzards (*Buteo buteo*) with 4385, 1660 and 782 individuals of each species respectively (Table 2).

Three new species were recorded in Autumn 2025. Eurasian jay (*G. glandarius*), Cinereous vulture (*A. monachus*), European stonechat (*S. torquatus*). The appearance of Cinereous vulture is likely associated with the intensive reintroduction efforts of conservation projects in Bulgaria. The two other new species are common, and appearance of these birds is probably a reflection of changes in land use and crop structure around the observation points during the study period.

On recorded white stork numbers in autumn during ISPB studies, by year, these amounted to: 2018 - 451, 2019 - 1557, 2020 – 1137, 2021 – 12859, 2022 - 14249, 2023 - 6386, 2024 – 6 and 2025 - 1660. The lowest autumn count of white storks between 2018 and 2025 was in 2024, probably due to an absence of winds with northern components in the period of intensive migration of the species around the study area. The European nesting population of the white

stork is estimated to be between 180000 and 220000 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 (between 0.02 % and 6.5 % of the Via Pontica population) and the area still remains east of the main migratory route of white storks along the western Black Sea migration flyway. Strong fluctuations of white stork numbers have been observed in ISPB territory, in over 10 years of our monitoring in a part of the same territory (see autumn migration reports from AES Geo Energy at SNWF <https://www.aesgeoenergy.com/Studies.html>). In 2010, in two days at the end of August and beginning of September under westerly winds over 24000 white storks were observed over the same territory. The coincidence of westerly winds in Kaliakra with the days of most intensive migration of white storks over the whole territory of Bulgaria (30 August – 2 September) was associated with an increased number of white storks over Kaliakra.

The remaining registered bird species were also observed in low numbers in respect to total numbers of these species passing along the Via Pontica flyway, as observed previously in typical bottleneck sites – e.g. Burgas Bay (Michev et al. 2018). For example, counts of black storks (*C. nigra*) in Kaliakra have varied between 7 and 793 in contrast to Burgas where over 5000 black storks were observed in autumn 2017. Marsh harriers (*Circus aeruginosus*) counts varied from 180 to 442 in Kaliakra compared to 1468 in Burgas. Lesser-spotted eagles (*Clanga pomarina*) in Kaliakra varied between 22 and 232 in contrast to over 22000 in Burgas. Red-footed falcons (*Falco vespertinus*) counted in Burgas reached over 15000 in contrast to totals between 149 and 1215 in Kaliakra. The differing annual proportions of the most numerous birds of prey using the ISPB area during autumn migration are shown in Figure 5.

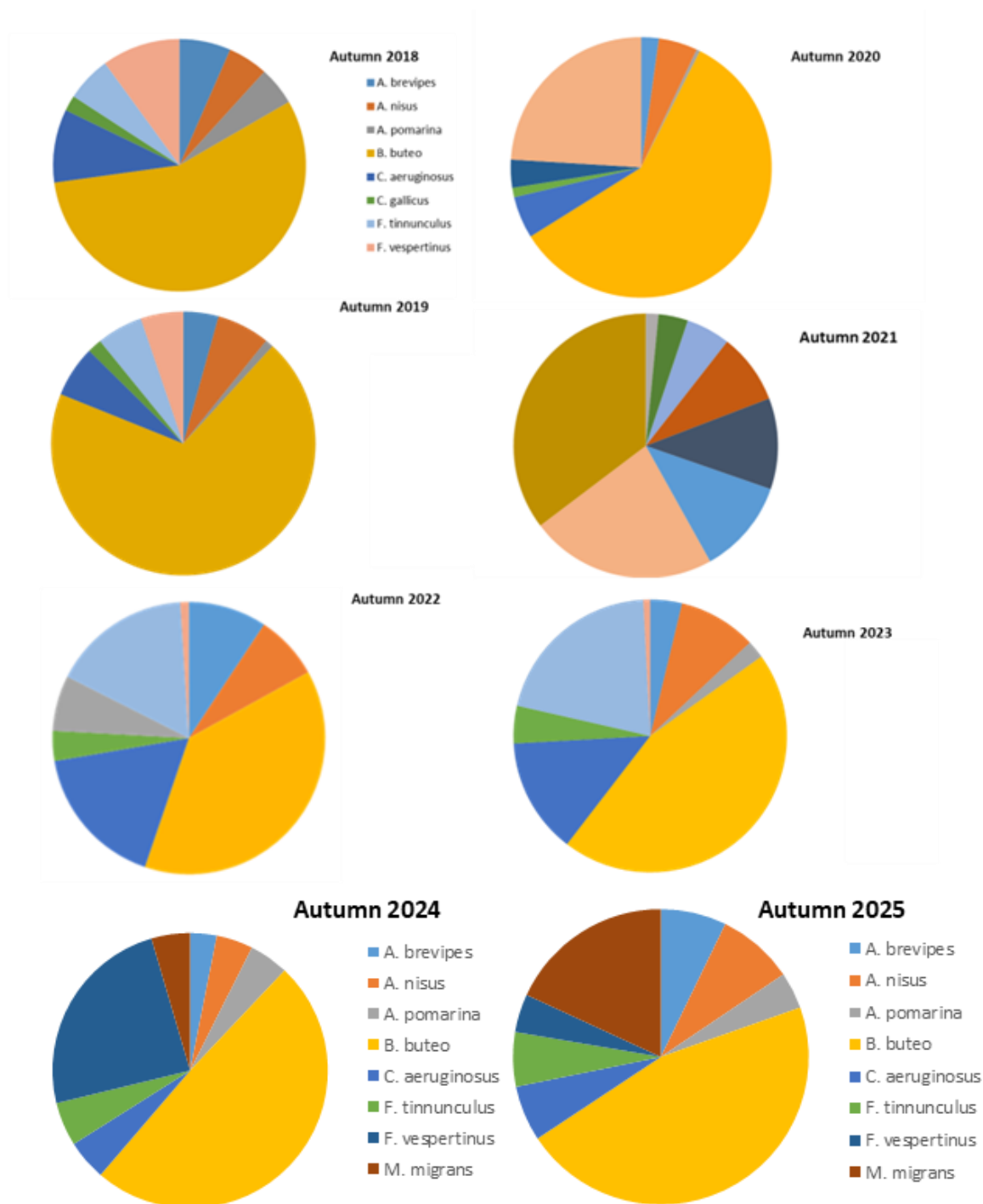


Figure 5. Proportional representations of the eight most numerous birds of prey recorded during autumn migration in 2018, 2019, 2020, 2021, 2022, 2023, 2024 and 2025.

5.2. Frequency of appearance

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 (OP), indicated in location by Figure 1, and on data presented in Table 2.

Activity of observed soaring birds in respect to wind turbines during the autumn migratory period did not indicate any avoidance of the area with turbines. The daily activity of autumn migratory birds from records collected in the ISPB study area is shown in Figure 6.

Table 2. Number of days with records of the most numerous soaring bird species, according to every observation point, during the period of monitoring in ISPB territory in 2025 autumn season.

Species	OP1	OP2	OP4	OP5
<i>A. brevipes</i>	6	16		100
<i>A. cinerea</i>	100			
<i>A. monachus</i>	1			
<i>A. nisus</i>	30	42	21	49
<i>A. pennata</i>	9			8
<i>C. pomarina</i>	51	13		4
<i>B. buteo</i>	42	539	7	194
<i>B. rufinus</i>	18	5		6
<i>C. aeruginosus</i>	36	35	1	31
<i>C. ciconia</i>	1295			365
<i>C. cyaneus</i>	1	2	1	1
<i>C. gallicus</i>	10		1	18
<i>C. macrourus</i>		8		2
<i>C. nigra</i>	1	149		11
<i>C. pygargus</i>	10	4		4
<i>F. subbuteo</i>	6	9	8	15
<i>F. tinnunculus</i>	16	65	3	17
<i>F. vespertinus</i>	34	19	10	8
<i>M. migrans</i>	20	221	3	63
<i>M. milvus</i>	1			
<i>P. apivorus</i>	160			
<i>P. crispus</i>	2			18
<i>P. haliaetus</i>				1
<i>P. onocrotalus</i>	629	1904		1852

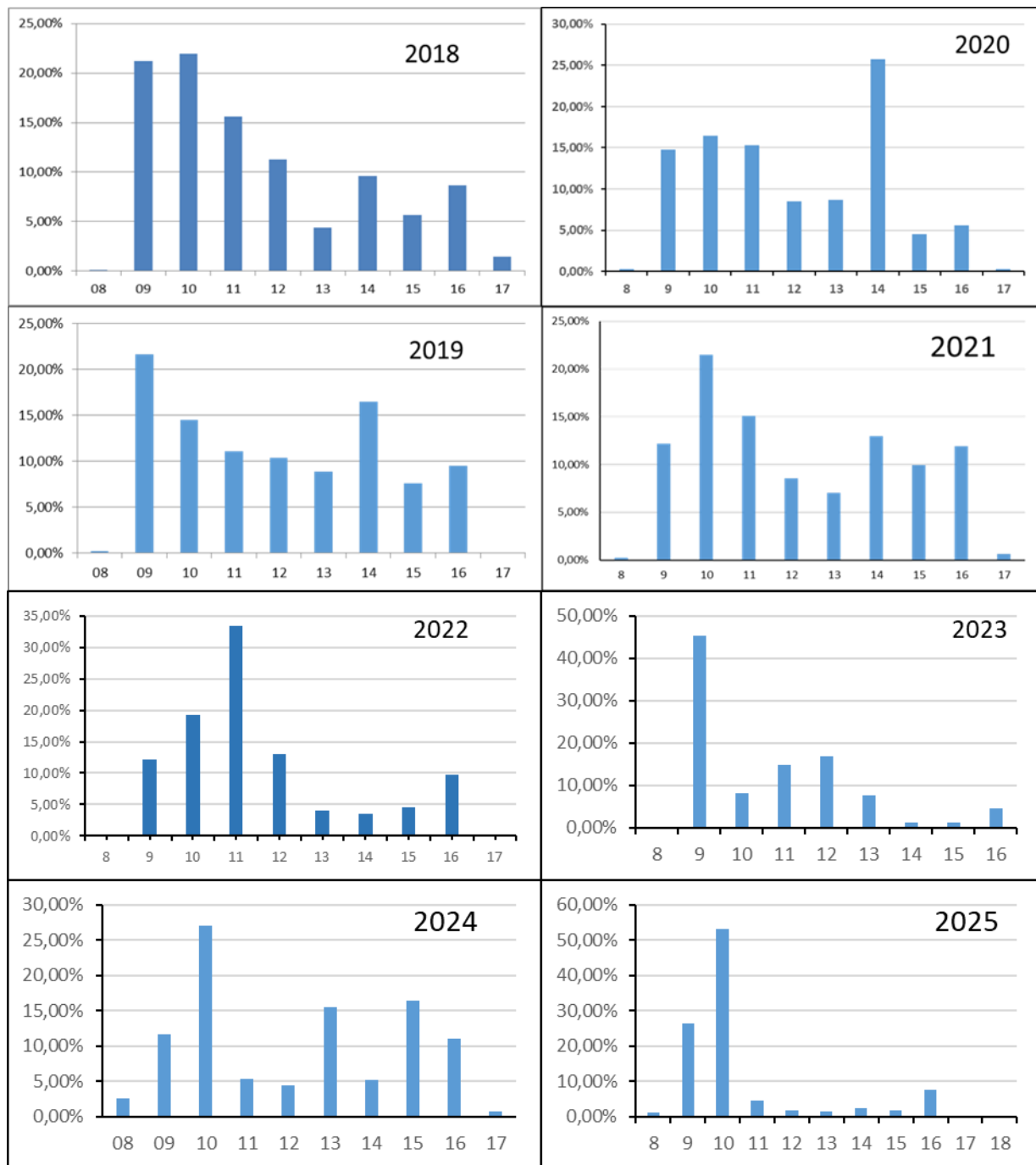


Figure 6. The dynamics of the presence of birds by hour of the day in the ISPB territory in the autumns of 2018, 2019, 2020, 2021, 2022, 2023, 2024 and 2025.

5.3. Direction of migrating birds

In order to examine a potential barrier effect of the study area's wind turbines on migrating birds we analysed deviation of the flight directions from the expected main migratory direction of autumn migration – southerly directions. An important parameter for determining the presence of a barrier effect is the degree of observed circumvention of the ISPB territory with its operating wind turbines. The recorded flight directions in autumn are presented in Table 3.

Table 3. Percentages of recorded birds by direction during autumn migration, in and approaching the territory of ISPB for the period 01 August – 31 October 2018, 2019, 2020, 2021, 2022, 2023, 2024 and 2025. In grey are the observed proportions (%) as expected for autumn migration migratory directions.

Direction	2018	2019	2020	2021	2022	2023	2024	2025
N	3,49%	1,51%	0,56%	1,73%	4,88%	1,69%	1,53%	1,92%
NE	8,73%	1,02%	1,40%	3,38%	8,74%	0,52%	3,87%	0,22%
NNE	0,02%		0,03%		0,19%	0,34%	3,29%	0,07%
NNW	0,01%	0,02%	0,12%	0,01%	0,27%	0,30%	0,20%	0,08%
NW	4,76%	1,77%	3,21%	0,54%	1,31%	6,00%	10,90%	0,87%
E	1,75%	5,83%	2,14%	2,05%	0,90%	1,14%	0,91%	0,25%
ENE						0,32%	0,07%	
ESE	0,09%		0,05%		0,03%	0,10%	0,05%	0,01%
SE	5,64%	7,01%	4,38%	3,74%	3,65%	3,01%	3,21%	0,08%
SSE	0,01%				1,04%	0,86%	0,20%	0,18%
S	41,52%	49,57%	35,58%	12,72%	14,48%	15,93%	4,30%	33,33%
SSW	0,12%		0,03%	0,68%	2,69%	1,62%	4,02%	24,70%
SW	20,43%	19,35%	43,06%	38,63%	48,01%	55,99%	14,14%	35,49%
WSW	0,71%	0,01%	0,04%	21,56%	1,02%	0,14%	13,37%	1,97%
W	12,70%	13,91%	9,24%	14,62%	12,74%	10,52%	18,09%	0,80%
WNW	0,02%		0,08%	0,12%	0,04%	1,52%	21,68%	

The observed flight directions in autumn 2025 showed a predominantly south and southwest movement, with more than 90% of all recorded individuals following this flight direction. The observed main direction of birds during all previous seasons was towards the south to southwest, with over 70 % of observations in 2018 to 2023 and over 40% in 2024 (Table 3). Within this pattern of movement, the tendency of many migratory birds (around 20 %) to be on a south/southwesterly direction is also probably an indication that when winds came from the west more birds were observed in ISPB (as noted above), having been diverted from the major Via Pontica migratory route to the west. A southwesterly flight direction is indicative of birds attempting to return to that route. A trend in that southwesterly direction, around a general southerly path, is also likely to be related to the study area's geography, in that a persistent southerly flight path across ISPB and beyond would take birds over the Black Sea which would curtail any further migration through lack of supporting winds. Therefore, there was no observed marked deviation from the seasonal expectation of migratory flight directions, which were centered around the south in eight consecutive years of monitoring. No changes were apparent in the migratory directions of the birds due to the presence of wind turbines.

5.4. Altitude of birds

In autumn 2025, the prevailing flight altitude was above 500 m, largely due to the numerous large flocks observed passing over the study area. No changes in flight height due to the proximity of wind turbines were observed. The distribution of migratory birds in height is shown in Figure 7.

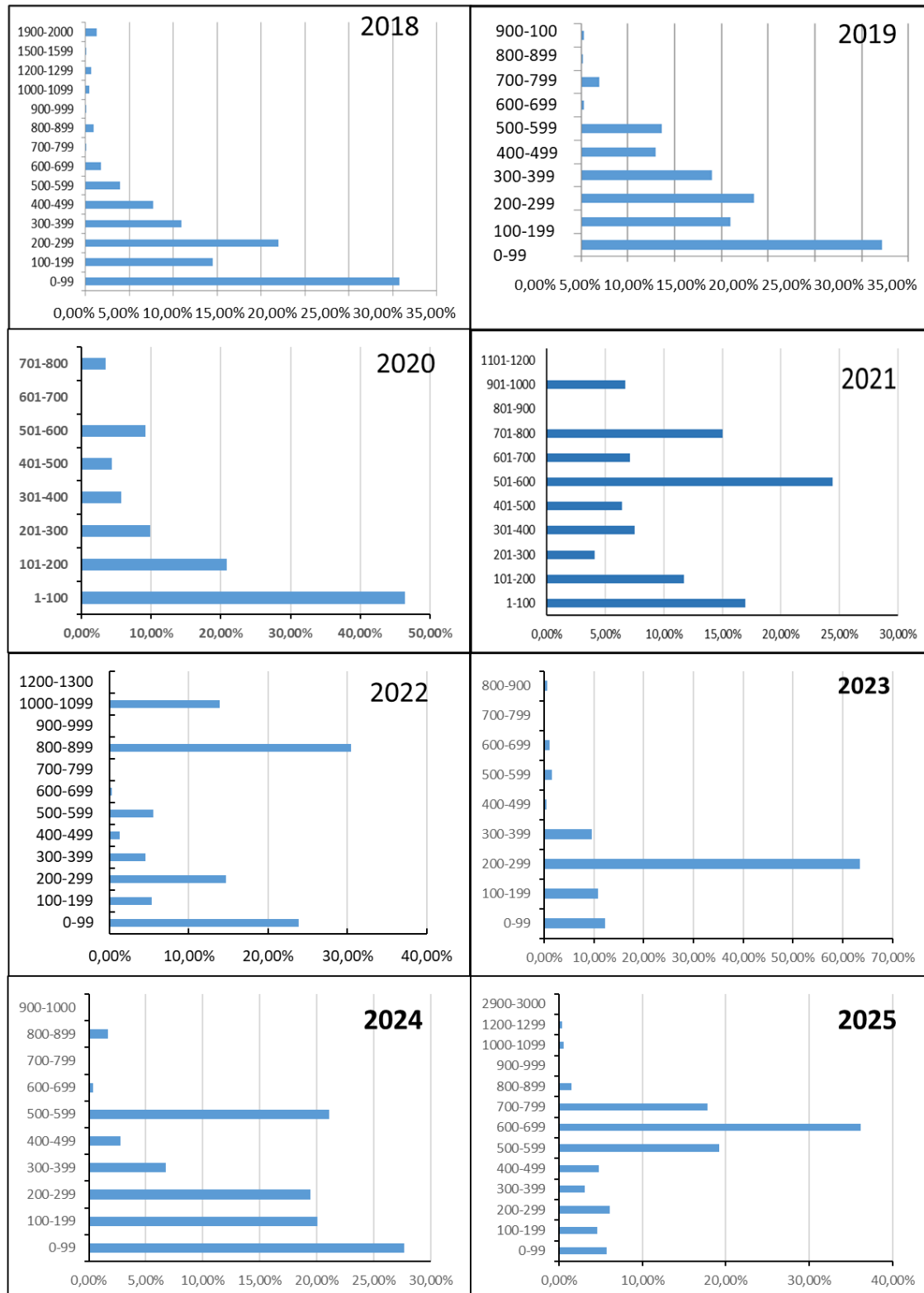


Figure 7. Proportional (expressed as %) distributions of passing birds by altitude (metres) in ISBP as observed in autumn 2018, 2019, 2020, 2021, 2022, 2023, 2024 and 2025 monitoring periods.

5.5. Ordered wind turbine stops during the autumn migration period

As a result of the simultaneous observations at four constant observation points and three radar systems (Figure 1) during the whole period of the 2025 autumn migration, there was only one brief stop of one group of turbines (AES – Group E) in the territory of the Kaliakra SPA and

adjacent territories. The stop orders given to the engineers on duty were executed in a timely manner, thus avoiding any collision risk of bird passing through the territory. Detailed information on the duration of the ordered stops and their reasons is given in Table 4

Table 4. Data for stops of wind turbines ordered by field observers during the autumn migration of birds 2025.

Date	Wind Farm	Turbine code №/ Group	Species	Number of birds	Time stop	Time restart
01.09.2025	AES	Group E	<i>C. ciconia</i>	400	09:51:00	10:00:00

5.6. Observed flocks of target bird species for ISPB as documented in autumn migration 2025

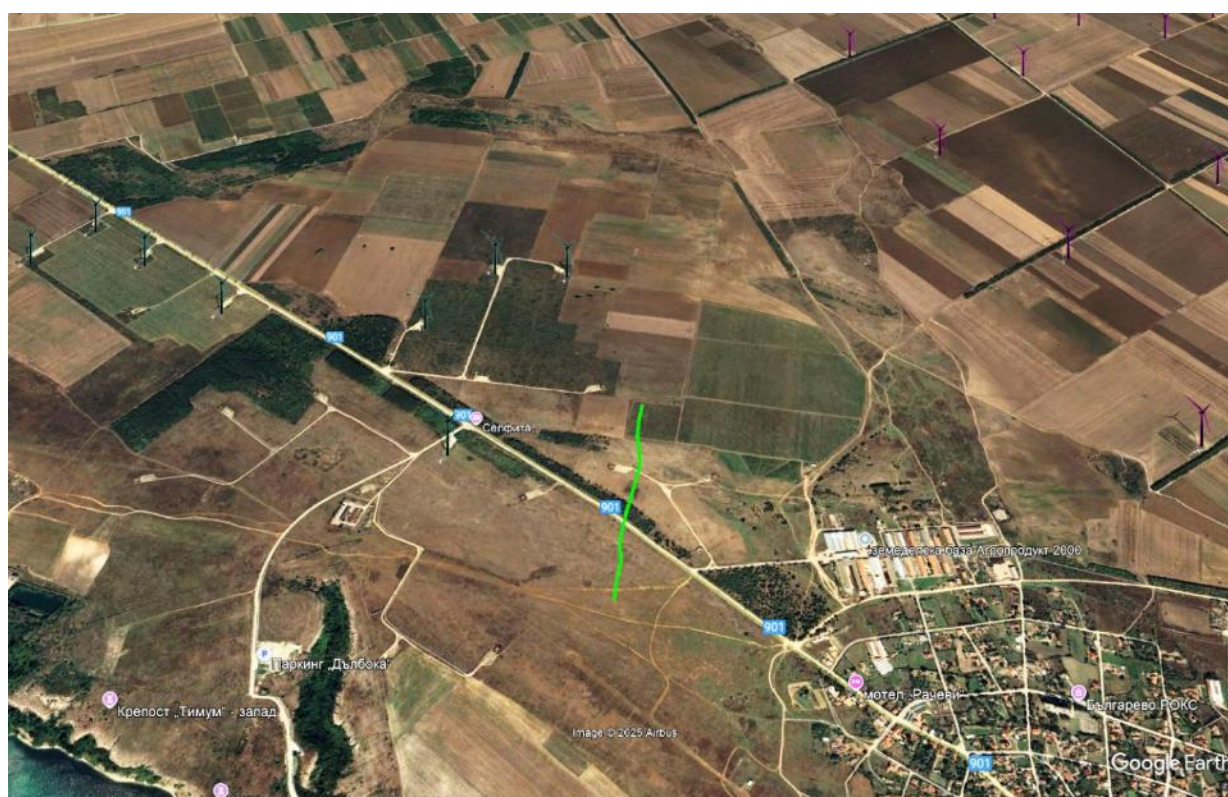


Figure 8. One flock of eight Great white pelicans (in green), recorded on 23 August 2025.

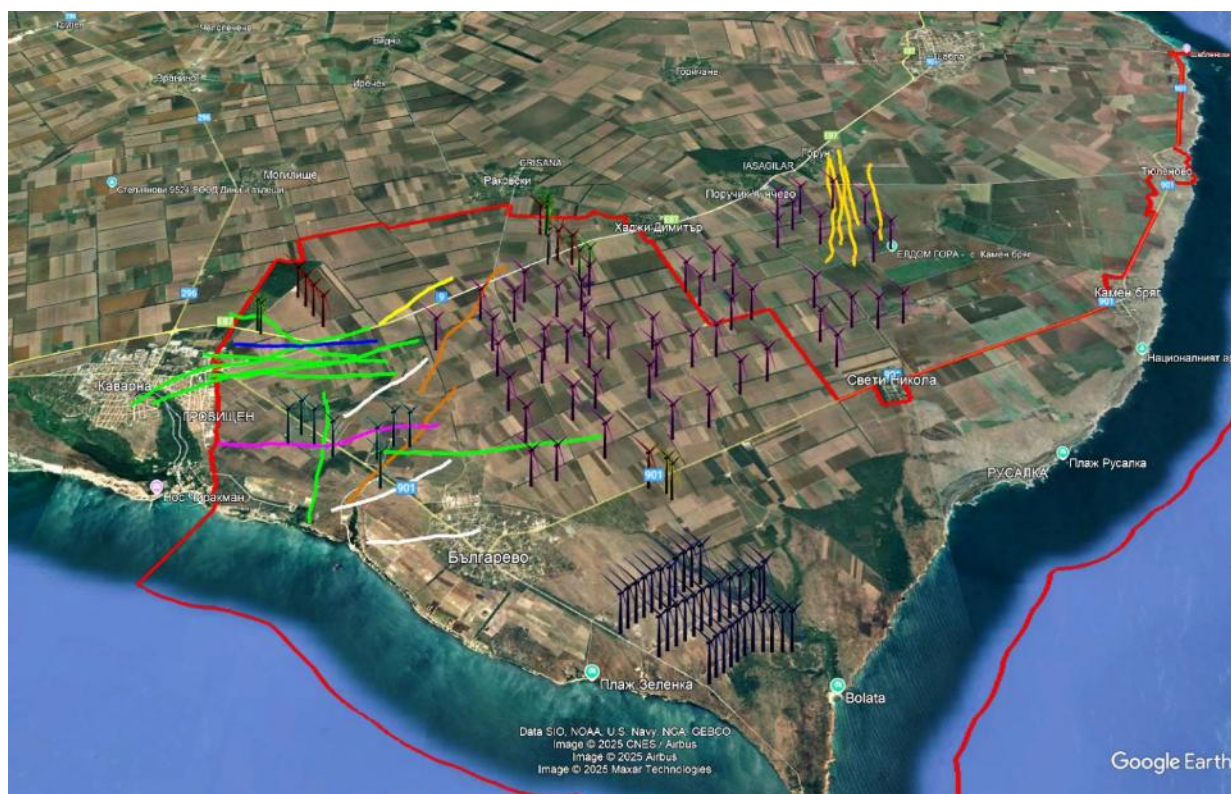


Figure 9. Flocks of 400, 180, 100, 105, 260, 190 and 60 White storks (in green), recorded on 1 September 2025; one flock of 160 European honey buzzards (in blue), recorded on 1 September 2025; flocks of 307 and 37 White storks (in brown), recorded on 2 September 2025; one flock of 15 Levant sparrowhawks (in yellow), recorded on 2 September 2025; flocks of 18, 25 and 15 Black kites (in white), recorded on 2 September 2025; flocks of 37, 45, 52, 38 and 47 Black kites (in orange), recorded on 3 September 2025; one flock of 30 Great cormorants (in pink), recorded on 7 September 2025.



Figure 10. One flock of 13 Black kites (in green), recorded on 18 September 2025.

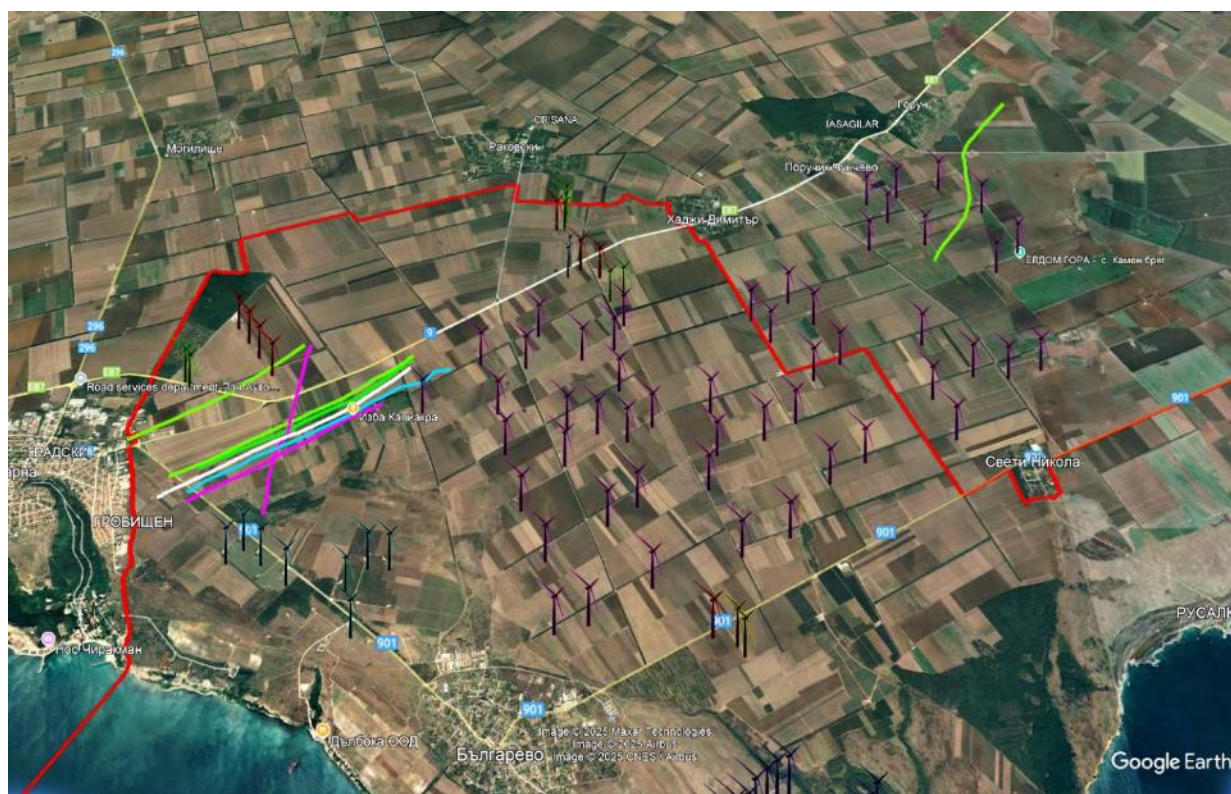


Figure 11. One flock of 100 Grey herons (in white); flocks of 10 and 13 Common kestrels (in pink); and flocks of 600, 19, 10 and 19 Great white pelicans (in green), recorded on 25 September 2025.



Figure 12. One flock of 10 White Storks (in pink), recorded on 30 September 2025; flocks of 1,600 and 250 Great white pelicans (in white), recorded on 30 September 2025; one flock of 120 Mediterranean gull (in yellow), recorded on 2 October 2025; and one flock of 6 Black storks (in green), recorded on 4 October 2025.

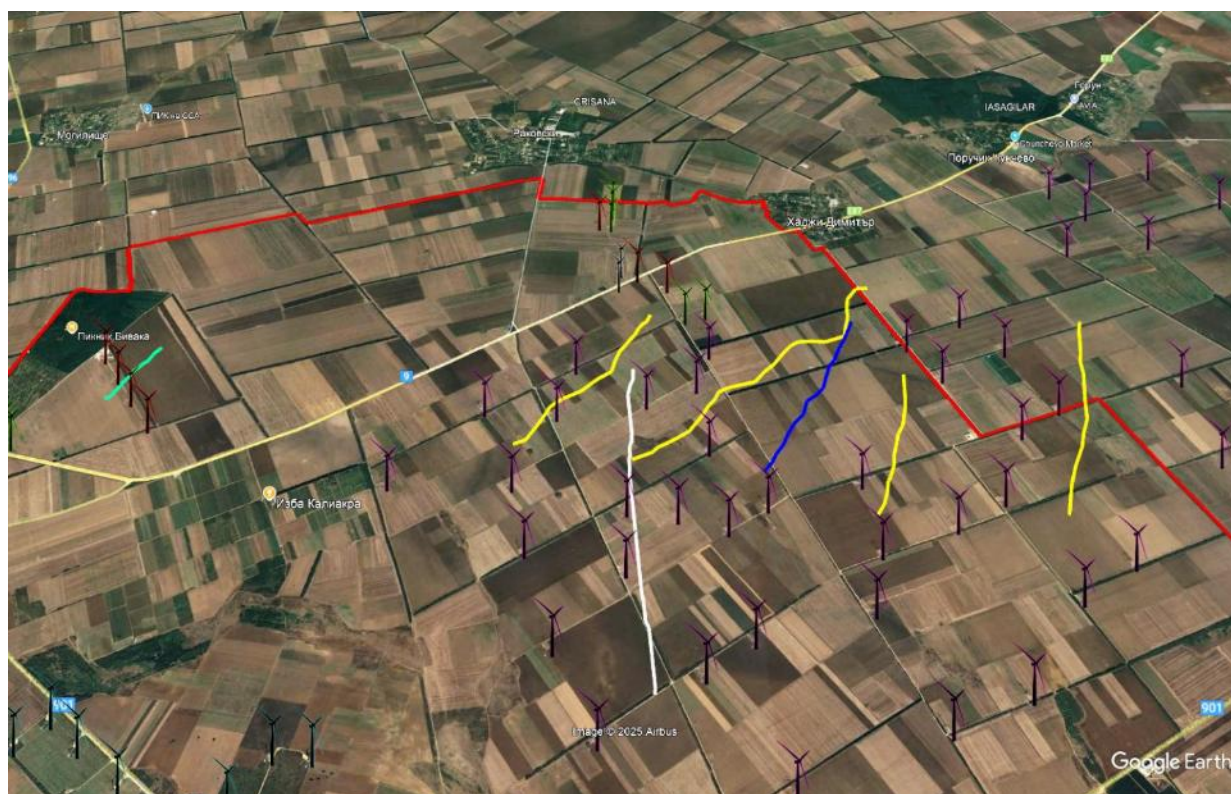


Figure 13. One flock of 27 Great Cormorants (in white), recorded on 6 October 2025; flocks of 26, 57, 32 and 28 Black Storks (in yellow), recorded on 10 October 2025; one flock of 54 Great Cormorants (in green), recorded on 11 October 2025; and one flock of 25 Great Cormorants (in blue), recorded on 12 October 2025.



Figure 14. A flock of 20 Eurasian Sparrowhawks (in green); one flock of 10 Black Storks (in white); one flock of 14 Common Cranes (in pink); and two Great White Pelicans (in blue), recorded on 13 October 2025.

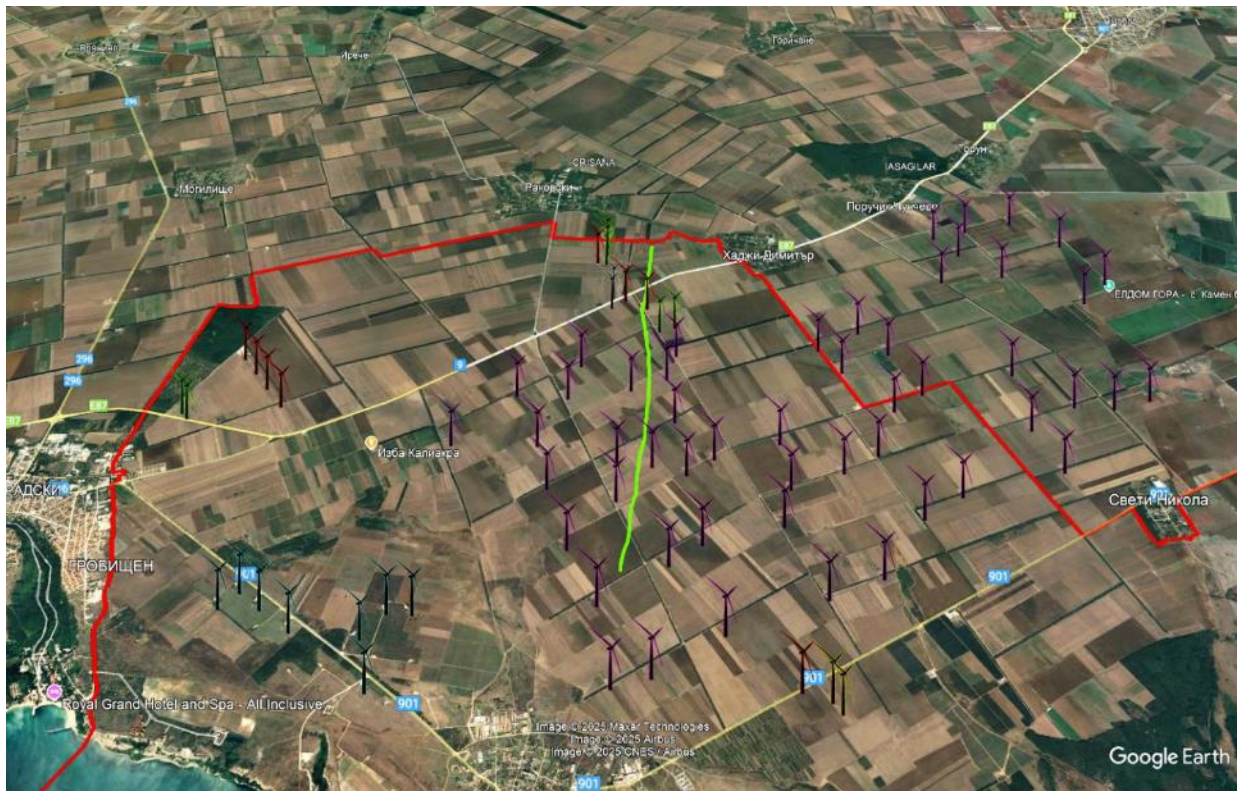


Figure 15. One flock of 27 Great White Pelicans (in green), recorded on 30 October 2025.

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 autumn migrating birds, each of the 115 turbines covered by the ISPB programme was checked at least once a week for collision victims during the autumn migration monitoring period of 2025. It is well known that searches for victims of collision around working wind turbines do not detect all dead birds for several reasons. The two main factors behind this 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 eventually be discovered by the searcher. Reporting on these two potential parameters can substantially improve the assessment of mortality due to collision in operating wind farms. To foresee such corrections, field experiments were undertaken in ISPB territory in autumn 2018. According to additional previously performed carcass removal and searcher efficiency tests during autumn migration and in winter at SNWF, a weekly search regime 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 birds from collision with the turbines in the ISPB. This allows estimation of bird mortality from collision with the turbines in the Kaliakra SPA and others of the total 115 wind turbines included in the ISPB. For details of relevant previous studies at SNWF within the wider ISPB territory, see: <http://www.aesgeoenergy.com/site/Studies.html>

Table 5. Number of checks for victims of collision in the territory of ISPB during the period 01 August - 31 October 2025.

Turbine	Aug	Sept	Oct	Total
ABBalgarevo	4	4	5	13
ABΓ1	4	4	4	12
ABΓ2	4	4	4	12
ABΓ3	4	4	4	12
ABΓ4	4	3	4	11
ABMillenium Group	3	4	5	12
ABMillenium Group Micon	3	4	5	12
AE10	4	4	5	13
AE11	4	4	5	13
AE12	3	5	4	12
AE13	3	4	5	12
AE14	4	4	3	11
AE15	4	4	3	11
AE16	4	4	5	13
AE17	4	4	5	13
AE18	3	5	4	12
AE19	3	5	4	12
AE20	4	4	3	11
AE21	4	4	5	13
AE22	4	4	5	13
AE23	4	4	5	13
AE24	4	4	4	12
AE25	4	4	4	12
AE26	4	4	5	13
AE27	3	4	5	12
AE28	3	4	5	12
AE29	4	4	4	12
AE31	3	4	5	12
AE32	3	4	5	12
AE33	3	4	5	12
AE34	3	4	5	12
AE35	3	4	5	12
AE36	4	4	3	11
AE37	3	5	4	12
AE38	4	4	3	11
AE39	4	4	4	12
AE40	4	4	4	12
AE41	4	4	4	12
AE42	4	4	4	12
AE43	4	4	4	12
AE44	4	4	4	12
AE45	3	4	5	12
AE46	3	5	4	12

Turbine	Aug	Sept	Oct	Total
AE47	3	5	4	12
AE48	3	5	4	12
AE49	3	5	4	12
AE50	3	4	5	12
AE51	3	5	4	12
AE52	3	5	4	12
AE53	3	5	4	12
AE54	3	5	4	12
AE55	3	5	4	12
AE56	3	5	4	12
AE57	3	5	4	12
AE58	3	5	4	12
AE59	3	5	4	12
AE60	3	4	5	12
AE8	4	4	3	11
AE9	4	4	3	11
DBΓ1	4	4	4	12
DBΓ1HSW250	4	4	4	12
DBΓ2	4	4	4	12
DBΓ2MN600	4	4	4	12
DBΓ3	4	4	4	12
DBΓ4	3	5	5	13
DBΓ5	3	4	5	12
DC1	3	4	5	12
DC2	3	4	5	12
E00	4	4	5	13
E01	4	4	4	12
E02	4	4	4	12
E04	4	4	4	12
E05	4	4	4	12
E07	4	4	4	12
E08	4	4	4	12
E09	4	4	5	13
M1	4	4	5	13
M10	3	4	5	12
M11	3	4	5	12
M12	3	4	5	12
M13	3	4	5	12
M14	3	4	5	12
M15	3	4	5	12
M16	3	4	5	12
M17	3	4	5	12
M18	3	4	5	12
M19	3	4	5	12

Turbine	Aug	Sept	Oct	Total
M2	4	4	5	13
M20	3	5	4	12
M21	3	5	4	12
M22	3	5	4	12
M23	3	5	4	12
M24	3	5	4	12
M25	3	5	4	12
M26	3	5	4	12
M27	3	5	4	12
M28	3	5	4	12
M29	3	5	4	12
M3	4	4	5	13
M30	3	5	4	12
M31	3	5	4	12
M32	3	5	4	12

Turbine	Aug	Sept	Oct	Total
M33	3	5	4	12
M34	3	5	4	12
M35	3	5	4	12
M4	3	4	5	12
M5	3	4	5	12
M6	3	4	5	12
M7	3	4	5	12
M8	3	4	5	12
M9	3	4	5	12
VP1	4	4	5	13
VP2	4	4	5	13
ABZevs	4	4	4	12
BTel Каварна	4	4	4	12
Grand Total	394	493	502	1389

As a result of 1389 single inspections of 115 individual turbines between 1 August and 31 October 2025, a total of only three dead birds of two species and one bat were identified. The numbers of identified collision victims by species are given in Table 6.

Table 6. Victims of collision with turbines during the autumn migration period in 2025 according to the Red Data Book for Bulgaria and IUCN conservation status classifications (LC = Least Concern).

Species name	Scientific name	Number	Red Data Book	IUCN
Yellow-legged gull	<i>Larus michahellis</i>	2	not listed	LC
Red-backed shrike	<i>Lanius collurio</i>	1	not listed	LC
Common noctule	<i>Nyctalus noctule</i>	1	not listed	LC

IUCN classifications as Least Concern (LC) were appropriate to all species identified as collision victims. The category Least Concern indicates that the species has been evaluated against the Red List criteria and does not qualify for Critically Endangered, Endangered, Vulnerable or Near Threatened. Widespread and abundant taxa are included in this LC category.

The two bird species and one bat species identified as victims are not listed in the Red Data Book of Bulgaria.

6. CONCLUSIONS

1) During the monitoring of ISPB territory, there were no substantive differences in the main characteristics of the ornithofauna typical for the autumn migration in the whole country and the specific characteristics of 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 or over it and no apparent negative influence of the operating wind farms on bird populations during their autumn 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 roost sites of the flying birds passing through the area and the observation points indicated the absence of a barrier effect of the 115 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 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 autumn period.
- 6) The quantitative characteristics of bird migration in the ISPB area during autumn 2018, 2019, 2020, 2021, 2022, 2023, 2024 and 2025 and the low 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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