2026

Cumulative bird study in the central Gulf of Suez area: Shadwan 900MW

PREPARED FOR:

RCREEE

Regional Center for Renewable Energy and Energy

إقليمي للطاقة المتجددة وكفاءة الطاقة

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23/03/2026

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Conclusions

Specific for Shadwan 900 MW project

- Considering the data analyzed the **Shadwan 900MW WPP does not present any risk other than those already highlighted in similar operational /planned projects in the study area. There are no "non-go" zones within the project footprint.**

- The project shares the same migratory species, qualitatively and quantitatively, compared to other WPPs in the Red Sea. The behavior of the birds is the same in spring and autumn. Differences detected are in accordance with species specific behaviors and weather conditions during the monitoring periods.

- The only difference –not for Shadwan itself, but any other projects close or along the mountain range is the presence of potential resident raptor populations like the Golden eagle or the Sooty falcon, not previously recorded because of the lack of suitable habitat. The approach to study them should be shared with other developers to reduce costs and improve results, which would be beneficial for the wind developments. Further site specific assessments should be done in any future project in the region during the pre-construction studies, not only focusing on VP monitoring.

- In addition, the implementation of the monitoring programs and managing attraction sites for MSBs, and offsets should be implemented in accordance with lender requirements, potentially in a collaborative approach amongst developers.

General remarks for all projects after the review of the data used for this assessment

- The pre and post construction bird monitoring, both for wind projects and OHTL's, show inconsistencies which require supervision of a wind and wildlife expert with science and statistics background. As far as have been reviewed, the current works rely on the decision of the site-specific teams /consultancies. The goals of this supervision are 1) establish data gathering and analyses consistent throughout the projects and time 2) allow preparing databases for the right analyses to get robust and comparable conclusions and 3) improve and evaluate the mitigation measure needs accomplishing to the lenders requirements.

- There is a need to clarify what, how, and why some information should be gathered: e.g. for "non-soaring birds", methods should be species focused. Otherwise, unless the presence of threatened taxa –where specific count methodology is required, e.g. sandgrouses- the collection and use of existing information is useless and limited to the presence/absence.

ACRONYMS

AoA	Area of Analysis
CEA	Cumulative effects Analysis
EBRD	European Bank for Reconstruction and Development
PCFM	Post-construction fatality monitoring
GoE	Government of Egypt
GoS	Gulf of Suez
IBA	Important Bird Area
IFC	International Finance Corporation-World Bank
NREA	New and Renewable Energy Authority
RCREEE	Regional Center for Renewable Energy and Energy Efficiency
RVRSF	Rift Valley Red Sea Flyway
SCADA	Supervisory Control and Data Acquisition
SDOD	Shut-down of demand
SEACIA	Strategic Environmental and Cumulative Impact Assessment
WPP	Wind Power Project

Cover image. Red Sea IBA landscape. A. Camina.

Citation: Camina, A., Martín, J., Vicente, N., Garrido, J.R. 2026. Cumulative bird study in the central Gulf of Suez area: Shadwan 900MW

1 Area of Analysis (AoA): Central Gulf of Suez

According to the baseline description in 2001, the Gebel El Zeit IBA (EG031), light green color in FIGURE 1, consists of a narrow, 100-km-long strip extending along the Gulf of Suez/Red Sea coast, from Ras Gharib in the north to the Bay of Ghubbet El Gemsa in the south. It is oriented in NW-SE direction and traversed by two mountain ranges. The smaller one is the one which gives the name to the IBA, reaching up to 457 m and falls steeply to the Red Sea. The western one slopes gently and merges with a 20-km-wide plain that separates Gebel El Zeit from the rest of the Red Sea hills further west, reaching up to 900 m. To the north there is a wide coastal plain fringed near the shore by several areas of sabkha, the largest of which is Sabkhet Ras Shukheir. This contains several pools of hyper-saline water and large patches of saltmarsh. To the south are Ghubbet El Zeit and Ghubbet El Gemsa, two large shallow bays with extensive intertidal mud and sandflats. Numerous small wadis drain the mountains of the area and dissect adjacent plains. These are lined with scattered Acacia trees.

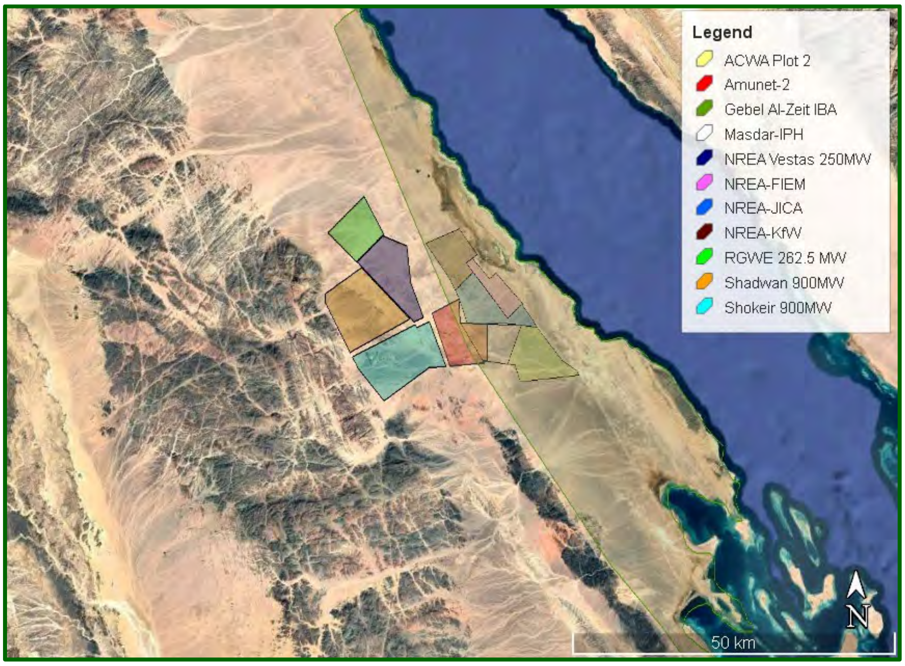

FIGURE 1 Location of the Gebel Al Zeit IBA (light green) and the wind developments included in this assessment in the central Gulf of Suez.

IBAs are areas identified by BirdLife International, using an internationally agreed set of criteria, as being globally important for the conservation of bird populations. The Rift Valley/Red Sea (RVRS) flyway is the second largest flyway for migratory birds in the world. The Gebel El Zeit area is a very important migration corridor, and the narrowest point in the southern part of the Gulf of Suez with around 23 km from the Sinai Peninsula. Over 250,000 *Ciconia ciconia* and many other migrant soaring birds are funneled through this stretch of coast on both spring and autumn journeys. Birds of prey, storks and pelicans migrate through and usually land, rest or roost near the coastline and on the surrounding desert plains and hills. Resting and roosting storks, especially, utilize the two bays of Ghubbet El Zeit and Ghubbet El Gemsa and the saltmarsh at Sabkhet Ras Shukheir.

IBA criteria met there are:

- **A1**: Globally threatened species
- **A4iv:** Congregations, The site is known or thought to hold congregations of ≥1% of the global population of one or more migratory species on a regular or predictable basis.

1.1 The Wind energy projects

The Government of Egypt (GoE) has taken steps to adopt an energy diversification strategy with increased development of renewable energy and implementation of energy efficiency, including assertive rehabilitation and maintenance programs in the power sector (IRENA, 2018). For this purpose, in 2013, the Arab Republic of Egypt (through the Ministry of Electricity and Renewable Energy) developed and adopted the Integrated Sustainable Energy Strategy (ISES) 2015 – 2035, providing an ambitious plan to increase the contribution of renewable energy to 20% of the electricity generated by the year 2022, of which 12% of wind power plants is foreseen, mostly in the Gulf of Suez (GoS) due to the availability of wind resource in the area.

With this goal, the Egyptian Government issued the Renewable Energy Law (Decree Law 203/2014) to support the creation of a favourable economic environment for a significant increase in renewable energy investment in the country. The law sets the legal basis to implement a Build, Own and Operate (BOO) scheme. Through this mechanism, the Egyptian Electricity Transmission Company (EETC) sets allowed capacities and invites private investors to submit offers for solar and wind development projects. Bidders are awarded based in the lowest Kilowatt Hour (kWh) price. In addition, the GoE through the New and Renewable Energy Authority (NREA) provides the land for the investors.

All the avifaunal assessments developed, and used for this assessment, are based on local and international requirements including:

- EIA Guidelines and Monitoring Protocols for Wind Energy Development Projects along the RVRSF with a particular reference to wind energy in support of the conservation of Migratory Soaring Birds (MSBs)(2013)
- Strategic ESIA for an Area of 300 km² of potential wind farms at the Gulf of Suez (2013)
- Strategic and Cumulative Environmental and Social Assessment Active Turbine Management Program for Wind Power Projects in the Gulf of Suez (2019)
- IFC PS6 and its GN6 as well as IFC EHS Guideline for Wind Energy,
- EBRD ESR6.

Within the AoA there are several operational and planned wind power projects (WPPs) which are the backbone of this analysis, see Figure 1. The WPP projects are administratively located within the Red Sea Governorate and they are either planned or operational already as follows:

1) OPERATIONAL: RGWE 262.5 MW, NREA-Vestas 250 MW, NREA-Gebel el Zeit wind farm XXX MW,
2) PLANNED: Shadwan 900MW, Amunet 2, Shokeir 900MW
3) APPROVED: Scatec, ACWA Plot 2

This CEA provides an assessment of the potential cumulative effects on birds of five WPPs. Of all the WPPs in the wider area which forms the outermost boundaries of all these projects.

2 Scope of the assessment

Up to now, the bird assessment of the Shadwan 900MW WPP has been done individually, at project level. There have been two bird monitoring migration campaigns 2025 (spring and autumn). However, there has not been a cumulative study in relation or together with the neighboring projects. This new report deal with the project data but also including other projects in the vicinity and a broader area, see las paragraph of the previous section. This is important to:

1) Understand if there are constraints (No-go areas) or sensitive zones in the entire study area, which would need from further, or even fully avoidance of wind projects, or additional mitigation, always following the Principles of the Mitigation Hierarchy. Existing developments may restrict more spaces or areas remaining free of turbines, and these could be essential for bird migration.

2) To provide an expert opinion on the cumulative effects in the wider area.

Question: WHAT DOES THIS STUDY DO AND WHAT DOES NOT? This study analyzes the MSBs migrating through this portion of the Gulf of Suez in a wider area. It is not an analysis study it is not a Cumulative Effects, where data have not deeply, and properly, analyzed analysis when establishing priority species. The species are there already, and we try to understand how they behave and are affected by environmental variables. With robust results, we intend to inform the project development.

2.1 Preliminary methodological considerations and limitations

The terms: “roosting” and “resting”

To clarify from the outset, the terms 'roosting' and 'resting' are used differently by the projects in the region. According to the Oxford Dictionary, their meanings are the following:

- **Roost**: Of birds, bats, and other animals: to settle on a perch or other place for sleep or rest; a place where customarily birds or bats can sleep or rest safely.
- **Rest:** To stop doing a particular activity or stop being active for a period of time to relax and regain strength. This involves a period of relaxation, sleep, or inactivity after a period of activity.

When observers record birds on the ground during the bird monitoring studies (BMSs), observers use either of the two terms without accuracy. The difference between a roosting and a resting place is the adverb “customarily”, so the animals have a recurrent place –roost- where they return regularly, e.g., after feeding or foraging. This is not the case in places where observations take place during the bird monitoring in the WPPs assessments along the GoS. Birds migrate, and they tend to reach their breeding or wintering areas as soon as possible. Within the RVRS Flyway, birds are forced to stop because of two major reasons: exhaustion or darkness, and adverse weather conditions (sand storms strong winds which make migration unsafe at critical sites like the sea crossing). But there is a third option which is voluntary, to feed on route, and not all the MSBs do so.

The observers at the vantage points record birds on the ground (landed), unaware of the reason why the birds are there: whether they are really roosting, exhausted, or preying upon something. The same occurs when annotating in the spreadsheets that a bird/flock is “soaring” or “gliding”. Any soaring bird will glide at some time, as it is part of its performance when flying (Pennycuick 1972). But soaring is not only depending of up current air lifts.

Soaring birds may use the slope soaring as well, which does not require thermals, but air currents blowing against mountains.

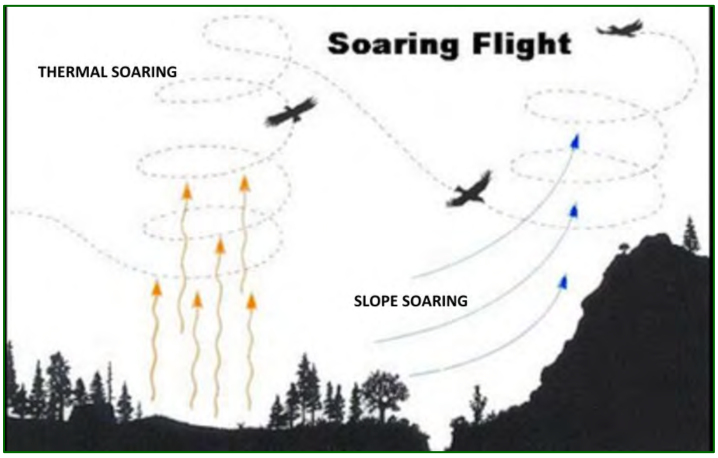

Figure 2 Example of Thermal soaring and slope soaring.

Places to stop are thus either predictable or unpredictable. Among the predictable ones, there are the mountains of Gebel Zeit on the sea shore before the Red Sea crossing, a dam with water in the middle of the desert, as occurs in the Acwa Plot 1 (www.acwapower.com), or a predictable food source in space and time, or the existing Ras Gharib Rubbish dump. All these mentioned sites, which do not occur at the Shadwan project or its vicinity, may gather large bird groups, increasing the collision risk for certain species. Birds find food there and may remain there for some timeWhen referring to these sites we do not consider those used during the construction works of a wind farm.

Where conditions are unpredictable, birds are recorded incidentally. These have implications for the mitigation of wind energy projects, as an unpredictable site should not constrain a wind development, e.g., turbine location, whilst a predictable one does, unless appropriate management, avoidance, and mitigation measures are in place.

This assessment will try to assess these two concepts too and provide guidance on where and what management /mitigation measures should follow in that case.

Monitoring time, Vantage points, and bird numbers

We must consider the following preliminary questions, which affect the results:

1) Not all projects invest the same monitoring time, nor do they have the same number of Vantage points. Thus, it is very important to note that THE RAW BIRD COUNTS CANNOT BE USED FOR DIRECT COMPARISONS BETWEEN PROJECTS. The monitoring time and number of vantage points have a strong influence on the results; e.g., the more time you invest, the higher the numbers to be recorded. Thus, we must use another metric for comparisons between projects, as it is the passing rate (birds per unit of time), see Istúriz et al. (2020).

2) Secondly, WE CANNOT USE THE GLOBAL BIRD NUMBERS FOR AN ANALYSIS. Each species has a migration timing and strategy (Shirihai et al. 2000). The White Stork, primarily but also other species flying in large flocks (Great White Pelican, Levant Sparrowhawk, and Honey Buzzard), may mask the pattern/s of the other species migrating in loose groups (Steppe eagle) or individually, like the Egyptian vulture. We require a species-by-species account, which is not normally the case for any of the reports, e.g., see Ecoda 2007 although.

3) Finally, each species has its own characteristic, like wing load, shape, or weight, which influences the flight. In other words, they are obligate or facultative soaring ones. An obligate soaring bird must use thermals all the time. A facultative one, may not, and use flapping which allows more flexibility when crossing the sea. A last option includes species like the Lesser kestrel, which also migrates at night, or over large sea bodies, and the current counts may result in underestimates.

Operational and forecasted projects

This assessment is based in the comparison of already operational and non-operational projects. This could make the birds to avoid migration flux over already occupied areas, like the NREA and RGWE wind farms, and thus directing their flights to those non-occupied (Amunet 2, Shadwan and Shokeir).

It is not possible to conclude from a comparison that there is any kind of avoidance. For that, it would require a comparison of all these areas “without turbines” versus “with turbines”, BUT collecting data with the exact same methodology. This will be only feasible in the future, but only under the complete turbine scenario (all projects installed).

3 Macroscale approach

Up to now, for the approval of a project, each of them has been assessed individually (microscale approach), as per ESIA; CHA; BAP or any other requirement. However, very little has been done considering a series of projects altogether. Different databases from baseline studies of different projects have been kindly provided for this assessment. However, it does not make sense to get all the projects and try to find a pattern or a magic response. Instead of that, we selected those projects that could highlight the two main questions of the scope of the study.

Projects to compare must belong to the same season and year. There can be weather variations in temperature or wind conditions, which have not been included, or at least partially, in this rapid assessment. If required, this could be done, but would need further data curation and preparation, and a more elaborate analysis methodology.

For the scope of this rapid analysis, we proceeded as follows:

- Analysis and comparison of the migration patterns in 2025, spring and autumn.
- Comparison of the migration flux between three clearly defined areas: close to the mountains, central plain, and coastline, see the zoning below.
- Comparison of the migration flux between “northern” and “southern” areas, based on a latitude gradient as per defined in other previous work (Camiña et al. 2024, 2025).
- Site specific analysis of birds landing within the scope of this assessment; e g., all projects as a whole.

3.1 Zoning

The study area involves a figure rather a quadrat of 30 width, from the mountains to the coast x 35 km long from north to south, FIGURE 3. For the purpose of the analysis and interpretation, the wind farms and each respective Vantage points, have been grouped in two ways:

- **WEST TO EAST**: The projects and their respective Vantage points have been classified in three zones, FIGURE 3:

I) The Coast-sea: includes the three NREA (Jica, Fiem & KfW) operational, plus ACWA-plot 2.
II) The Central plains which comprise RGWE, NREA-Vestas, and Amunet 2; and
III) Mountains: for those closer to the mountain range: Shadwan 900MW and Shukeir 900MW.

The rationale for this split is because of the well-known flying MSBs strategy either using the thermal wind uplifts for soaring but also the "slope-soaring" flight when the strong winds blow near rugged terrain (Pennycuick 1972).
This division roughly overlaps with the Gebel El Zeit IBA delineation, being the coastal projects fully within its limits, whilst those in the "Central" and "Mountains" out of that, except one portion of Amunet 2.

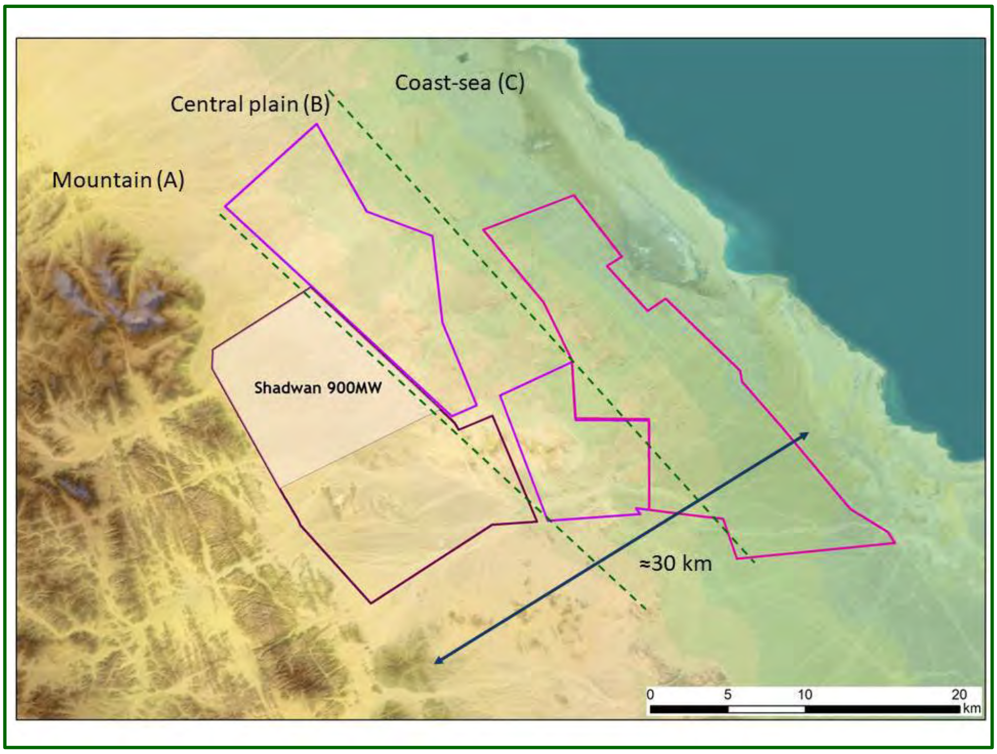

FIGURE 3 DEM model showing the Shadwan 900MW (white spot). The green lines encompass the zoning of the area (Mountain, central plains and coast) and the purple lines the footprints of the current projects either operational or planned; see text for definitions.

Figure 4 Profile view of the study area from Shadwan 900MW project (left) to the sea coast right of "NREA", defining the three areas considered as Mountain, Central Plain, and Coast-sea in Figure 3.

- **North and south**: These projects extend from the 27.5° latitude at the southernmost tip of Gebel el Zeit IBA to 28.5° latitude further north of RGWE. As previous studies suggested a decrease in the migratory flux as the latitude decreases when moving north –most of the birds would use the Gebel el Zeit as crossing point- we divided the area in two sections:
  I) North (above the 28°): RGWE, Vestas, Shadwan, KfW, and Fiem,
  II) South (below the 28°): Amunet 2, GOS III, JICA, ACWA.

  The division has been made based on 0.5° degrees latitude. The latitude from 27.5°N to 28.5°N runs one degree. One degree arc has 60 minutes, which is equivalent to sixty (60) nautical miles or around 111 km. This allows the division in two sections which may make a difference when migrating over the mainland (See Camina et al. 2025 for a similar approach on a wider area).

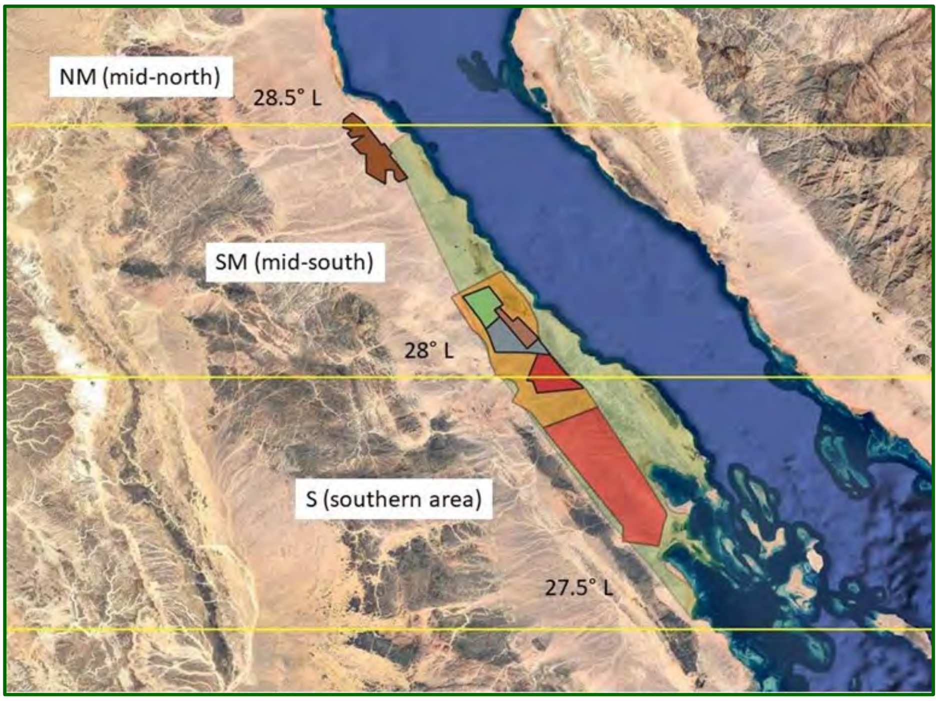

Figure 5 Distribution of the wind projects in the Gulf of Suez after Camina et al. (2025) based on latitude (N-S) location. See text for details.

According to the above described classification, the current operational or planned WPPs are distributed as showed in Table 1. If one project overlaps with the two zones – as it is the case of some NREA projects, appears twice, regardless if entire or partially. Where WPPs overlap between two zones, each Vantage point which was assigned to the location it was situated.

Table 1 Distribution of WPPs according to the different zoning (north to south and mountains to sea coast zones). A project may belong to the two zones because of the distribution of the turbines/VPs, see text.

Project area	Latitudes	Mountain	Plains	Coastal
North	Above 28°	SHADWAN	RGWE 262.5 MW VESTAS500MW AMUNET2	KfW, FIEM JICA

South	Below 28°	GOS III (Shokeir)	NREA SCATEC ACWA	JICA FIEM

3.1.2 Quantitative analysis

The spring and autumn 2025 has gathered good amount of data. It included twenty eight (28) species plus six major groups according to their morphology; these "groups" refer to the unidentified individuals to species level like buzzards, harriers, eagles, or even raptors. Overall, there was not equal sampling at all VPs because of different reasons like adverse weather conditions or logistical issues. As stated in the general methods, numbers were standardized prior to the analysis to make them comparable; there were instances with six hours difference in monitoring time among VPs. Standardization is a required method to allow comparisons when existing uneven sampling and robust results needed (Istúriz et al. 2022).

As the autumn seasons have always lower number of species, records, and individuals compared to spring, from now onwards, we only proceed with the spring data for most of the species. Nevertheless, we will present maps for those species with enough numbers in such season, like the White stork, Great White pelican, and Honey Buzzard.

3.1.3 Species selection spring 2025

Up to thirty-one (31) species of birds are included under the definition of "Migratory Soaring Birds" (MSBs), although many of them are facultative soaring or are not true soarers. The use of soaring flight is a key variable affecting the numbers of each species crossing over land.

To focus on the most representative (enough data collected) species, we followed a four-step process using the field data, to have a representative sample but also suitable to get robust results as described below:

Step 1: We excluded from the list those individuals who remained unidentified in the database and those recorded at very low numbers.

a) **Records and numbers which were not recorded at species level:** They are "raptor", "buzzard", "eagle", "falcon", "kestrel", or "harrier".

b) **Species that are not true soaring birds or recorded at very low numbers:** The Crested honey buzzard is a rare species through the RVRS Flyway. All the Falco family, like Eleanora's falcon *Falco eleonorae*, which migrates through a broad front without following special topographical features (Mellone 2021), not restricted to the flyway. On the other side, the Lesser kestrel *Falco naumanni* also migrates at night, and detectability for the observers is much reduced due to the small size of the species (Sará et al. 2021). The Osprey (*Pandion haliaetus),* despite being a VU species, is also a broad front migrant that does not require the mainland for migration (Monti 2021). The Eurasian griffon (*Gyps fulvus*) is partially migratory and passes in low numbers, whilst the Bonelli's eagle (*Aquila fasciata*) could be resident or dispersal individuals.
As a result, the initial list is reduced to 20 species.

A	Individuals/records which cannot be assigned to species
B	Not true MSBs and/or very low numbers
C	Species with more than n = 30 records)
D	Congregatory vs. rather solitary
E	Species whenever & wherever recorder grounded in the GoS

Table 2 Species under the Step 1 (see text), IUCN Status, number of observations, total birds recorded, and number of birds per observation in spring 2025 at Shadwan site.

Species spring	IUCN Red List	records	birds	birds/record
White stork *Ciconia Ciconia*	LC	115	49,758	433
White pelican *Pelecanus onocrotalus*	LC	41	8,855	216
Levant Sparrowhawk *Accipiter brevipes*	LC	15	3,731	249
Steppe buzzard *Buteo buteo*	LC	1,331	23,506	18
Honey buzzard *Pernis apivorus*	LC	315	15,253	48
Buzzard sp.				
Common crane *Grus grus*	LC	2	207	103
Raptor sp.				
Black Kite *Milvus migrans*	LC	1,044	10,149	10
Black stork *Ciconia nigra*	LC	79	636	8
Eagle sp.				
Steppe Eagle *Aquila nipalensis*	EN	1,392	6,584	5
Lesser spotted eagle *Clanga pomarina*	LC	340	949	3
Short-toed eagle *Circaetus gallicus*	LC	573	832	1
Booted eagle *Aquila pennata*	LC	280	359	1
Long-legged buzzard *Buteo rufinus*	LC	131	141	1
Egyptian vulture *Neophron percnopterus*	EN	121	147	1
G. Spotted eagle *Clanga clanga*	VU	11	11	1

Eurasian Sparrowhawk *Accipiter nisus*	LC	68	79	1
Marsh harrier *Circus aeruginosus*	LC	51	56	1
Montagu's harrier *Circus pygargus*	LC	7	7	1
Osprey *Pandion haliaetus*				
Kestrel	-			
Eastern imperial eagle *Aquila heliaca*	VU	22	22	1
Bonelli's Eagle *Aquila fasciata*				
Crested Honey Buzzard *Pernis ptilorhynchus*	LC			
Eleanora's falcon *Falco eleonorae*	LC			
Falco sp.				
Griffon vulture *Gyps fulvus*	LC			
Harrier sp.				
Hobby *Falco subbuteo*	LC			
Lesser kestrel *Falco naumanni*	LC			
Pallid harrier *Circus macrourus*	NT	4	4	1

STEP 2: We reduced the initial list by extracting those species that had fewer than thirty (n = 30) records in a migratory season. This further reduced the number of species to fourteen (14). We filtered the number of records to get as representative a sample as possible for the analyses.

A	Individuals/records which cannot be assigned to species
B	Not true MSBs and/or very low numbers
C	Species with more than 50 records
D	Congregatory vs. rather solitary
E	Species whenever & wherever recorder grounded in the GoS

Table 3 The fourteen species list remaining after the Step 2; notations as in Table 2 (number of records, birds and bird numbers per record).

Species spring	IUCN Red List	records	birds	birds/record
White stork *Ciconia ciconia*	LC	115	49,758	433
White pelican *Pelecanus onocrotalus*	LC	41	8,855	216
Levant Sparrowhawk *Accipiter brevipes*	LC	15	3,731	249
Steppe buzzard *Buteo buteo*	LC	1,331	23,506	18
Honey buzzard *Pernis apivorus*	LC	315	15,253	48
Buzzard sp.				
Common crane *Grus grus*	LC	2	207	103
Raptor sp.				
Black Kite *Milvus migrans*	LC	1,044	10,149	10
Black stork *Ciconia nigra*	LC	79	636	8
Eagle sp.				
Steppe Eagle *Aquila nipalensis*	EN	1,392	6,584	5
Lesser spotted eagle *Clanga pomarina*	LC	340	949	3
Short-toed eagle *Circaetus gallicus*	LC	573	832	1

Booted eagle *Aquila pennata*	LC	280	359	1
Long-legged buzzard *Buteo rufinus*	LC	131	141	1
Egyptian vulture *Neophron percnopterus*	EN	121	147	1
G. Spotted eagle *Clanga clanga*	VU	11	11	1
Eurasian Sparrowhawk *Accipiter nisus*	LC	68	79	1
Marsh harrier *Circus aeruginosus*	LC	51	56	1
Montagu's harrier *Circus pygargus*	LC	7	7	1
Osprey *Pandion haliaetus*				
Kestrel	-			
Eastern imperial eagle *Aquila heliaca*	VU	22	22	1
Bonelli's Eagle *Aquila fasciata*				
Crested Honey Buzzard *Pernis ptilorhynchus*	LC			
Eleanora's falcon *Falco eleonorae*	LC			
Falco sp.				
Griffon vulture *Gyps fulvus*	LC			
Harrier sp.				
Hobby *Falco subbuteo*	LC			
Lesser kestrel *Falco naumanni*	LC			
Pallid harrier *Circus macrourus*	NT	4	4	1

(1) We left the "Spotted eagle" to be considered together with the "Lesser spotted eagle". Distinction in the field is challenging and also hybridization has been described

Step 3: We split the remaining list of fourteen (14) species into three groups according to the average flock size. For analysis purposes and given the scientific evidences of hybridization (Vali et al. 2010). *Widespread hybridization between the Greater Spotted Eagle Aquila clanga and the Lesser Spotted Eagle Aquila pomarina (Aves: Accipitriformes) in Europe*. https://doi.org/10.1111/j.1095-8312.2010.01455.x), we merged the data of the Lesser and Greater spotted eagles, which may appear indistinguishable for observers under the desert conditions of light (see Porter 2005). Based in the 2025 data Shadwan, there were seven species that are largely congregatory, whilst the six remaining were rather solitary.

A	Individuals/records which cannot be assigned to species
B	Not true MSBs and/or very low numbers
C	Species with more than 30 records
D	Congregatory vs. rather solitary
E	Species whenever & wherever recorder grounded in the GoS

Table 4 Final Table of the species for which this study will enter into the final analysis.

Species spring	IUCN Red List	records	birds	birds/record
White stork *Ciconia ciconia*	LC	211	83,763	397
White pelican *Pelecanus onocrotalus*	LC	100	21,974	220
Steppe buzzard *Buteo buteo*	LC	1,388	36,018	26

Honey buzzard *Pernis apivorus*	LC	291	15,716	54
Black Kite *Milvus migrans*	LC	1,041	17,646	17
Black stork *Ciconia nigra*	LC	165	1,464	9
Steppe Eagle *Aquila nipalensis*	EN	1,547	12,219	8
Spotted eagle *Clanga sp.*	"VU"	355	603	2
Short-toed eagle *Circaetus gallicus*	LC	471	665	1
Booted eagle *Aquila pennata*	LC	306	383	1
Long-legged buzzard *Buteo rufinus*	LC	56	56	1
Egyptian vulture *Neophron percnopterus*	EN	116	137	1
Eurasian Sparrowhawk *Accipiter nisus*	LC	64	69	1

STEP 4: From Step 3, and among all the projects throughout the GoS, we kept those wherever recorded on the ground in whatever the season, year, and wind project. This step keeps the same number of species from Step 3.

A	Individuals/records which cannot be assigned to species
B	Not true MSBs and/or very low numbers
C	Species with more than 30 records
D	Congregatory, intermediate vs. rather solitary
E	Species whenever & wherever recorder grounded in the GoS

Species spring	**IUCN Red List**
White stork *Ciconia ciconia*	LC
White pelican *Pelecanus onocrotalus*	LC
Steppe buzzard *Buteo buteo*	LC
Honey buzzard *Pernis apivorus*	LC
Black Kite *Milvus migrans*	LC
Black stork *Ciconia nigra*	LC
Steppe Eagle *Aquila nipalensis*	EN
Spotted eagle *Clanga sp.*	LC
Short-toed eagle *Circaetus gallicus*	LC
Booted eagle *Aquila pennata*	LC
Long-legged buzzard *Buteo rufinus*	LC
Egyptian vulture *Neophron percnopterus*	EN
Eurasian Sparrowhawk *Accipiter nisus*	LC

We proceeded with the analysis for each species among the three geographic landscape areas from Mountain to Coast. For this, we used non-parametric tests and the median passing rate (birds /hour) of each species as an explanatory variable (Istúriz et al. 2022).

3.1.4 Species selection autumn 2025

Here we refer to the Bird Monitoring report Camina, A., Vicente, N., Martín, J., Garrido, J.R. 2025. Bird Migration Study for the SCATEC Power BOO (Shadwan) Wind Power Plant GW during autumn season 2025.

Twenty four (24) species were recorded with a total of 58,713 birds accounting for 605 records. 99.01% of the total birds belonged to only three (3) species; the White Stork, Honey Buzzard, and the Great White Pelican. Only two (2) additional – the Black and the Steppe buzzard accounted for more than 100 individuals. In terms of records, the highest number (194) belongs to the European Honey buzzard (194 and a 32.07%), followed by the Great white pelican and the Black kite. These numbers greatly reduce the number of species to deal with for the autumn.

4 Cumulative analysis of Shadwan 900MW and other WPPs

To present the results we will follow a species by species approach in a structured manner as follows:

1) We first present the species, its IUCN classification and population estimates (IUCN Red List 2020) and migratory behavior following Mellone and Shirihai (2000).
2) For each species we have calculated the median passing rate (birds /hour) for the Mountain, central and sea coast zones. We performed statistical comparisons between the passing rates to check for significant differences (preferred area in spring 2025) or non-significant ones (the birds moved randomly). Then we produced distribution maps for a better visual experience of the differences.
3) On a third step, we compared the passing rates among zones but also according to hour intervals. For that, we split the median passing rates per hour interval of 1 h from the start of the monitoring to sunset (08:00-09:00, 09:00-10:00…. Until 17:00-18:00). We created a joint database with all the bird monitoring data obtained from all the projects.
4) We consulted the available data of satellite tracking of migratory birds; see Camiña et al. (2025). With the tracking data, we developed heat maps (Kernel contours), to check for preferred migratory corridors across the Gulf of Suez. Finally, we interpreted this data with the outcomes of 1 to 3.

4.1 Summary of results

We start this section with the summary results of the analyses which come below. The Table shows the passing rates per season, spring and autumn, and each species. As said before, the data from the autumn season are scarce because of the nature of the migration, and not a monitoring gap.
The Table 5 shows the median passing rates expressed in birds per hour –without confidence intervals- for the species in spring 2025.

The Table shows that **all the species which migrate in small groups or solitary have overall similar passing rates throughout the Mountains, Central Plains or coastal areas**. In other words, potential risk to them in terms of bird numbers would be the same regardless the area they are flying over.

For species migrating in flocks, within species, there are variations which can be affected by the mean flock size (group composition), see the next section with the species accounts. There is inconsistency between species with some migrating at higher passing rate in the Mountains (Great White pelican, Steppe Buzzard, or the White Stork) whilst others mainly occur through the central plains (Honey Buzzard) or coastal areas (Black stork, Steppe eagle, and Black Kite).

Table 5 Median passing rates (birds/hr) for spring 2025 for species migrating in flocks and those that migrate in small groups or individually.

	Spring		
Species	**Mtn**	**Ctr**	**Sea**
Flocking behavior			
White stork	31.13	30.38	21.86
G. White pelican	47.80	32.78	22.72
Honey Buzzard	6.34	7.42	4.53
Black stork	1.15	1.16	1.53
Steppe buzzard	3.57	2.63	2.05
Steppe eagle	0.81	0.83	1.04
Black kite	1.48	1.79	2.34
Solitary or small groups			
Marsh harrier	0.12	0.12	0.10
Egyptian vulture	0.17	0.15	0.13
Spotted eagles	0.25	0.16	0.17
E. imperial eagle	0.13	0.13	0.11
Booted eagle	0.12	0.12	0.10
Long-legged buzzard	0.15	0.17	0.11
Short-toed eagle	0.17	0.16	0.13

For the autumn season results are more limited, due to the nature of the migration, Table 6. There is a higher influx of birds through the mountains, as happens with the White stork, Great White Pelican and the Honey Buzzard. Results are equal for the Steppe buzzard through the three areas, whilst there are no Steppe eagles. For the latter, the migratory behavior is different from spring, so these are expected results.

Table 6 Median passing rates (birds/hr.) for autumn 2025 for species migrating in flocks and those that migrate in small groups or individually.

	Autumn		
	Mtn	Ctr	Sea
White stork	86.82	82.95	51.26
G. White pelican	20.09	22.54	9.58
Steppe eagle	n.s.	n.s.	n.s.
Steppe buzzard	0.23	0.22	0.22
Honey Buzzard	5.14	0.77	0.48

Results suggest that the migration occurs in a wide area exceeding the footprint of a project or even "the projects" boundaries, being a question of scale. The Gulf of Suez would be too small compared to the Rift-Valley Res Sea Flyway occupied by the species; and species are exposed to wind energy regardless the specific location of a WPP project. Thus, a common approach to mitigation is desirable for all WPPs. The observed variations for the species migrating in flocks would be related to the group composition (size) rather than to site conditions. Higher or lower bird passing rates would be year and month dependent of weather conditions.

NOTE: In the methods we explained that a north-south zoning was made between the 27.5º and the 28.5º. As we did not find significant differences between these two areas (birds densities and median numbers were the same), we omit the results. However, due to the results from previous analysis (Camina et al. 2025) we prefer to mention here for clarity purposes in case the readers have access to such document.

4.2 Species accounts

In this section we will see values with variations compared to what presented in the Summary of results". This could make us to think that results are different. However, here we include the confidence intervals for the medians.

A median is a single point value representing the 50th percentile of data, while a confidence interval (CI) of the median is a range of values likely to contain the true population median. The median shows the middle value, whereas the CI shows the precision and uncertainty of that estimate. Thus, is so important to have a sample size (see Sections 3.1.3 and 3.1.4).

4.2.1 WHITE STORK *Ciconia ciconia*

The White stork is a Least Concern species (LC) with a migratory population through the Rift Valley - Red Sea Flyway population estimated of being 450,000 individuals. The European population is estimated at 224,000-247,000 pairs, which equates to 447,000-495,000 mature individuals (BirdLife International 2015). This provides an idea about the importance of the GoS for this species.

In spring, the highest and significant migration intensity occurred through the plains and mountain areas, which were both higher when compared to the coastal projects; we present the graphs using a visualization and statistics which allows comparisons (violin and boxplots). The violin plots are wider where more data are presented, whilst the narrowest sections represents the reverse. The data presents great variation, many flocks of similar size and a few quite large. In autumn 2025 there were significant differences between the coastal wind farms when compared to central and mountains. The difference between mountain and centre was quite small.

In the Figure 5 we see that through the Coast-sea the points are more grouped (similar values), whilst in the Mountain and central plains values show more variation. A plausible explanation would be that white storks show more cohesion in the groups; they would need to behave all in the same way to solve potential thermal constraints. In the Central plain and Mountain, soaring conditions would be more flexible.

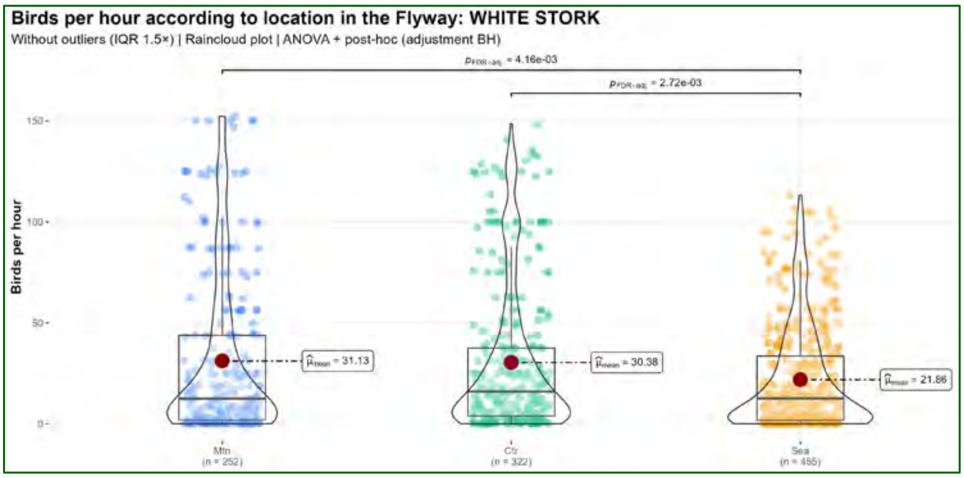

Figure 6 Violin and cage plots in spring 2025 for the White Stork from Mountain (left) to Coast (east). Each coloured point represents one observation.

The pattern in autumn 2025 was similar, Figure 6 but birds cross in a less disperse manner (see the violin graphs especially for the central plains, which are similar to those in the coastal area.

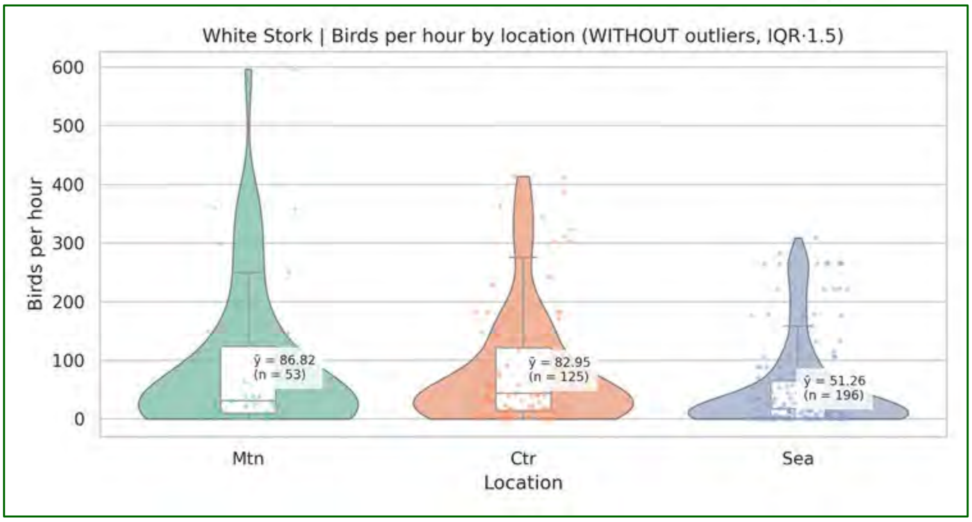

Figure 7 Violin and cage plots in spring 2025 for the White Stork from Mountain (left) to Coast (east). Each coloured point represents one observation.

Despite the differences in the passing rates among the three zones, the trend –passing rates per hour interval were very similar to all of them, Figure 6. There is a peak in the early morning, and a lower peak in the afternoon. The Mountains do not have such a variation compared to central areas and sea. This would suggest a different behaviour of departure and flight in the central and sea areas, where thermals could be weaker (more variation in appropriate conditions for flying.

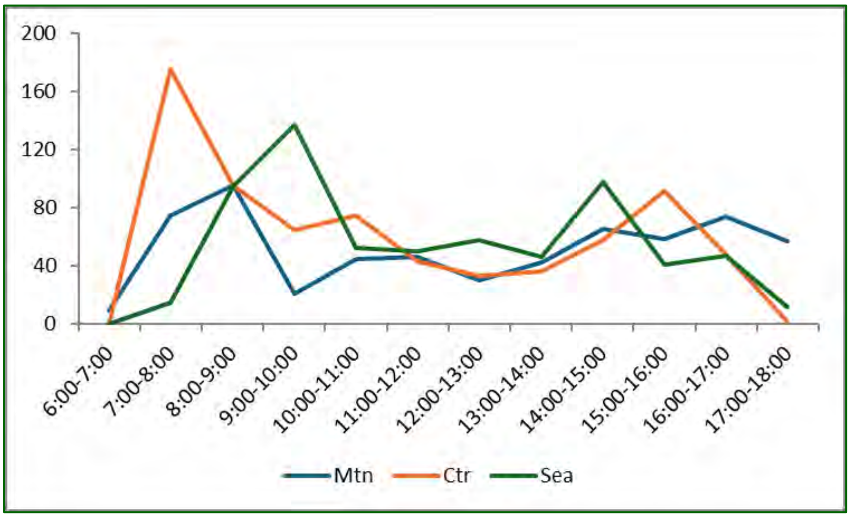

Figure 8 Median passing rates (birds per hour) for the White stork in spring 2025 for the mountain, central and coastal areas.

For the study and comparison of the passage of the White Stork we relied on the work by Van den Bossche (2002), who uses data from the 90's for his analyses. Note: the Shirihai et al. (2000) study is related to raptor migration and given that the White Stork is not a raptor it cannot be included her. The Van den Bossche (2002), study refers to smaller flocks in April and May. In autumn, White storks migrate early compared to all the remaining species.

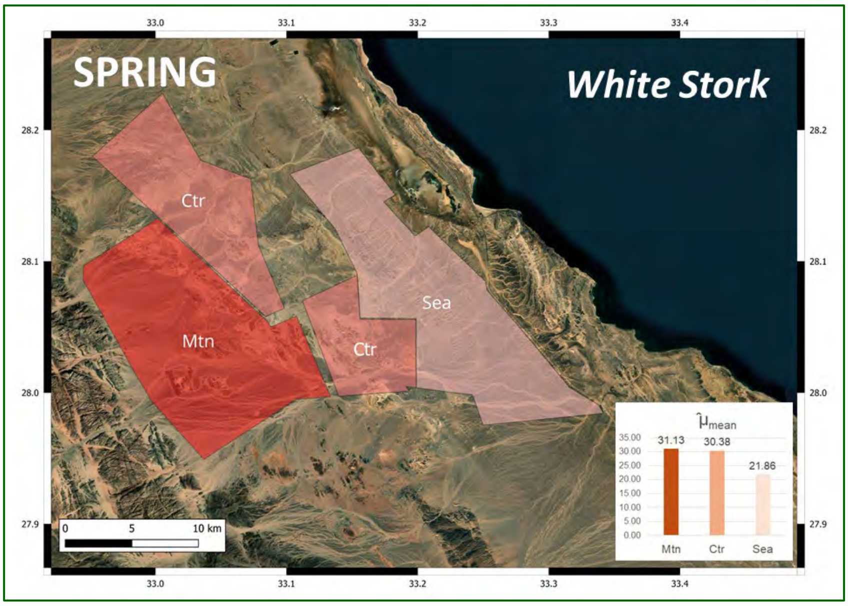

Figure 9 Sensitivity map for the White stork for spring 2025. The higher passing rate occurred closer to the mountains and Central plains.

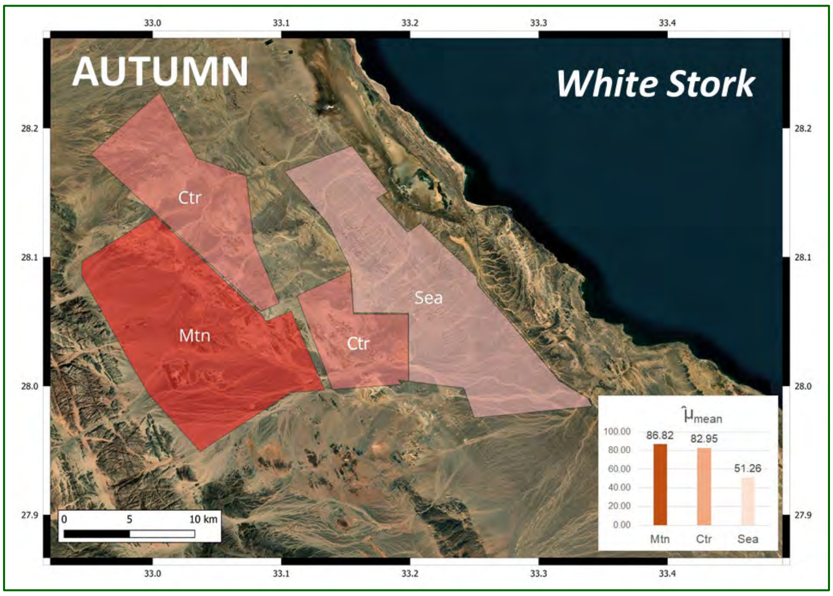

Figure 10 Sensitivity map for the White stork for autumn 2025. The higher passing rate occurred closer to the mountains and central plains.

The White stork is the species with the better knowledge on its migratory behavior. Over years, satellite tracking technology has provided with accurate data about movements and scientific studies (Berthold et al. 2024, Fiedler et al. 2022 or Carlson et al. 2021). We got the tracking data from their forty eight (48) birds, in multiple spring and autumn seasons. The FIGURE 9 and FIGURE 10 show the spring and autumn tracks of the species through the GoS.

These Figures taken from a previous work in the region (Camiña et al. 2025) show a heat map with concentrations of the species around the Red Sea which crosses to and from the Sinai Peninsula (both spring and autumn) flying over the WPPs in the region, and not only those in this assessment. The tracks show highest densities of tracks over a wide area s little bit to the south of the study are in this report, near the Gebel el Zeit Mountain. This could be the reason that migrating through the Shadwan and adjacent WPPs be higher compared to the sea. The White Stork is an obligate soaring bird, and could potentially use not only thermals, but also slope soaring for the movements.

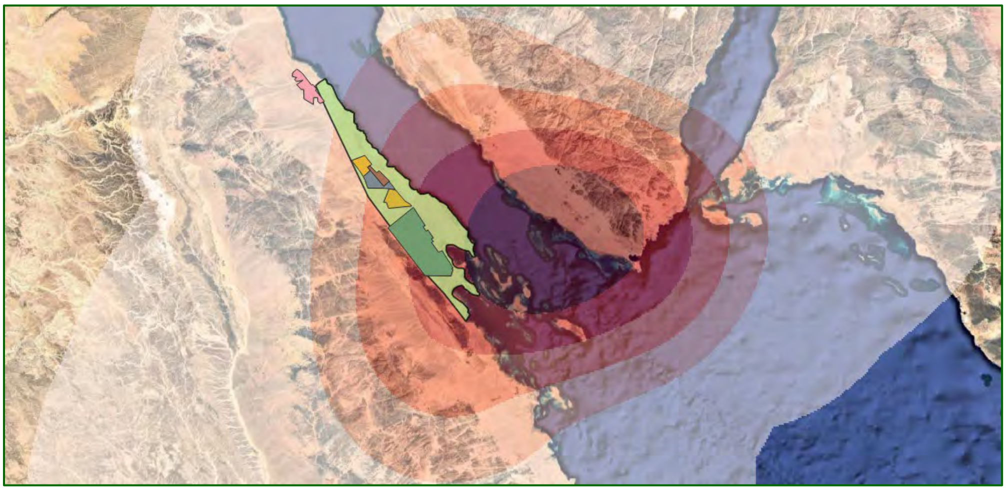

FIGURE 11 General view of the White Stork migration through the GoS. The main crossing area is the narrowest Red Sea area. Flights represent both spring and autumn migration.

The FIGURE 9 shows the tracks (lines) of the monitored birds in more detail, and also revealing the broad crossing front over water. This involves areas where WPPs have been developed already, not only those in this study but further north. It is also noteworthy to see tracks over the mountain range towards the Nile River in undeveloped areas.

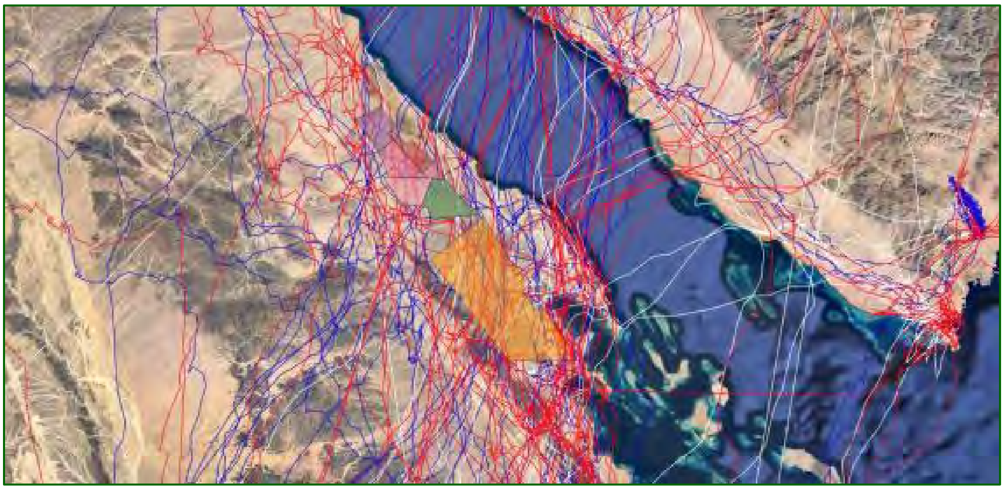

FIGURE 12 Closer view with the location of the WPPs overlapped with > 20 yr. of White Stork satellite tracking data from spring and autumn migrations. Tracks in blue, red and white belong to different projects and large bird sample of > 80 individuals Image from Camina et al. 2025.

The white stork has been widely found landing among WPPS, rubbish dumps, waste water treatment plans, and dams in the region. Even some birds remained for a while in the whole region, visiting several of the projects on consecutive days before resuming the migration.

4.1.2 GREAT WHITE PELICAN *Pelecanus onocrotalus*

The Great White Pelican is a Least Concern species with a population estimate of 70,000 individuals. It also migrates in large groups, but it does not appear in all the projects existing in the Gulf of Suez. However, when appearing, it is recorded in large numbers, as the White stork.

The graphs in spring - Figure 11- show a higher density in the Mountain area but similar presence over the central plains and the coast. This species has a special characteristic, which is the capability of landing over water. Also, its biology and migration is not so well known as for raptors. Looking to the Figure 11, we see that the median passing rate in spring is rather similar in the mountains and central plains. Nevertheless, it is not followed by the composition of the groups. There are larger groups over the mountains whilst similar ones in the Central plains and the Coast-sea area.

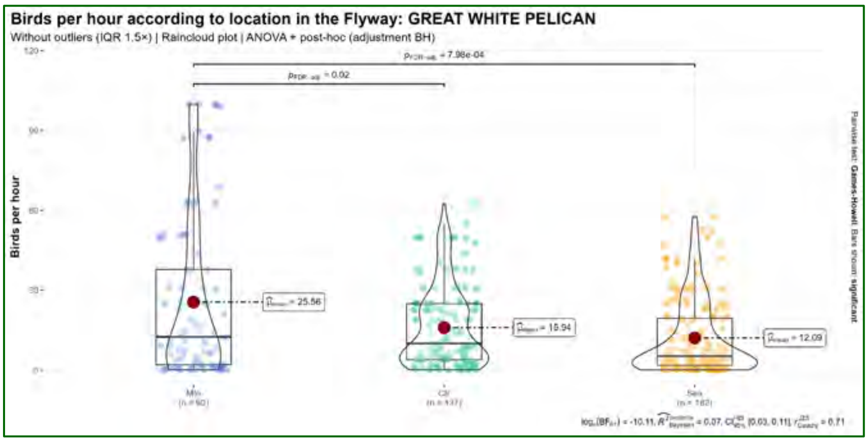

Figure 13 Violin and cage plots in spring 2025 for the Great White pelican from Mountain (left) to Coast (east). Each coloured point represents one observation.

On the contrary, in autumn, Figure 12, the similarities occur in the Mountain and central areas, with lower values and group composition in the coastal area. Flocks are larger –greater variation in their composition- in the two former areas as represented by the violin and boxplot graphs.

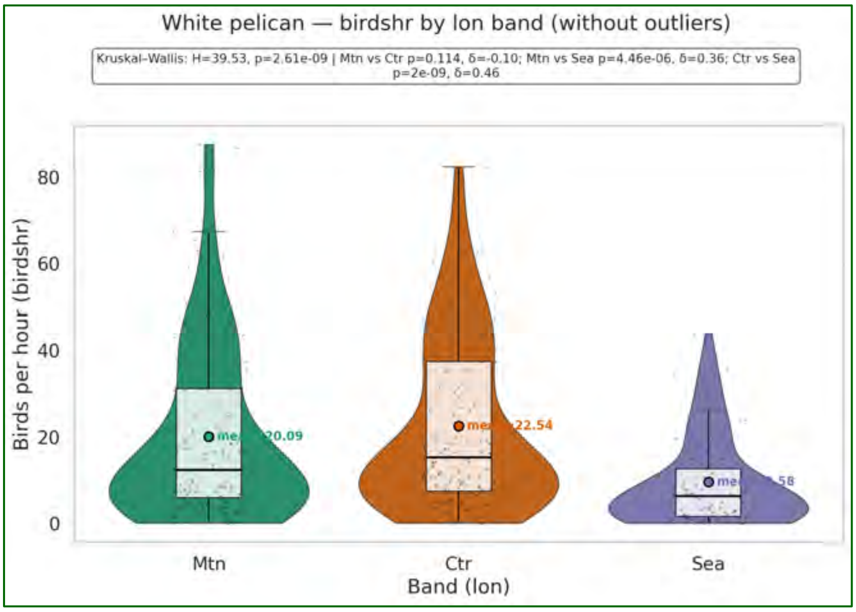

Figure 14 Violin and cage plots in autumn 2025 for the Great White pelican from Mountain (left) to Coast (east). Each coloured point represents one observation.

Due to the scattered data obtained, because of the own nature of the species migration, we are not able of providing an hourly passing analysis as it was done for the White Stork.

The following maps Figure 14 and Figure 15 show a visual perspective of the Great White Pelican migration. However, please refer to the Summary section for a better understanding of the meaning of high-low passing rates.

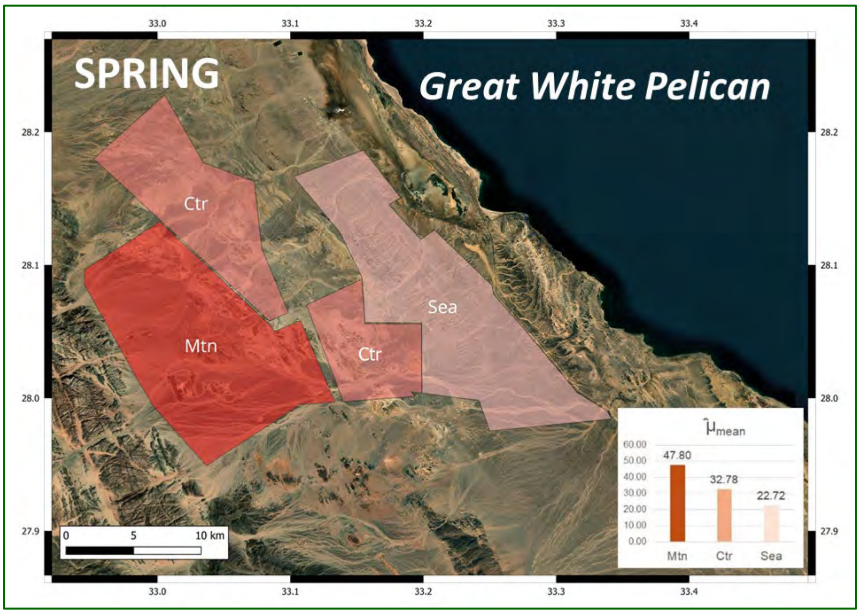

Figure 15 Sensitivity map for the Great White Pelican in spring 2025. The higher passing rate occurred closer to the mountains

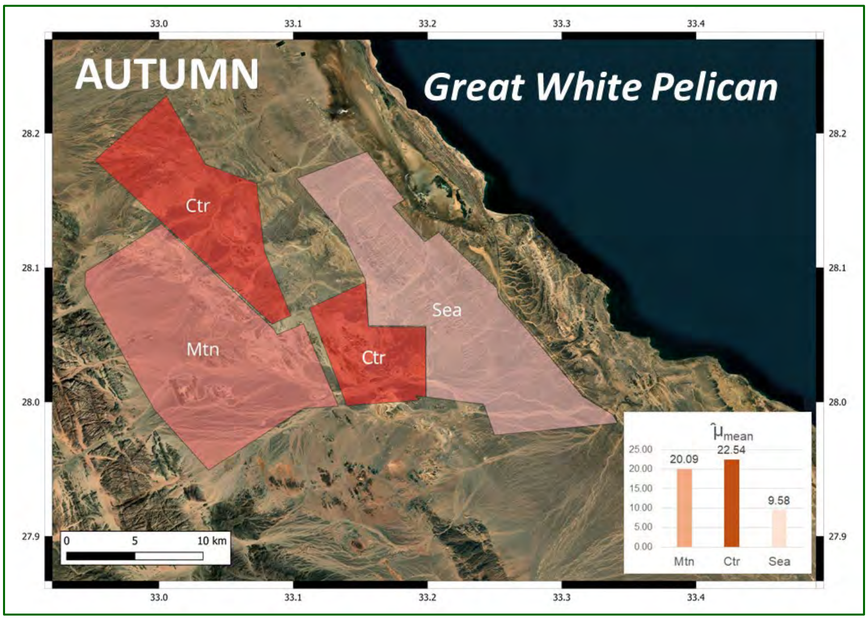

Figure 16 Sensitivity map for the Great White pelican in autumn 2025.

4.2.2 STEPPE EAGLE *Aquila nipalensis*

The Steppe eagle is an Endangered (EN) species according to the IUCN Red List (2019), with a Rift Valley-Red Sea flyway population of 37,500 individuals. The species has been subject of a great amount of scientific research on its migration (Panuccio et al. 2021, Shirihai et al. 2000). It exhibits a loop migration with great difference between the spring and autumn. During the spring is the time where the species crosses the Red Sea in large amounts. This also reflects in the multiple bird monitoring reports from the Gulf of Suez.

The Figure 15 shows the violin and cage plots, where more eagles follow the coastal area compared to the Mountains and central plains. This agrees with the migration in the area. May Steppe eagles cross the Red Sea through Gebel El Zeit Mountain, whilst another "branch" continues further north.

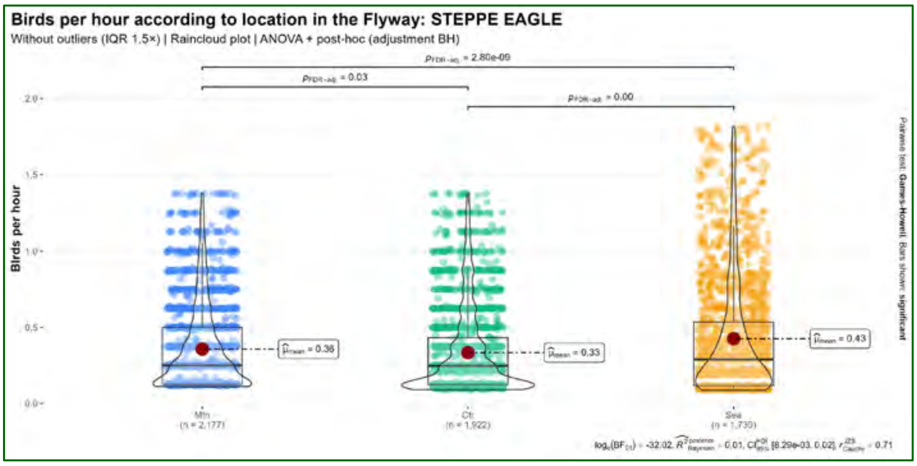

Figure 17 Violin and cage plots in spring 2025 for the Steppe eagle from Mountain (left) to Coast (east).

The crossing times are consistent with being a large eagle, which requires soaring conditions for flying. The three areas show a similar pattern with highest numbers by the noon time, Figure 17.

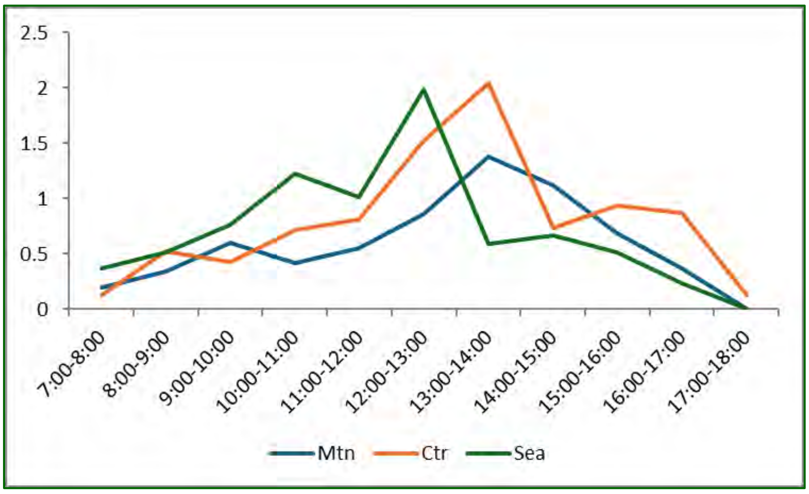

Figure 18 Median passing rates (birds per hour) for the Steppe eagle in spring 2025 for the mountain, central and coastal areas.

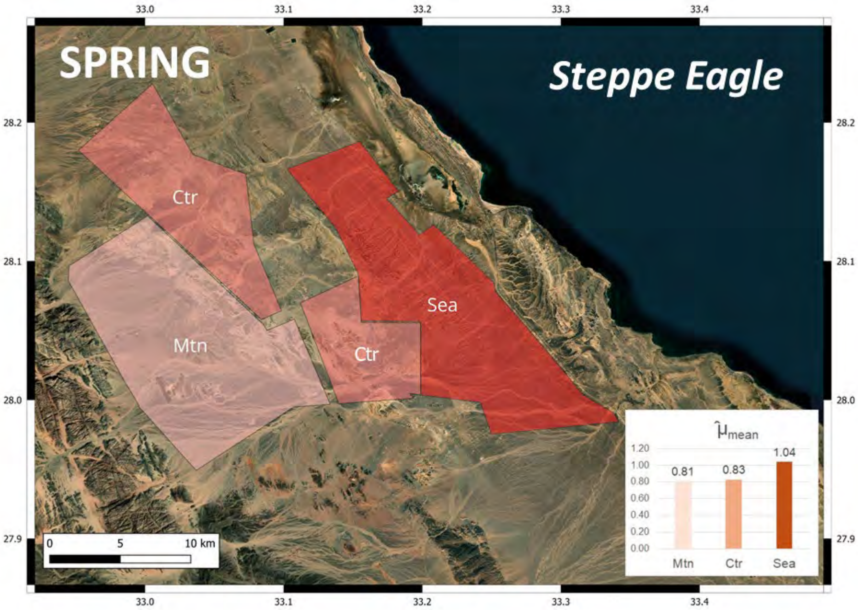

Figure 19 Sensitivity map for the Steppe eagle for the spring 2025.

Lessons learned from our previous research and monitoring of the Steppe eagle in the Gulf of Suez, and the Middle East, revealed it is a sensitive species to collision with powerlines and wind turbines (fatalities have been recorded already at some wind projects in the Red Sea. It also actively feeds on migration, e.g., chicken farms (Wadi Dara area) or rubbish dumps (Ras Gharib, Hurghada). In such circumstances may form large gatherings up to several hundreds of birds. Thus, any WPP should be aware of changes in the landscape which could during the operational phase which could alter the current circumstances of the assessment.

4.2.3 HONEY BUZZARD *Pernis apivorus*

The Honey buzzard is one of the most studied species related to the migration; see Panuccio et al (2021). This species is considered a facultative soaring bird, and thus exhibits great flexibility in its patterns, crossing large water areas like the Mediterranean Sea. Also, studies have demonstrated how the different ages, juveniles and adults; migrate differently in timing and routes, revealing that migration are more complicated than just counting birds as is the case of the good industry practices related to wind impact assessments. For the scope of this assessment we will not detail too much all the research on this species.

The violin and cage plots, Figure 19 , flux is rather similar between the mountains and the central plains, with a lower pass through the coastal area. However, there are greater variations in group size in the plains compared to the other two areas.

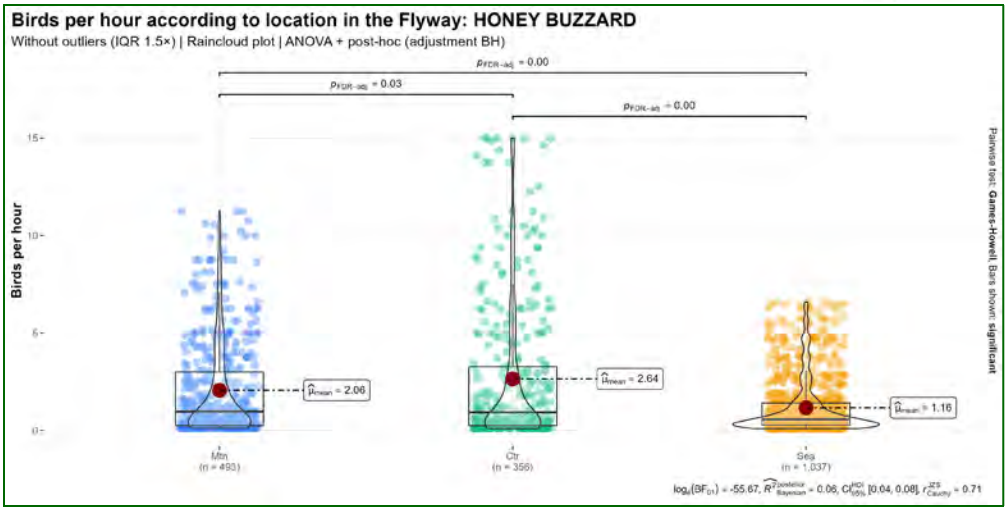

Figure 20 Violin and cage plots in spring 2025 for the Honey buzzard form Mountain (left) to Coast (east).

This pattern changes in the autumn Figure 20. There are more birds flying through the mountains compared to the other two areas. In addition, group size is more variable.

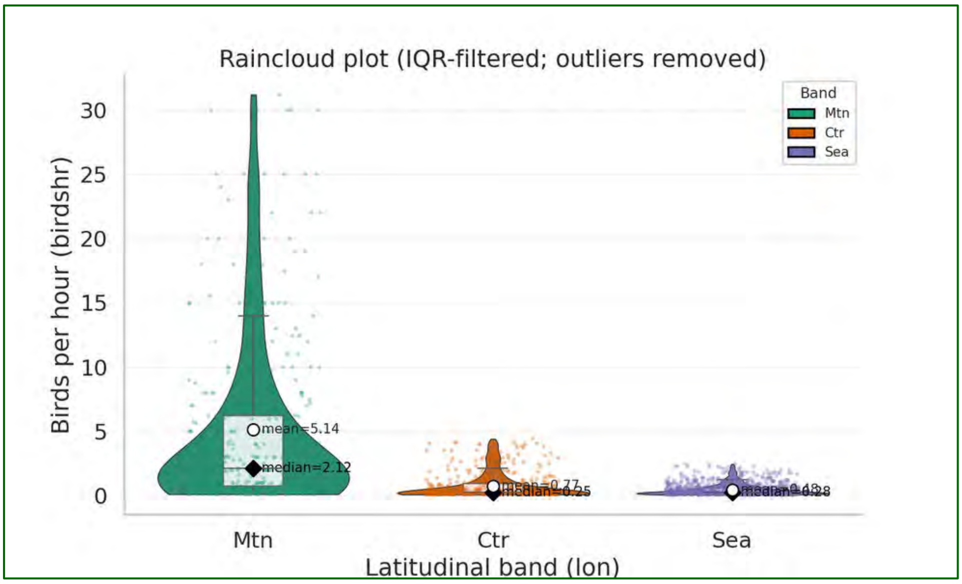

Figure 21 Violin and cage plots in autumn 2025 for the Honey buzzard form Mountain (left) to Coast (east).

The hourly timing of migration, Figure 21, showed that birds used the central hours of the day, between 10:00 am to 15:00. Also, a great increase in the passing rate over the central plains in the late afternoon. We observed this behavior in a project further north in the region (Camiña 2022, *Bird Migration Study for ACWA Power BOO Wind Power Plant 1.1 GW during spring and autumn seasons 2022*).

We must point out that information on where do the migrating birds overnight on rout is completely lacking. Bird monitoring is referred only to what happens in the different project footprints, but bird settlements for overnight are unknown. We speculate it should occur on route, as it has been noticed with a few satellite tracked individuals, which landed at high altitude in mountainous points in the region like Gebel el Zeit mountain.

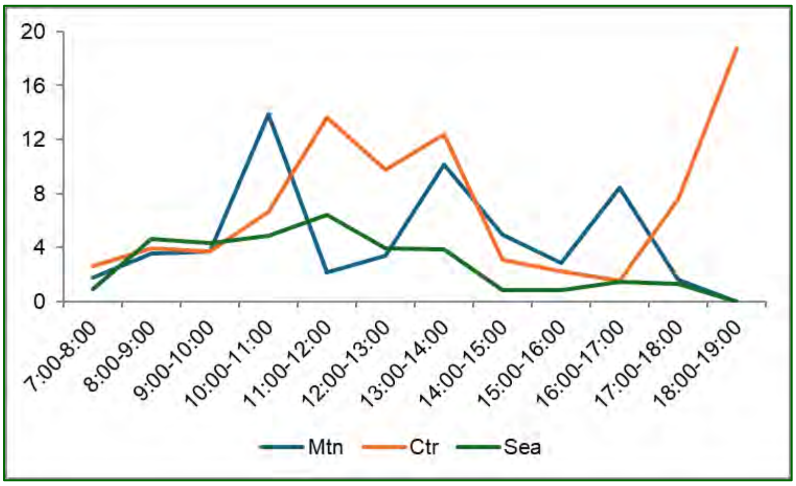

Figure 22 Median passing rates (birds per hour) for the Steppe eagle in spring 2025 for the mountain, central and coastal areas.

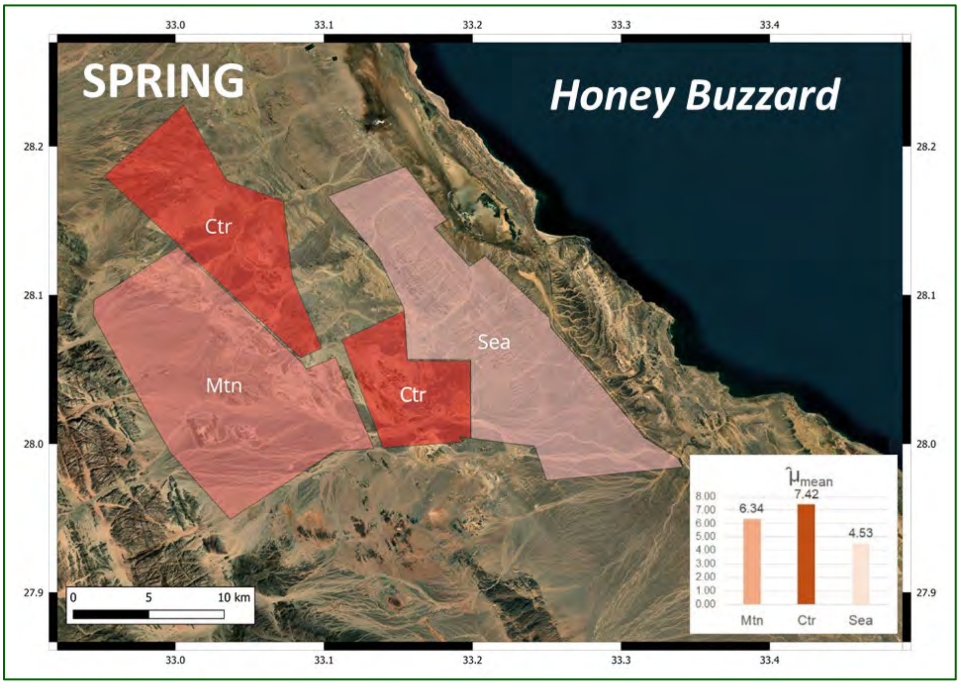

Figure 23 Sensitivity map for the Honey buzzard for spring 2025. The higher passing rate occurred in the central plains.

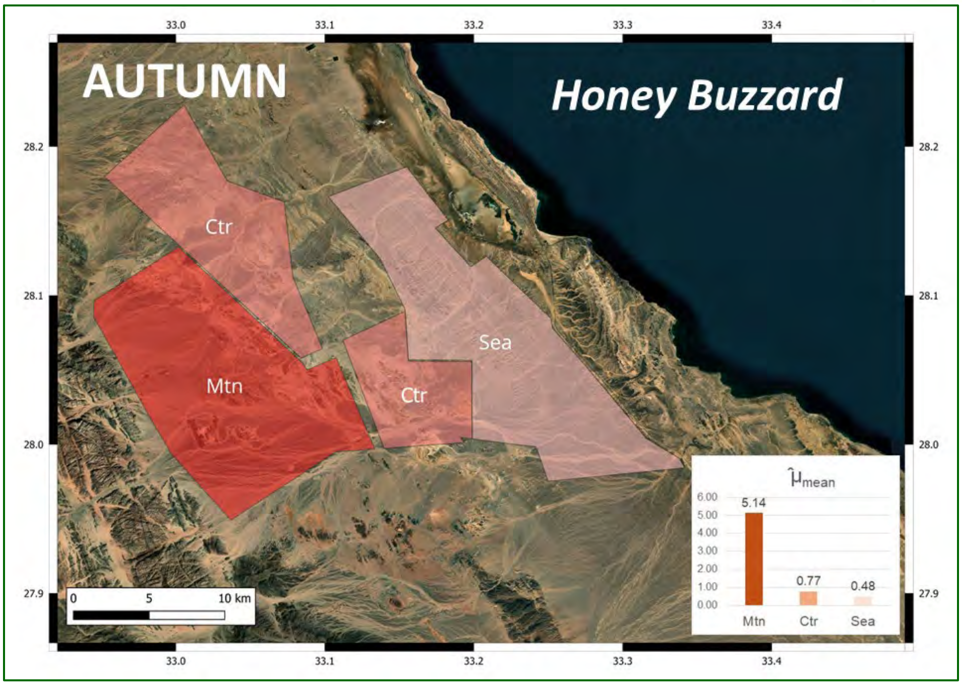

Figure 24 Sensitivity map for the Honey Buzzard for autumn 2025. The higher passing rate occurred closer to the mountains.

Even a wider migration route and front is that of the Honey buzzard. Despite the high numbers recorded at the GoS, these numbers are a partial view of the many other migrating through Africa. The Figure 23 shows the heat maps of satellite tracked Honey buzzards. As it can be seen, the spots occupy a broad and wide front which extends further west in Egypt (Sidi Barrani, Salum), reaching and even crossing borders into Libya.

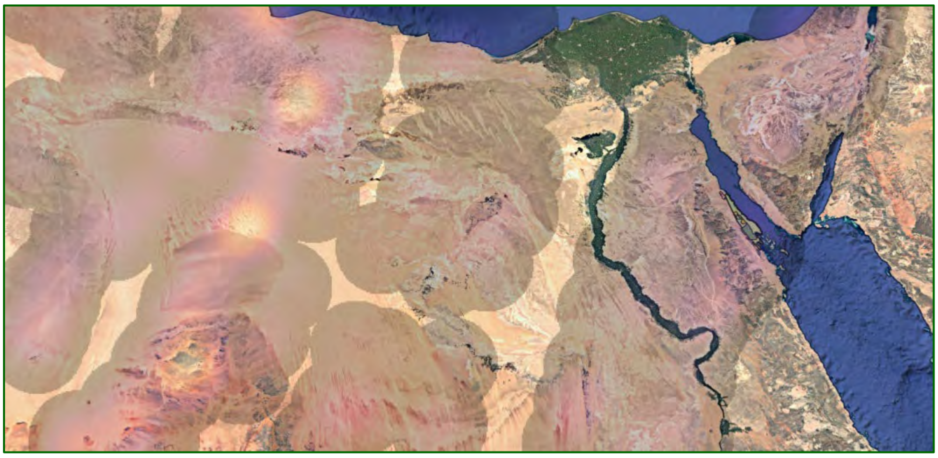

Figure 25 Broader front of the migration of the Honey buzzard in northern Africa.

Contrary to the classification by Birdlife International in the Migratory Soaring birds Tool and Avistep (2024), several MSBs are *facultative soaring birds*. This means they can migrate over the sea and their populations are not forced to fly over the mainland all the time. Vansteelant et al. (2017) found that none of the juveniles tracked died by drowning during the outbound migration, in contrast to the high mortality rate among larger soaring migrants that attempt long flights across the Mediterranean like the Griffon vultures. Concluding, not all the species and populations follow the same route over the same sites every season and year, so assessments should account on this (uncertainty).

4.2.4 STEPPE BUZZARD *Buteo rufinus*

The steppe buzzard is a Least Concern (LC) species with a Flyway population estimated in 1,250,000 individuals. There is not much information on this species compared to the other Migratory Soaring Birds (Panuccio et al. 2021). It is very common especially in spring, always in large numbers as expected.

Despite its abundance, neither spring nor autumn, show great variations in the passing rates (Table 5 and Table 6). This reflects in the graphs below, showing similar patterns in spring and autumn. Whilst in spring the groups are larger in the mountains and central plains, in autumn occurred the reverse, more variation in the coast.

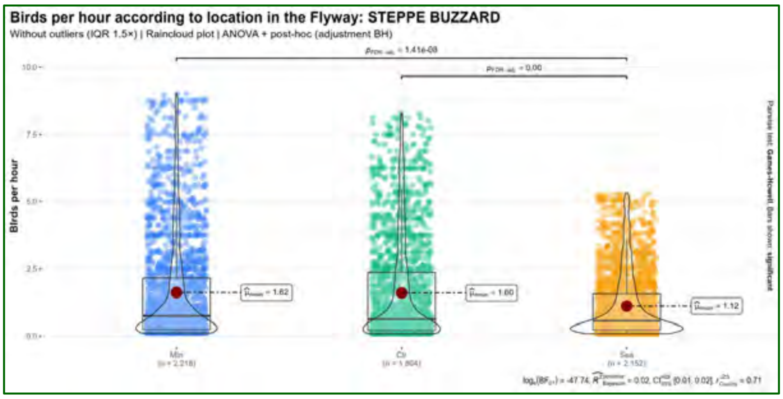

Figure 26 Violin and cage plots in spring 2025 for the Steppe buzzard from Mountain (left) to Coast (east).

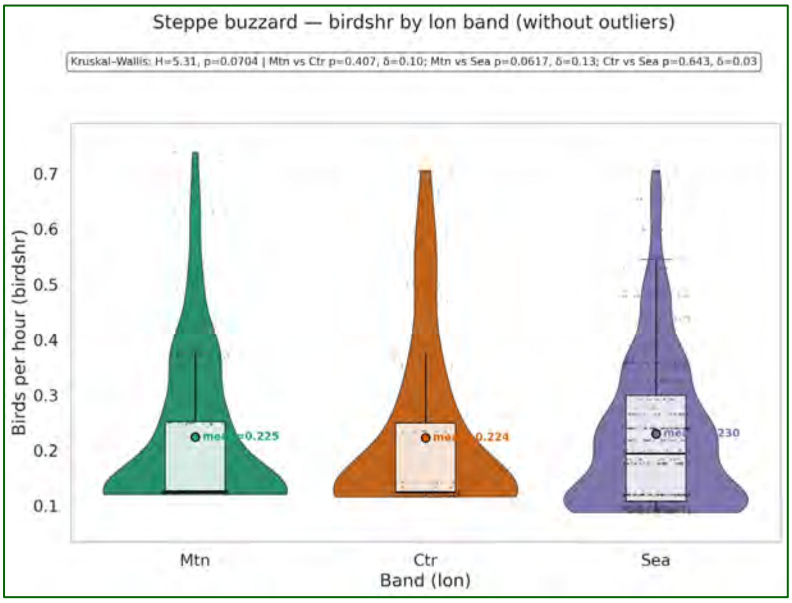

Figure 27 Violin and cage plots in spring 2025 for the White Stork form Mountain (left) to Coast (east).

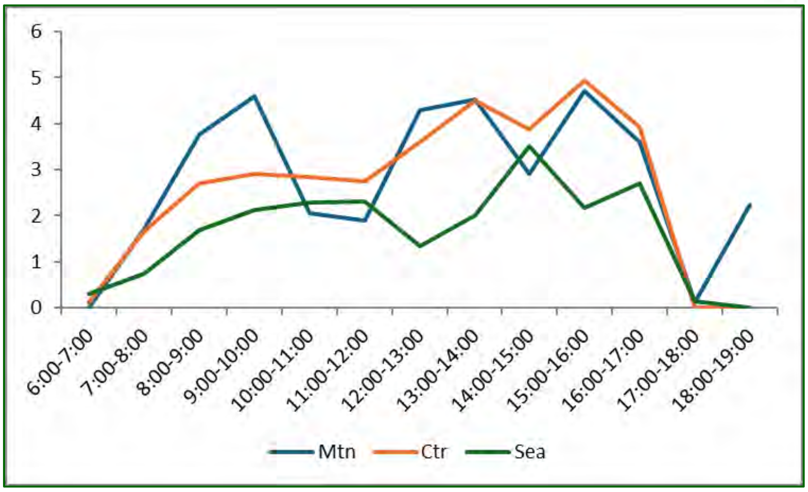

Figure 28 Median passing rates (birds per hour) for the Steppe eagle in spring 2025 for the mountain, central and coastal areas.

The passing hours also show consistency between zones with two migration peaks in the morning but especially that in the afternoon and close to sunset. We must point out that this behaviour is similar to what we detected in other WPP projects within the Gulf of Suez but out of the current assessment.

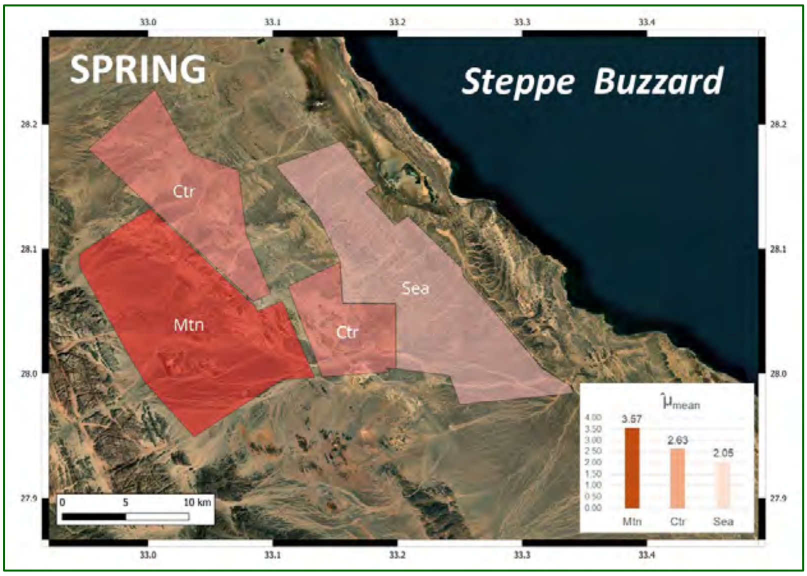

Figure 29 Sensitivity map for the Steppe buzzard in spring 2025. The higher passing rate occurred closer to the mountains

4.2.5 EGYPTIAN VULTURE *Neophron percnopterus*

The Egyptian Vulture is another Endangered (EN) species according to the IUCN (2019) Red List, with a Flyway population of around 4,400 individuals. This is an example of a species migrating in small groups or solitary. From tracked individuals some cross the Red Sea at the Gebel el Zeit IBA or they can follow a further northern route along the axis of the mountains and plains overlapping or not with the WPPs depending on their locations and the route the bird/s follow in a precise year. The most important concept here is "flexibility" (Panuccio et al. 2021), which was also published for the Egyptian vultures in West Africa after crossing the Strait of Gibraltar. Birds do not have constraints other that weather changes along the migration (López-López 2011). This means they do not need to exactly follow the same route on each bound.

The Figure 30 shows the passing rates along the three areas. Mountains and plains had higher passing rates compared to the coast. Also, at the coast, there were more variations in the passing rates. Reasons for these could be double. First a real lack of good weather conditions at all times for migrating, which would result in these variations, or the effect of Egyptian vultures departing to the other side of the "eastern" coast of the Red Sea. Look also to the scale of the left Y axis 0.12 birds per hour at mountains and central plains and 0.12 in the coast.

Despite being significant differences, they are useless for the interest of the report, to provide assessment of the potential risks for the wind development of the Shadwan 900MW project.

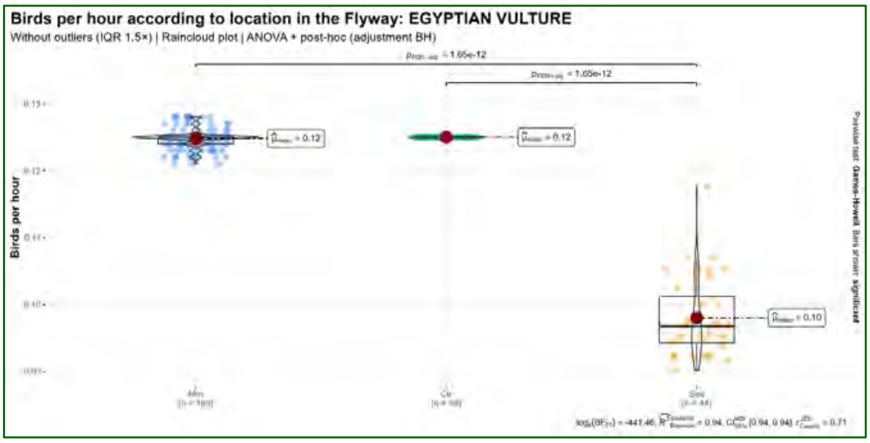

Figure 30 Violin and cage plots in spring 2025 for the Egyptian vulture form Mountain (left) to Coast (east).

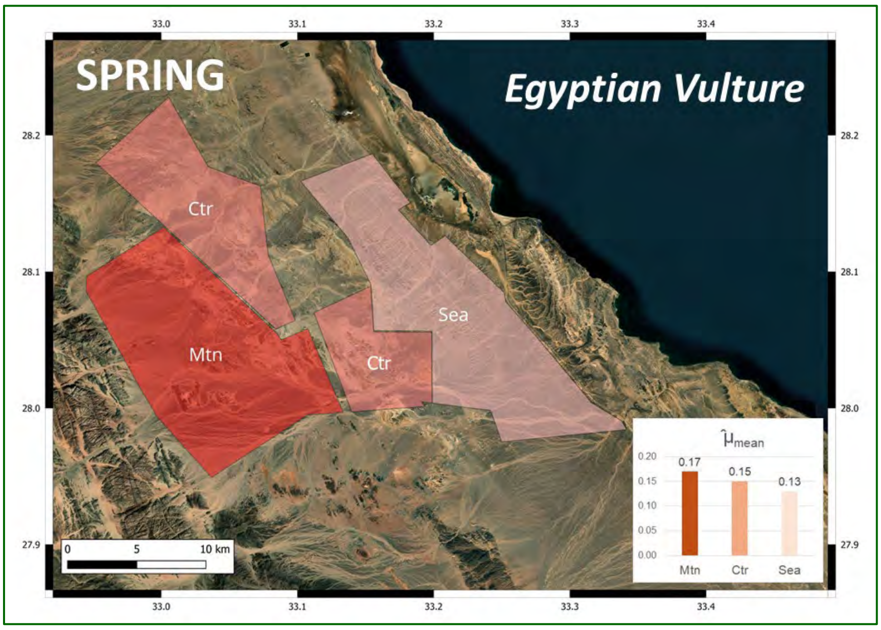

Figure 31 Sensitivity map for the Egyptian vulture in spring 2025.

More insight into the movements of the species through the region comes from our assessment in 2025 (Camina et al. 2025). The Kernel map in the Figure 30 showed that Egyptian vulture tracks were homogeneously distributed over the Red Sea Flyway, with no concentration areas. This suggest a similar risk for the species regardless the location of a project. In other words, the risk exists but with the existing data any fine tuning analysis to the scale of project level is not possible. Existing or planned projects pose a risk for the species; the issue is how to manage that risk, e.g. proper implementation of the shut down on demand).

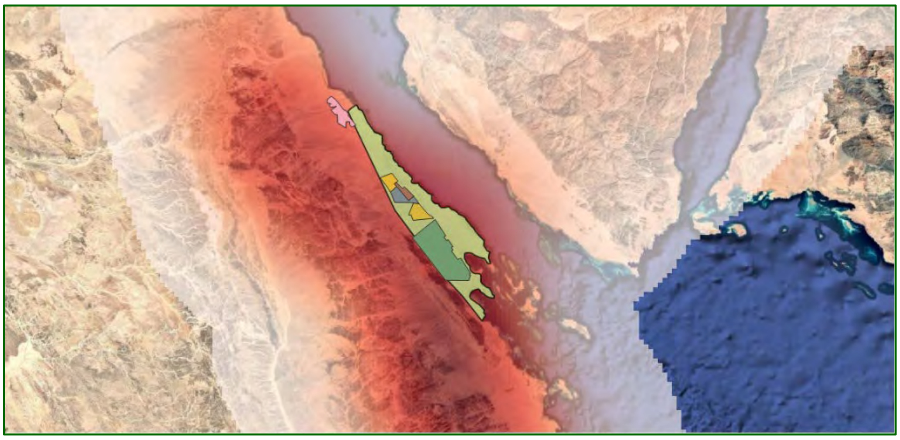

FIGURE 32 Satellite tracking of Egyptian vulture Kernel map (after Camina et al 2025), using a mix of migration paths, either crossing from the Gebel el Zeit IBA, but also using the mountain corridor.

The flexibility of flying routes: example with the spotted eagles

A vissual view of the explained flexibility of the migratory routes through the Gulf of Suez is that of the spotted eagles. The Figure 33 show real tracking data of Spotted eagles through the Red Sea corridor. This Figure was prepared for another cumulative study in the area (Camiña et al. 2025). The birds in the Figure, use a 160 km wide migration front, also with high densities over the mountain range, even beyond of that. These routes belong to several individuals across several seasons. As it can be seen the Mountain is an important part of the migration route but also the projects along the Red Sea coast.

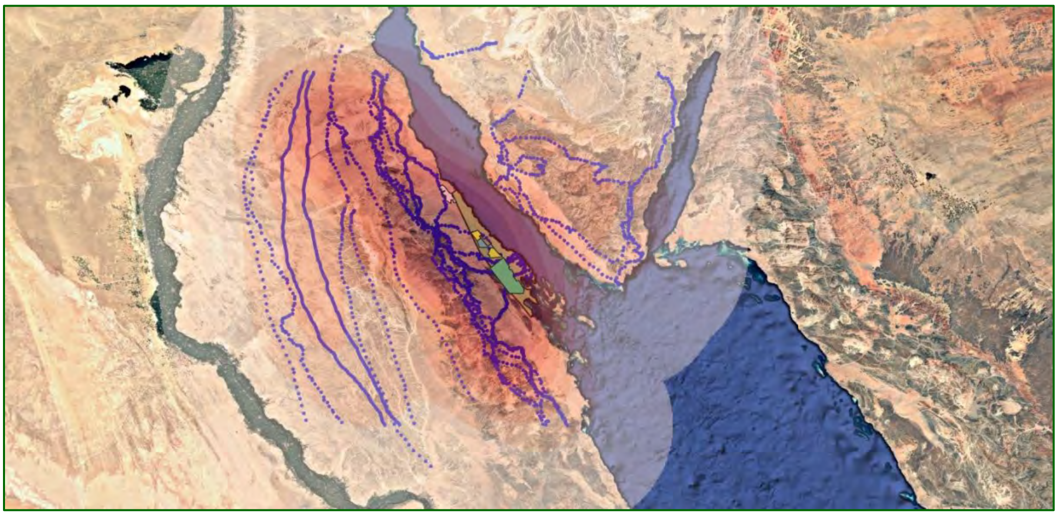

Figure 33 Broader view of the Spotted eagles satellite tracking in the GoS.

5 Flights at risk

Another question which arises is the number of flights at risk. We used the database to classify the number of birds at risk/non risk for an expected turbine model with a hub height plus blade of 220-240 m. We do not perform a Collision Risk Modelling, which was part of the Bird Monitoring analysis of each project.

We used all the projects as done in the previous sections, merging the data into a single database. However, it appeared the first MAJOR GAP: **There are operational projects which do not record the flying heights of birds, e.g. NREA Jica, Fiem and KfW and Vestas**. The data from Acwa plot 2 were from a different year so cannot be used because of different weather conditions. **The analysis should be limited to the Mountain and Central plains and only for spring because of the amount of data**.

The Figure 32 shows the paired tests between Mountain (left) and Central plains (right):

i) Those in blue are the species for which significant differences in risk height appeared;
ii) The longer the bar the highest difference.
iii) Those bars in grey were non-significant differences. Risks were the same wherever in the area.
iv) Five species at higher risk in the mountains: White stork, Levant Sparrowhawk, Lesser spotted eagle, Honey buzzard, and common crane.
v) Five species at higher risk heights on the central plains: White pelican, Steppe eagle, Short toed eagle, Steppe buzzard, and Black kite.
vi) Five species with no significant differences = risk is the same in the mountains and central plains: Marsh harrier, Eastern Imperial eagle, Egyptian vulture, Black stork, and booted eagle.

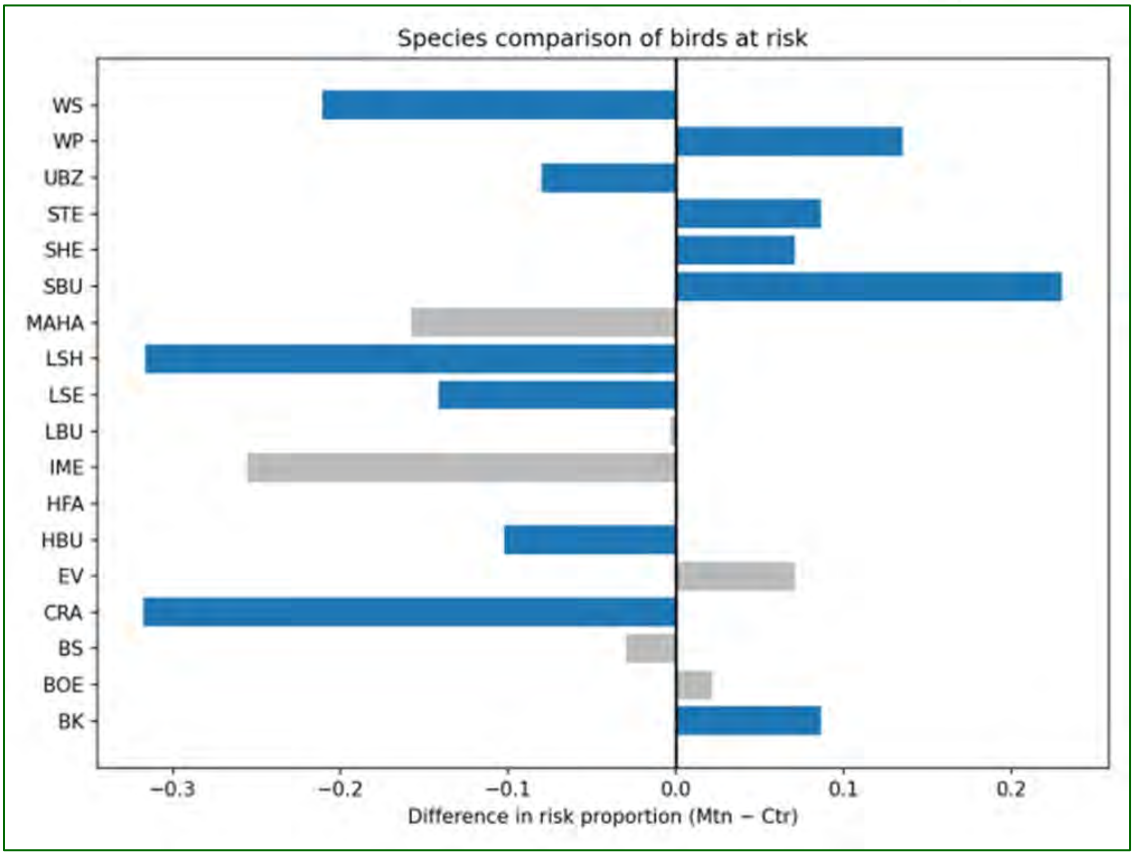

Figure 34 Results of the paired tests for each species for collision risk numbers between the Mountains and the Central plains. See text for explanations. Those in blue showed significant differences. Acronyms: WS-White Stork, WP-White Pelican, STE-Steppe eagle, SHE-Short-toed eagle, SBU-Steppe Buzzard, MAHA-Marsh Harrier, LSH-Levant Sparrowhawk, LSE-Lessee Spotted eagle, LBU-Long-legged buzzard, IME-Eastern Imperial eagle, HBU-Honey Buzzard, EV-Egyptian vulture, CRA-Common crane, BS-Black stork, BOE-Booted eagle, and BK-Black kite.

There was the same number of species at higher risk at the mountains, at central plains, and non-significant. These results suggest that these findings were obtained by chance and based only in the 2025 data. Thus, there may be an effect of seasonally weather conditions which influence the birds during the migration, and thus risk change over time not being fixed.

The above also raise an important question. **ALL the projects**, **despite operational or planned SHOULD collect data using a standardized methodology** to allow comparisons like was the intention of this report.

6 Resident species

The close proximity to the mountain range favors the appearance of cliff nesting birds of importance. Unless specific targeted studies were being done, concern exists for two raptor species, one resident the entire year, the Golden eagle (*Aquila chrysaetos*) and the Sooty Falcon (*Falcon concolor*).

This has not been raised before in WPPs in the Gulf of Suez, because the projects were located in open areas, but could be of increasing interest as new places are subject to development.

The golden eagle

The species has appeared not only in the Shadwan project, but also in Shokeir, and in the Central plains (Amunet-2). The species is categorized as least concern (LC) according to the IUCN (WESTRIP, J.R.S. et al. 2022. *Aquila chrysaetos*. The IUCN red list of threatened species 2022: e.t22696060a210501592. https://dx.doi.org/10.2305/iucn.uk.2022-1.rlts.t22696060a210501592.en).

This finding opens the chance that more pairs could exist in the mountains of the red sea in Egypt, which have been probably not properly monitored before. From an ecological perspective, this observation would extend the breeding range to the south, and to the east in northern Africa, where it would be really very scarce. In the Golden eagle, population growth rates are particularly sensitive to adult mortality rates and only a 4% reduction in adult survival is enough to trigger population decline, which cannot be offset by increased productivity (Tack, J.D., Noon, B.R., Bowen, Z.H., Strybos, L. & Fedy, B.C. (2017). No substitute for survival: Perturbation analyses using a Golden eagle population model reveal limits to managing for take. *J. Raptor Res*. 51, 258–272.

Appropriate mitigation measures should apply, despite the LC category but because of the biodiversity value of being the current southernmost region in the Mediterranean where the species do breed. Despite globally, the loss of one individual is minimal for the entire world population; it is not at regional level due to its small population.

A detailed breeding survey on this species would be necessary to assess the real population size in this area, unique for the world in the edge of its distribution range. The finding on this wind farm pre-construction monitoring is highly relevant due to the protected species list in Egypt (BirdLife International (2025) available at https://datazone.birdlife.org/country/factsheet/egypt

A complete survey comprising the entire breeding cycle of the species would be necessary to properly assess the potential impact of this and other similar projects planned near the mountains and suitable cliffs. This monitoring should be developed with experts on the species, and GPS tagging highly recommended to save time and improve budgets. This monitoring could be shared by other developers in a similar situation. **THIS IS A MEASURE TO BE TAKEN TOGETHER WITH OTHER PROJECTS AND NOT ALONE.**

The Sooty Falcon[1]

Following Garrido et al. (2021), the Sooty falcon breeds colonially in hot, arid deserts and coastal habitats without vegetation, and on coral islands, where its breeding coincides with the autumn migration of the small birds on which it feeds (Clark and Davies, 2018). It nests in a hole or on a cliff ledge. It is classified as Vulnerable (VU) in the IUCN Red List 2021. It is a migratory species; birds arrive in their breeding grounds in April and return to their wintering sites in October (del Hoyo et al., 1994).

Despite only two individuals have been recorded in the spring migration, up to ten individuals were recorded between August and October. This is a species, for which observers are not able of proper monitoring from the Vantage Points due to its small size (e.g., observers lost their capabilities for detecting and recording the birds at very short distances, much shorter than the 1.8- 2 km radius. In other words the species is UNDERESTIMATED.

The Sooty falcon has been recorded already colliding with wind farms in the Gulf of Suez, close to the proposed project. A recent paper on the Lesser Kestrel *Falco naumanni* quantified the potential long-term demographic impact of collisions to anthropogenic structures like windfarms in a relatively short-lived bird species. Additional mortalities induced by collisions with turbines may also have a strong impact on their population dynamics.

Due to the habitat characteristics, close to the cliffs and mountain ridge, we consider the potential breeding population has not been properly assessed in this and other surrounding projects with similar characteristics. The current monitoring is limited to the migratory seasons, without non species specific breeding monitoring. This should be done.

Following Garrido et al. 2022: The species is included in the CMS Appendix II. There is a draft International Single Species Action Plan (Gallo-Orsi et al., 2014, unpublished). The main conservation and research actions needed: Awareness of the species should be raised. Research should be conducted to inventory, survey and monitor the population to determine, protect and manage potential breeding sites and key dispersal areas, including migration corridors. Research on the ecology of breeding, non-breeding and migrating birds is needed, involving GPS tagging and on-the-ground investigations, to assess potential threats to the species. **THIS IS ALSO A MEASURE TO BE TAKEN TOGETHER WITH OTHER PROJECTS AND NOT ALONE.**

[1] BirdLife International. 2021. Falco concolor. The IUCN Red List of Threatened Species 2021: e.T22696446A180387681. https://dx.doi.org/10.2305/IUCN.UK.2021-3.RLTS.T22696446A180387681.en. Accessed on 22 December 2025.

7 REFERENCES

- Amunet 2022. Cumulative Effects Analysis (CEA). AMUNET WIND FARM 500MW AT GULF OF SUEZ. Cumulative Effects Analysis (CEA). Ecoconsult.
- Berthold P, Kaatz C, Kaatz M, Querner U, van den Bossche W, Chernetsov N, Fiedler W, Wikelski M. 2022. Data from: Study MPIAB Argos white stork tracking (1991-2017). Movebank Data Repository. https://www.doi.org/10.5441/001/1
- BirdLife International (2024) Important Bird Area factsheet: Gebel El Zeit (Egypt). Downloaded from https://datazone.birdlife.org/site/factsheet/gebel-el-zeit-iba-egypt on 16/09/2024.
- BirdLife International (2024) Species factsheet: White Stork *Ciconia ciconia*. Downloaded from https://datazone.birdlife.org/species/factsheet/white-stork-ciconia-ciconia on 24/09/2024.
- Blas J, Reyes Salas AF, Torres-Medina F, Sergio F, Wikelski M, Fiedler W. 2020. Overland and oversea migration of white storks through the water barriers of the straits of Gibraltar. Scientific reports. https://doi.org/10.1038/s41598-020-77273-x
- Buechley ER, Michael J, McGrady M, Çoban E, Şekercioğlu CH. 2018. Satellite tracking a wide-ranging endangered vulture species to target conservation actions in the Middle East and East Africa. Biodivers Conserv https://doi.org/10.1007/s10531-018-1538-6
- Carlson BS, Rotics S, Nathan R, Wikelski M, Jetz W. 2021. Individual environmental niches in mobile organisms. Nat Commun. 12:4572. doi:10.1038/s41467-021-24826-10.1038/s41467-021-24826
- Fiedler W, Leppelsack E, Leppelsack H, Stahl T, Wieding O, Wikelski M. 2024. Data from: Study LifeTrack White Stork Bavaria (2014-2024).
- Friedemann G, Leshem Y, Izhaki I. 2016. Data from: Multidimensional differentiation in foraging resource use during breeding of two sympatric raptors: space, habitat type, time and food. Movebank Data Repository. https://www.doi.org/10.5441/001/1.
- Friedemann G, Leshem Y, Kerem L, Shacham B, Bar-Massada A, McClain KM, Bohrer G, Izhaki I. 2016. Multidimensional differentiation in foraging resource use during breeding of two sympatric top predators. Sci Rep. 6:35031. https://doi.org/10.1038/srep35031
- Green Plus. 2019. Bird Migration Study (BMS) BOO RGWE Wind farm 262.5 MW at the Gulf of Suez. Prepared for Ras Ghareb Win Energy S.A.E. and RCREEE. 86 pp.
- Hilgerloh, G. 2011. The desert at the Zait Bay/Egypt: a critical bird migration bottleneck area of global importance—ERRATUM. Bird Conservation International 21: 362–363.
- Hilgerloh, G, G Pegram & A Schreiber. 2011. The influence of wind conditions and topography on soaring migrants near the southern gulf of Suez. Sandgrouse 33: 139–148.
- Hilgerloh, G, J Weinbecker & I Weiss. 2009. The timing of spring passage of soaring birds at Zait bay, Egypt. Sandgrouse 31:26–35.
- IPH (Infinity Power Holding).2023. Site-Specific Environmental and Social Impact Assessment (ESIA) Infinity Power Holding Wind Power Plant 320 MW at Gulf of Suez. Cumulative effects analysis (CEA). 23 pp.
- Istúriz A, Astráin C, Ibarrola I, Milon É, Castegè I. (eds). 2022. Oiseaux terrestres et marins dans les Pyrénées atlantiques changement climatique, migration et évolution des populations. GAN-NIK/CMB/POCTEFA NaturClima EFA 311/19. 82 pp.

- SENS. 2020. RGWE BOO 262.5 MW Wind Farm - Bird and Bat Fatality Monitoring, autumn 2020. Prepared for RCREEE, 66 pp.
- SENS. 2021a. RGWE BOO 262.5 MW Wind Farm - Bird and Bat Fatality Monitoring, autumn 2021. Prepared for RCREEE, 34 pp.
- SENS. 2021b. RGWE BOO 262.5 MW Wind Farm - Bird and Bat Fatality Monitoring, spring 2020. Prepared for RCREEE, 66 pp.
- Serckx A, Wilson D, Katariya V, Pollard E. 2018. Lekela North Ras Gharib 250 MW: Analysis of cumulative effects to biodiversity. The Biodiversity Consultancy.
- Shohdi, WS. 2019. RGWE BOO 262.5 MW Wind Farm - Bird and Bat Fatality Monitoring, autumn 2019. Prepared for RCREEE.
- Shohdi, WS. 2020. RGWE BOO 262.5 MW Wind Farm - Bird and Bat Fatality Monitoring, spring 2020. Prepared for RCREEE.
- Martín J, Garrido JR, Camiña A. 2015. WASTE MANAGEMENT: Best practices and impact to conserve Migrating Soaring Birds (MSB's) in the Rift Valley-Red Sea Flyway. Prepared for BirdLife International. 123 pp.
- Mellone U. 2021. Eleanora's Falcon *Falco eleanorae,* Pp: 228-234 in: Panuccio, M., Mellone. U., and Agostini, A. (Eds.) Migration Strategies of Birds of Prey in Western Palearctic. CRC Press, Boca Raton, Florida.
- Monti F. 2021. Osprey *Pandion haliaetus.* Pp:12-21 in: Panuccio, M., Mellone. U., and Agostini, A. (Eds.) Migration Strategies of Birds of Prey in Western Palearctic. CRC Press, Boca Raton, Florida.
- Nourani E, Vansteelant WMG, Byholm P, Safi K. 2020 Dynamics of the energy seascape can explain intra-specific variations in sea-crossing behaviour of soaring birds. Biol. Lett. 16: 20190797. http://dx.doi.org/10.1098/rsbl.2019.0797
- Oppel S, V Arkumarev, S Bakari, V Dobrev, V Saravia, S Adefolu, L Aktay, P Tersoo, Ş Arslan, Y Barshep, T Bino, A Bounas, T Çetin, M Dayyoub, D Dobrev, Kl Duro, L El-Moghrabi, H ElSafoury, A Endris, N Ghazal Asswad, J H Harry, S T Ivande, S Jbour, E Kapsalis, E Kret, B A Mahamued, S A Manu, S Mengistu, A Razack MZabeirou, S I Muhammad, S Nakev, A Ngari, J Onoja, M Osta, S Özuslu, N Petrovski, G Popgeorgiev, Cloé Pourchier, A Ruffo, M Shobrak, L Sidiropoulos, T Skartsi, Ö Sözüer, K Stara, M Tesfaye, M Topi, D Vavylis, Velevski, Z Vorpsi, M Wondafrash, E Xeka, C Yeniyurt, E Yordanov, S C Nikolov. 2019 Major threats to a migratory raptor vary geographically along the eastern Mediterranean flyway. J Avian Biol. 49(7):e01629. https://doi.org/10.1111/jav.01629
- Pennycuick CJ. 1972. Soaring behaviour and performance of some East Africa birds observed from a motor-glider. Ibis 114: 178-218.
- Riad, SA. 2020. Bird and Bat Fatality Monitoring Program in autumn 2020 BOO RGWE Wind Farm 262.5 MW at Gulf of Suez. Prepared for RCREEE. 66 pp.
- Riad, SA. 2022. Ectoparasites Associated with Migratory Birds, Eastern Desert, Red Sea, Egypt. Egypt. Acad. J. Biolog. Sci. (B. Zoology) Vol. 14(2) pp: 19-33. DOI: 10.21608/EAJBSZ.2022.249312
- Robinson Willmott, JC, Forcey,G, Kent, A. 2013. The Relative Vulnerability of Migratory Bird Species to Offshore Wind Energy Projects on the Atlantic Outer Continental Shelf: An Assessment Method and Database. Final Report to the U.S. Department of the Interior, Bureau of Ocean Energy Management, Office of Renewable Energy Programs. OCS Study BOEM 2013-207. 275 pp.

- Rotics S, Kaatz M, Turjeman S, Zurell D, Wikelski M, Sapir N, Eggers U, Fiedler W, Jeltsch F, Nathan R. 2018. Early arrival at breeding grounds: causes, costs and a trade-off with overwintering latitude. J Anim. Ecol. 87(6):1627-1638. https://doi.org/10.1111/1365-2656.12898
- Santos CD, Silva JP, Muñoz A-R, Onrubia A, Wikelski M. 2020. The gateway to Africa: What determines sea crossing performance of a migratory soaring bird at the Strait of Gibraltar? J Anim Ecol;89: 1317–1328. https://doi.org/10.1111/1365-2656.13201
- Sará M, Bustamante J, Ceccere Jg, Rubolini D. 2021. Lesser Kestrel *Falco naumanni*. Pp: 200-211 in: Panuccio, M., Mellone. U., and Agostini, A. (Eds.) Migration Strategies of Birds of Prey in Western Palearctic. CRC Press, Boca Raton, Florida.
- Sens. 2021. Bird and Bat Fatality Monitoring Program in autumn 2021 BOO RGWE Wind Farm 262.5 MW at Gulf of Suez. Prepared for RCREEE. 67 pp.
- Shohdi, WM. 2019. Bird and Bat Fatality Monitoring Program in autumn 2020 BOO RGWE Wind Farm 262.5 MW at Gulf of Suez. Prepared for RCREEE. 67 pp.
- SNH. 2017. Recommended bird survey methods to inform impact assessment of onshore wind farms. March 2017, Version 2. 37 pp.
- Thomas, L., Buckland, ST, Rexstad, EA, Laake, JL, Strindberg, S, Hedley, SL, Bishop, JRB, Marques, TA, Burnham,KP. 2010. Distance software: design and analysis of distance sampling surveys for estimating population size. Journal of Applied Ecology 47: 5-14. DOI: 10.1111/j.1365-2664.2009.01737.x
- Tobolka, M., Nowak B, Bia JT, Jagio Z, Zieliska Z. 2020. The influence of parental experience and conditions during breeding and non-breeding period on reproductive success of long-lived birds, an example of the White Stork.
- Väli U, Dombrovski V, Treinys R, Bergmanis U, Daróczi SJ, Dravecky M, Ivanovski V, Lontkowski J, Maciorowski G, Meyburg BU, Mizera T, Zeitz R, Ellegren H. 2010. Widespread hybridization between the Greater Spotted Eagle *Aquila clanga* and the Lesser Spotted Eagle *Aquila pomarina* (Aves: Accipitriformes) in Europe. Biological Journal of the Linnean Society, 2010, 100, 725–736.
- Vansteelant WMG, Bouten W, Klaassen RHG, Koks BJ, Schlaich AE, van Diermen J, van Loon EE, Shamoun-Baranes J. 2015 Regional and seasonal flight speeds of soaring migrants and the role of weather conditions at hourly and daily scales. J. Avian Biol. 46, 25– 39. doi:10.1111/jav.00457
- Vansteelant WMG, Kekkonen J, Byholm P. 2017 Wind conditions and geography shape the first outbound migration of juvenile honey buzzards and their distribution across sub-Saharan Africa. Proc. R. Soc. B 284: 20170387. http://dx.doi.org/10.1098/rspb.2017.0387
- Vansteelant, WMG, Agostini, A. 2021. European Honey Buzzard Pernis apivorus. Pp: 35-48 in: Panuccio, M., Mellone. U., and Agostini, A. (Eds.) Migration Strategies of Birds of Prey in Western Palearctic. CRC Press, Boca Raton, Florida.