

**MIGRATION PARAMETERS OF SOARING BIRDS  
CROSSING WIND FARMS OF GABEL AL-ZEIT  
CORRIDOR ON THE RIFT VALLEY/RED SEA FLYWAY,  
EASTERN DESERT, EGYPT**

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**ABSTRACT**

Egypt includes a great part of the Great Rift Valley/Red Sea flyway; the second world's most important flyway for migratory soaring birds. It acts as a corridor between Eurasia and Africa. The aim of the present study is to study the phenology and survey the numbers of species and individuals of migratory soaring birds that pass through a wind farm (240 Megawatts (MW) wind energy project of Kreditanstalt für Wiederaufbau (Germany's development bank) (KfW) located in Gebel Al-Zeit area, Red Sea Governorate, Egypt. Bird monitoring was conducted by visual observations, for eight hours during daytime at the whole survey period in two fixed observation points, during the period extending from March 4<sup>th</sup> to May 10<sup>th</sup>, 2018. This observation period covered a four-week peak of spring migration season. A total of 143,906 soaring birds belonging to 32 species were counted. The most common bird species was the white stork (63.1%), the northern steppe buzzard/common buzzard (13.21%), the great white pelican (7.42%), the European honey buzzard (6%), the Levant sparrowhawk (2.38%), and the black kite, (2.17%). Globally threatened (vulnerable, endangered, and critically endangered) migratory soaring bird species recorded in the study area surpassed 1% of the flyway population. These species include the Egyptian vulture (1.2%) and the steppe eagle (3.02%). Two other near threatened bird species; i.e., the pallid harrier (6 individuals), and the red-footed falcon (two individuals), were also observed. These results

spotlight on the importance of protecting the study area as a bird migration corridor.

**Keywords:** migratory soaring birds, wind farms, Rift Valley/Red Sea flyway, Gabel Al-Zeit, spring migration, flyway population, steppe eagle, white stork.

## INTRODUCTION

Egypt includes a great part of the Great Rift Valley/Red Sea flyway; the second world's most important flyway for migratory soaring birds. It acts as a corridor between Eurasia and Africa, and is characterized by wide geographical, geological, and meteorological variations with sporadic urban and religious establishments, and scattered human societies (Riad, 2019; Riad & Mahmoud, 2020). It is an important passage for migrating soaring birds between Eurasian breeding grounds and African wintering grounds (Bergen, 2007; CarlBro, 2010; Bergen & Gaedicke, 2013).

At the core of the Rift Valley/Red Sea Flyway lies the Gulf of Suez with few bottlenecks represented by Gabel Al Zeit, Suez, Ain Sukhna, Ras Mohamed National Park, and the Qaa' Plain, which are universally perceived as Important Bird Areas (IBAs) (Baha El Din, 1999). Hundreds of thousands of migrating raptors, storks, and pelicans pass each autumn and from their breeding areas in Eurasia to sub-Saharan Africa, where they spend the winter, and then return back in the next spring to their homelands (Moreau, 1972).

Migratory birds face extremely hard conditions as they cross extensive areas of seas and deserts. The greater part of bird species, especially small ones, perform immediate and active flights, choosing the shortest way

between breeding and wintering grounds (Riad et al. 2019). Soaring birds, on the other hand, are almost entirely dependent on the updraft of warm air to sustain their migration trip which greatly reduces their free choice of migration routes and restricts them along very narrow ones. The lack of updrafts over large areas of water prevents them from flight over water except at the narrowest of straits (Newton, 2008). Many soaring birds that migrate to and from East Africa even avoid crossing the Gulf of Suez and convolute via Suez instead. Other birds that migrate to Sinai in spring converge at Zeit Bay because it is the narrowest crossing point in the southern part of the Gulf of Suez.

Globally threatened species such as eastern imperial eagle, (vulnerable), greater spotted eagle, (vulnerable), Egyptian vulture (endangered) and the near threatened pallid harrier, are known to migrate through this area. The most numerous species reported over the Eastern Desert of Egypt include the white stork, and the Levant sparrowhawk, (Baha El Din, 1999). The main migration route of the white stork passes through Zeit Bay, and the entire world population of the Levant sparrowhawk migrate through this area, usually in large flocks, in few days (Baha El Din, 1999; Schulz, 1988; Berthold *et al.* 2001).

The main migration corridors through Egypt are still not precisely identified because there have been no synchronous migration studies across the whole width of the flyway, and the total number of soaring birds that fly through Egypt is still to be determined accurately. In the present study, data

were collected on the species, number, altitude and direction of soaring birds during their spring migration between the African and Eurasian grounds across the part of the Great Rift valley/Red Sea flyway that lies in Egypt.

## MATERIALS AND METHODS

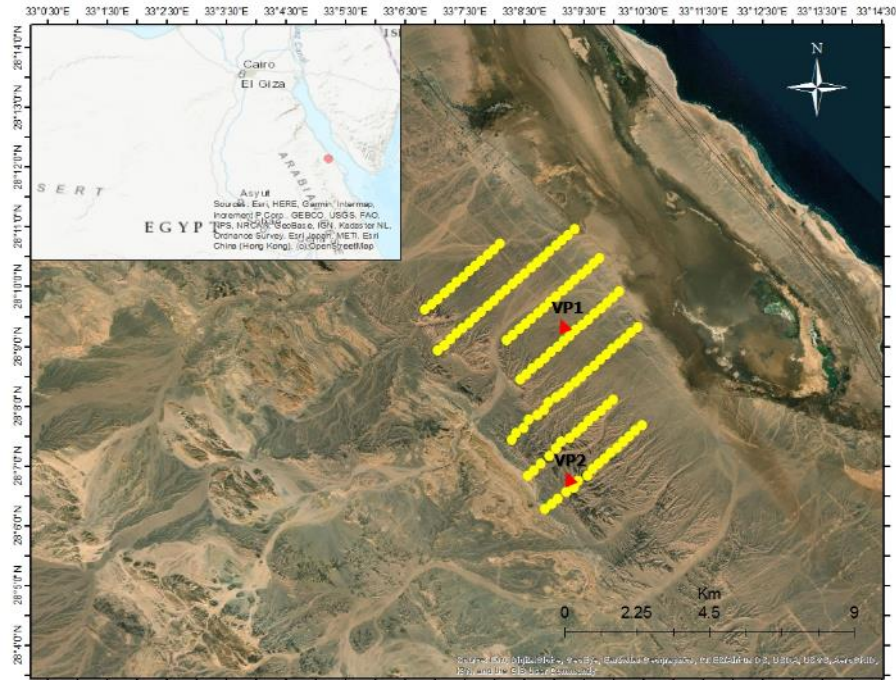
**Study area:** The study site is the KFW 240 MW wind farm, located on the Red Sea coastal plain that stretches between Sabkhet Ras Shukhair and the foothills of the Red Sea Mountains. It is located on the western bank of the Gulf of Suez, about 10 km away from Ras Shukair, 120km to the north of Hurghada, and about 5km to the West of the Hurghada – Suez Road (Fig. 1). It has a total area of about 38.5km<sup>2</sup> with a maximum extension of about 6.5km (west to east) and about 9.3km (south to north) of the KFW wind farm. The eastern part of the site is flat or slightly undulating, with increased elevation and topographic complexity in the western part.

There are 120 wind turbines arranged in seven parallel arrays and are oriented from the northeast to the southwest. The distance between adjacent arrays is about 1.1km and the longest array is 5.2km long. A 220-kV power line runs along the eastern perimeter of the wind farm (Fig. 1). The study area was partially monitored, only 8 hours on a daily basis in spring migration (from March 4<sup>th</sup> – May 10<sup>th</sup>, 2018

**Observation technique:** Visual observations were carried out during daylight hours from March 4<sup>th</sup> to May 10<sup>th</sup>, 2018, (four-weeks) which represent the peak of spring migration season in Egypt. The standard

technique for bird enumeration followed the Scottish Natural Heritage guidance (SNH, 2010) and the methodology described in Sutherland (2006). Bird monitoring was conducted from two fixed observation points, and observation posts were positioned to provide the best visual coverage of the bird's movements. Each vantage point almost completely covered about 2500m view scope within each selected point in the study area.

The survey covered all point watches for 8 hours/day, 7 days/weekly, from 8:00 a.m. to 16:00 p.m. with an hour break. Bird altitude was recorded using the turbine height as an indicator at time intervals of fifteen seconds, weather conditions (wind direction and speed, temperature, cloud/mist, rains, and visibility) were recorded hourly according to the method followed by Riad (2019). The researcher at each point was supplied by professional binoculars, digital cameras, bird identification field guide, clipboards, compass and recording sheets and maps.



**Fig. (1):** A map showing turbines distribution in the study area (VP1 and VP2).

## RESULTS

**Bird numbers and bird records:** A sum of 456 survey hours for each of the two vantage points (a total of 912 observation hours for the whole study area) were completed in the field during the study period, generally 4 hours in the daily morning session and 4 in the afternoon session. A total of 143,906 individual birds belonging to thirty-two migratory soaring bird species were recorded during the standard field observations carried out from March 4<sup>th</sup> to

May 10<sup>th</sup>, 2018 (Table 1). Four common bird species formed about 90% of the total recorded number. They included the white stork (63.03%), the steppe buzzard/common buzzard (13.21%), the white pelican (7.42%), and the honey buzzard (6.01%). The remaining 28 bird species were rare ones since they formed 10% of the recorded species. The number of records (observations) of a given bird species is not necessarily proportional to its total number during these records. For example, the black kite is one of the rare bird species, however, the number of its records formed (12.51%) of the total number of records. Other bird species which were frequently recorded were the steppe buzzard/common buzzard (39.46%), the steppe eagle (11.16%), and honey buzzard (8.93%). All globally threatened (vulnerable, endangered, and critically endangered) migratory soaring species recorded in the study area surpassed 1% of the flyway population. These species include the Egyptian vulture (1.2%), the steppe eagle (3.02%). Two other near-threatened bird species; i.e., the pallid harrier and the red-footed falcon were recorded. Only 6 individuals of the first species and two individuals of the second one were observed.

**Table (1):** English names, scientific names, number of individuals, number of records, minimum and maximum observed number of birds, and percentages of numbers and records of bird species observed in the study area during spring 2018

No	English name	Scientific name	B. No.	R. No.	Min.	Max.	% Birds	% Records
1	White Pelican	<i>Pelecanus onocrotalus</i>	8678	33	4	1200	7.42	0.88
2	White Stork	<i>Ciconia Ciconia</i>	92706	135	1	12000	63.03	3.59
3	Black Stork	<i>Ciconia nigra</i>	916	53	1	190	0.64	1.41
4	Eleonora's Falcon	<i>Falco eleonorae</i>	2	2	1	1	0.00	0.05
5	Great Cormorant	<i>Phalacrocorax carbo</i>	364	4	22	90	0.25	0.11
6	Egyptian Vulture	<i>Neophron percnopterus</i>	60	27	1	3	0.04	0.72
7	Osprey	<i>Pandion haliaetus</i>	18	12	1	2	0.01	0.32
8	Eastern Imperial Eagle	<i>Aquila heliaca</i>	54	38	1	2	0.04	1.01
9	Lesser Spotted Eagle	<i>Aquila pomarina</i>	442	141	1	2	0.31	3.75
10	Greater Spotted Eagle	<i>Aquila clanga</i>	6	5	1	1	0.00	0.13
11	Steppe Eagle	<i>Aquila nipalensis</i>	1298	419	1	11	0.90	11.16
12	Short-toed Eagle	<i>Circaetus gallicus</i>	160	90	1	4	0.11	2.40
13	Booted Eagle	<i>Hieraaetus pennatus</i>	100	57	1	5	0.07	1.52
14	Common Crane	<i>Grus grus</i>	80	1	40	40	0.06	0.03
15	Marsh Harrier	<i>Circus aeruginosus</i>	28	21	1	1	0.02	0.56
16	Montagu's Harrier	<i>Circus pygargus</i>	6	5	1	1	0.00	0.13



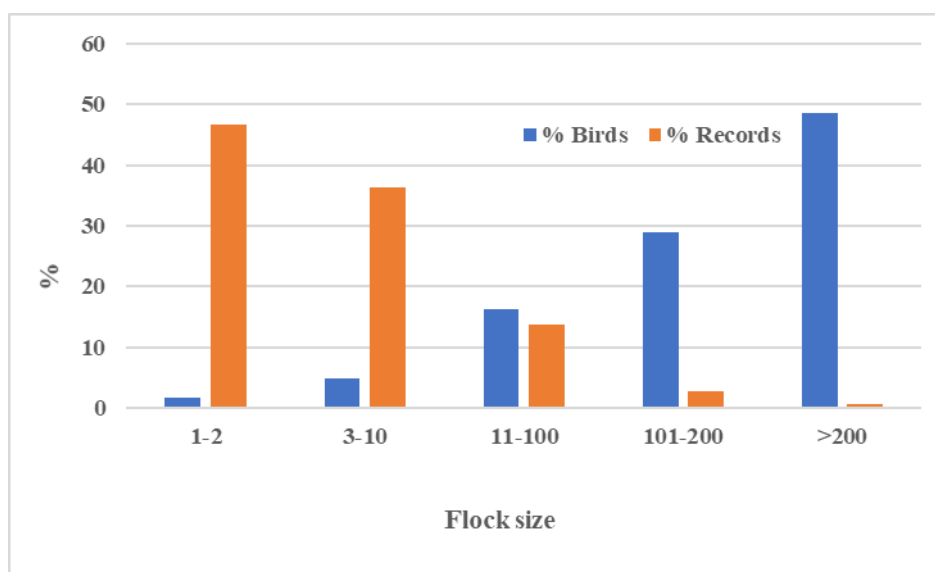
**Cont. Table (2):**

No	English name	Scientific name	B. No.	R. No.	Min.	Max.	% Birds	% Records
17	Pallid Harrier	Circus macrourus	6	5	1	1	0.00	0.13
18	Long-legged Buzzard	Buteo rufinus	234	114	1	7	0.16	3.04
19	Steppe Buzzard/common buzzard	Buteo buteo vulpinus	19012	1482	1	450	13.21	39.46
20	European Honey Buzzard	Pernis apivorus	8646	336	1	330	6.01	8.93
21	Eurasian Sparrowhawk	Accipiter nisus	122	45	1	8	0.08	1.20
22	Levant Sparrowhawk	Accipiter brevipes	3422	21	1	600	2.39	0.56
23	Kestrel	Falco tinnunculus	38	24	1	2	0.03	0.64
24	Lesser Kestrel	Falco naumanni	8	6	1	1	0.01	0.16
25	Red-footed Falcon	Falco vespertinus	2	2	1	1	0.00	0.05
26	Hobby	Falco Subbuteo	3	3	1	1	0.00	0.08
27	Yellow billed kite	Milvus migrans aegyptius	2	1	1	1	0.00	0.03
28	Black Kite	Milvus migrans	3120	470	1	120	2.17	12.51
29	Raptor sp.	Accipitridae sp.	1302	90	1	100	0.90	2.40
30	Eagle sp.	Aquila sp.	210	33	1	40	0.15	0.88
31	Harrier sp.	Circus sp.	81	6	1	1	0.06	0.16
32	Buzzard sp.	Buteo/Pernis sp.	2780	75	1	550	1.93	2.00
	Total		143906	3756			100.00	100.00

Sp.: Species; B. No: Numbers of Birds; R. No.: Numbers of bird records; %: percentage; Min: Minimum; Max, Maximum.

**Flock size:** In the present study, the observed flying flocks varied greatly in size since it ranged between flocks of one or two individuals to flocks of more than 200 bird individuals. During the study period, the number of small flocks which contain one or two bird individuals formed 47% of the total number of observed flocks (3756 records) and 2% of observed birds (143906 birds) and the number of individuals they contain (from 3 to 10 birds) were

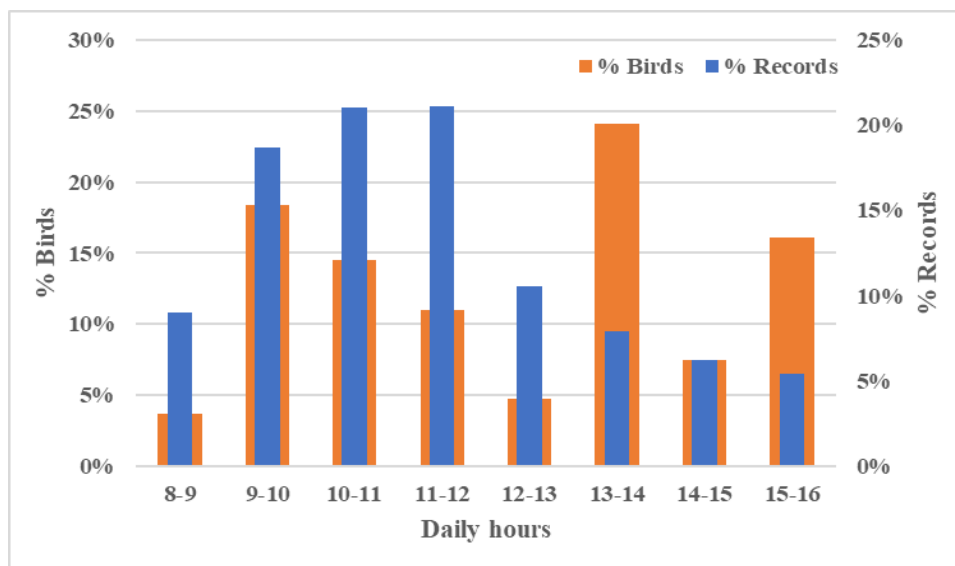
formed 36% of the total number of records and 5 % of the total number of birds. The flock size ranging from (11 to 100) birds were formed 14% of the total number of records and 16% of the total number of observed birds. The flock size includes (101 to 200) birds were only formed 3% of the total number of flocks and 29% of observed birds. The corresponding figures for large flocks which contain more than 200 individuals were 1% of bird records and 49% bird numbers respectively (Fig. 2).



**Fig. (2):** Percentages of bird numbers and bird records calculated for different flock sizes in the study area during spring 2018

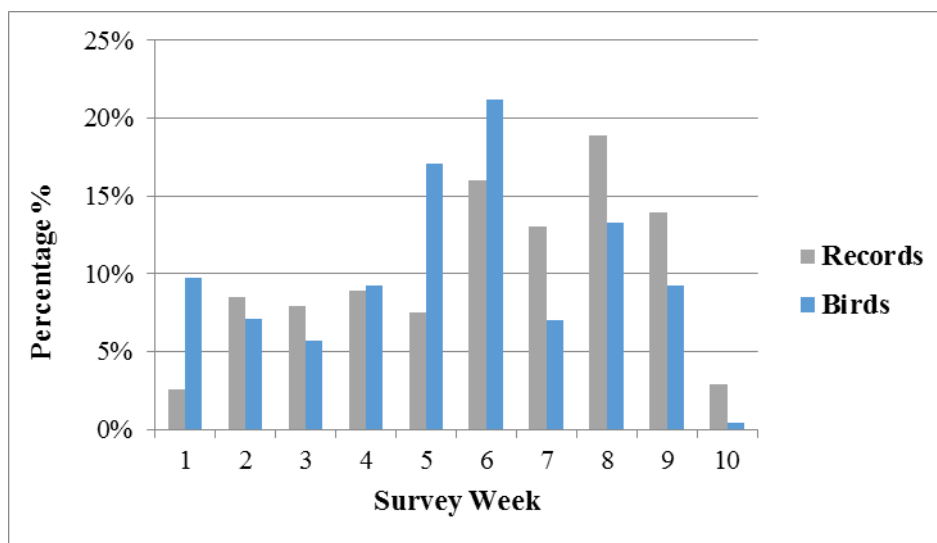
**Daily changes in bird numbers and bird records:** The percentage of records was higher during morning observation (from 8:00 am to 12:00 pm) since it formed about 70% of total records. The percentage of observed birds,

on the other hand, was slightly higher during the afternoon hours (12:00 pm to 4 pm) since it formed about 53% of the total number of birds (Fig. 3).



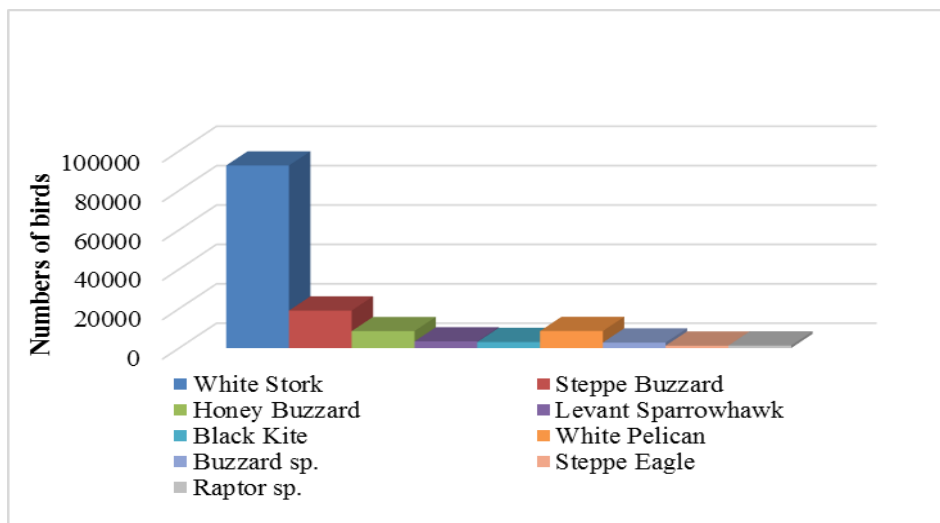
**Fig. (3):** Average migration rate in morning and evening survey hours for all observations in the study area

**Weekly changes in bird numbers and bird records:** The number of observed bird species and number of records were generally low in the first four weeks and the last two weeks of the study period. The highest percentage of bird numbers (17.1%, 21.2%, and 13.3%) were recorded in weeks 5, 6 and 8 respectively. The highest percentages of records (16%, 13%, 19% and 14%) were recorded in weeks 6, 7, 8, and 9, respectively (Fig. 4).

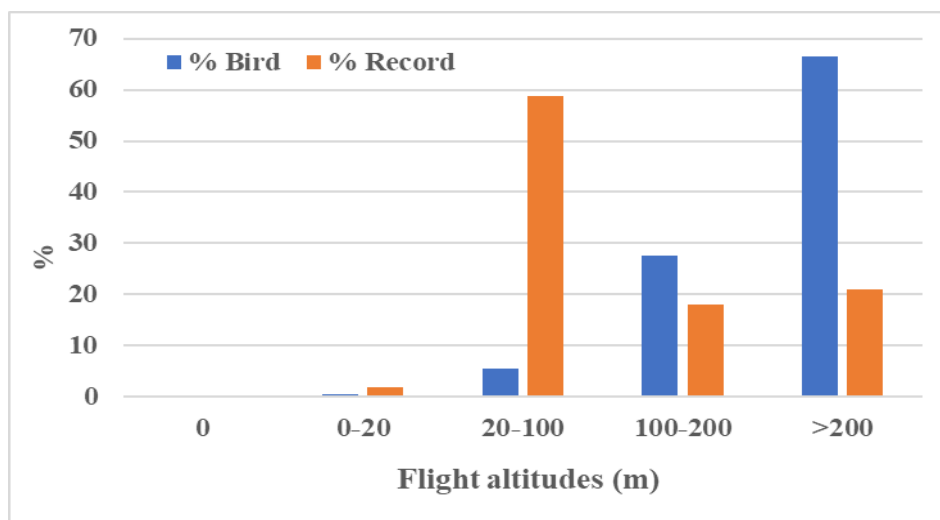


**Fig. (4):** Weekly percentages of numbers and records of birds observed in the study area from March 4<sup>th</sup> – May 10<sup>th</sup> during spring 2018

**Flying altitudes of common bird species:** In the present study, the white stork, steppe buzzard, Levant sparrowhawk, honey buzzard, black kite, and steppe eagle common bird species, were mostly recorded flying at altitudes of more than 200 m (Fig. 5 A and B). The white pelican, which is also a common bird species, flew at lower altitudes since a high percentage (69%) of this bird was recorded flying at altitudes ranging from 100 m to 200m.



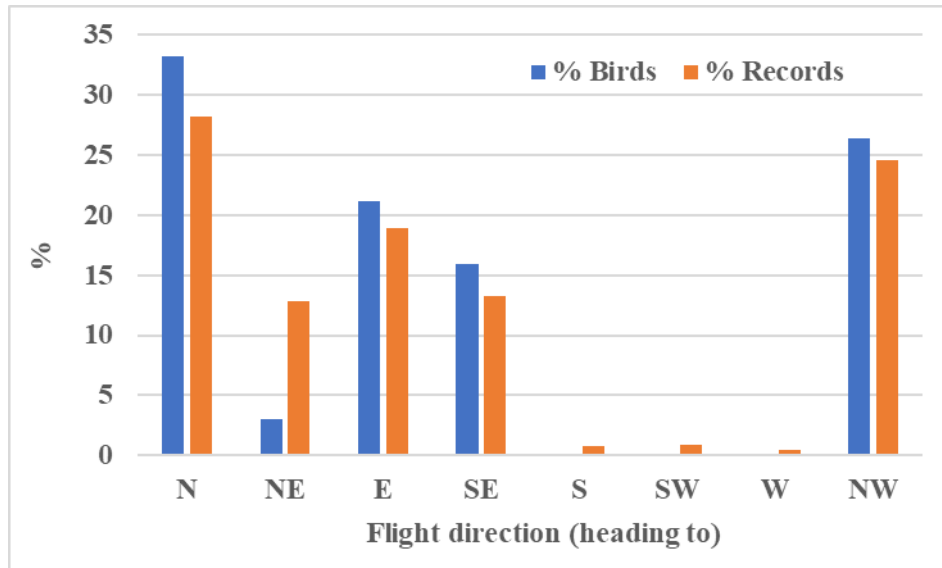
**Fig. (5 A):** Numbers of the most dominant birds recorded in the study area



**Fig. (5 B):** Percentages of numbers and records of common migratory soaring birds flying at different altitudes in the study area

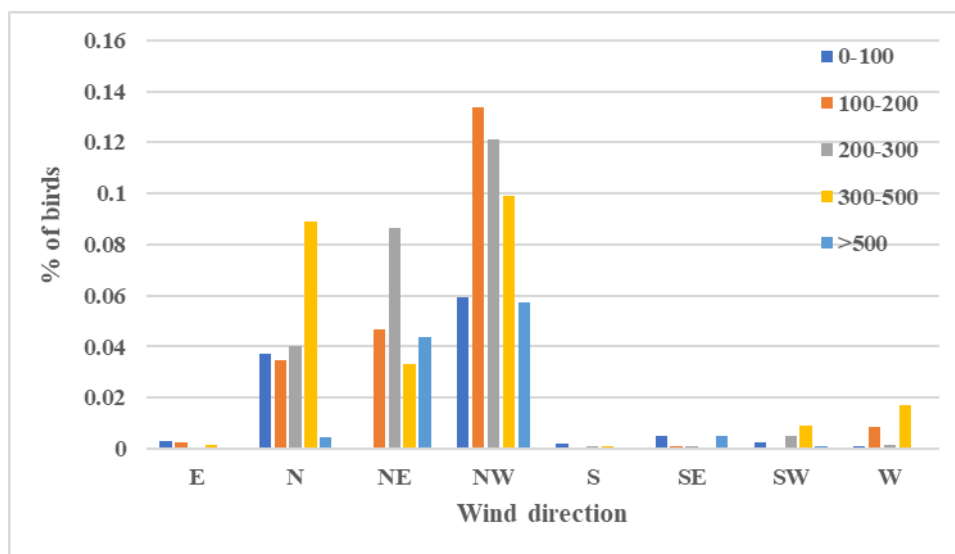
**Flying direction of migrating birds:** During the study period, the direction of all bird species passing through the study area was determined. The dominant bird migration course was generally heading northward. Sixty-two percent of observed birds adopted northern (N), northeastern (NE), and northwestern (NW) directions, which is expected for northward spring migration. A considerable proportion of observed records (23%) adopted an eastern direction of flight, and a lesser proportion of observed records (15%) had a northeastern migration route (Figs. 6).

In all flight directions, the highest percentage of the bird's numbers has been recorded at more than 200m. Also, we recorded more than 20% of birds between 100-200m (Fig. 7).



N, North; NE, Northeast; E, East; SE, Southeast; S, South; SW, Southwest; W, West; NW, Northwest.

**Fig. (6):** Percentage of flight direction of birds/records of soaring birds recorded in the study area



E, East; N, North; NE, Northeast; NW, Northwest; S, South; SE, Southeast; SW, Southwest; W, West.

**Fig. (7):** Percentage of birds flying at each flight direction at different flight altitudes to the overall recorded birds in the study area

## DISCUSSION

The present study describes substantial migration of birds across the Eastern Desert of Egypt. In the spring; migratory birds are under the pressure of time as they must reach their summer breeding grounds early enough to successfully compete for a suitable breeding site. They have to mate, incubate eggs and raise young before they leave back to African wintering grounds the



next autumn. Birds arriving too late or too exhausted will not be able to reproduce successfully (Hilgerloh, 2009).

In some studies, migratory birds did not show preference for special routes through the study area. Raptors mostly migrate individually or in small groups and show a somewhat regular migration pattern. Soaring birds (storks, pelicans, and cranes), on the other hand, mostly migrate in massive herds, thus producing very distinct regional fluctuations (Langston & Pullan, 2003; Drewitt, & Langston, 2006 & Langston, 2006; Riad, 2020). While the researcher in this study indicated that soaring birds were recorded in vantage point 2 (VP2) at a far distance from the coast of the Gulf of Suez to have enough time to raise up and reach a considerable height to be able to cross the bay easily at its narrowest point at Ras Shukier or Ras Gharib.

The study results showed that many threatened species; i.e., steppe eagle, Egyptian vulture, greater spotted eagle, eastern imperial eagle, and pallid harrier, use this pathway of migration from Africa to Eurasia. Many recorded numbers were seen flying at altitudes less than 200 meters, which suggests that they will continue to migrate north and cross the Gulf from Ras Gharib or may continue to the end of the Gulf at the city of Suez. According to these results, some individual migrants observed to the south of the study area often move to Sinai at the latitude of El Gouna and the Malaha Valley rest area, the only freshwater valley. These results are in accordance with the study of Christensen & Jensen which indicated that migrants heading to Suez mainly concentrate along the mountain range west of the Gulf. Most white storks that

reach the southern end of Sinai continue northwest of the country along the coast of Sinai before starting to cross the sea, thus reaching the mainland of Egypt between Ras Gharib and Ras Gamasa (Christensen & Jensen, 2002). However, more observations are needed to accurately determine their migration pathway (Grieve, 1996 & Baha El Din, 1999).

Observations carried out during the present study showed that migrants fly along the foothills of the Red Sea Mountains and then to the coastal hills of Gabel Al Zeit or the coast adjacent to the northern area. Large portions of the population of bird species such as the white stork and this was in agreements with other studies (Creutz 1985; Schulz 1988; Goodman & Meininger 1989 & Berthold et al. 2001), levant sparrowhawk (Grieve, 1996 & Baha El Din, 1999) and common crane regularly cross the Gulf of Suez. Consequently, many birds have no choice but to cross the study area. Other bird species such as the lesser spotted eagle, a species that avoids any sea crossing, continue to migrate to Suez (Grieve, 1996; Meyburg et al. 2002; Riad et al. 2020).

Migration patterns are highly variable from one year to another as they are highly dependent on weather conditions. This way, variation in weather conditions in the upcoming years may cause changes in the migratory patterns compared to what was recorded in previous years. Future studies should describe other areas in the flyway other than the current study area that soaring birds use to cross the Suez Canal to South Sinai. Future studies should also explore the complex migration patterns of soaring birds that

migrate through the Rift Valley/Red Sea Flyway, especially storks, pelicans and crane, during different weather conditions.

### CONCLUSION

This study indicates the significance of the Gabel Al Zeit as an important bottleneck for soaring bird spring migration.

The dominant bird migration course was generally heading northward. Sixty-two percent of observed birds adopted Northern (N), North Eastern (NE), and North-Western (NW) directions, which is expected for northward spring migration.

Observations of this study showed that migratory soaring birds fly along the foothills of the Red Sea Mountains and then head for the coastal hills of Gabel Al Zeit or the coast adjacent to the northern area, especially in those species such as White Stork and Levant Sparrowhawk. These results clarify the importance of the study area as a bird migration corridor that highlighted the potential impacts and required actions to protect migratory birds. Although this number significantly represents a high portion of spring migration, the number of birds passed over Gabel Al Zeit does not reflect the real number as many migrating birds cross different areas along the flyway.

In conclusion, soaring bird migration monitoring continuation at this site is important for recording population dynamics and behavior to set the required action plans.

### **ACKNOWLEDGMENTS**

We would like to thank a group of ornithologists and bird watchers who helped us to monitor the migration and collect some data for the study. Also, we thank the Egyptian New and Renewable Energy Authority (NREA), Migratory Soaring Birds project in Egypt and Egyptian Environmental Affairs Agency (EEAA) for their support and facilitation of obstacles during the study.

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## معالم هجرة الطيور الحوامة العابرة لمحطات طاقة الرياح بمعبر جبل الزيت بمسار الوادي المتصدع/ البحر الأحمر لمعبر الطيور، الصحراء الشرقية- مصر

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(١) وزارة البيئة (٢) كلية العلوم، جامعة عين شمس

### المستخلص

يهدف هذا البحث إلي دراسة أشكال الهجرة ودراسة أعداد وأنواع الطيور الحوامة المهاجرة التي تمر بمحطة طاقة الرياح بقدرة ٢٤٠ ميجاوات والممولة من بنك التعمير الألماني والتي تقع بمنطقة جبل الزيت بمحافظة البحر الأحمر بمصر. تم رصد الطيور من خلال المشاهدات البصرية في نقطتين ثابتتين في الفترة من ٤ مارس وحتى ١٠ مايو خلال هجرة الربيع ٢٠١٨، وخلال هذه الفترة كانت هناك أربعة أسابيع ذروة للطيور المهاجرة. تم إحصاء ١٤٣,٩٠٦ من الطيور الحوامة ينتمون إلي ٣٢ نوعاً. كانت أكثر أنواع الطيور المسجلة هم: اللقلق الأبيض بنسبة ٦٣,١% - الصقر الحوام بنسبة ١٣,٢% - البجع الأبيض الكبير بنسبة ٧,٤٢% - والباشق بنسبة ٢,٣٨% والحدأة السوداء بنسبة ٢,١٧%. كذلك تم تسجيل عدد من أنواع الطيور الحوامة المهددة بخطر الإنقراض زادت نسبة تسجيل كل نوع منها عن ١% من العدد الإجمالي المسجل في مسار الهجرة، كانت هذه الأنواع هي: النسر المصري بنسبة ١,٢% وعقاب السهول بنسبة ٣,٠٢%، كما تم تسجيل نوعين من الطيور الحوامة في حالة اقتراب من التهديد بالإنقراض وهما مرزة البطائح بعدد ٦ طيور والصقر أحمر القدمين بعدد ٢ طائر. تشير هذه النتائج إلي أهمية حماية الطيور الحوامة المهاجرة بمنطقة الدراسة حيث تعتبر كممر رئيسي لها.

**الكلمات المفتاحية:** الطيور الحوامة المهاجرة - محطات طاقة الرياح - مسار هجرة البحر الأحمر والأخدود الإفريقي العظيم - هجرة موسم الربيع بجبل الزيت - أعداد الطيور المسجلة بمسار الهجرة - عقاب السهول - اللقلق الأبيض.