THE BIODIVERSITY CONSULTANCY

Lekela

Lekela North Ras Gharib 250 MW:

Analysis of cumulative effects to biodiversity

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Executive summary

Key findings

- *Many wind power projects are in operation or planned in the Gulf of Suez, and the area is also a key location for oil and gas operations in Egypt. Therefore, the risk of cumulative effects is high for the Lekela North Ras Gharib 250 MW project.*
- *13 migratory soaring birds, two bats, and three ecosystems are identified as priority Valued Environmental Components which are at potential risk from significant cumulative effects.*
- *The project aims to minimise impacts to migratory soaring birds, and mortality thresholds for adaptive management have been set.*
- *Mitigation and monitoring actions are proposed to reduce the risk of cumulative effects to migratory soaring birds.*

This report presents the findings of a rapid analysis of the potential cumulative effects on biodiversity of a wind farm in development by Lekela Power in the Ras Gharib – Gebel El Zeit area on the Gulf of Suez, Egypt (the Project). The analysis identifies priority Valued Environmental Components (VECs) (IFC 2013), and fatality thresholds for adaptive management for priority bird VECs. Recommended high-level mitigation and monitoring actions to be adopted by Lekela for project are given. Additional actions that Lekela can undertake or support to contribute to managing cumulative effects of their developments together with others in the region are also presented. Available data on wind farm and other industrial developments in the area are given in Appendix 1. These provide context and assist the identification of other developers whose collaboration will support the management of cumulative effects to biodiversity.

The Gulf of Suez is the centre for Egypt's oil and gas industry, and the focal region for the development of wind farms in Egypt. The area has high wind power generation potential and it is estimated that the western side of the Gulf of Suez could host wind energy projects with a total capacity of around 20,000 MW (Mansour & Eisa 2014). The government of Egypt is targeting the development of wind farms providing about 13,500 MW by 2022 (NREA 2015). Lekela Egypt is developing the Lekela North Ras Gharib 250 MW and has interest in other potential developments in the region.

The Gulf of Suez is an area of international significance for migratory birds (Grontmij 2010; Hilgerloh *et al.* 2011; Environics 2016a, 2016b, 2017a, 2017b; BirdLife International 2018a). One of the most significant bottlenecks (Porter 2005) in the migration flyway is the Gebel El Zeit Important Bird Area

(IBA)[1], which is known to be used by high numbers of White Stork during the migration, as well as 18 species of birds of prey, pelicans and other migratory soaring birds (e.g. observers have seen more than 56,000 White Storks – c. 8% of the flyway population – in one day in Autumn 1996) (Hilgerloh 2009; BirdLife International 2018a). Three wind farms are currently operational in the IBA, with more in development. The Project is located immediately to the north of the IBA.

To determine priority VECs for the Project, an approach modelled on the Tafila Region Wind Power Projects Cumulative Impact Assessment (IFC 2017), modified to the local conditions and data available, was developed. This results in **13 migratory bird species, two bat species, and three ecosystems as priority VECs for the Project.** (Table 1).

In addition the Project has carried out a Critical Habitat Assessment (TBC 2018a) which identified 11 birds and one reptile as Priority Biodiversity Features (PBFs) (Table 1). The VECs and PBFs are the targets for on-site impact mitigation, with a goal of no net loss.

Impact thresholds have been set for the bird VECs. These represent the number of fatalities per year above which triggers an adaptive management response for Lekela, and potential changes in mitigation (Table 1). Ideally these thresholds should apply for the combined impacts of all wind farms in the study area. Lekela's power to influence other operators is yet to be determined, however and so currently will only be followed by Lekela.

A set of mitigation and monitoring actions are proposed (Section 6). These include those to be adopted by Lekela for the current (and any future) Project, and those that Lekela will undertake or support in order to contribute to managing cumulative effects from wind farm developments in the wider region. These mitigation and monitoring actions are aimed at minimizing turbine blade and power line collision fatalities for the 13 priority bird VECs, as well as for other bird and bat populations identified as at high risk, during the operational phase. The approach follows industry good practice and focuses on two areas:

- On-site mitigation and monitoring methods, to minimise collision risk, validate the effectiveness of proposed mitigation methods, allow estimation of residual impacts and provide information to adapt monitoring and mitigation to prevailing conditions; and,
- Collaborative efforts with other wind farm entities, to minimise the cumulative effects of all the proposed wind farm developments in the area.

[1] Gebel/Gabal has different spellings due to differences in transliteration from Arabic. For this report, both official names, i.e. Gebel El Zeit when referring to the Important Bird Area, and Gabal El-Zeit when referring to the Lekela wind project, are used.

Table 1: Priority VECs and PBFs for the Lekela Ras Gharib 250 MW project (species in brackets are PBFs but not VECs)

Species	Scientific name	Type	IUCN status*	PBF?	Overall risk	Adaptive management threshold (fatalities / year)
Black Stork	*Ciconia nigra*	Bird	LC	✓	Major	3
Booted Eagle	*Hieraaetus pennatus*	Bird	LC		Major	0
Common Crane	*Grus grus*	Bird	LC		Major	3
Great White Pelican	*Pelecanus onocrotalus*	Bird	LC	✓	Major	3
Steppe Eagle	*Aquila nipalensis*	Bird	EN	✓	Major	0
White Stork	*Ciconia ciconia*	Bird	LC	✓	Major	5
Black Kite	*Milvus migrans*	Bird	LC		Moderate	3
Egyptian Vulture	*Neophron percnopterus*	Bird	EN	✓	Moderate	0
Eurasian Buzzard	*Buteo buteo*	Bird	LC	✓	Moderate	5
European Honey-buzzard	*Pernis apivorus*	Bird	LC	✓	Moderate	5
Greater Spotted Eagle	*Clanga clanga*	Bird	VU	✓	Moderate	0
Levant Sparrowhawk	*Accipiter brevipes*	Bird	LC	✓	Moderate	3
Pallid Harrier	*Circus macrourus*	Bird	NT		Moderate	0
[Sooty Falcon]	*Falco concolor*	Bird	VU	✓	n/a	n/a
[Eastern Imperial Eagle]	*Aquila heliaca*	Bird	VU	✓	n/a	n/a
Desert Pipistrelle	*Hypsugo (Pipistrellus) ariel*	Bat	DD		Moderate	n/a
Rueppell's Pipistrelle	*Pipistrellus rueppelli*	Bat	LC		Moderate	n/a
[Egyptian Spiny-tailed Lizard]	*Uromastyx aegyptia*	Reptile	VU	✓	n/a	n/a
Wadi		Ecosystem			Not evaluated	n/a
Saltmarsh		Ecosystem			Not evaluated	n/a
Rocky outcrops / caves		Ecosystem			Not evaluated	n/a

* EN = Endangered; VU = Vulnerable; NT = near threatened; LC = least concern; DD = Data Deficient

1 Scope and objectives

This report presents an analysis of potential cumulative effects ("the analysis") to biodiversity of the Lekela North Ras Gharib 250 MW wind farm development (the Project), by Lekela Power Ltd (Lekela), with other current and planned industrial developments in the Gulf of Suez, Egypt.

The Gulf of Suez is an area of international significance for migratory birds (Grontmij 2010; Hilgerloh *et al.* 2011; Environics 2016a, 2016b, 2017a, 2017b; BirdLife International 2018a). One of the most significant bottlenecks (Porter 2005) in the migration flyway is the Gebel El Zeit Important Bird Area (IBA)[2], which is known to be used by high numbers of White Stork during the migration, as well as 18 species of birds of prey, pelicans and other migratory soaring birds (e.g. observers have seen more than 56,000 White Storks – c. 8% of the flyway population – in one day in Autumn 1996) (Hilgerloh 2009; BirdLife International 2018a). The Gulf of Suez is the target for the development of wind power projects in Egypt, with 11 find farms in operation or development (as of December 2018). The development of multiple wind farms in an area of international importance for migratory soaring birds has the potential for significant cumulative effects, especially from collision, and barrier effects.

The analysis aims to identify priority biodiversity[3] Valued Environmental Components (VECs) which are most at risk from the combined impacts of all the existing and potential wind developments identified within the study area (see Section 1.1), and sets impact thresholds for adaptive management of mitigation measures. This analysis also proposes mitigation, monitoring and other management actions for projects operating within the study area to address potential impacts to the identified priority VECs. The report presents:

- A list of potential species VECs;
- Identification of VECs with 'sensitivity' to wind farm developments;
- A list of priority VECs assessed to be at highest risk of cumulative effects from wind farm development in the study area;
- Impact threshold for bird VECs; and
- Mitigation and monitoring actions for priority VECs, including identifying opportunities where Lekela can contribute to the management of cumulative effects.

[2] Gebel/Gabal has different spellings due to differences in transliteration from Arabic. For this report, both official names, i.e. Gebel El Zeit when referring to the Important Bird Area, and Gabal El-Zeit when referring to the Lekela wind project, are used.

[3] This analysis focuses only on globally significant biodiversity values, species and ecosystems. The analysis does not include any evaluation of potential ecosystem services VECs. In addition, consultation with Egyptian stakeholders has not been feasible, and therefore VECs which might be considered as a priority by local experts, but not readily identifiable with global data sets, might be missed. A stakeholder review and input process is planned to address this gap (see section 7).

Additionally, supporting information (Appendix 1) provides:

- A compiled list of potential onshore industrial projects and other additional external biodiversity stressors in the western Gulf of Suez; and
- A summary of potential impacts to VECs from industrial developments.

The analysis broadly follows the approach used by the International Finance Corporation (IFC) for the cumulative effects assessment (CEA) for the Tafila Region Wind Power Projects (IFC 2017) in Jordan. The methodology also follows the IFC's general guidance on cumulative impact assessment (IFC 2013). The approach has been adapted to the local context, in particular to account for the variation in quality and quantity of baseline data which have been collected by different developers in the landscape.

1.1 The study area

The Project area is located in the eastern desert, within the Red Sea Governate of Egypt, approximately 28 km north of the coastal town of Ras Gharib. It is part of a complex of potential wind farm developments in the Ras Gharib – Gebel El Zeit area along the Gulf of Suez.

To appropriately capture all industrial projects in the vicinity of the Project that could result in cumulative impacts on the priority biodiversity VECs, **the study area was defined as the region of the potential wind farm developments in the Ras Gharib – Gebel El Zeit area**. Figure 1 presents the location of, and the relationship between, the Project and the overall study area.

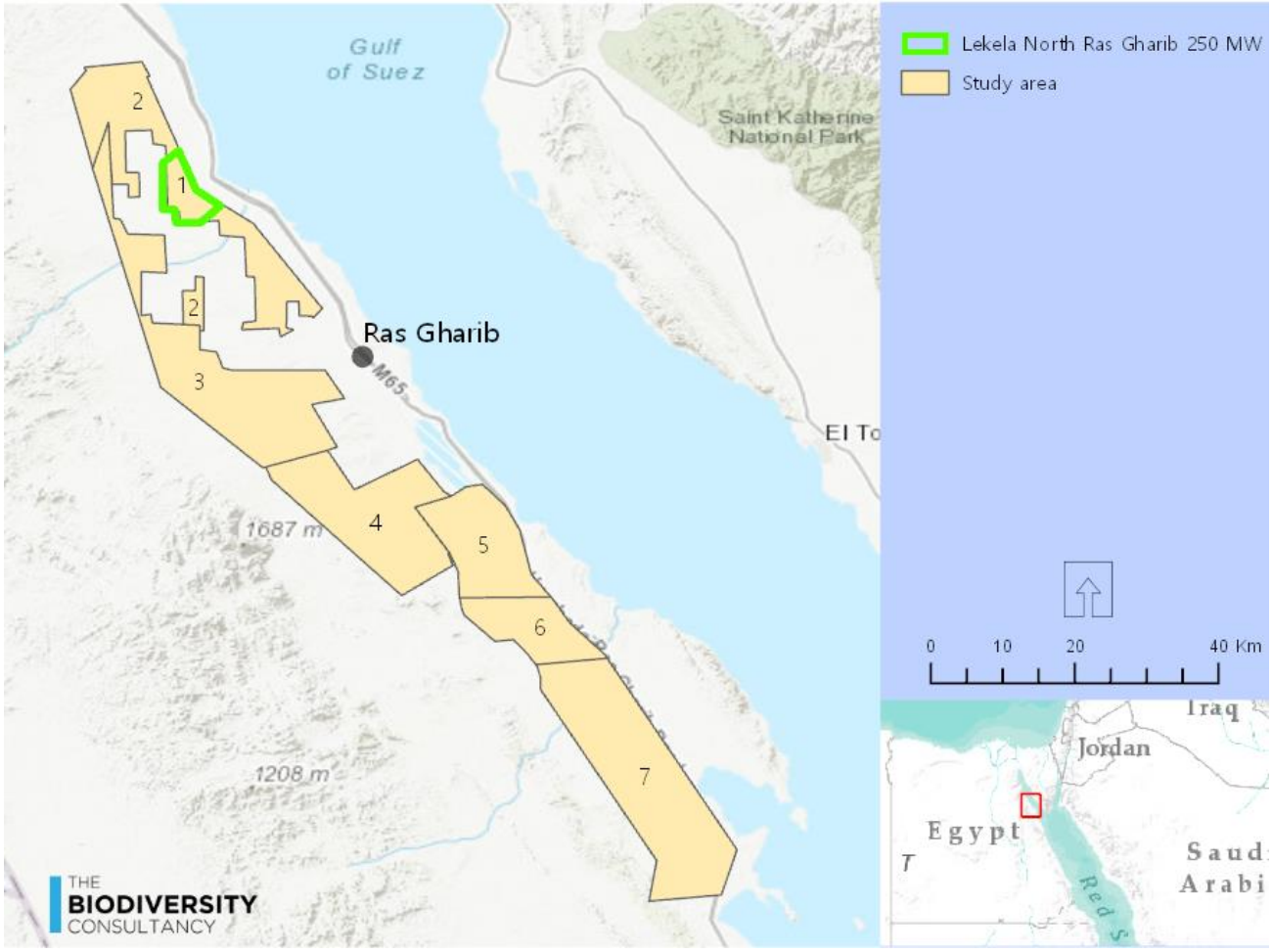

Figure 1: Study area (numbers refer to survey areas used to extract data for the VECs[4])

The Project is one of eleven wind farms that are known to be operating, in construction, or planned (as of December 2018), in the Ras Gharib – Gebel El Zeit area, i.e. the study area (2; Figure 2). These areas have been designated by the Egyptian New and Renewable Energy Authority (NREA) for wind farm development. Further information on the potential wind farm developments on the western side of the Gulf of Suez is provided in Appendix 1.2.

Table 2: Summary of wind farm developments in the Ras Gharib – Gebel El Zeit area

Concession name	Operation stage	Capacity	Reference
Lekela North Ras Gharib 250 MW Project	In development	250 MW	(Environics 2018)
Alfanar Project	In development	50 MW	(RCREEE 2018)
ACWA Project	In development	100 MW	(RCREEE 2018)

[4] Survey areas: 1: Lekela North Ras Gharib 250 MW (Environics 2016b, 2016a, 2017a, 2017b), 2: RCREEE area (RCREEE 2018), 3: block located west to Lekela North Ras Gharib 250 MW (Ecoda 2013), 4: block located north to Italgen Gabal El-Zeit 320 MW (Ecoda 2011), 5,6 and 7: NREA concession (Ecoda 2007), 6: Italgen Gabal El-Zeit 320 MW (Grontmij 2009; EcoConServ 2017)

Concession name	Operation stage	Capacity	Reference
NREA AFD (North)	In development	200 MW	(NREA 2013, 2015)
Masdar/NREA	In development	200 MW	(NREA 2013, 2015)
NREA AFD (South)	In development	200 MW	(NREA 2013, 2015)
Engie/Orascom/Toyota BOO	In construction	250 MW	(ENGIE 2017)
Italgen Gabal El-Zeit Project	In development	320 MW	(Grontmij 2010; EcoConServ 2014)
KfW/NREA	Operating since 2015	240 MW	(NREA 2013, 2015)
JICA/NREA	Operating since 2018	220 MW	(NREA 2013, 2015; JICA 2018)
Fund for International Business Expansion (FIEM) /NREA	Operating since 2018	120 MW	(NREA 2013, 2015)

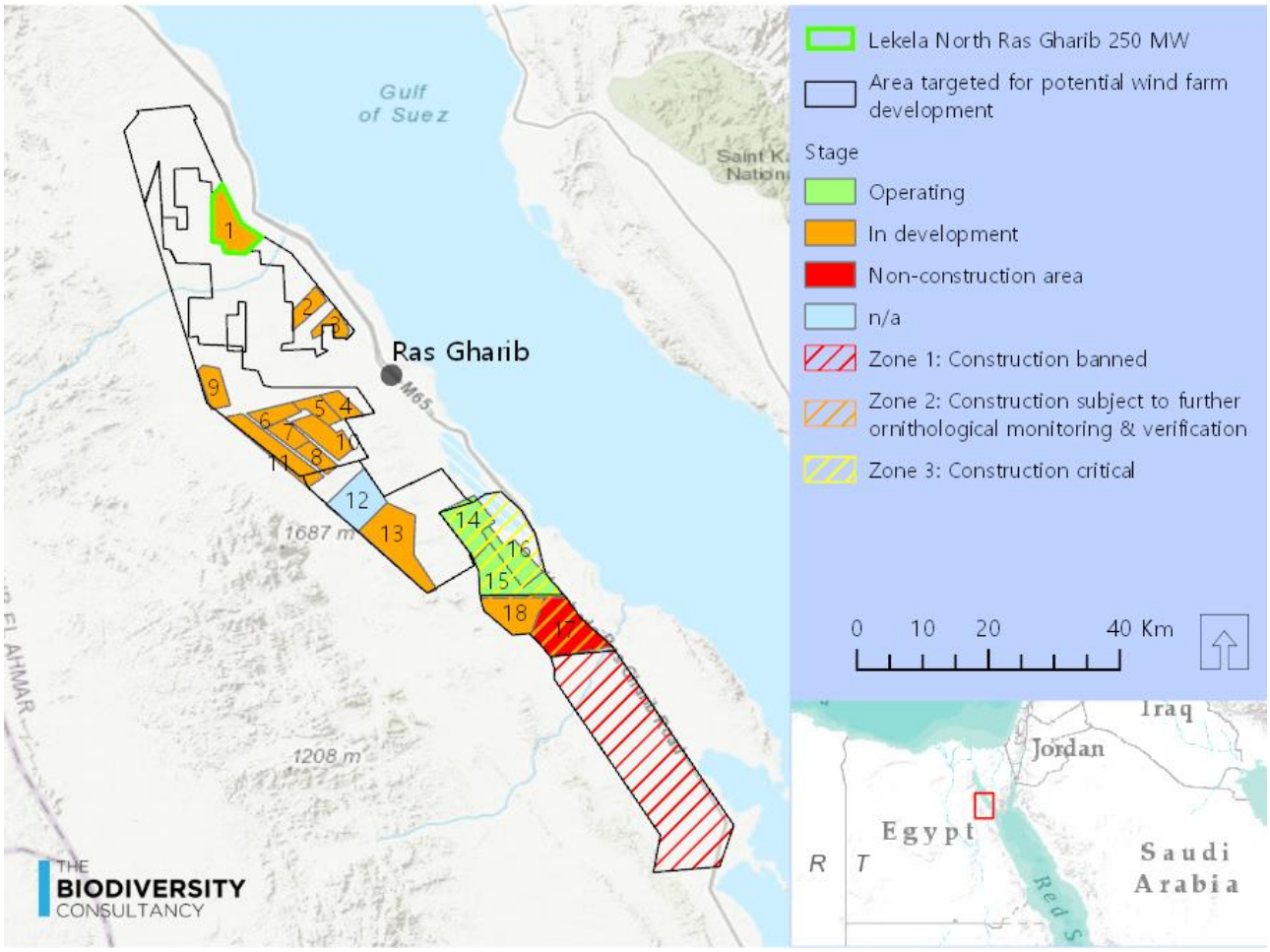

Figure 2: Potential wind farm developments in the Ras Gharib – Gebel El Zeit area[5]

1.2 Temporal scope

The different wind farms in the study area are in varying stages of development, three are operating in the Gebel El Zeit area (Appendix 1.2). At the time of writing this report, the timeframe for the construction and operation of the Project is unknown.

There is some uncertainty regarding the actual impacts on the VECs at this early stage of the Project. To account for uncertainty, the temporal scope of the analysis is defined as the timeframe during which the proposed mitigation, monitoring, and management measures will be implemented by the Project, and by Regional Center for Renewable Energy and Energy Efficiency (RCREEE). This timeframe should be sufficient to understand the actual impacts on the VECs of the projects. An

[5] Wind farm concessions: 1: Lekela North Ras Gharib 250 MW (Environics 2018), 2: ACWA Gharib One for Energy and ACWA Gharib Two for Energy 100 MW, 3: Aalfa Wind Energy 50 MW (RCREEE 2018), 4: Auction System 1 100 MW, 5: Auction System 2 100 MW, 6: Auction System 3 100 MW, 7: Auction System 4 100 MW, 8: Auction System 5 100 MW, 9: Auction System 6 100 MW, 10: EU partners/NREA (AfD Suez 3) 200 MW, 11: Masdar/NREA 200 MW, 12: Engie/Orascom/Toyota BOO 250 MW, 13: EU partners/NREA (AfD Suez 1) 200 MW, 14: KfWEPs/NREA 240200 MW, 15: JICA/NREA 220 MW, 16: Spain/NREA 120 MW (NREA 2013, 2015)(NREA 2013, 2015), 17: Italgen non-construction area, 18: Italgen 320380 MW (Grontmij 2010)

initial three-year period (from the start of the Project becoming operational) is proposed, following which an evaluation of the effectiveness of the proposed management measures will be conducted to determine future monitoring efforts. This evaluation must also consider cumulative effects of other developments that might be operational in the future.

1.3 Potential impacts, and planned Project mitigation and monitoring

The Project has also completed a Critical Habitat Assessment (CHA) which evaluates whether the project is located in Critical Habitat following IFC Performance Standard 6 (PS6) (IFC 2012) and EBRD Performance Requirement 6 (PR6) (EBRD 2014).

The CHA concludes that the Project is not located in Critical Habitat, but that the area appears to broadly be Natural Habitat (per PS6) albeit highly degraded in some areas. While there are no species which qualify under the criteria for Critical Habitat, one reptile and 11 migratory bird species are still considered to be Priority Biodiversity Features per EBRD PR6 (Table 3) as they are of stakeholder concern and are representative of the region's natural environment.

Table 3: Species considered as Priority Biodiversity Features

Species		IUCN Red List status
Levant Sparrowhawk	*Accipiter brevipes*	LC
Egyptian Vulture	*Neophron percnopterus*	EN
Steppe Eagle	*Aquila nipalensis*	EN
Greater Spotted Eagle	*Clanga clanga*	VU
Eastern Imperial Eagle	*Aquila heliaca*	VU
Sooty Falcon	*Falco concolor*	VU
Eurasian Buzzard	*Buteo buteo*	LC
European Honey-buzzard	*Pernis apivorus*	LC
White Stork	*Ciconia ciconia*	LC
Black Stork	*Ciconia nigra*	LC
White Pelican	*Pelecanus onocratalus*	LC
Egyptian Spiny–tailed Lizard	*Uromastyx aegyptia*	VU

Since the Project is located in an area which seasonally sees globally-important concentrations of migratory soaring birds, contains Priority Biodiversity Features and is broadly Natural Habitat, the Project will proceed with caution. The Project aims to achieve at least no net loss for the Egyptian Spiny-tailed Lizard, the eleven bird species, and Natural Habitat, and to demonstrate this achievement through a robust monitoring and adaptive management programme.

1.3.1 Potential project impacts to biodiversity

Wind farm developments contribute four main potential impacts to biodiversity, and the effect of these may be compounded when many similar developments occur in close proximity. Impacts to biodiversity could primarily occur via:

- **Collision with turbine blades**. Many bird and bat species are known to collide with wind turbine blades, and collision risk modelling has been undertaken for some of the proposed wind farms in the study area (e.g. Environics 2017a). Cumulative effects may be greater than the sum of individual project effects, as individuals that would have avoided a single project are now directed into adjacent projects. Thus, collision risk models that use pre-construction counts from individual wind projects may underestimate the number of fatalities by not including birds that have 'avoided' adjacent wind projects.
- **Collision with powerlines**. Many bird species that are known to collide with turbine blades are also known to collide with high- and medium-voltage powerlines, while some species are also at electrocution risk from poorly-designed low-voltage power lines. Project-related power lines should thus be included in any proposed monitoring, and have appropriate mitigation measures applied.
- **Barrier effects**, where infrastructure prevents or alters normal movement patterns. The large number of turbines in the study area may present a real and / or visual barrier to the flight movements migrating species. This may force individuals to use routes that are less preferred, expending additional energy, and potentially exposing them to new threats. For soaring species which rely on thermals to gain height, individuals could be forced to fly through wind turbines, backtrack or land if thermals do not exist where needed to gain height; and,
- **Loss of habitat**. Development of each project will result in ground disturbance and the permanent loss of habitat for ground-dwelling species. The direct footprint of individual wind projects is typically a small portion of the project area, but if species also avoid areas of project infrastructure, the resultant area effectively lost can be large. Avoidance of roads and powerlines can also result in barrier effects. With multiple developments, habitat loss and barrier effects may have implications for the connectedness of populations of some species.

1.3.2 On-site mitigation

The Project's Power Purchase Agreement includes a 'Bird Migration Protocol'. This stipulates that the Project will participate in a region wide Active Turbine Management Program (ATMP), coordinated by RCREEE. The ATMP will take place during the spring and autumn migration periods, and involves use of radar by the Egyptian Army to collate data on bird migrations. These data will be analysed by RCREEE to provide recommendations to Lekala and other operators on the timing and location of planned shut-downs. In addition, the Project will implement a responsive, on-site shut-down on demand system to minimise collision risk with migratory soaring birds.

2 The VEC screening process

Valued Environmental Components (VECs) are attributes, both environmental and social, that are considered important in assessing the risks that a project, or suite of projects poses to the environment. While VECs may be directly or indirectly affected by a specific development, they are often also affected by the cumulative effects of several developments as they are typically the ultimate recipient of impacts. VECs may include (IFC 2013):

- Physical features, habitats, wildlife populations (e.g., biodiversity);
- Ecosystem services;
- Natural processes (e.g., water and nutrient cycles, microclimate);
- Social conditions (e.g., health, economics); or
- Cultural aspects (e.g., traditional spiritual ceremonies).

Identification of VECs in this analysis is restricted to flora and fauna species and ecosystems. The analysis was carried out via a desk-based exercise using: (i) published and grey literature such as studies and assessments undertaken by windfarms in the Ras Gharib – Gebel El Zeit area (Table 4); and (ii) available spatial databases (accessed under licence from the Integrated Biodiversity Assessment Tool (IBAT)). The need for rapid identification of risks to meet the project development time-line precluded the opportunity to carry out additional field work and stakeholder consultation, which might have led to additional VECs being identified.

Table 4: List of published and grey literature used for the analysis

No.	Published/grey literature	Reference
1.	Biodiversity Risk Screening for Lekela Ras Gharib BOO project, Egypt	(TBC 2018b)
2.	Lekela North Ras Gharib 250 MW Project: Critical Habitat Assessment	(TBC 2018a)
3.	Lekela North Ras Gharib 250 MW Environmental and Social Impact Assessment (ESIA)	(Environics 2018)
4.	Lekela North Ras Gharib 250 MW baseline bird studies from autumn 2015, spring 2016, spring 2017 and autumn 2016	(Environics 2016b, 2016a, 2017a, 2017b)
5.	RCREEE Strategic and Cumulative Environmental and Social Assessment Active Turbine Management Program (ATMP) for Wind Power Projects in the Gulf of Suez	(RCREEE 2018)
6.	The ESIA of the area located to the west of Lekela North Ras Gharib 250 MW Project area	(Ecoda 2013)
7.	The ESIA of Alfa Wind Project	(EcoConServ 2016)

No.	Published/grey literature	Reference
8.	Illustrated Bat Key of Egypt	(Dietz 2005)
9.	Italgen Gabal El-Zeit 320 MW bird baseline studies in autumn 2008, spring 2009, autumn 2013, spring 2014 and autumn 2016	(Grontmij 2009; EcoConServ 2014, 2017)
10.	Italgen Gabal El-Zeit 320 MW EIA study in 2010	(Grontmij 2010)
11.	The ESIA of the area located north of Italgen Gabal El-Zeit 320 MW presenting bird baseline studies from spring and autumn 2010 and additional bird baseline studies from spring 2014	(Ecoda 2011; El-Gebaly & Al-Hassani 2017)
12.	The Feasibility Study of NREA concession presenting bird baseline studies from autumn 2006 and spring 2007	(Decon 2007)
13.	A survey in autumn 2006 in Gebel El Zeit Important Bird Area	(Hilgerloh et al. 2011)
14.	Species qualifying the listing of Gebel El Zeit as an Important Bird and Biodiversity Area	(BirdLife International 2018a)
15.	The Migratory Soaring Bird Database	(BirdLife International 2018b)
16.	The list of bird and bat species included in the assessment of global vulnerability to wind power development compiled by Thaxter et al. (2017), filtered by species mapped in IBAT as occurring in the project area.	(Thaxter et al. 2017)

3 The Cumulative Assessment framework for birds

3.1 Overview of the framework for birds

The framework for birds has two objectives: to identify bird species populations at highest risk from the potential cumulative effects of developments in the study area, and to propose mitigation, monitoring and other management activities to address risks to those bird species. This framework follows a five-step process (Figure 3):

Step 1: Develop a preliminary list of potential bird VECs comprising species potentially at risk from developments in the study area, because they are either known or predicted to occur in the study area. A relevant population scale (Unit of Analysis, UoA) on which to base the analysis for birds was identified (see Section 3.2).

Step 2: Determine the relative *sensitivity* of the species population, being a combination of the following:

- *Vulnerability*: a scoring of each species based on the, (i) conservation status at a scale relevant to the UoA, and (ii) susceptibility to the adverse effects of wind power projects, especially collision risk, based on peer-reviewed evidence; and
- *Relative Importance*: an estimate or judgment of the proportion of each species' population likely to use the study area, in relation to the appropriate UoA (see Section 1.1).

Species which were determined to have negligible *sensitivity* were dropped from the analysis before proceeding to Step 3. For species where the flyway population comprised <1% of the global population, and for which any impact would be negligible for the species at a global level, these were also dropped at this stage.

Step 3: Determine the *overall risk* to each species' population from the cumulative effects of wind farm developments within the study area, being a combination of the:

- *Sensitivity* of the species, as identified in Step 2; and
- Cumulative *Likelihood of Effect* (LoE) rating for each species (see Section 3.4).

Those species with an *overall risk* of Major or Moderate are considered to be priority bird VECs.

Step 4: Determine an impact threshold for each priority bird VEC, being the point at which further fatality could be a risk to long-term viability of the population (see section 3.5).

Step 5: Propose a range of mitigation, monitoring and management actions, to avoid fatalities of priority bird VECs, and to accurately estimate priority bird VEC fatalities to facilitate compliance with thresholds and inform adaptive management responses (see Section 6).

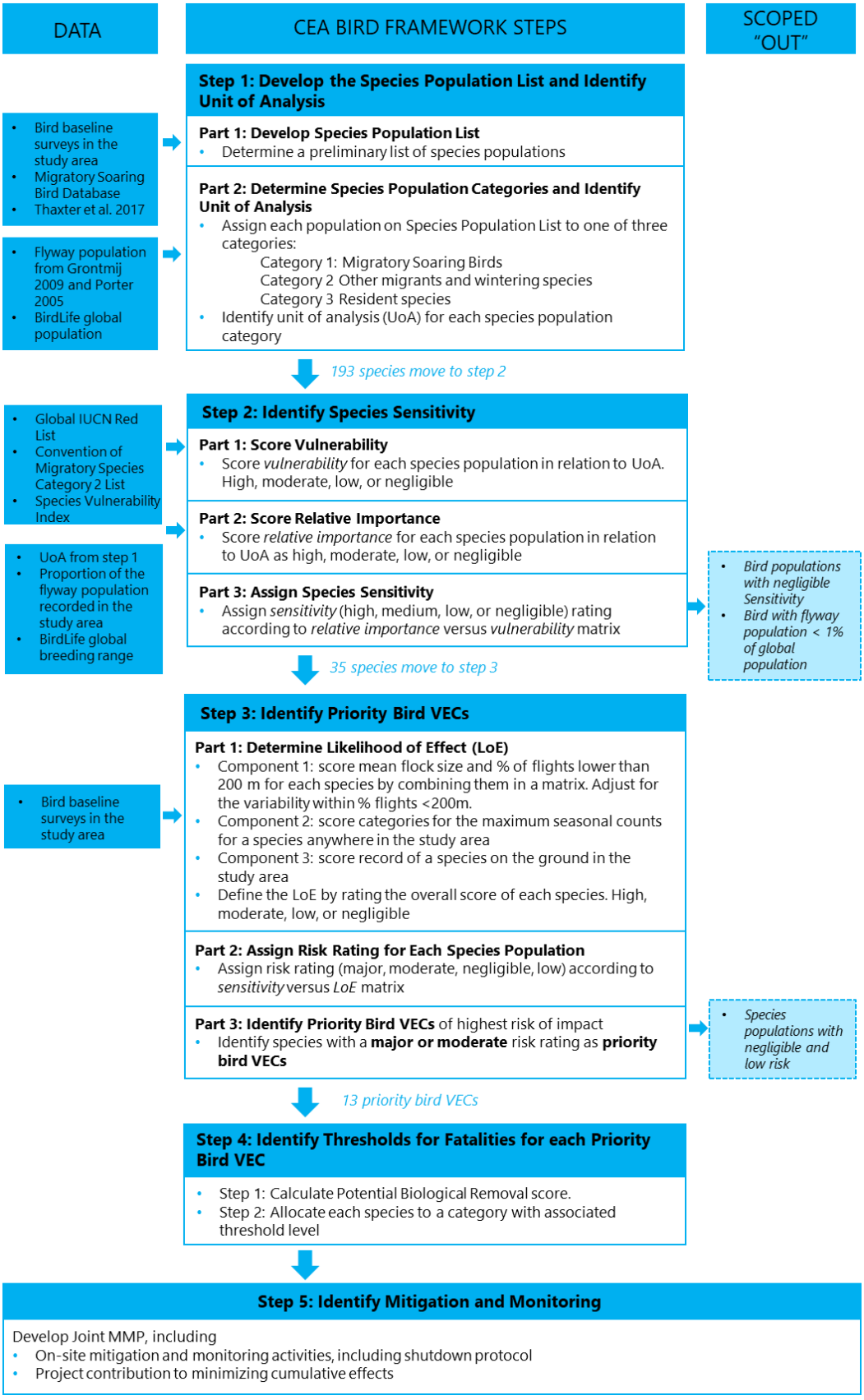

Figure 3: Process for cumulative effects analysis for priority bird VECs

3.2 Step 1 – Develop the bird species population list and identify the Unit of Analysis

The purpose of Step 1 is to identify all bird species or populations that could potentially be at risk from the cumulative effects of developments in the study area, and to determine a relevant scale by which any effects on each species or population should be measured.

3.2.1 Methods

A list of bird species known or likely to be present in the study area was compiled from:

- Lekela North Ras Gharib 250 MW Environmental and Social Impact Assessment (ESIA) (Environics 2018);
- Lekela North Ras Gharib 250 MW baseline bird studies from autumn 2015, spring 2016, spring 2017 and autumn 2016 (Environics 2016b, 2016a, 2017a, 2017b);
- RCREEE Strategic and Cumulative Environmental and Social Assessment Active Turbine Management Program (ATMP) for Wind Power Projects in the Gulf of Suez (RCREEE 2018);
- The ESIA of the area located to the west of Lekela North Ras Gharib 250 MW Project area (Ecoda 2013);
- The ESIA of Alfa Wind Project (EcoConServ 2016);
- Italgen Gabal El-Zeit 320 MW bird baseline studies in autumn 2008, spring 2009, autumn 2013, spring 2014 and autumn 2016 (Grontmij 2009; EcoConServ 2014, 2017);
- The ESIA of the area located north of Italgen Gabal El-Zeit 320 MW presenting bird baseline studies from spring and autumn 2010 (Ecoda 2011) and additional bird baseline studies from spring 2014 (El-Gebaly & Al-Hassani 2017);
- The Feasibility Study of NREA concession presenting bird baseline studies from autumn 2006 and spring 2007 (Decon 2007);
- A survey in autumn 2006 in Gebel El Zeit Important Bird Area (Hilgerloh *et al.* 2011);
- Species qualifying the listing of Gebel El Zeit as an Important Bird and Biodiversity Area (BirdLife International 2018a);
- The Migratory Soaring Bird Database (BirdLife International 2018b), filtered by species mapped as occurring in the project area; and,
- The list of bird species included in the assessment of global vulnerability to wind power development compiled by Thaxter *et al.* (2017), filtered by species mapped in IBAT as occurring in the project area.

Different bird species groups (e.g., raptors (birds of prey) and passerines (perching birds)) and ecologies (e.g., migrant, and resident populations) have differing risk profiles in relation to effects from wind farms. To simplify the analysis each species was assigned to one of three broad category based on its type and ecology.

The UoA should ideally be biogeographically determined. However, this was not possible because the origin of migratory birds and the detailed range of resident and breeding populations using the study area is unknown. In the absence of such information, the UoA is defined at scales appropriate

to spatially relevant conservation units, i.e. the flyway population or global distribution, and are relevant to the group characteristics of birds in each of the three categories.

These three categories and the UoA determined for each category were defined as:

- **Category 1**: Migratory Soaring Bird (MSB) populations (as per BirdLife International 2018b), with the UoA being the Rift Valley / Red Sea flyway population. Data on populations of these species in the flyway are summarised in Grontmij (2009) which is the primary source used in this analysis[6]. Additional (albeit older) data are available in Porter (2005) and have supplemented the information as needed;
- **Category 2**: Other migrants and wintering species populations, with the UoA being the global breeding range extent (taken from Birdlife International 2017), as no national or regional estimates exist which would allow definition of a smaller UoA; or,
- **Category 3**: Resident species populations, with the UoA being the global breeding range extent (taken from Birdlife International 2017).

3.2.2 Results

Step 1 produced a list of 193 bird species which could potentially be at risk from cumulative effects. The results are summarised in

[6] This paper is used as the primary source as it provides the most comprehensive peer-reviewed dataset which used a common methodology to collect information from multiple sites across the study area..

Table 5. The complete list is in Appendix 2 which is available as online supplementary materials.

Table 5: List of bird species known or likely to be present in the study area

Order		Unit of Analysis			Number of potential VECs
Common Name	Scientific Name	Category 1 – MSB populations	Category 2 – Other migrants and wintering populations	Category 3 – Resident populations	
Diurnal birds of prey	*Accipitriformes*	21	2	8	**31**
Waterbirds	*Anseriformes*	0	8	0	**8**
Swifts, tree swifts and hummingbirds	*Apodiformes*	0	3	0	**3**
Hornbills, hoopoes, wood hoopoes	*Bucerotiformes*	0	1	0	**1**
Shorebirds	*Charadriiformes*	0	29	14	**43**
Storks	*Ciconiiformes*	2	0	2	**4**
Pigeons and doves	*Columbiformes*	0	1	2	**3**
Kingfishers and related species	*Coraciiformes*	0	5	0	**5**
Falcons and Caracaras	*Falconiformes*[7]	9	1	0	**10**
Ground feeding birds	*Galliformes*	0	1	1	**2**
Cranes, crakes and rails	*Gruiformes*	1	4	0	**5**
Perching birds	*Passeriformes*	0	46	14	**60**
Ibises, herons and pelicans	*Pelecaniformes*	1	6	6	**13**
Grebes	*Podicipediformes*	0	1	0	**1**
Sandgrouse	*Pteroclidiformes*	0	0	2	**2**
Nocturnal birds of prey	*Strigiformes*	0	1	0	**1**
Cormorants, gannets and boobies	*Suliformes*	0	1	0	**1**
	Totals	34	110	49	**193**

[7] For this analysis, Barbary Falcon (*Falco peregrinoides*) was considered a subspecies of Peregrine Falcon *F. peregrinus*.

3.3 Step 2 – Identify bird species sensitivity

The purpose of Step 2 is to determine the *sensitivity* of each species identified in Step 1. This step prioritises species which are globally rare, known to be vulnerable to wind power developments, and are present in the study area in notable numbers. Thus, sensitivity is a reflection of a bird species *vulnerability* at a national, regional, or international scale, depending on the UoA, and the *relative importance* of the study area to the population.

3.3.1 Methods

Sensitivity, as considered here, relates to the species population known or likely to be present in the study area, and combines two components:

- **Vulnerability** was determined using:
  - IUCN threat categories (IUCN 2018);
  - Category 2 of Annex of the Convention of Migratory Species (CMS), reflecting species considered to have an unfavourable conservation status at a regional level within the Range States and territories; and
  - Species Vulnerability Index (SVI)[8] for species, mainly soaring birds, where this has been assessed (BirdLife International 2018b).

  The guidance and associated ratings used to assess vulnerability are summarised in Table 6.
- **Relative importance**, proportional to the UoA, was identified for:
  - Category 1 (MSB populations) as the proportion of the Rift Valley / Red Sea flyway population (sourced from Grontmij (2009), supplemented with information from Porter (2005)) recorded in the study area; and
  - Category 2 (other migrants/wintering populations) and Category 3 (resident species) as the global breeding range (sourced from Birdlife International species accounts).

  The scoring and associated ratings used to assess relative importance for (1) MSBs, and (2) other migrants/wintering, and resident populations are summarized in Table 7 and Table 8 respectively. For the population recorded in the study area, this number was taken as the maximum count recorded in any season for any survey.

Species *sensitivity* was assigned based on a matrix (Table 9) that accounts for the combined *vulnerability* and *relative importance* ratings for each species. Species with a negligible *sensitivity* did not progress to Step 3. Additionally, to reflect the very low importance of the Rift Valley / Red Sea flyway population at a global level, species where the estimated flyway population was <1% of the total estimated global population were discounted.

[8] The Species Vulnerability Index scores species' vulnerability (on a scale of 1-10) to wind turbine collisions based on body mass, flight style, behaviour and documented incidents of collision.

Table 6: Vulnerability rating criteria

Vulnerability	Migratory Soaring Birds (and other species where an SVI has been designated)	Other migrants and Resident species *
Negligible	• LC on IUCN Global Red List, and SVI of 6 or below	LC on IUCN Global Red List
Low	• VU or NT on IUCN Global Red List and SVI 6 or below; • LC on IUCN Global Red List and SVI of 7 or 8; or • CMS Category 2 Species and SVI of 6 or below	NT on IUCN Global Red List
Moderate	• VU or NT on IUCN "Global" Red List and SVI of 7 or 8; • LC on IUCN Global Red List and SVI of 9 or 10; or • CMS Category 2 Species and SVI of 7 or 8	VU on IUCN Global Red List
High	• CR or EN on IUCN Global Red List; • VU or NT on the IUCN Global Red List and SVI of 9 or 10; or • CMS Category 2 Species and SVI 9 or 10	CR or EN on IUCN Global Red List
Note: * LC – Least Concern, NT – Near Threatened, VU – Vulnerable, EN – Endangered, CR – Critically Endangered		

Table 7: Relative importance rating for Migratory Soaring Birds

Relative Importance	Maximum total count for a species within a single season from any one project in the study area as a percentage of flyway population
Negligible	≤ 1%
Low	>1% and ≤ 5%
Moderate	>5% and ≤10%
High	>10%

Table 8: Relative importance rating for other migrants and resident species

Relative Importance	Global resident or breeding range (km2) – extent of occurrence
Negligible	>10,000,000
Low	>100,000 and <10,000,000
Moderate	>50,000 and <100,000
High	<50,000

Table 9: Sensitivity rating matrix

Sensitivity	Relative Importance			
	Negligible	Low	Moderate	High

Vulnerability	Negligible	Negligible	Negligible	Low	Low
	Low	Negligible	Low	Low	Medium
	Moderate	Low	Low	Medium	High
	High	Low	Medium	High	High

3.3.2 Results

Step 2 produced a list of 35 bird *sensitive* bird species (i.e. greater than negligible *sensitivity*) (Table 10)[9].

Table 10: Rating at Step 2 for species with greater than negligible sensitivity

Species	Scientific name	Rating		
		Vulnerability	Relative importance	Sensitivity
Black Stork	*Ciconia nigra*	Moderate	High	High
Booted Eagle	*Hieraaetus pennatus*	Moderate	High	High
Common Crane	*Grus grus*	Moderate	High	High
Great White Pelican	*Pelecanus onocrotalus*	Moderate	High	High
Steppe Eagle	*Aquila nipalensis*	High	High	High
White Stork	*Ciconia ciconia*	Moderate	High	High
Black Kite	*Milvus migrans*	Low	Moderate	Low
Egyptian Vulture	*Neophron percnopterus*	High	Low	Medium
Eurasian Buzzard	*Buteo buteo*	Low	Moderate	Low
European Honey-buzzard	*Pernis apivorus*	Moderate	Low	Low
Greater Spotted Eagle	*Clanga clanga*	High	Low	Medium
Levant Sparrowhawk	*Accipiter brevipes*	Negligible	High	Low
Pallid Harrier	*Circus macrourus*	Moderate	Moderate	Medium
Cinereous Vulture	*Aegypius monachus*	High	Negligible	Low
Eastern Imperial Eagle	*Aquila heliaca*	High	Low	Medium
European Turtle Dove	*Streptopelia turtur*	Negligible	Moderate	Low
Lesser Spotted Eagle	*Clanga pomarina*	Moderate	Low	Low
Long-legged Buzzard	*Buteo rufinus*	Low	Moderate	Low
Montagu's Harrier	*Circus pygargus*	Moderate	Negligible	Low
Short-toed Snake-eagle	*Circaetus gallicus*	Low	Moderate	Low
Bar-tailed Godwit	*Limosa lapponica*	Low	Low	Low
Bateleur	*Terathopius ecaudatus*	Moderate	Negligible	Low
Black-winged Pratincole	*Glareola nordmanni*	Low	Low	Low
Bonelli's Eagle	*Aquila fasciata*	Moderate	Negligible	Low

[9] four species that were initially rated above a negligible sensitivity but were not carried through to Step 3 due to the low importance of the flyway for the species were White-tailed Sea Eagle (*Haliaeetus albicilla*), Griffon Vulture (*Gyps fulvus*), Hen Harrier (*Circus cyaneus*) and Red Kite (*Milvus milvus*).

Species	Scientific name	Rating		
		Vulnerability	Relative importance	Sensitivity
Curlew Sandpiper	*Calidris ferruginea*	Low	Low	Low
Cyprus Warbler	*Sylvia melanothorax*	Negligible	High	Low
Dalmatian Pelican	*Pelecanus crispus*	High	Negligible	Low
Golden Eagle	*Aquila chrysaetos*	Moderate	Negligible	Low
Great Snipe	*Gallinago media*	Low	Low	Low
Lappet-faced Vulture	*Torgos tracheliotos*	High	Negligible	Low
Saker Falcon	*Falco cherrug*	High	Negligible	Low
Tawny Eagle	*Aquila rapax*	High	Negligible	Low
Verreaux's Eagle	*Aquila verreauxii*	Moderate	Negligible	Low
White-eyed Gull	*Larus leucophthalmus*	Low	Low	Low
Yellow-billed Stork	*Mycteria ibis*	Moderate	Negligible	Low

3.4 Step 3 – Conduct the ecological risk assessment and identify priority bird VECs

The purpose of Step 3 is to identify priority bird VECs. **This is based on a combination of the general species sensitivity (from Step 2) with an estimate of the site-specific risk based on information on the behaviour of birds in the study area.** This is done by combining each species' *sensitivity* score from Step 2, with a 'Likelihood of Effect' (LoE), to identify populations most at risk from adverse effects of the wind developments in this study area.

3.4.1 Methods

Collision with turbine blades is assumed to be the primary risk associated with windfarms in the study area for these species' populations. Hence, the LoE for each population was scored using three different collision risk components from the study area-specific baseline dataset. The scores relate to:

- flight behaviour,
- abundance; and
- birds landing within the study area[10].

[10] Data were sourced from bird baseline surveys of Lekela North Ras Gharib 250 MW Project (site 1 in Figure 1; Environics 2016a, 2016b, 2017a, 2017b), RCREE survey area (site 2 in Figure 1; RCREEE 2018), the block located west to Lekela North Ras Gharib 250 MW Project (site 3 in Figure 1; Ecoda 2013), ItalgenLekela South Gabal El-Zeit 320380 MW (site 6 in Figure 1; Grontmij 2009; EcoConServ 2017), the block located north to ItalgenLekela South Gabal El-Zeit 320380 MW (site 4 in Figure 1; (Ecoda 2011), and NREA concession (sites 5,6 and 7 in Figure 1; Ecoda 2007). Other datasets were discarded since they did not present required information for this step.

3.4.1.1 Component 1: Flight behaviour

This component looks at the flight height and flock size of each species. It is based on the reasoning that, (i) those populations with a higher percentage of migrating individuals flying at approximately turbine rotor / powerline height (<200m) will be at greater risk of collision, and (ii) populations with larger mean flock sizes will potentially have a higher risk of multiple fatality collision events.

The outcome score is derived through a matrix which combines (i) the percent of individuals recorded flying below 200m, and (ii) the mean flock size (Table 11).

Percent of individuals recorded flying below 200m - For each species population, the proportion of individuals recorded flying below 200m was calculated using the total number of individuals where flight height above/below 200m was recorded. Species with no data for calculating the percent of records below 200 m, were scored as having 50% of records below 200 m.

Mean flock size - Mean flock size was derived from the average flock sizes reported during each survey period: no weighting was applied as not all surveys covered the full migration period for all species, and flocking behaviour might vary throughout this period. Species with no data on mean flock size were conservatively scored as having a maximum flock size equal to the maximum count recorded in a season.

In some situations, flight height behaviour was very variable and the average percent below 200m is potentially less informative as a risk predictor. To account for this, species with flying height variability greater than the median height variability for all species flights below 200m, had their matrix score increased by 1 (note this was only possible for species with values for both percent of individuals below 200m and mean flock size).

3.4.1.2 Component 2: abundance.

This component considers the number of individuals of each species which have been recorded anywhere in the study area. Species with higher counts in the study area are potentially more likely to be affected by wind developments.

This component is thus a score based on the maximum total count for each species within a single season from any one dataset in the study area (Table 12).

3.4.1.3 Component 3: birds landing

This component reviews whether any species are recorded to be coming to ground in the study area (or whether they stay airborne) Species recorded on the ground must pass through the collision risk zone, and hence are at greater risk of collision than those species for which landing on the ground has not been recorded.

A score was assigned to each species to indicate whether a species had been recorded on the ground anywhere within the study area, irrespective of the numbers of individuals involved (species with records of landing scored 1 while those with no records of landing scored 0).

3.4.1.4 Determining overall risk rating

The three components were summed to arrive at a final LoE score for each species (possible range 2-10), which was separated into quartiles to derive a LoE rating for that species (Table 13). This LoE rating was then combined with the sensitivity *rating from Step 2 to derive an* overall risk *rating (*

Table 14). Species which had an *overall risk* of major or moderate were considered priority bird VECs for the study area.

Table 11: Matrix for scoring mean flock size and % of flights less than 200 m for each species.

Mean flock size	% of flights <200m			
	0-25	25-50	50-75	75-100
<10	1	1	2	2
10-50	1	2	2	3
50-100	2	2	3	4
>100	2	3	4	4

Table 12: Score categories for the maximum seasonal counts for a species in the study area.

Maximum season count	
Range	Score
0 to 10	1
10 to 1000	2
1000 to 10000	3
> 10000	4

Table 13: LoE rating based on overall score for each species evaluated at Step 3

LoE	
Overall score (based on quartiles)	Level of Effect
<=2	Negligible
>2 and <=3	Low
>3 and <=6	Medium
>6	High

Table 14: Overall project risk matrix

Overall risk	Likelihood of effect			
Sensitivity	Negligible	Low	Medium	High
Low	Negligible	Minor	Minor	Moderate
Medium	Minor	Minor	Moderate	Major
High	Minor	Moderate	Major	Major

3.4.2 Results

Step 3 identified 13 species with an *overall risk* of major or moderate from the project, and these species are considered priority bird VECs (Table 15)[11]. Thus, the overall list of 193 bird species potentially present has been filtered to 13 high-risk species. These were all categorised as MSBs (Category 1) earlier in Step 1 (Table 16). The complete dataset is in Appendix 2 which is available as online supplementary materials.

[11] Note that this list is derived from existing reports and a desk-top analysis. No in-country expert consultation has been carried out for this rapid assessment. Local stakeholder review may identify additional species of particular concern, or provide additional data which could affect the findings.

Table 15: Details of scores and ratings allocated to the 13 species identified as priority bird VECs

Species	Scientific name	Category	Red List status	CMS Category 2	SVI	Vulnerability	Highest count	Flyway population	% of UoA	Relative importance	Sensitivity	% flights <200m	Mean flock size	Variability in % flights <200 m[12]	Highest count	Landing in Area	LoE	Overall risk
Black Kite	*Milvus migrans*	1	LC	Yes	8	Low	8,251	132,700	6.2	Moderate	*Low*	52	5	13	8,251	Yes	*High*	*Moderate*
Black Stork	*Ciconia nigra*	1	LC	No	10	Moderate	6,738	19,500	34.6	High	*High*	36	12	23	6,738	Yes	*High*	*Major*
Booted Eagle	*Hieraaetus pennatus*	1	LC	No	9	Moderate	418	3,169	13.2	High	*High*	27	1	14	418	No	*Medium*	*Major*
Common Crane	*Grus grus*	1	LC	No	10	Moderate	12,004	35,000	34.3	High	*High*	19	100	40	12,004	Yes	*High*	*Major*
Egyptian Vulture	*Neophron percnopterus*	1	EN	No	10	High	154	4,535	3.4	Low	*Medium*	43	1	28	154	No	*Medium*	*Moderate*
Eurasian Buzzard	*Buteo buteo*	1	LC	No	7	Low	82,540	1,250,000	6.6	Moderate	*Low*	36	24	14	82,540	Yes	*High*	*Moderate*
European Honey-buzzard	*Pernis apivorus*	1	LC	Yes	7	Moderate	35,423	1,000,000	3.5	Low	*Low*	38	42	15	35,423	Yes	*High*	*Moderate*
Great White Pelican	*Pelecanus onocrotalus*	1	LC	No	10	Moderate	31,001	70,000	44.3	High	*High*	40	222	30	31,001	Yes	*High*	*Major*
Greater Spotted Eagle	*Clanga clanga*	1	VU	No	9	High	63	2,180	2.9	Low	*Medium*	26	2	35	63	No	*Medium*	*Moderate*
Levant Sparrowhawk	*Accipiter brevipes*	1	LC	No	6	Negligible	30,134	75,000[13]	40.2	High	*Low*	40	110	29	30,134	No	*High*	*Moderate*
Pallid Harrier	*Circus macrourus*	1	NT	No	8	Moderate	100	1,505	6.6	Moderate	*Medium*	85	1	16	100	No	*Medium*	*Moderate*
Steppe Eagle	*Aquila nipalensis*	1	EN	No	9	High	6,488	37,500	17.3	High	*High*	25	5	12	6,488	Yes	*Medium*	*Major*
White Stork	*Ciconia ciconia*	1	LC	No	10	Moderate	212,030	450,000	47.1	High	*High*	35	653	21	212,030	Yes	*High*	*Major*

[12] Values are the standard deviation of all values for a species used to calculate the % of flights <200 m.

[13] This value for Levant Sparrowhawk from Grontmij (2009) is significantly larger than the Birdlife International estimate (population size 10,000-19,000: BirdLife International 2016).

Table 16: Scoping out of species populations in steps 1 to 3 of the Cumulative Effects Analysis

Group	Number of species		
	Step 1	Step 2	Step 3
All birds	**193**	**35**	**13**
Category 1: Migratory Soaring Birds (MSBs)	34	19	13
Category 2: Other migrants and wintering species	110	7	0
Category 3: Resident species	49	9	0
Filtered out	-	*158*	*180*

3.5 Step 4 – The threshold setting process

This step establishes a fatality threshold for each priority bird VEC from wind farm impacts, setting the point at which further losses would be a risk to the long-term viability of the bird population. Exceeding threshold values triggers a requirement for adaptive management. This will lead to a review of wind farm operations and improvements to mitigation measures.

Thresholds were developed for each priority bird VEC relative to the number of fatalities a population could sustain on an annual basis at any location in the flyway.

3.5.1 Methods

Stage 1: For each priority bird VEC population, a potential biological removal (PBR) value was calculated (Dillingham & Fletcher 2008). This precautionary approach is appropriate where there is only limited information on species population biology, and uses species-specific rates of adult survival rate and year of first breeding to calculate an annual rate of human-caused mortality that, in the long term, would likely lead to a nonviable population.

The PBR is calculated as:

$$PBR = \frac{1}{2} R_{max} N_{min} f$$

Where:

R_{max} is the annual recruitment rate, which can be calculated from the maximum annual population growth rate via $R_{max} = Y_{max} - 1$. Y_{max} is calculated as:

$$Y_{max} = \frac{(sa - s + a + 1) + \sqrt{(s - sa - a - 1)^2 - 4sa^2}}{2a}$$

with s as the mean annual adult survival and a as the mean age at first breeding (Niel & Lebreton 2005). Information on s and a were sought for each priority bird VEC, however where this was not available, parameters from a closely-related surrogate species were used (Table 17).

N_{min} is a conservative estimate of population size, and is calculated as:

$$N_{min} = \hat{N}e^{(Z_p CV_{\hat{N}})}$$

with $\hat{N}$ as the population estimate from the UoA, Z_p as the p^{th} standard normal variate (set at -0.842) and $CV_{\hat{N}}$ is the coefficient of variation for $\hat{N}$ (set at 10%) (Wade 1998; Dillingham & Fletcher 2008) ; and,

f is the recovery factor, applied as per Dillingham and Fletcher (2008), with f = 0.5 for LC species, 0.3 for VU species and 0.1 for CR or EN species.

Stage 2: The annual fatality estimate from the PBR test was then assigned to one of three categories (Table 17). The PBR values provide an indication of the potential significance of additional impacts. The PBR values have not been directly used to set the thresholds, but rather to assign the species into management categories. Species with a PBR >1,000 were assigned to Category 1, with a PBR 1,000-10,000 were assigned to Category 2 and those with a PBR >10,000 were assigned to Category 3. The rationale behind the categorisation is that for the species with the lowest PBRs any additional impact will have a population-level effect, while those with higher PBRs can cope with some additional mortality.

Expert opinion has been sought on flyway population fatality rates due to other human derived sources (e.g. powerlines; persecution; and other industrial power sources, including non-RCIA confirmed and existing wind energy projects,) for each of the 13 priority bird VECs. This information could be used to get a deeper understanding of the potential consequence of additional fatalities at the Project, and thus influence the threshold level. At the time of writing, insufficient information had been gathered to influence the results. The thresholds described below may be subject to change.

Stakeholder concerns, and the project aim for no net loss of biodiversity have also been considered in setting the thresholds. These result in conservative thresholds well below the PBR, which will drive the Project to minimise impacts as far as is practicable.

3.5.1.1 Thresholds

During operations, fatality search surveys and other observations will be carried out continuously through the migration period. Each fatality encountered is documented in a 'priority bird fatality incident report', including identifying the species, and potential cause of death. These data, and the output of fatality estimate analyses will be reviewed periodically (timing to be determined) to evaluate whether thresholds have been exceeded and adaptive management is triggered.

The annual thresholds for each species have been set as follows[14]:

[14] These thresholds were derived from consideration of both the long term viability of each population and expert opinion on stakeholder concerns of biodiversity risk at the project level. Ideally these thresholds should apply to the whole study area. However, Lekela's ability to influence other operators is yet

- Category 1 species: zero fatalities.
- Category 2 species: three fatalities.
- Category 3 species: five fatalities.
- All categories: An additional threshold is set of 20 fatalities in total, irrespective of the species involved.

The ‘all categories’ threshold has been set to: (i) address a potential scenario where low numbers of all species are impacted, but for which no individual species would trigger a threshold; and (ii) act as an adaptive management trigger for extreme events where there are multiple simultaneous fatalities.

3.5.2 Results

Species-specific PBR values ranged from nine (Greater Spotted Eagle) to approximately 43,700 (Eurasian Buzzard). Five species were assigned to Category 1 with a threshold of zero fatalities before adaptive management actions are required, while five were assigned to Category 2 and three to Category 3 (Table 17).

to be determined. The thresholds are conservative and at a minimum each operator should be encouraged to apply the same thresholds to adaptive management.

Table 17. Input parameters, sources and results for the calculation of the Potential Biological Removal value for each bird VEC

Species	Scientific name	Unit of analysis	Flyway population	Red List status	Recovery factor	Mean adult survival	Mean age at first breeding	Source for demographic parameters	PBR value	Threshold category	Fatality threshold
Booted Eagle	*Hieraaetus pennatus*	Red Sea / Rift Valley flyway	3,169	LC	0.5	0.96	4	-[15]	63	1	0
Egyptian Vulture	*Neophron percnopterus*		4,535	EN	0.1	0.93	5	Sanz-Aguilar *et al.* (2015) in Spain	20	1	0
Greater Spotted Eagle	*Clanga clanga*		2,180	VU	0.1	0.95	4	-[16]	9	1	0
Pallid Harrier	*Circus macrourus*		1,505	NT	0.3	0.72	3	-[17]	47	1	0
Steppe Eagle	*Aquila nipalensis*		37,500	EN	0.1	0.92	4	-[18]	197	1	0
Black Kite	*Milvus migrans*		132,700	LC	0.5	0.96	4	-[19]	2,626	2	3
Black Stork	*Ciconia nigra*		19,500	LC	0.5	0.838	3	Tamás (2011) in eastern Europe	1,804	2	3
Common Crane	*Grus grus*		35,000	LC	0.5	0.90	4	Mathews and Macdonald (2000) in the UK	1,005	2	3
Great White Pelican	*Pelecanus onocrotalus*		70,000	LC	0.5	0.78	3	-[20]	3,334	2	3
Levant Sparrowhawk	*Accipiter brevipes*		75,000	LC	0.5	0.69	1	-[21]	9,597	2	3
Eurasian Buzzard	*Buteo buteo*		1,250,000	LC	0.5	0.90	3	Kenward et al. (2000) in the UK	43,739	3	5
European Honey-buzzard	*Pernis apivorus*		1,000,000	LC	0.5	0.86	3	BTO (2018c) for adult survival, and Jais (2018) for age at first breeding	40,066	3	5
White Stork	*Ciconia ciconia*		450,000	LC	0.5	0.78	3	Barbraud *et al.* (1999) in France	21,430	3	5

[15] No demographic parameters exist for Booted Eagle, so information from Red Kite (Newton *et al.* 1989) was used as a surrogate, as per IFC (2017)

[16] No demographic parameters exist for Greater Spotted Eagle, so information from Eastern Imperial Eagle (Katzner et al. 2006) was used as a surrogate

[17] No demographic parameters exist for Pallid Harrier, so information from Montagu's Harrier (BTO 2018a) was used as a surrogate

[18] No demographic parameters exist for Steppe Eagle, so information from Eastern Imperial Eagle (Katzner et al. 2006) was used as a surrogate, as per IFC (2017)

[19] No demographic parameters exist for Black Kite, so information from Red Kite (Newton et al. 1989) was used as a surrogate

[20] No demographic parameters exist for Great White Pelican, so information from American Brown Pelican (Walter *et al.* 2013) was used as a surrogate

[21] No demographic parameters exist for Levant Sparrowhawk, so information from Eurasian Sparrowhawk (BTO 2018b) was used as a surrogate

3.5.3 Adaptive management

For priority bird VECs that are principally at risk from colliding with turbine blades, adaptive management is triggered when target annual thresholds for each species are exceeded and should follow a set of clear sequential actions, specifically:

1. Conduct a review to determine the primary reasons why a threshold was exceeded.

2. Review the effectiveness of existing mitigation in light of the findings and determine whether a revised mitigation strategy is required. Possible options for revised mitigation may be extending the temporal period of shut-down on demand, increasing the number of observers, additional observer training, etc.

3.5.3.1 Periodic review of the CEA

An additional form of adaptive management is the periodic review of the CEA. This is necessary because increased information from the study area and elsewhere along the flyway may increase or decrease the risk to priority bird VECs, or add new ones. Information which may change includes the Red List status of birds, improved flyway population estimates and study area data (and hence knowledge of the proportion passing through the study area), and changes in the understanding of likelihood of effect.

Key parameters will be evaluated annually to determine whether the risk assessment for any bird VECs needs updating.

3.6 Step 5 – Identify a mitigation and monitoring approach for priority bird VECs

The broad recommended **mitigation and monitoring actions that Lekela will undertake or support to address their contribution to the cumulative effects from wind farm developments to priority bird VECs**, is presented in Section 6. This section also presents options for Lekela to influence the actions of other operators in the study area.

4 The Cumulative Assessment framework for other vertebrates

4.1 Overview of the framework for other vertebrates

The framework for vertebrate species, excluding birds, has two objectives: **to identify other vertebrate species at highest risk from the potential cumulative effects of developments in**

the study area, and to propose mitigation, monitoring and other management activities if species are identified to be at risk. This framework comprises a four-step process (Figure 4):

Step 1: Develop a preliminary list of vertebrate species potentially at risk from developments in the study area, because they are known or predicted to occur in the study area. A relevant scale (UoA) on which to base the analysis for these species was identified (see Section 4.2).

Step 2: Determine the relative *sensitivity* of each species, being a combination of the following:

- *Vulnerability*: a scoring of each species based on the conservation status at a scale relevant to the UoA; and
- *Relative Importance*: an estimate or judgment of the proportion of each species' population likely to use the study area, in relation to the appropriate UoA (see Section 4.3).

Species which were determined to have negligible *sensitivity* were dropped from the analysis before proceeding to Step 3.

Step 3: Determine the *overall risk* to each species from the cumulative effects of wind farm developments within the study area, being a combination of the:

- *Sensitivity* of the species, as identified in Step 2; and
- Cumulative *likelihood of effect* (LoE) rating for each species (see Section 4.4).

Species with an *overall risk* of Major or Moderate were considered as priority VECs for the project.

Step 4: Propose a range of mitigation, monitoring and management actions for priority non-bird species VECs to, if necessary, minimise collision risk for bats, habitat loss for terrestrial vertebrates, and to inform any adaptive management responses (see Section 6).

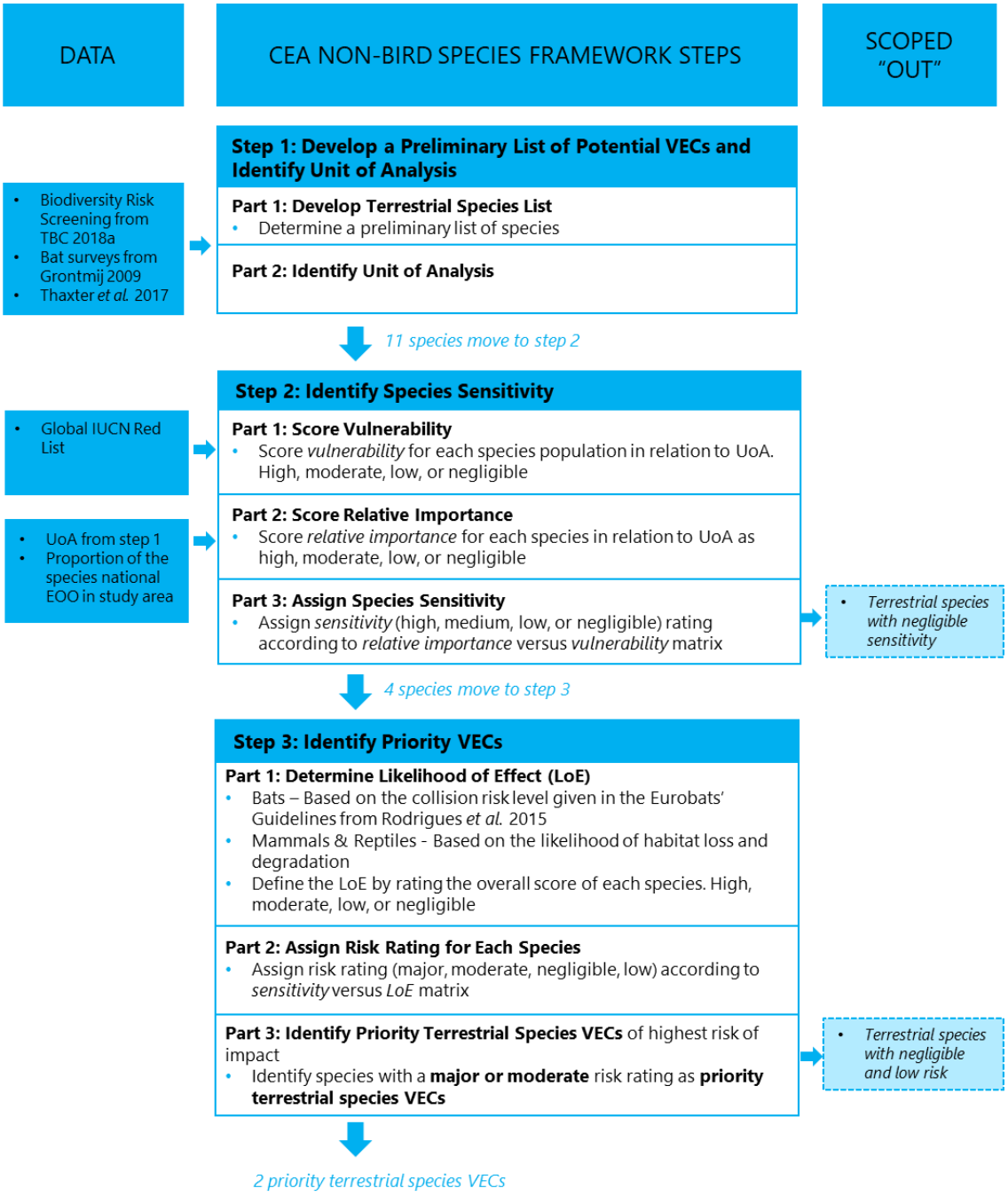

Figure 4: Process to identify priority non-bird species VECs

4.2 Step 1 – Develop the non-bird species list and identify the Unit of Analysis

The purpose of Step 1 is to identify all vertebrate species, excluding bird species (non-bird vertebrate species), that could potentially be at risk from the cumulative effects of the study area, and to determine a relevant scale by which any effects on each species could be measured.

4.2.1 Methods

A list of threatened and protected vertebrate species, excluding bat species, were identified in a Biodiversity Risk Screening for the project (TBC 2018b), and the Critical Habitat Assessment (TBC 2018a). This included all species listed on the IUCN Red List and Egyptian protected species which may occur in the study area based on their known range, and reports from baseline studies. Lists of additional mammal and reptile species reported from the study area were obtained from wind farm EIAs (see Table 4).

In the case of the bat species likely to be present in the study area, a list of all bat species known or predicted to occur in the study area was compiled from:

- Italgen Gabal El-Zeit 320 MW EIA study in 2010 (Grontmij 2010);
- Italgen Gabal El-Zeit 320 MW bird baseline studies in autumn 2008 and spring 2009, (Grontmij 2009);
- Illustrated Bat Key of Egypt (Dietz 2005); and
- The list of bat species included in the assessment of global vulnerability to wind power development compiled by Thaxter *et al.* (2017), filtered by species mapped in IBAT as occurring in the project area.

The UoA was identified based on a review of any available information on non-bird vertebrate species populations in Egypt and the wider Middle East region.

4.2.2 Results

31 species, comprising 20 mammal species and 13 reptile species, were identified as known or predicted to occur in the study area (Table 18), which are potentially at risk from wind farm developments.

Table 18: List of non-bird vertebrate species known or likely to be present in the study area (species with asterisk are not evaluated in the IUCN Red List)

Group	Order	Species	
		Common Name	Scientific Name
Bats	*Chiroptera*	Greater Mouse-tailed Bat	*Rhinopoma microphyllum*

Group	Order	Species	
		Common Name	Scientific Name
		Lesser Mouse-tailed Bat	*Rhinopoma hardwickii*
		Geoffroy's Trident Leaf-nosed Bat	*Asellia tridens*
		Kuhl's Pipistrelle	*Pipistrellus kuhlii*
		Botta's Serotine	*Eptesicus bottae*
		Desert Pipistrelle	*Hypsugo (Pipistrellus) ariel*
		Rueppell's Pipistrelle	*Pipistrellus rueppelli*
Other mammals	*Carnivora* (carnivores)	Egyptian Jackal	*Canis aureus*
		Rüppell's Sand Fox	*Vulpes rueppellii*
		Red Fox	*Vulpes 39orcas pusilla*
	Lagomorpha (lagomorphs)	Cape Hare	*Lepus capensis*
	Cetartiodactyla (ungulates)	Nubian Ibex	*Capra nubiana*
		Dorcas Gazelle	*Gazella dorcas*
	Rodentia (rodents)	Lesser Egyptian Gerbil	*Gerbillus gerbillus*
		Greater Egyptian Gerbil	*Gerbillus pyramidum*
		Lesser Egyptian Jerboa	*Jaculus jaculus*
		Silky Jird*	*Meriones crassus*
		Bush-tailed Jird*	*Sekeetamys calurus*
		Golden Spiny Mouse*	*Acomys russatus*
		Cairo Spiny Mouse*	*Acomys cahirinus*
Reptiles	*Squamata* (lizards and snakes)	Egyptian Spiny–tailed Lizard	*Uromastyx aegyptia*
		Bosc's Lizard*	*Acanthodactylus boskianus*
		Red Spotted Lizard*	*Mesalina rubropunctata*
		Sinai Agama*	*Pseudotrapelus sinaitus*
		Middle Eastern Agamid Lizard*	*Trapelus mutabilis*
		Keeled Rock Gecko	*Cyrtopodion scabrum*
		Egyptian Gecko*	*Tarentola annularis*
		Egyptian Fan-toed Gecko*	*Ptyodactylus hasselquistii*
		Shokari Sand Snake*	*Psammophis schokari*
		Horned Viper*	*Cerastes cerastes*

Group	Order	Species	
		Common Name	Scientific Name
		Sand Snake*	*Psammophis aegyptius*

The UoA identified for non-bird vertebrate species is the species' EOO within Egyptian national boundaries, based on IUCN global species distribution maps (IUCN 2018). Due to limited baseline data, no population estimates of any species known or likely to occur in the study area could be derived for the purpose of this analysis. Therefore, the extent of occurrence (EOO) for each non-bird vertebrate species within Egyptian national boundaries served as the best available information to be used for this study.

Review of baseline studies in the project area, and input from appropriate experts indicated that while Nubian Ibex (*Capra nubiana*) and Dorcas Gazelle (*Gazella dorcas*) are still present in low numbers in the wider landscape, they no long occur regularly in the study area. These species are therefore dropped from the analysis and do not proceed to Step 2. Nine reptile and four rodent species have been recorded during baseline assessments in the study area which have not yet been evaluated in the IUCN Red List (marked * in Table 18). There are therefore no vulnerability or range data and these species have not been carried through into Step 2.

4.3 Step 2 – Identify species sensitivity

The purpose of Step 2 is to determine the *sensitivity* of each species. **This step prioritises mammals and reptiles which are globally rare, known to be vulnerable to wind power developments, and are present in the study area in notable numbers.** It is based on its *vulnerability* of the species identified in Step 1 at the international scale and the *relative importance* of the study area to the species.

4.3.1 Methods

The *sensitivity* of each species takes into account a combination of two components:

- **Vulnerability** of the species using IUCN threat categories (IUCN 2018). The rating system is summarised in Table 19.
- **Relative importance** of the study area in relation to the UoA was identified for each species. This was calculated using the equation below with the rating system summarised in Table 20.

$$\frac{Species\ EOO\ in\ study\ area}{Species\ EOO\ in\ Egypt\ (UoA)} \times 100 = Relative\ Importance\ (\%)$$

The IUCN range data of three bat species, the Botta's Serotine (*Eptesicus bottae)*, Desert Pipistrelle (*Pipistrellus ariel*) and Rueppell's Pipistrelle (*Pipistrellus rueppelli*), and Red Fox (*Vulpes Vulpes*), do not overlap with the study area, suggesting that these species have not been recorded within this area. However, bat surveys have indicated that these species are

likely to be found within the study area. Thus, a conservative approach was adopted for the calculation of *relative importance* by using the entire extent of the study area as the 'Species' EOO in the study area' following the equation given above.

The *sensitivity* of the species was subsequently assigned based on a matrix (Table 21) that accounts for the combined *vulnerability* and *relative importance* ratings for each species. Non-bird vertebrate species with a negligible sensitivity did not progress to Step 3.

Table 19: Vulnerability rating criteria for non-bird vertebrate species

Vulnerability	IUCN Global Red List of Threatened Species*
Negligible	LC on IUCN Global Red List
Low	NT or DD on IUCN Global Red List
Moderate	VU on IUCN Global Red List
High	CR or EN on IUCN Global Red List
Note: * LC – Least Concern, NT – Near Threatened, VU – Vulnerable, EN – Endangered, CR – Critically Endangered	

Table 20: Relative importance rating criteria for non-bird vertebrate species

Relative Importance	Percentage of Species EOO present within Study Area
Negligible	≤ 1%
Low	>1% and ≤ 5%
Moderate	>5% and ≤10%
High	>10%

Table 21: Sensitivity matrix for non-bird vertebrate species

Sensitivity		Relative Importance			
		Negligible	Low	Moderate	High
Vulnerability	Negligible	Negligible	Negligible	Low	Low
	Low	Negligible	Low	Low	Medium
	Moderate	Low	Low	Medium	High
	High	Low	Medium	High	High

4.3.2 Results

Four *sensitive* species were identified (all with rating of low) (Table 22). All other non-bird species had a negligible rating and are not considered in subsequent steps.

Table 22: Summary of rankings assigned at Step 2 for non-bird vertebrate species

Species	Scientific name	Vulnerability		Relative importance				Sensitivity
		Red List	Score	Approx. Egyptian range (km²)	Study area	% of range in study area	Score	
Greater Mouse-tailed Bat	*Rhinopoma microphyllum*	LC	Negligible	920,850	1,386	0.25%	Negligible	Negligible
Lesser Mouse-tailed Bat	*Rhinopoma hardwickii*	LC	Negligible	545,500	1,386	0.1%	Negligible	Negligible
Geoffroy's Trident Leaf-nosed Bat	*Asellia tridens*	LC	Negligible	921,900	1,386	0.1%	Negligible	Negligible
Kuhl's Pipistrelle	*Pipistrellus kuhlii*	LC	Negligible	188,550	1,386	0.75%	Negligible	Negligible
Botta's Serotine	*Eptesicus bottae*	LC	Negligible	16,200	1,386	8.5%	Moderate	Low
Desert Pipistrelle	*Hypsugo (Pipistrellus) ariel*	DD	Low	14,100	1,386	9.8%	Moderate	Low
Rueppell's Pipistrelle	*Pipistrellus rueppelli*	LC	Negligible	188,550	1,386	7.5%	Moderate	Low
Egyptian Jackal	*Canis aureus aureus*	LC	Negligible	921,800	1,386	0.1%	Negligible	Negligible
Rüppell's Sand Fox	*Vulpes rueppellii*	LC	Negligible	851,900	1,386	0.1%	Negligible	Negligible
Red Fox	*Vulpes vulpes*	LC	Negligible	160,000	1,386	0.9%	Negligible	Negligible
Cape Hare	*Lepus capensis*	LC	Negligible	371,300	1,386	0.4%	Negligible	Negligible
Lesser Egyptian Gerbil	*Gerbillus gerbillus*	LC	Negligible	850,000	1,386	0.1%	Negligible	Negligible
Greater Egyptian Gerbil	*Gerbillus pyramidum*	LC	Negligible	750,000	1,386	0.2%	Negligible	Negligible
Lesser Egyptian Jerboa	*Jaculus jaculus*	LC	Negligible	900,000	1,386	0.1%	Negligible	Negligible
Egyptian Spiny–tailed Lizard	*Uromastyx aegyptia*	VU	Moderate	69,382	1,386	2%	Low	Low
Keeled Rock Gecko	*Cyrtopodion scabrum*	LC	Negligible		1,386		Negligible	Negligible

4.4 Step 3 – Conduct the ecological risk assessment and identify priority non-bird vertebrate species VECs

The purpose of Step 3 is to identify priority non-bird vertebrate species VECs from the four species carried through from Step 2, i.e. the 3 bat species Botta's Serotine, Desert Pipistrelle, Rueppell's Pipistrelle and the Egyptian Spiny–tailed Lizard. This was carried out by combining each species' *sensitivity* rating with an estimate of site-specific risk based on locally collected data. This "Likelihood of Effect" (LoE), identifies species at the highest risk from wind developments in the study area.

4.4.1 Methods

4.4.1.1 LoE for bat species

The LoE for each bat species was identified using the level of collision risk in Eurobats' *Guidelines for consideration of bats in wind farm projects – Revision 2014* (Rodrigues *et al.* 2015) (Table 23) and further informed by global collision rates given in Thaxter *et. al* (2017), as there was no available information on the collision risk of bat species in the study area or at the country or regional level.

4.4.1.2 LoE for vertebrate species excluding birds and bats

The LoE for the Egyptian Spiny–tailed Lizard was identified based on the likelihood of habitat loss and degradation *occurring from the cumulative effects of the potential wind farm developments in the study area (*

Table 24). This LoE rating was decided based on expert knowledge of the CEA team on the likely effects that are expected to occur on this species as a result of these developments.

4.4.1.3 Overall risk rating for non-bird vertebrate species

The LoE rating was then combined with the *sensitivity* rating from Step 2 to derive an *overall risk* rating (Table 25). **Species which had an *overall risk* of major or moderate were considered priority VECs for the study area.**

Table 23: LoE rating criteria for bat species

LoE Rating	Level of Bat Collision Risk (based on Eurobats' Guideline)
Negligible	Species and/or genus with low level of collision risk
Low	Species and/or genus with unknown level of collision risk
Medium	Species and/or genus with medium level of collision risk
High	Species and/or genus with high level of collision risk

Table 24: LoE rating criteria for vertebrate species excluding birds and bats

LoE Rating	Criteria
Negligible	Negligible risk from habitat loss and degradation due to the cumulative effects of the developments.
Low	Low risk from habitat loss and degradation due to the cumulative effects of the developments.
Medium	Medium risk from habitat loss and degradation due to the cumulative effects of the developments.
High	High risk from habitat loss and degradation due to the cumulative effects of the developments.

Table 25: Overall project risk matrix for non-bird vertebrate species

Overall risk		LoE			
		Negligible	Low	Medium	High
Sensitivity	Low	Negligible	Minor	Minor	Moderate
	Medium	Minor	Minor	Moderate	Major
	High	Minor	Moderate	Major	Major

4.4.2 Results

Of the four non-bird species carried through from Step 2 (all with *sensitivity* ratings of low), two bat species are identified to have an *overall risk* rating of moderate (Table 26). These two species **Desert Pipistrelle and Rueppell's Pipistrelle are thus considered priority VECs.**

The Egyptian Spiny-tailed Lizard did not qualify as a priority VEC, but is identified as a PBF (per EBRD PR6). A conservative LoE of moderate has been applied until evidence is available that indicates the likelihood of impacts to burrows is low. The potential impacts to the Egyptian Spiny-tailed Lizard come from destruction of burrows and fatalities. These are more likely during construction, but vehicle collision fatalities are also possible during operations. This species has been recorded in the project area, and elsewhere in the study area but the species density, and number and location of burrow systems is not known.

Table 26: Details of scores allocated to the non-bird vertebrate species identified as priority terrestrial species VECs

Species	Scientific name	Sensitivity	Collision risk	LoE	Overall risk
Desert Pipistrelle	*Hypsugo (Pipistrellus) ariel*	*Low*	High	*High*	*Moderate*
Rueppell's Pipistrelle	*Pipistrellus rueppelli*	*Low*	High	*High*	*Moderate*
Botta's Serotine	*Eptesicus bottae*	*Low*	Medium	*Moderate*	*Minor*
Egyptian Spiny–tailed Lizard	*Uromastyx aegyptia*	*Low*	n/a	*Moderate*	*Minor*

4.5 Step 5 - Identifying a potential mitigation and monitoring approach for priority terrestrial VECs

The recommended broad **mitigation and monitoring actions that Lekela will undertake or support to address their contribution to the cumulative effects from wind farm developments to priority terrestrial species VECs**, is presented in Section 6.

5 The Cumulative Assessment for ecosystems

A subjective approach to identifying priority ecosystem VECs has been followed. Data on land cover in the study area are very limited and a quantitative approach was not feasible. In this context, the approach was to review what features in the landscape that are likely to be valued as important for supporting the biodiversity of the region.

The study area lies in the coastal plains of the eastern desert and consists primarily of a flat pebble desert (RCREEE 2018). The project area is not considered to contain particularly unique or threatened ecosystems (see Critical Habitat Assessment for the Lekela North Ras Gharib 250 MW Project (TBC 2018a)). A literature review revealed three features known, or potentially present in the study areas which are relatively important for supporting biodiversity. All three are considered priority ecosystem VECs.

- Wadis;
- Rocky outcrops and caves; and
- Saltmarsh (*sabkha*).

Vegetation is known to be largely restricted to salt marshes and wadis in the eastern desert region (Ministry State of Environment Affairs 2014). These ecosystems are present but sparse in the study area (Environics 2018; RCREEE 2018). They are known to have biodiversity value in their own right, but are also of potential importance for other priority VECs, e.g. bats could be utilising small caves for roosting (Grontmij 2010) and wadis for foraging when they flood intermittently with water (Voigt & Kingston 2016).

6 The mitigation and monitoring approach for priority VECs

This section establishes recommended broad mitigation and monitoring actions that will be adopted by Lekela for their specific projects, and actions that Lekela will undertake or support to address

their contribution to the cumulative effects from wind farm developments in the study area. These mitigation and monitoring actions focus on the 13 priority bird VECs, as identified in this document, and will also deliver benefits for other bird species passing through the wind farms. Recommendations are also listed for monitoring impacts to the two priority bat VECs, and avoiding impacts to priority ecosystem VECs. In all cases, mitigation and monitoring actions will follow industry good practice. The mitigation and monitoring approach will focus on two areas:

- **On-site mitigation and monitoring methods,** to minimise collision risk, validate the effectiveness of the proposed mitigation methods once they have been implemented, allow estimation of residual impacts and provide information to adapt monitoring and mitigation to prevailing conditions[22]; and,
- **Collaborative efforts with other wind farm entities,** to minimise the cumulative effects of all the proposed wind farm developments in the study area.

By adopting the proposed approach, Lekela will be able to reduce its impact as far as practicable for the identified VECs, adhering to an approach that will facilitate alignment with PS6/PR6, and particularly be pursuing a goal of No Net Loss. By doing this, Lekela sets a benchmark for other wind projects in the study area and provides an example of successful best-practice implementation for others to follow. A co-ordinated approach to mitigation, particularly migration monitoring and turbine shutdown would be beneficial to Lekela and all other wind projects in the study area. By adopting a single shutdown protocol across the whole study area and sharing real-time survey data, individual project operational costs and risks to birds can be reduced through optimized and coordinated use of field observers across multiple projects.

[22] Note that radar assisted shut down on demand is already being implemented in the study area. The system is being operated by STRIX in the Gabal el Zait area, and reports a high level of success http://www.strix.pt/index.php/en/projects/projects-birdtrack/monitoring-migratory-soaring-birds-gabal-el-zayt.

Table 27: Suggested Mitigation and Monitoring Actions for the Project

Action	Measure	Description	Key objective	Responsible entity	Time frame	Target VEC
On-site mitigation actions						
1	Development of appropriate protocols	All actions require clear and detailed protocols that can be followed by survey teams and project management: this information should be included in the relevant Project documents. Protocols should align with industry good-practice guidelines and be designed by specialists experienced in assessing biodiversity risk at wind farm developments.	Ensure that all actions are undertaken in a consistent manner and collect appropriate data to make decisions.	Lekela	Approved protocols at least three months prior to commencement of operation	Birds, terrestrial species and habitats
2	Observer-led shut-down on demand	Monitoring the numbers and flight activity of priority bird VECs within the wind farm is vital for effective and efficient shutdown of specific turbines to avoid collisions. Birds must be monitored by trained and experienced field observers, and monitoring effort should cover the whole operational turbine area. The principal aim of monitoring is to implement shut-down on demand protocols (see Observer-led shut-down on demand below), when priority birds are at immediate risk of colliding with turbine blades. Additional aims are to record the numbers of priority bird VECs in the wind farm, and to observe collisions or near misses (if or when these occur). **Observer-led shut-down on demand** When field observers identify priority bird VECs that are likely to result in collision, they must initiate a temporary shutdown of one or more turbines until the birds are no longer at risk, at which time the turbines can be restarted. This approach is a well-established method for minimizing the risk to birds of colliding with rotating wind turbine blades. Shut-down on	To avoid collisions of priority birds with wind turbines by initiating and achieving timely shutdown of one or more turbines in response to birds observed on a likely collision flight path	Lekela	Protocols and tested system in place prior to commencement of operation. Initial three-year period and will be evaluated after this time to assess their effectiveness and determine ongoing needs,	Birds

Action	Measure	Description	Key objective	Responsible entity	Time frame	Target VEC
		demand may also be triggered by other events not involving VECs, as defined in site-specific management plans. Protocols will be established under Action 1, and will include the conditions for initiating and recording: • 'Near-miss incidents' (i.e. those situations where there was a failure to shutdown in a high-risk situation to a priority bird VECs; • Elevated risk situations (i.e. periods when environmental or other conditions result in specific or general risk to priority birds.); • Shutdown and resumption of operation, required communications between field observers and wind farm operator; and, • Information to record in the event a shutdown occurs (both outcomes for the bird(s) involved and the operator actions). When one or more individuals of a priority bird VEC is observed, the field observer should consider shutdown of specific turbines based on their judgment considering the following parameters: • Height at which bird is flying (i.e., turbine risk height); • Likely flight path, flight pattern, and behavior of bird; and, • Distance from bird to turbine (i.e., distance within which a priority bird could be at risk). Automated shut-down on demand system options (e.g. radar, camera) should be explored, but should only supplement field-based observers for				

Action	Measure	Description	Key objective	Responsible entity	Time frame	Target VEC
		at least three years until such approaches have been demonstrated to work effectively in this situation.				
3	Migration monitoring	A dedicated team of observers (separate from those employed to implement shut-down on demand (Action 2)) will collect detailed flight activity data during spring and autumn migration seasons for the development and surrounding area. Observers will monitor from vantage points strategically located to maximize information on seasonal migration activity of priority and other MSBs over and around the project site. **Focus:** monitoring should focus on priority bird VECs, with data recorded on other bird species as time allows. Unidentified species should precautionarily be considered priority bird VECs until proven otherwise (e.g. Greater and Lesser Spotted Eagles are often difficult to distinguish at distance). **Method**: monitoring should primarily use a series of pre-determined Vantage Points, the number and location of which will be dictated by local topography, turbine layout and flight activity of priority bird VECs. **Observers**: should be experienced with identifying all priority bird VECs, and sufficiently knowledgeable about the goals of the project to alter methods if conditions warrant (e.g. move VPs if bird flight activity changes). **Effort**: as all priority bird VECs are migratory in the study area, monitoring must occur for the full spring and autumn migration periods, with start and end dates robustly justified (noting that the timing of migration varies considerably between species). Monitoring must also occur at all times of	To better understand flight activity of priority birds VECs and other MSBs to optimize on-site mitigation strategies, specifically shut-down on demand and fatality search surveys.	Lekela	Initial three-year period and will be evaluated after this time to assess their effectiveness and determine ongoing needs.	Birds

Action	Measure	Description	Key objective	Responsible entity	Time frame	Target VEC
		day when birds are known to be active. Reduced effort is required outside of these periods and should be regularly reviewed as to its relevance. **Data collection**: observers must use standard data forms to record all observations, to allow for improvements to the methods and analysis of approach / responses in cases where collisions occur. Data collected will include; mapped flight tracks of all observed individuals and flocks, detailed flying height estimate data, behavioral responses of birds approaching, and in the vicinity of operational turbines as well as general movements relating to topographic features in the wider landscape. Field, environmental, and topographic data will be analyzed to identify, and better understand fluxes in collision risk for priority bird VECs and other MSBs during each seasonal migration period. **Results**: will be briefly reported seasonally, with an annual 'Migration Monitoring Report' containing detailed results, analyses and recommendations for optimizing on-site mitigation.				
4	Installation of wildlife-friendly Project power lines	Many bird species are known to collide with power lines (particularly high-voltage lines) and there is some evidence to suggest that both a) flight diverters, and b) line configuration might lessen this risk. The configuration (type and spacing) of bird flight diverters and alignment (height, number and spacing) of wires should be based on industry good-practice where available, and be informed by robust evidence of effective deployment at existing wind power projects in comparable environments.	To minimize the number of collisions between priority bird VECs with Project power lines (Storks, cranes and pelicans would be the VECs most at risk from this type of impact.)	Lekela	During power line erection	Birds

Action	Measure	Description	Key objective	Responsible entity	Time frame	Target VEC
5	Micro-siting and alignment of turbines	Turbines should be micro-sited to provide the maximum gap between turbines, especially along the axes of likely migration routes. This approach is recommended with precaution as the ability of species to navigate through a wind farm is poorly understood. Micro-siting should also be used to avoid areas containing habitat VEC (e.g. wadis, saltmarsh) and burrows or shelter sites used by mammal or reptile VECs.	Allow priority bird VECs to pass through the wind farm	Lekela	In the project design phase	Birds, terrestrial species and habitats
6	Fatality search surveys – turbines	This involves regular surveys of the area beneath turbines to detect bird and bat fatalities that have collided with turbine blades. Protocols for these searches, including frequency, number of turbines searched and the search area under each turbine will be determined under Action 1, and will be based on industry good-practice.	To determine the level of observed fatalities due to collisions with turbines at the wind farm site.	Lekela	Initial three-year period and will be evaluated after this time to assess their effectiveness and determine ongoing needs	Birds and bats
7	Fatality search surveys – powerlines	The Project will conduct regular surveys under Project power lines to determine the levels of mortality from birds and bats colliding with lines. Collisions with power lines are a known source of mortality for many bird species. Protocols for these searches, including frequency and the search area will be determined under Action 1 and based on industry good-practice.	To determine the level of observed fatalities due to collisions with power lines at the wind farm site.	Lekela	Initial three-year period and will be evaluated after this time to assess their effectiveness and determine ongoing needs	Birds and bats
8	Bias correction experiments for	Bias correction factors need to be applied to convert the observed carcasses under turbines and power lines to an actual estimate of	To provide species specific bird and bat fatality	Lekela	During both spring and autumn	Birds and bats

Action	Measure	Description	Key objective	Responsible entity	Time frame	Target VEC
	fatality search surveys	mortalities, as some fatalities will be removed before they have been recorded in a fatality survey (carcass removal bias), and searchers will not detect all fatalities present (searcher efficiency bias). These approaches are standard good-practice for wind farms, and if designed correctly, both experiments can be conducted concurrently. Carcasses used in experiments should be as similar as possible to the type of expected fatalities to mimic real conditions. Experiments should be planned and led by a bird consultant /ornithologist experienced in assessing bird risk at wind farms and familiar with these approaches. Searchers used in the searcher efficiency experiments should be those who will undertake the fatality search surveys (Action 6 and Action 7). The number and distribution of carcasses used in experiments will depend on the habitat types and topography within the wind farm site. Analysis of resulting data should be conducted using an established method: the Generalised Fatality Estimator recently developed by the United States Geological Survey (USGS) is recommended.	estimates 'corrected' for carcasses not found during fatality search surveys.		migration periods for two years, then reassessment. Can begin prior to commencement of operation.	
9	Review to improve monitoring and mitigation effectiveness	Periodic reviews of Actions 1, 2, 4-8, 10-11 will be undertaken to improve the effectiveness of monitoring and mitigation actions. This will include: **Immediate** review of the in-field monitoring and response process if a priority bird VEC threshold is exceeded, to recommend what, if any, additional actions may be implemented to further reduce collision risk. **Quarterly** review of carcass survey results and effectiveness of shut-down on demand protocols.	Adaptive management to reduce risk	Lekela	On-going from start of construction	Birds and bats

Action	Measure	Description	Key objective	Responsible entity	Time frame	Target VEC
		Bi-annual review of monitoring data, following the end of each bird migration season, to evaluate and suggest improvements to the effectiveness of monitoring and protocols, also to identify collision risk hotspots and evaluate adaptive management options. **Annual** review of bias correction experiments, all bird monitoring and responses of the Project to the monitoring and mitigation actions. If thresholds are exceeded, the annual review should recommend additional mitigation measures that must be adopted during future monitoring.				
10	Avoid construction in wadis, caves and saltmarshes	Impacts to priority ecosystem VECs will be avoided during construction. All wadis, caves and saltmarshes will be mapped and infrastructure sited to avoid them.	Impact avoidance.	Lekela	Pre-construction	Wadis, caves and saltmarshes
11	Avoid and minimize impacts to Egyptian Spiny-tailed Lizard	The lizard is not a priority VEC, but is a Priority Biodiversity Feature (*sensu* PR6), and impacts need to be reduced as far as is practicable by: - Mapping and avoiding burrows during construction; - Driver training and awareness to ensure vehicles stay on demarcated roads and drivers avoid road fatalities	Impact avoidance.	Lekela	Pre-construction, construction and operations	
Lekela contribution to minimizing cumulative effects						
12	Data sharing	Lekela will make annual summaries of its monitoring and mitigation efforts publicly available to support baseline knowledge, increase transparency and understanding of the work being undertaken.	Achieve effective, efficient and responsive mitigation and adaptive management	Lekela	Periodically throughout the construction phase	Birds, terrestrial species and habitats

Action	Measure	Description	Key objective	Responsible entity	Time frame	Target VEC
		Lekela will also share raw data and relevant information in real time / monthly with other developers within the Project area to improve cumulative actions.	across wind projects in the area Provide example of best-practice for other operators to follow			
13	Joint training of observers	Lekela will contribute to the joint training of a pool of skilled bird observers who are able to carry out baseline and monitoring surveys throughout the study area, and adjacent Important Bird Area	Ensure comparable observer standards are maintained across all project sites.	All / other	On-going, with establishment prior to commencement of operation	Birds
14	Coordination of observer networks	Lekela will co-ordinate with other developers in the Project area to site observer networks where these can be of greatest benefit. Lekela will also share protocols so that shut-down on demand can be initiated by observers from other projects.	Maximise the benefits from an extended observer network	Lekela	On-going, with establishment prior to commencement of operation	Birds
15	Discussion forum	Facilitate / support an annual biodiversity workshop / conference for all wind farms in the Project area, to facilitate knowledge exchange, share experiences and plan cumulative actions.	Improve regional knowledge of priority bird VECs and improve wind farm operations	All / Lekela	Annually	All
Other actions						
A	Prepare and follow a Biodiversity Action Plan (BAP)	Overarching Project plan to guide the mitigation of biodiversity impacts. The BAP should summarise anticipated impacts, demonstrate how the Project will apply the mitigation hierarchy, and forecast how the Project will achieve at least no net loss for the VECs and other priority biodiversity.	Support the implementation of mitigation measures and	Lekela	If required	Birds, terrestrial species and habitats

Action	Measure	Description	Key objective	Responsible entity	Time frame	Target VEC
		This would include a review of collision risk models to determine what, if any, residual impacts remain after the application of mitigation actions. If collision risk models indicate that such impacts do remain, this will also need to include a plan for compensating or offsetting residual impacts on priority biodiversity.	deliver NNL / NG to priority bird VECs			

7 Next steps

In order to maximise the effectiveness of the cumulative effects analysis, the following actions are required:

1. Provide the current draft of this document to stakeholders for review. Relevant stakeholders include, but are not limited to: government agencies (e.g. NREA), RCREEE, wind farm developers, lenders, NGOs (e.g. Nature Conservation Egypt, BirdLife International, Wetlands International, secretariat of the Convention on the Conservation of Migratory Species of Wild Animals (CMS)), environmental impact experts, and ecologists with local expertise. Comments, corrections and requests for additional information will be sought from all stakeholders. Where appropriate the analysis can be revised based on the feedback.
2. Share the findings of the cumulative effects analysis with any other proposed cumulative impact assessments in Egypt.
3. Provide the final Cumulative Effects Analysis to developers, regulators and other relevant stakeholders in the Gulf of Suez.

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Glossary

Active Turbine Management Program (ATMP)	A region-wide program of turbine management aimed to minimize potential collision risks to migratory soaring birds.
Adaptive management	A systematic process for continually improving management policies and practices by learning from the outcomes of previously employed policies and practices (Millennium Ecosystem Assessment 2003).
Avoidance	Measures taken to anticipate and prevent adverse impacts on biodiversity before actions or decisions are taken that could lead to such impacts.
Biodiversity	Defined by the Convention on Biological Diversity (CBD) as 'the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems'.
Critical Habitat	A subset of Natural or Modified Habitat identified by the presence of high biodiversity values (including (i) Critically Endangered and/or Endangered species; (ii) endemic and/or restricted-range species; (iii) globally significant concentrations of migratory species and/or congregatory species; (iv) highly threatened and/or unique ecosystems; and/or (v) areas associated with key evolutionary processes) as defined by International Finance Corporation Performance Standard 6 (IFC PS6).
Critical Habitat Assessment (CHA)	Process and documentation to identify the presence of Critical Habitat-qualifying biodiversity values. A CHA may also include identification of Natural and Modified Habitat (per IFC Performance Standard 6) and Priority Biodiversity Features (per EBRD Performance Requirement 6).
Cumulative impacts/effects	Impacts resulting from the accumulation of demands or stresses on habitat, biodiversity, resources, or ecosystem services from multiple causes or activities. The impacts will exceed those that would result from any of the individual causes or activities.
Ecosystem	A community of plants, animals and smaller organisms that live, feed, reproduce and interact in the same area or environment.

Ecosystem Services	The benefits that people obtain from ecosystems.
Environmental and Social Impact Assessment	The process of predicting and evaluating the social and environmental impacts and risks of a proposed project, and identifying mitigation measures that will enable the project to meet the requirements of stakeholders, lenders, applicable laws and regulations, and any additional requirements for social or environmental performance identified by the project.
Habitat	An ecological or environmental area that is inhabited by a particular species of animal, plant or other type of organism. It is the natural environment in which an organism lives, or the physical environment that surrounds (influences and is used by) a species population.
Integrated Biodiversity Assessment Tool (IBAT)	An online tool that provides up-to-date biodiversity information to support critical business decisions. The tool is the result of a partnership between BirdLife International, Conservation International, IUCN and UNEP-WCMC. https://www.ibat-alliance.org/
IUCN Red List	List of species classified into categories based upon their extinction risk. The categories are Critically Endangered (CR), Endangered (EN), Vulnerable (VU), Near Threatened (NT) and Least Concern (LC). Categorisation is based upon data-driven criteria. Species whose correct category cannot be determined are classified as Data Deficient (DD). CR, EN and VU species are collectively termed Threatened. https://www.iucnredlist.org/
Likelihood of Effect	In the context of this Cumulative Effects Analysis conducted, this is an estimate of site-specific risk to biodiversity as a result of the cumulative impacts of the windfarms in the study area. It is determined using locally collected information and not based on general data.
Migratory Soaring Birds	With reference to Birdlife's Migratory Soaring Bird Project (BirdLife International 2018b), these are soaring birds that migrate through the Red Sea/Rift Valley Flyway.
Minimisation	Measures taken to reduce the duration, intensity, significance and/or extent of impacts (including direct, indirect and cumulative impacts, as appropriate) that cannot be completely avoided, as far as is practically feasible. (Minimize as used here does not imply an intention to 'reduce to zero', which is its legal meaning in some jurisdictions. Some companies have chosen to avoid using the words Minimize'/'Minimization' and instead use words like 'Limit'/'Limitation' and 'Reduce'/'Reduction'.)
Mitigation Hierarchy	The sequence of actions to anticipate and avoid, and where Avoidance is not possible, Minimize, and, when impacts occur, Restore, and where significant

	residual impacts remain, Offset for biodiversity-related risks and impacts to affected communities and the environment.
Natural Habitat	Natural habitats are areas composed of viable assemblages of plant and/or animal species of largely native origin, and/or where human activity has not essentially modified an area's primary ecological functions and species composition
New and Renewable Energy Authority (NREA)	Egyptian regulatory authority for wind and other renewable energy developments.
No net loss	The point at which project-related impacts on biodiversity are balanced by measures taken according to the Mitigation Hierarchy on an appropriate geographic scale (e.g. local, ecosystem-level, national, regional). May be assessed relative to underlying rates of loss.
Offset	Measurable conservation outcomes, resulting from actions applied to areas not impacted by the project, that compensate for significant, adverse project impacts that cannot be avoided, minimized and/or rehabilitated/restored, in order to achieve no net loss or a net gain of biodiversity and/or ecosystem services.
Potential Biological Removal	A simple, robust, and precautionary test developed for situations in which information on species population biology is limited (Wade 1998; Niel & Lebreton 2005; Dillingham & Fletcher 2011). It uses species-specific biological and demographic parameters, specifically adult survival rate and year of first breeding, to calculate an annual rate of human-caused mortality that if realized would likely result in a nonviable population in the long term.
Priority Biodiversity Features	A subset of biodiversity that is particularly irreplaceable or vulnerable, but at a lower priority level than Critical Habitats (as defined by the Environmental and Social Policy of The European Bank for Reconstruction and Development (EBRD))
Regional Center for Renewable Energy and Energy Efficiency (RCREEE)	An intergovernmental organization with diplomatic status that aims to enable and increase the adoption of renewable energy and energy efficiency practices in the Arab region. http://www.rcreee.org/

Relative Importance	In the context of this Cumulative Effects Analysis conducted, this is an estimate or judgment of the proportion of each species' population that is likely to use the study area.
Residual impacts	Project-related impacts that might remain after on-site mitigation measures (Avoidance, set-asides, management controls, abatement, rehabilitation/restoration etc.) have been implemented. Any reliable determination of residual impacts on biodiversity needs to take into account the uncertainty of outcomes due to mitigation measures.
Stakeholders	Individuals or groups that are directly or indirectly impacted by a project either by interest or by their capacity to influence the result of it in either a positive or negative way.[23]
Sensitivity	In the context of this Cumulative Effects Analysis conducted, this is assigned based on the combined *vulnerability* and *relative importance* ratings for each species.
Unit of Analysis (UoA)	A population scale on which the analysis of cumulative effects is based, for example national population, flyway population or global.
Valued Environmental Components (VEC)	Attributes, both environmental and social, that are considered important in assessing the risks that a project, or suite of projects poses to the environment.
Vulnerability	In the context of this Cumulative Effects Analysis conducted, this is a scoring of each species based on the, (i) conservation status at a scale relevant to the UoA, and/or (ii) susceptibility to the adverse effects of wind power projects, especially collision risk, based on peer-reviewed evidence.

[23] ARPEL (2011). Stakeholder Engagement Manual. Corporate Social Responsibility Management System. Other similar definitions can be found in the American Petroleum Institute's Community Engagement Guidelines, and the IFC's Stakeholder Engagement: A Good Practice Handbook for Companies Doing Business in Emerging Markets.

Appendix 1 Industrial developments in Gulf of Suez

Appendix 1.1 Mapping exercise

In the context of this assessment, the study area is the complex of potential wind farm developments in the Ras Gharib – Gebel El Zeit area in Red Sea Governate, Egypt (Figure 5). This will capture all industrial projects, in the vicinity of the Lekela Project, that might impact the priority biodiversity VECs within and passing through the Project area.

Mapping and initial understanding of industrial activities operating or in development within the study area have been compiled based on information from the following sources:

- Key word search on the web (using words like 'Wind farm'/'Wind concession' in 'Gulf of Suez', in 'Zafarana' or in 'Ras Gharib', 'oil fields', 'oil concession', etc.);
- Research on websites from official Egyptian organisations/agencies, such as the New & Renewable Energy Authority (NREA), and the Red Sea Governate;
- Website of the Regional Center for Renewable Energy and Energy Efficiency (RCREEE);
- A request for information from informed experts including EBRD, NREA, Kina Advisory Ltd., Environics, and AECOM; and
- Additional unpublished literature and documents provided by Lekela.

Project locations have been mapped using GIS coordinates, when available, or via digitisation of existing maps.

Appendix 1.2 Wind Farms

Wind farms are operating, in construction, or planned, in several locations of the western side of Gulf of Suez. They are planned in the areas surrounding Zafarana, Hurghada and Ras Gharib cities. Given the extent of the wind farm concessions around Ras Gharib, they are sub-divided in this area into four sub-locations based on the pre-construction studies (as in Figure 4 from Environics 2015). The main results are provided in Table 28 and illustrated in Figure 5 and Figure 6.

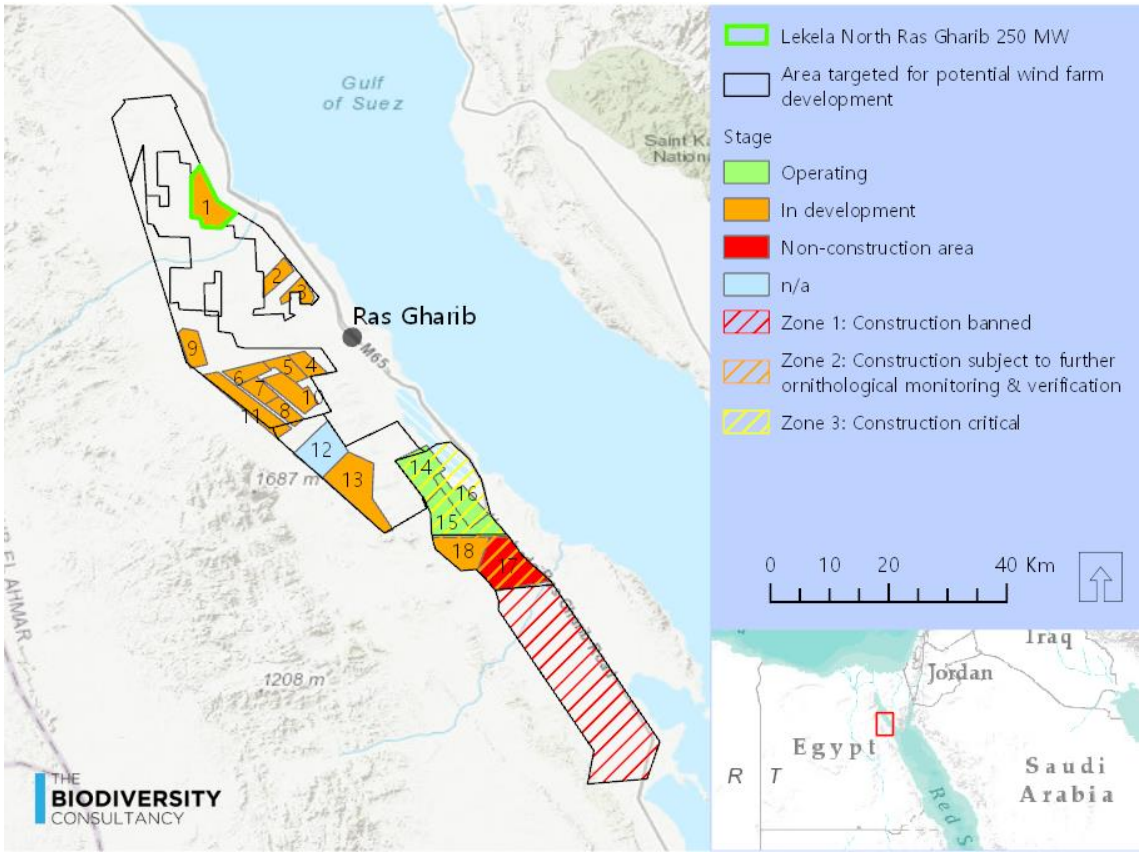

Figure 5: Potential wind farm developments in the Ras Gharib – Gebel El Zeit area[24, 25]

Table 28: Wind farm development in the western side of Gulf of Suez

Concession name	Operation stage	Capacity	Reference
North Ras Gharib (from RCREEE 2018) and West Ras Gharib (from Ecoda 2013 in Environics 2015)			
43 plots with a potential of 2100 MW (NREA 2015). 500 MW are sold as Build, Own and Operate (BOO, including the 250 MW bought by Lekela)			

[24] Wind farm concessions: 1: Lekela North Ras Gharib 250 MW (Environics 2018), 2: ACWA Gharib One for Energy and ACWA Gharib Two for Energy 100 MW, 3: Aalfa Wind Energy 50 MW (RCREEE 2018), 4: Auction System 1 100 MW, 5: Auction System 2 100 MW, 6: Auction System 3 100 MW, 7: Auction System 4 100 MW, 8: Auction System 5 100 MW, 9: Auction System 6 100 MW, 10: EU partners/NREA (AfD Suez 3) 200 MW, 11: Masdar/NREA 200 MW, 12: Engie/Orascom/Toyota BOO 250 MW, 13: EU partners/NREA (AfD Suez 1) 200 MW, 14: KfWEPs/NREA 240200 MW, 15: JICA/NREA 220 MW, 16: Spain/NREA 120 MW (NREA 2013, 2015)(NREA 2013, 2015), 17: Italgen non-construction area, 18: Italgen 320380 MW (Grontmij 2010)

[25] The NREA study area (southern block) has been divided into 3 zones based on bird survey results. In zone 1, development should not be permitted. In zone 2, additional ornithological monitoring and assessment should be conducted before development. In zone 3, development is permitted but subject to application of mitigation measures and post-construction monitoring (Wright 2017).

Concession name	Operation stage	Capacity	Reference
Lekela North Ras Gharib 250 MW Project	In development	250 MW	(Environics 2018)
Alfanar Project	In development	50 MW	(RCREEE 2018)
ACWA Project	In development	100 MW	(RCREEE 2018)
Data gap: • The status of the non-Lekela plots			
South-West Ras Gharib (KfW 1000 MW Study in 2011)			
NREA AFD (North)	In development	200 MW	(NREA 2013, 2015)
Masdar/NREA	In development	200 MW	(NREA 2013, 2015)
NREA AFD (South)	In development	200 MW	(NREA 2013, 2015)
Engie/Orascom/Toyota BOO	In construction	250 MW	(ENGIE 2017)
Auction System: A1, A2, A3, A4, A5, A6	n/a	6 x 100 MW	(NREA 2013, 2015)
Data gap: • Status of concessions in the BOO and the Auction system • Additional information (such of # of turbines – environmental commitment – use of shut-down on demand system).			
South Ras Gharib (KfW Gebel El Zeit Strategic Risk Assessment in 2007)			
Italgen Gabal El-Zeit Project	In development	320 MW	(Grontmij 2010; EcoConServ 2014)
KfW/NREA	Operating since 2015	240 MW	(NREA 2013, 2015)
JICA/NREA	Operating since 2018	220 MW	(NREA 2013, 2015; JICA 2018)
Fund for International Business Expansion (FIEM) /NREA	Operating since 2018	120 MW	(NREA 2013, 2015)
Data gap:			

Concession name	Operation stage	Capacity	Reference
• Additional information (such of # of turbines – environmental commitment – use of shut-down on demand system).			
Zafarana			
Zafarana Wind Farm	Operating since 2001	545 MW	(Elsobki 2009; Mansour & Eisa 2014; Abd el-aal *et al.* 2015; Ahmed *et al.* 2015)
Access Power	Operating since 2016	50 MW	(Access 2016)
Data gap: • Additional information (such of # of turbines – environmental commitment			
Hurghada			
Hurghada Wind Farm	Operating since 1993	100 & 300 MW	(Mansour & Eisa 2014)
Data gap: • Additional information (such of # of turbines – environmental commitment – use of shut-down on demand system)			

Appendix 1.3 Other industrial developments

Oil and gas concessions exist along the entire Gulf of Suez, with up-stream exploration and operations on-shore and off-shore. Solar energy development is also occurring in the region, with projects such as Egysol (Mansour & Eisa 2014). Tourism might also be present to some extent: in the north of Gulf of Suez, presence of cities such as Suez or Zafarana and beaches at Ain Sukhna (the closest beach from the Cairo) and in the south, for beaches and marine wildlife (Hurghada, Ras Mohammed National Reserve)[26].

[26] https://egyptourism.wordpress.com/tag/gulf-of-suez/, https://www.ask-aladdin.com/egypt-cities/suez/, http://www.touregypt.net/featurestories/beachvacations3.htm

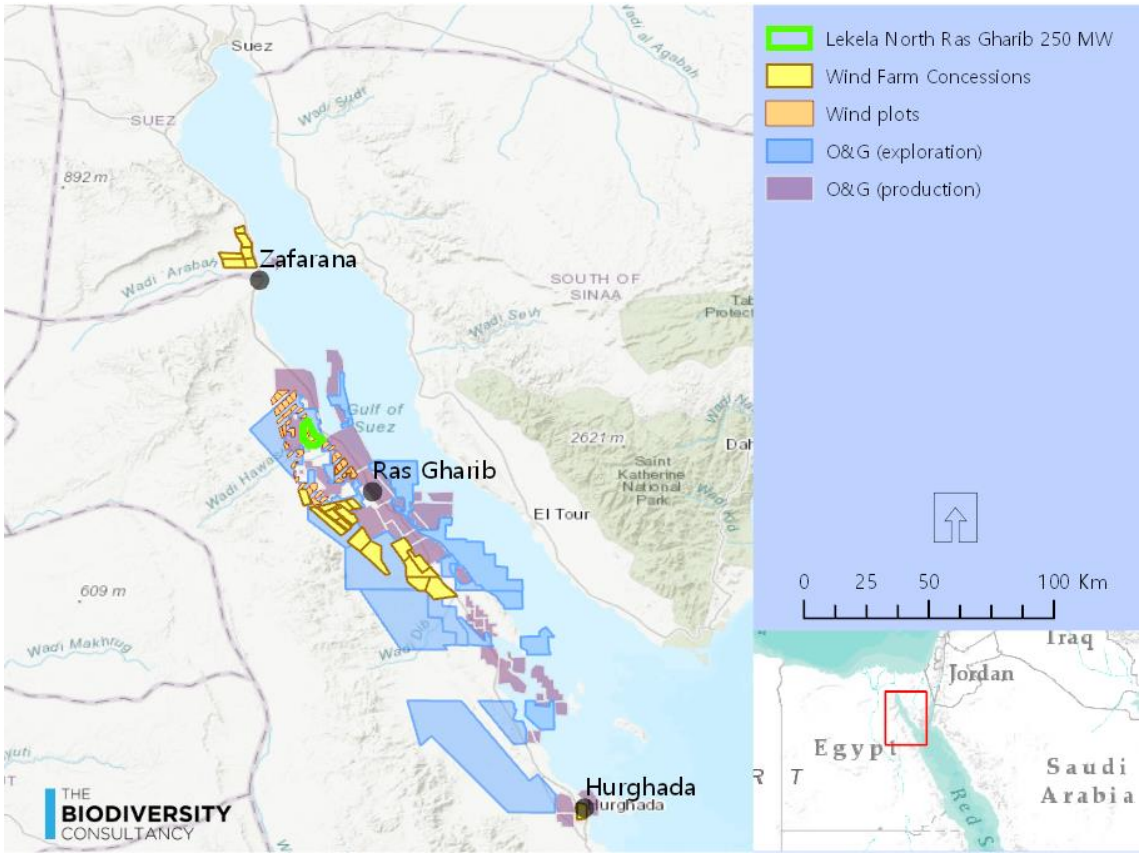

Figure 6: Location of wind farms and oil and gas concessions to the west of the Gulf of Suez, Egypt.

Data gaps:

- Development stage of oil and gas concessions, pipeline locations;
- Location of potential additional solar projects;
- Current extent of tourism in this region of Egypt and potential projects in development.

Appendix 2 Detailed results as supplementary materials

Appendix 2 provided in the accompanying workbook.