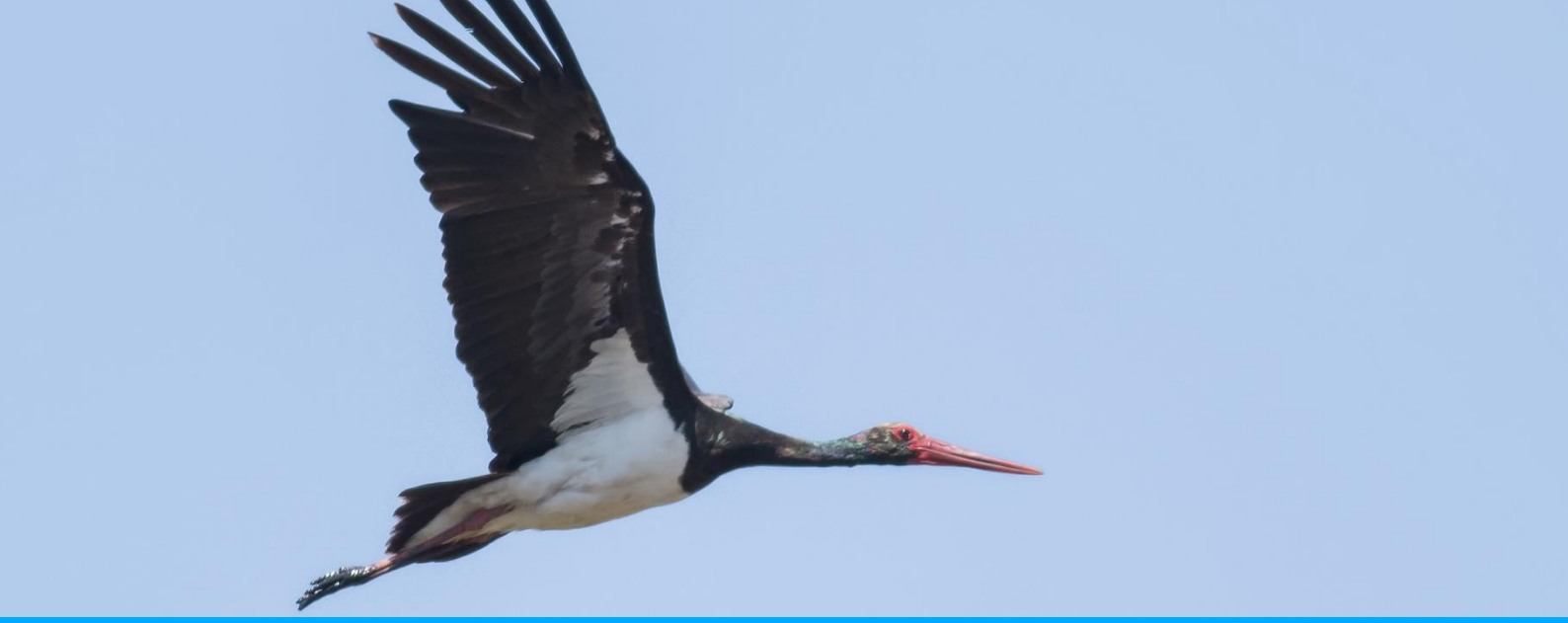

Lekela North Ras Gharib 250 MW: Analysis of cumulative effects to biodiversity

Serckx A., Wilson D., Katariya V. and Pollard E.

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 risks of cumulative effects are high for Lekela projects.*
- *13 migratory soaring birds are identified as priority Valued Environmental Components which are at potential risk from significant cumulative effects.*
- *Mitigation and monitoring actions are proposed to reduce the risk of cumulative effects to migratory soaring birds.*
- *Lekela has the opportunity to play a role demonstrating best-practice mitigation to minimise the risks in the region.*

THE BIODIVERSITY CONSULTANCY

Report date: October 2018

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Table of contents

1 Executive summary

This report presents the findings of a rapid analysis of the potential cumulative effects on biodiversity of wind farms in development by Lekela Power in the Ras Gharib – Gebel El Zeit area on the Gulf of Suez, Egypt. The analysis identifies priority bird Valued Environmental Components (VECs) (IFC 2013) and a preliminary list of other VECs. High-level mitigation and monitoring actions that will be adopted by Lekela for their specific projects are given. Additional actions that Lekela will undertake or support to address their contribution to the 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 appended to provide context and assist identification of other developers whose collaboration will support the management of cumulative effects on 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 (Wind Atlas) and it is estimated that the western side of the Gulf of Suez could host about 20,000 MW installed capacity of wind farms (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 future development in the region. Very limited public information is available on the planned nature and current status of most other potential wind farm developments in the Gulf of Suez.

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). For example, more than 5% of the flyway population of White Stork *Ciconia ciconia* flew through the Lekela North Ras Gharib 250 MW Project area during spring 2016 (Environics 2016b). The Egypt government plans on developing further projects, including in the Gebel El Zeit Important Bird Area[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).

To determine priority bird VECs for the Projects, we developed an approach modelled on the Tafila Region Wind Power Projects Cumulative Impact Assessment (IFC 2017), modified to the local conditions and data available. Similar to the Tafila approach, we undertook a staged screening of the list of preliminary bird species, to develop a final list of priority bird VECs that were likely to be at greatest overall risk from the Projects. Step 1 identified a species population list of 193 species which were known, or likely, to be present in the study area. Step 2 refined this list to 35 'sensitive' species populations, based on a combined assessment of their vulnerability and the relative importance of the Ras Gharib – Gebel El Zeit study area to each

[1] Gebel/Gabal has different spellings due to differences in transliteration from Arabic. For this report we use 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.

species population. Step 3 assessed the cumulative Likelihood of Effect (LoE) of wind farm developments in the study area on each of 35 sensitive species populations. A combined assessment of the sensitivity ratings from Step 2 and the LoE ratings from Step 3 were then used to determine those species predicted to be at highest risk from cumulative effects of the wind farm developments in the study area.

13 species, which had an Overall Risk of Major or Moderate, are considered priority bird VECs for the Projects (Table 1).

Eight bat, five terrestrial mammals, one reptile and eight habitat features potential qualify as VECs (Table 15). Due to the lack of information on any species or habitat feature, all should be considered potential VECs for the project, pending additional future research.

Table 1: Priority Bird VECs for the Lekela Ras Gharib 250 MW project

Species	Scientific name	Overall risk
Black Stork	*Ciconia nigra*	Major
Booted Eagle	*Hieraaetus pennatus*	Major
Common Crane	*Grus grus*	Major
Great White Pelican	*Pelecanus onocrotalus*	Major
Steppe Eagle	*Aquila nipalensis*	Major
White Stork	*Ciconia ciconia*	Major
Black Kite	*Milvus migrans*	Moderate
Egyptian Vulture	*Neophron percnopterus*	Moderate
Eurasian Buzzard	*Buteo buteo*	Moderate
European Honey-buzzard	*Pernis apivorus*	Moderate
Greater Spotted Eagle	*Clanga clanga*	Moderate
Levant Sparrowhawk	*Accipiter brevipes*	Moderate
Pallid Harrier	*Circus macrourus*	Moderate

Step 4 of the Tafila approach, identifying fatality thresholds for priority bird VECs, has not yet been undertaken as part of this process: but is planned for a later iteration of this analysis.

In step 5, a suite of Mitigation and Monitoring Actions are proposed (Section 4.6), both those to be adopted by Lekela for their specific projects, and those 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 potential impacts to the 13 priority VECs are based on industry good practice and focus 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.

2 Scope and objectives

This analysis represents the initial steps in understanding potential cumulative effects to biodiversity of wind farm developments by Lekela Power Ltd. and other operations in the Gulf of Suez, Egypt. It aims to identify priority 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. 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 species population list of potential VECs (see Section 4.2);
- Identification of bird VECs with 'sensitivity' to wind farm developments (see Section 4.3);
- A list of priority bird VECs assessed to be at highest risk of cumulative effects from wind farm development in the study area (see Section 4.4); and,
- Mitigation and monitoring actions for priority bird VECs, including identifying opportunities where Lekela can contribute to the management of cumulative effects (see Section 4.6).
- A compiled list of potential onshore industrial projects and other additional external biodiversity stressors in the western Gulf of Suez (see Appendix 1.2 and Appendix 1.3);
- A summary of potential impacts to VECs from industrial developments (see Appendix 1.4);

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 methods also follow 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 bird data which have been collected by different developers in the landscape.

The Tafila CEA followed six steps to complete the analysis. This rapid analysis has (to date) completed steps one to three (identification of priority VECs), and step five (mitigation and monitoring) of the Tafila process. Section 6 of this document outlines the potential next steps to completing the analysis.

2.1 The study area

The study area for assessing potential cumulative effects on biodiversity covers the area targeted for potential wind farm development in the Ras Gharib – Gebel El Zeit area, Red Sea Governate, Egypt. Figure 1 below shows the study area, and relationship with Lekela developments (see Appendix 10 for maps showing other wind farms and industrial developments in the study area).

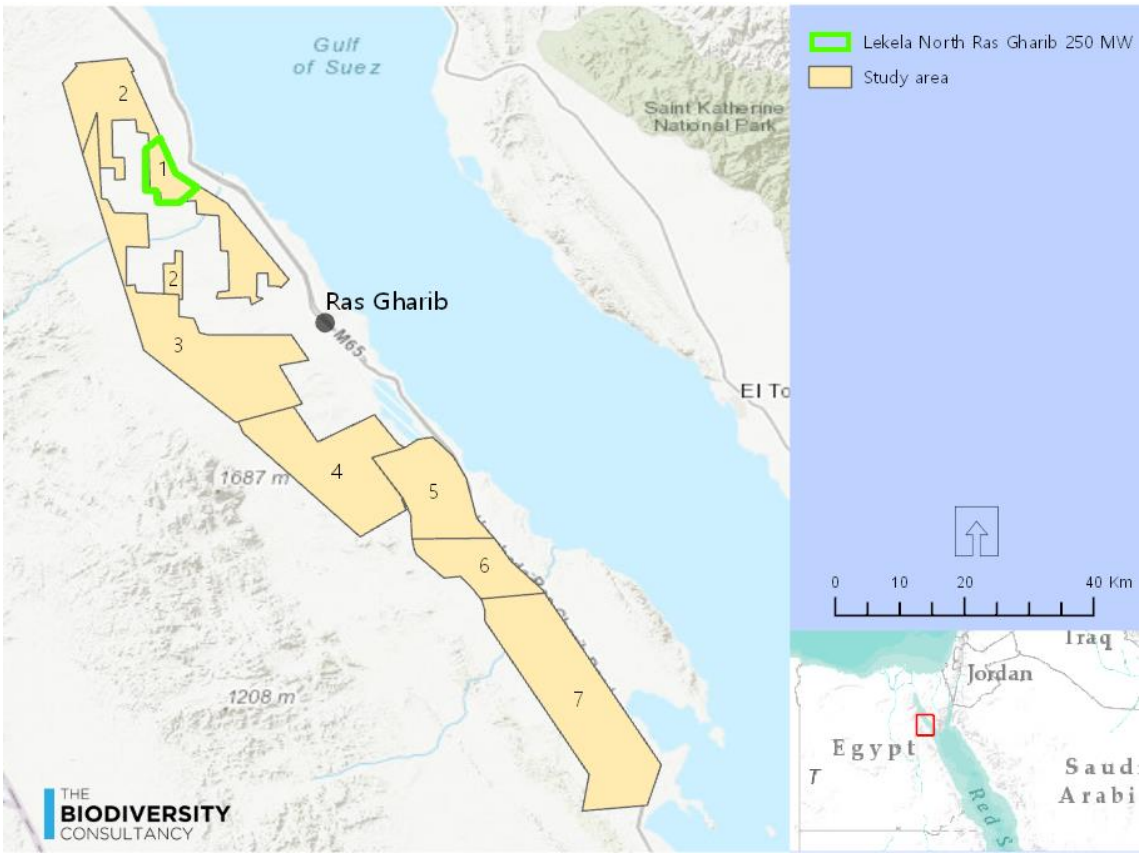

Figure 1: Study area (number refers to survey areas used to extract data for the VECs[2])

2.2 Overview of wind power projects

This study provides an initial assessment of the potential cumulative effects to biodiversity for the Lekela North Ras Gharib 250 MW Project. The Project area is in the eastern desert by the Red Sea coast, near the Gulf of Suez (Egypt), approximately 28 km north of the coastal town of Ras Ghareb (Figure 1). It has been designated by the Egyptian New and Renewable Energy Authority (NREA) for wind farm development. NREA has acquired this land from the Government of Egypt and identified five clusters of individual wind farm plots within the area. Developers will lease these plots directly from NREA. Lekela Power has acquired six plots in Cluster 5, to develop a 250 MW wind plant:

- Plot 2-5 acquired first under a feed-in tariff (FiT) regime, now developed as build, own and operate (BOO) followed by;
- Plots 3-5, 4-5, 5-5, 6-5 and 7-5 acquired later under the BOO regime.

[2] 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)

This development is part of eleven known wind farms which are operating, in construction, or planned, in several locations of the western side of Gulf of Suez (Appendix 1).

2.3 Temporal scope

The different wind farms in the study area are in varying stages of development, three are operating in the Gabel el Zait area (Appendix 1.2). At the time of writing the time frame for the construction and operation of the Lekela development is unknown.

The temporal scope of the analysis is defined as the time frame during which the proposed mitigation, monitoring, and management measures will be implemented by the Lekela Ras Gharib North Project. An initial three-year time frame (from the start of the project becoming operational) is proposed, following which an evaluation would be conducted to determine future monitoring efforts. This evaluation must also consider cumulative effects of other projects that might be operational in the future.

3 The VEC screening process

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. 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 was restricted to flora and fauna species (biodiversity), physical features and habitat via a desk-based exercise using published and grey literature, primarily those listed in Section 4.2.1, and 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. Data limitations has also meant that this report has focused on the features thought to be at highest risk – birds. For fauna (other than birds), physical features and habitats, the list of potential VECs was short and information allowing refinement of the list limited, and thus, no further prioritisation of VECs list was feasible. The list of potential bird VECs was long and required further prioritisation (see Section 4).

4 The Cumulative Assessment framework for birds

4.1 Overview of the framework for birds

This framework for birds has two objectives: to identify those species at highest risk from the potential impacts of developments in the study area, and to propose mitigation, monitoring and other management activities to address risks to those species. This framework follows a five-step process (Figure 2):

Step 1: develop a preliminary list of potential 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 (see Section 4.2).

Step 2: determine the relative 'Sensitivity' of the species, being a combination of the

- Vulnerability of the species; and
- Importance of the population recorded in the study area relative to the appropriate Unit of Analysis (UoA), i.e. the flyway population or global distribution (see Section 4.3).

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

Step 3: determine the Overall Risk to the species from the cumulative effects of wind farm developments within the study area, being a combination of the:

- Sensitivity, as identified in Step 2; and
- Cumulative Likelihood of Effect (LoE) rating for each species (see Section 4.4).

Those species with an Overall Risk of Major or Moderate are considered to be priority bird VECs for the project.

Step 4: determine a fatality threshold for each priority bird VEC, being the point at which further losses would be a risk to long-term viability of the population. This has not yet been undertaken, but is planned for a later iteration of this report.

Step 5: proposes 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 4.6).

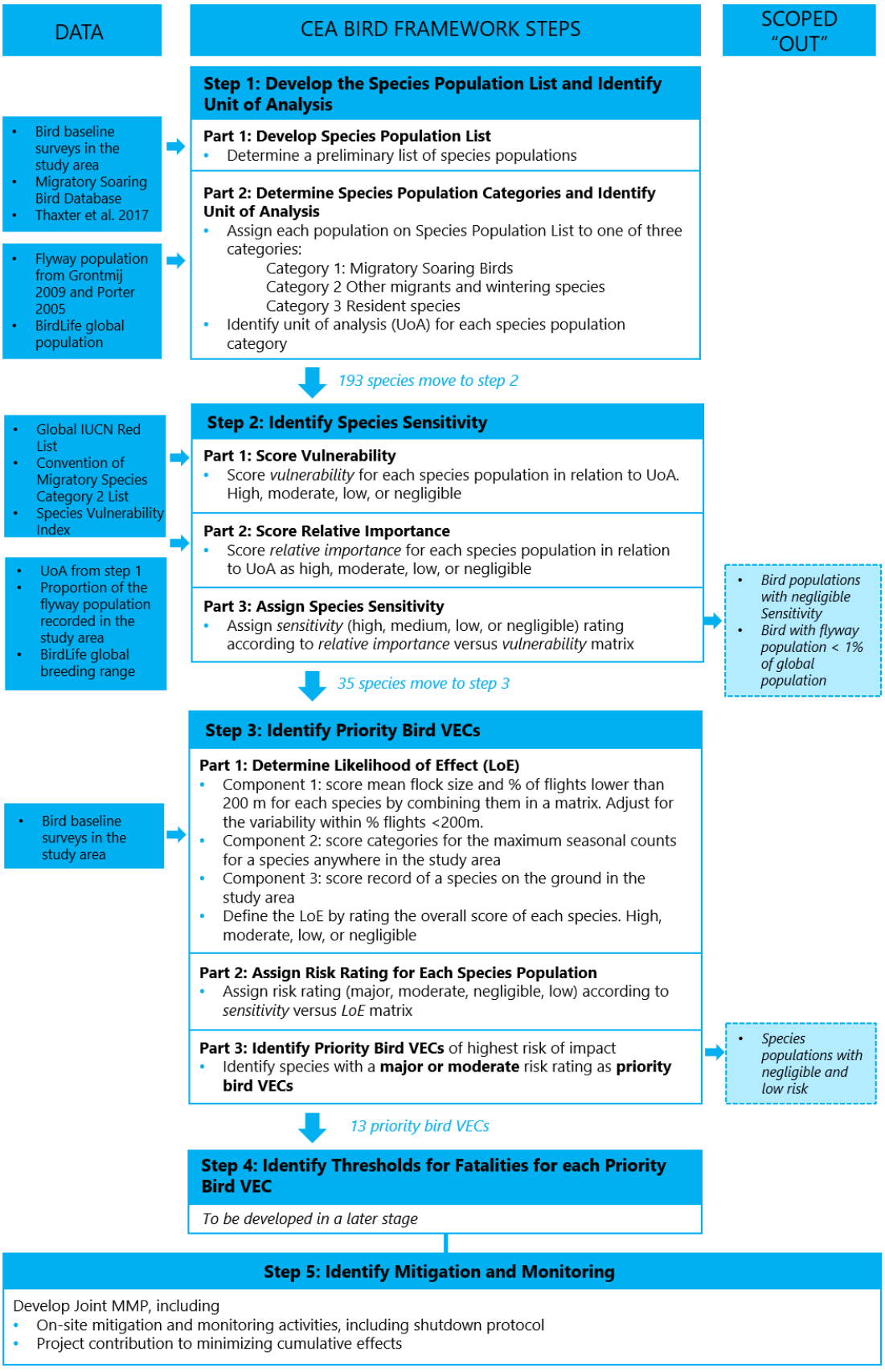

Figure 2: Process to identify priority bird VECs

4.2 Step 1 – Develop the 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 within the study area and to determine a relevant UoA by which any effects on each species or population should be measured.

4.2.1 Methods

A species population list of all 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 presented 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 lists 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 as.

These species were then allocated to one of three categories, and an appropriate Unit of Analysis (UoA) determined for each category:

- **Category 1**: Migratory Soaring Birds (as per BirdLife International 2018b), with the UoA being the Rift Valley / Red Sea flyway population. Data on populations of these species

were sourced from Grontmij (2009), supplemented with information from Porter (2005) as needed;

- **Category 2**: Other migrants and wintering species, 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, with the UoA being the same as for Category 2 species.

4.2.2 Results

Step 1 produced a species population list of 193 bird species (Table 2, Appendix 2).

Table 2: Species population list of potential bird VECs

Group	Order	Number of potential VECs
Birds	Accipitriformes (diurnal birds of prey)	31
	Anseriformes (waterfowls)	8
	Apodiformes (swifts, treeswifts and hummingbirds)	3
	Bucerotiformes (hornbills, hoopoe, wood-hoopoe)	1
	Charadriiformes (shorebirds)	43
	Ciconiiformes (storks)	4
	Columbiformes (pigeons and doves)	3
	Coraciiformes (kingfishers and allies)	5
	Falconiformes (falcons and caracaras)[3]	10
	Galliformes (ground-feeding birds)	2
	Gruiformes (cranes, crakes and rails)	5
	Passeriformes (perching birds)	60
	Pelecaniformes (ibis, herons and pelicans)	13
	Podicipediformes (grebes)	1
	Pteroclidiformes (sandgrouses)	2
	Strigiformes (nocturnal birds of prey)	1
	Suliformes (cormorants, gannets and boobies)	1

4.3 Step 2 – Identify species sensitivity

The purpose of Step 2 is to determine the sensitivity of each species or population identified in Step 1 based on its vulnerability at a national, regional, or international scale, depending on the UoA, and the relative importance of the study area to the population.

[3] For this analysis we consider Barbary Falcon *Falco peregrinoides* a subspecies of Peregrine Falcon *F. peregrinus*.

4.3.1 Methods

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

- **Vulnerability** was determined using IUCN threat categories (IUCN 2017), listing on 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 also the Species Vulnerability Index[4] for species, mainly soaring birds, where this has been assessed (BirdLife International 2018b) as per Table 3.
- **Relative importance** for Migratory Soaring Birds (MSBs) is 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 for other migrants and for resident species the global breeding range (sourced from Birdlife International species accounts), with ratings as per Table 4 and Table 5 respectively. For the population recorded in the study area, we have taken this number to be the maximum count recorded in any season for any survey.

These two factors are combined in a matrix (Table 6) to determine to overall species sensitivity. Species with a negligible sensitivity were not progressed to Step 3. Additionally, we discounted species where the estimated flyway population was <1% of the total estimated global population to reflect the very low importance of the Rift Valley / Red Sea flyway population at a global level: this removed four additional species that were rated above a negligible sensitivity (White-tailed Sea Eagle *Haliaeetus albicilla*, Griffon Vulture *Gyps fulvus*, Hen Harrier *Circus cyaneus* and Red Kite *Milvus milvus*).

Table 3: Vulnerability scoring criteria

Vulnerability Rating	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

[4] 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.

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

Table 4: Relative importance scoring 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 5: Relative importance scoring 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 6: Sensitivity 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

4.3.2 Results

Step 2 produced a list of 35 avian species with greater than Negligible Sensitivity (Table 7).

Table 7: Scoring at Step 2 for species rated as greater than Negligible Sensitivity

Species	Scientific name	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

Species	Scientific name	Vulnerability	Relative importance	Sensitivity
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
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

4.4 Step 3 – Ecological risk assessment and identify priority bird VECs

The purpose of Step 3 is to identify priority bird VECs from the 35 sensitive species remaining from Step 2. This is done by combining each species' sensitivity rating with an estimated of site-specific risk (the Likelihood of effect: LoE) to identify the species which are most at risk of significant impacts from wind farm developments in the study area.

4.4.1 Methods

Based on baseline bird data available we considered the LoE to comprise three components[5]:

- **Component 1**. A score for the combined effect of the percent of individuals recorded flying below 200 m and mean flock size (Table 8). These are birds which are potentially at risk of collision with turbines or could interact with transmission lines (collision or electrocution). We took the weighted mean percent of individuals recorded flying below 200 m (i.e. sum total of individuals <200 m divided by the sum total individuals for all seasons) for all seasons where this value was reported. For species with no data for the percent of records <200 m, we scored these as having 50% of records <200 m. 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. Larger flocks were considered to be at greater risk of multiple fatalities due to the higher numbers present and the reduced ability for individuals in the flock to see and avoid turbines or power lines. For species with no data on mean flock size, we conservatively scored these as having a maximum flock size equal to the maximum count recorded in a season (as per Component 2, below: i.e. equivalent to all individuals passing in a single flock). For species with values for both variables, the resulting matrix score was increased by one if the variability (taken as the standard deviation of all reported values for that species) of the percentage of flights <200 m was in the top two quartiles (i.e. the top 50% of values). We added this additional step to account for situations where flight height behaviour was very variable and the average value was less valid as a risk predictor;
- **Component 2**. The maximum total count for a species within a single season from any one project in the study area (Table 9) to reflect the fact that species with higher counts in the study area are more likely to be affected by wind developments; and,
- **Component 3**. Whether or not that species had been recorded on the ground within the study area, irrespective of the numbers of individuals involved (species with records of landing scored 1, those without 0). Those 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.

These three components were summed to arrive at a final LoE score for each species (theoretical range 2-10), which was separated into quartiles to derive a LoE rating for that species (Table 10). This LoE rating was then combined with the Sensitivity rating from Step 3 to derive an Overall

[5] Data are 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), Italgen Gabal El-Zeit 320 MW (site 6 in Figure 1; Grontmij 2009; EcoConServ 2017), the block located north to Italgen Gabal El-Zeit 320 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.

Risk rating from the project (Table 11). Species which had an Overall Risk of Major or Moderate were considered Priority bird VECs for the study area.

Table 8: 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 9: 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 10: LoE rating based on overall score for each species evaluated at Step 3

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

Table 11: 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

4.4.2 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 for this analysis (Table 12)[6].

[6] 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 12: Scoring and rating details for the 13 species identified as priority Bird VECs

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

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

[8] 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 13: Refinement of Bird VECs via the selection process

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

4.5 Step 4 – The threshold setting process

Step 4 determine a fatality threshold for each priority bird VEC from wind farm impacts, being the point at which further losses would be a risk to long-term viability of the population. The threshold value also informs adaptive management decisions for wind farm operations.

This process has not yet been undertaken, but is planned for a later iteration of this report.

4.6 Step 5 – Identifying a potential mitigation and monitoring approach

This section establishes the 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 (unquantified) benefits for other bird species passing through the wind farms. In all cases, mitigation and monitoring actions are based on industry good practice, adapted to be locally-relevant. Mitigation and monitoring actions focus 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[9]; 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 these best-practice mitigation measures and monitoring actions, Lekela will be able to reduce its impact as far as practicable for the identified VECs. By doing this, Lekela sets a

[9] 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.

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 can be reduced (through reduced need for observers throughout each project area) and risks to birds minimised through observations resulting in turbine shutdown right along the flight trajectory across multiple projects.

Table 14: Suggested Mitigation and Monitoring Actions for the Project

Action	Measure	Description	Key objective	Responsible entity	Time frame
On-site mitigation actions					
1	Development of appropriate protocols	All actions require clear and detailed protocols that can be followed by all survey teams: this information should be included in the relevant Project documents. Protocols should align with industry good-practice guidelines, and be designed by an ornithologist experienced in assessing bird 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
2	Shut-down on demand	When field observers identify flight paths of 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 well-established method for minimizing the risk to birds of colliding with rotating wind turbine blades. Protocols will be established under Action 1, and will include the conditions for 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). Requests to shut-down specific turbines will be based on observer experience of the species involved, their height likely flight path and pattern, and the distance from bird to turbine.	To minimize the number of collisions between priority bird VECs and wind turbines.	Lekela	Protocols and tested system in place prior to commencement of operation
3	Installation of bird flight diverters on Project power lines	Many bird species are known to collide with power lines (particularly high-voltage lines), and installing bird flight diverters has been shown to lessen this risk. The configuration (type and frequency) of bird flight diverters	Minimisation of collisions to priority bird VECs with Project power lines	Lekela	During power line erection

Action	Measure	Description	Key objective	Responsible entity	Time frame
		should be based on industry good-practice, relying on local examples of successful installation if available.			
4	Micro-siting and alignment of turbines	Turbines should be micro-sited to provide the maximum gap between turbines, especially along the axis of likely migration routes. While the ability of species to navigate through a wind farm is poorly understood, we precautionarily recommend this approach. 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 avian VECs to pass through the wind farm	Lekela	In the project design phase
5	Monitoring of priority bird VECs	Monitoring the numbers, activities and flight paths of priority bird VECs within the wind farm is vital to inform mitigation actions. Birds must be monitored by trained and experienced field observers, and sufficiently cover the whole operational turbine area. The principal aim of monitoring is to initiate shut-down on demand protocols (see Action 2), so as to avoid collisions of priority birds with turbine blades. Additional aims are to record the numbers of priority bird VECs in the wind farm, determine flight paths and height, and to observe collisions (if these occur). **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).	To ensure that shut-down on demand protocols can be initiated with sufficient time to minimize bird collisions	Lekela	Prior to commencement of operation

Action	Measure	Description	Key objective	Responsible entity	Time frame
		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 activity patterns 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 behaviour 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 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. **Records**: 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.			
6	Carcass surveys - turbines	This involves regular surveys of the area beneath turbines to detect carcasses from individual birds 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	On-going for at least the first three years of operation, then reassessment
7	Carcass surveys - powerlines	The Project will conduct regular surveys under Project power lines to determine the levels of mortality from birds colliding with lines. Collisions with power lines are a known source of mortality for many bird species.	To determine the level of observed fatalities due to collisions with power lines at the wind farm site.	Lekela	On-going for at least the first three

Action	Measure	Description	Key objective	Responsible entity	Time frame
		Protocols for these searches, including frequency and the search area will be determined under Action 1.			years of operation, then reassessment
8	Carcass correction factor determination	Correction factors need to be applied to convert the observed carcasses to an actual estimate of mortalities, as some carcasses will be removed prior to carcass surveys occurring (carcass removal bias), and searchers will not detect all carcasses present (searcher efficiency bias). These approaches are standard good-practice for wind farms, and if designed correctly, both trials can be conducted concurrently. Carcasses used should be as similar as possible to the type of expected fatalities to mimic real conditions. Experiments should be planned and led by someone familiar with the approaches, but the searchers used in the searcher efficiency trials should be those who will undertake the carcass surveys (Action 6 and Action 7). The number and distribution of carcasses used will depends on the habitat types and topography within the wind farm site. Analysis of resulting data should be through an established method: the Generalised Fatality Estimator recently developed by the USGS is recommended.	To determine the correction factor to apply to detected carcasses to estimate true project-related mortality	Lekela	Annually for three years, then reassessment. Can begin prior to commencement of operation.
9	Review to improve monitoring and mitigation effectiveness	Periodic reviews of Actions 1, 2, and 4-8 will be undertaken to improve the effectiveness of monitoring and mitigation actions. This will include: **Immediate** review of process in the event of a recorded mortality for a priority bird VEC, to determine if additional actions could be implemented to further reduce collision risk.	Adaptive management to reduce risk	Lekela	On-going from start of construction

Action	Measure	Description	Key objective	Responsible entity	Time frame
		Quarterly review of carcass survey results and effectiveness of shut-down on demand protocols. **Bi-annual** review of monitoring data, following the end of each migration season to determine if improvements can be made to the monitoring protocols **Annual** review of carcass correction factor determination and all bird monitoring and responses for the Project			
Lekela contribution to minimizing cumulative effects					
10	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. Lekela will also share raw data and relevant information in real time / monthly with other developers within the Project area to improve cumulative actions.	Maximise the knowledge base in the region Provide example of best-practice for other operators to follow	Lekela	Variable, depending on the data released
11	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
12	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.	Maximise the benefits from an extended observer network	Lekela	On-going, with establishment prior to commencement of operation

Action	Measure	Description	Key objective	Responsible entity	Time frame
		Lekela will also establish protocols so that shut-down on demand can be initiated by observers from other projects, where flight paths are well known.			
13	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 avian VECs and improve wind farm operations	All / Lekela	Annually
Other actions					
A	Determine mortality thresholds for priority bird VECs	For each priority bird VEC, Lekela will set a threshold of acceptable mortality, beyond which offsets for that species will need to be developed (Step 4 – not yet undertaken).	Set a threshold for acceptable mortality	Lekela	Prior to commencement of operations
B	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. 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 may remain, this will also need to include a plan for compensating or offsetting residual impacts on priority biodiversity.	Support the implementation of mitigation measures and deliver NNL / NG to priority bird VECs	Lekela	If required

5 Potential priority non-bird VECs

Eight bat, five terrestrial mammals, one reptile and eight habitat features potential qualify as VECs (Table 15). Due to the lack of information on any species or habitat feature, all should precautionarily be considered priority VECs for the project, pending additional future research.

Table 15: Priority non-bird VECs

Group	Order	Number of potential VECs
Bats	Chiroptera	8
Terrestrial mammals	Carnivora (carnivores)	2
	Lagomorpha (lagomorphs)	1
	Cetartiodactyla (ungulates)	2
Reptiles	Squamata (reptiles)	1
Habitat features		8

6 Next steps

The analysis to date has focuses on identifying priority bird VECs and outlining appropriate mitigation and monitoring actions. In order to complete the cumulative effects analysis the following actions are required:

1. Share the findings for review and input with stakeholders including (but not limited to): government agencies (e.g. NREA), RCREEE, wind farm developers, lenders, NGOs (e.g. Nature Conservation Egypt, BirdLife International), environmental impact experts, and ecologists with local expertise. Comments, corrections and requests for additional information will be sought from all stakeholders.
2. Where appropriate share the findings and collaborate with other proposed cumulative impact assessments in Egypt.
3. Determine impact thresholds and whether they are likely to be exceeded (per Tafila process Step 4)
4. Determination of non-bird biodiversity priority VECs through stakeholder/expert consultation and potentially additional field work and mapping.
5. Preparation of additional mitigation and monitoring measures for non-bird priority VECs if necessary.
6. Share final analysis with developers, regulators and civil society with an interest in wind farms in the Gulf of Suez.

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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 (**Error! Reference source not found.**). This will capture all industrial projects, in the vicinity of the Lekela Projects, that might impact the flyway population passing through Lekela Project areas.

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 16 and illustrated in

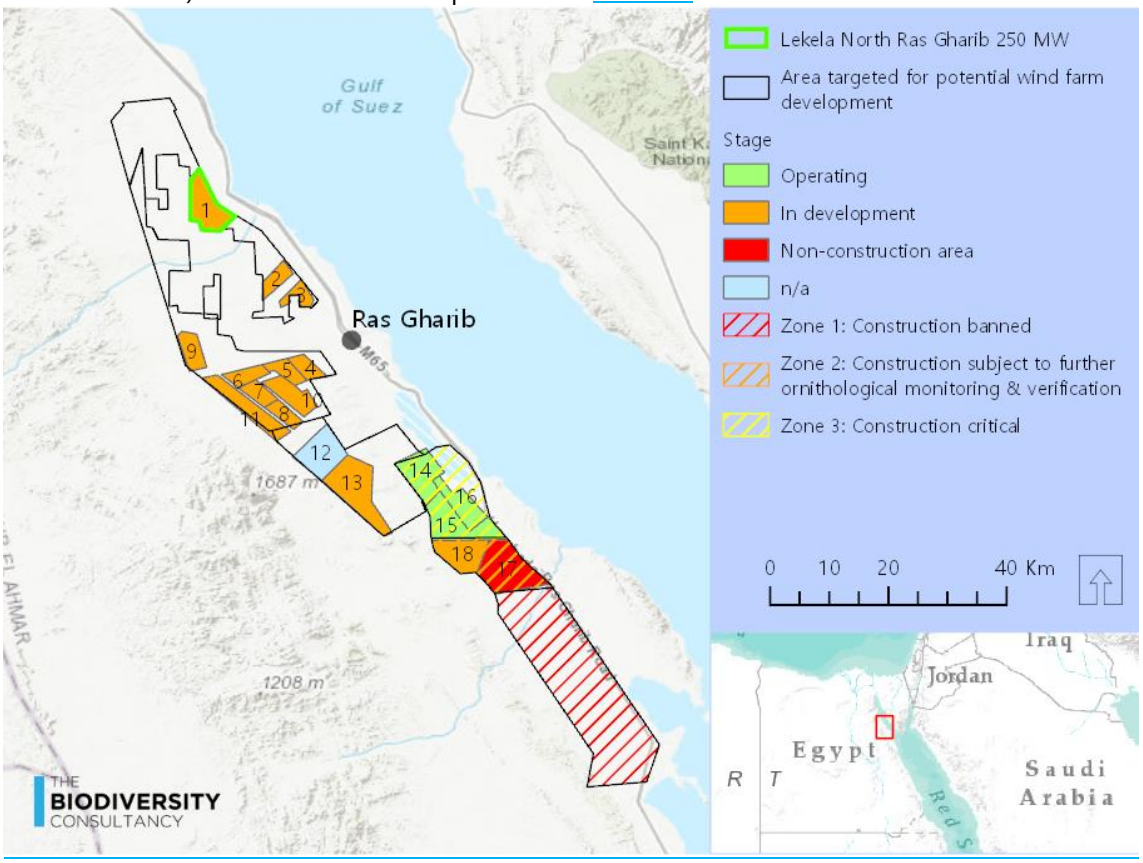

Figure 3 and Figure 4**Error! Reference source not found.**.

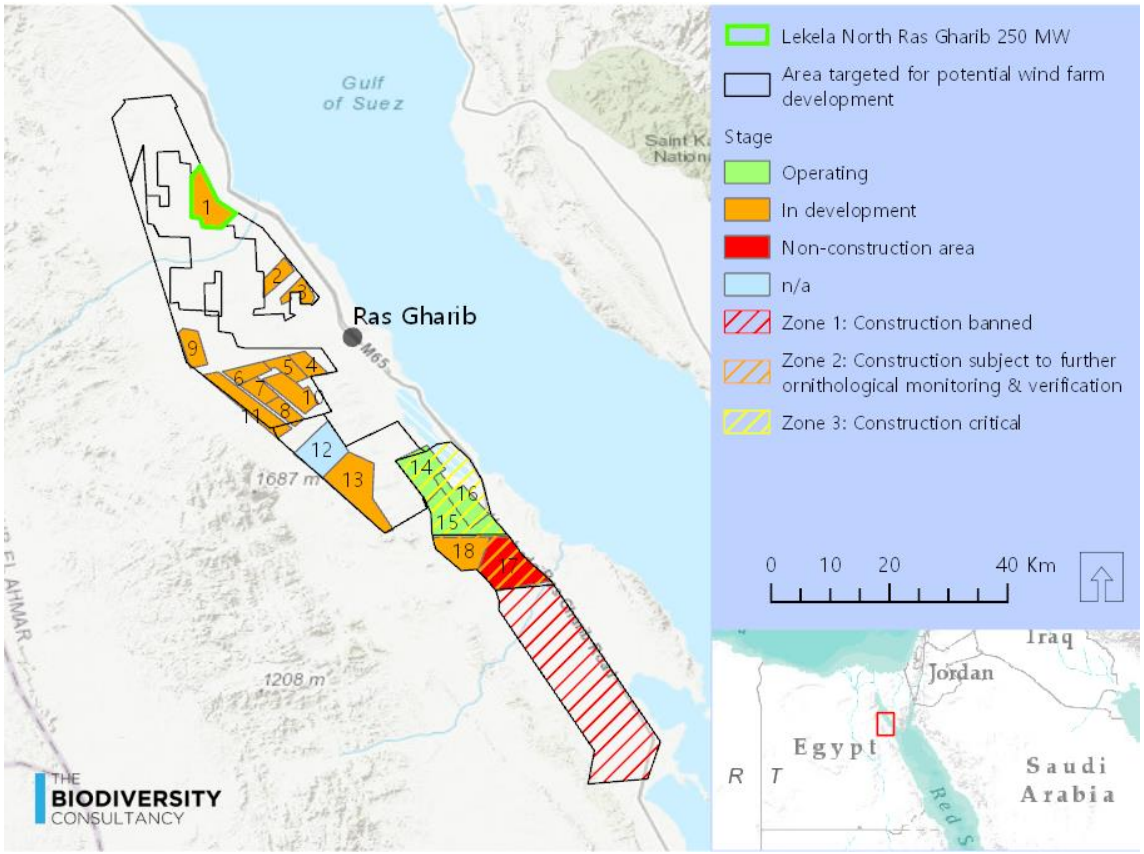

Figure 3: Potential wind farm developments in the Ras Gharib – Gebel El Zeit area[10, 11]

Table 16: 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)			

[10] 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: KfW/NREA 240 MW, 15: JICA/NREA 220 MW, 16: Spain/NREA 120 MW (NREA 2013, 2015), 17: Italgen non-construction area, 18: Italgen 320 MW (Grontmij 2010)

[11] 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 (SDOD)).			
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)
Spain/NREA	Operating since 2018	120 MW	(NREA 2013, 2015)
Data gap: • Additional information (such of # of turbines – environmental commitment – use of SDOD).			

Concession name	Operation stage	Capacity	Reference
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 – use of SDOD)			
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 SDOD)			

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)[12].

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

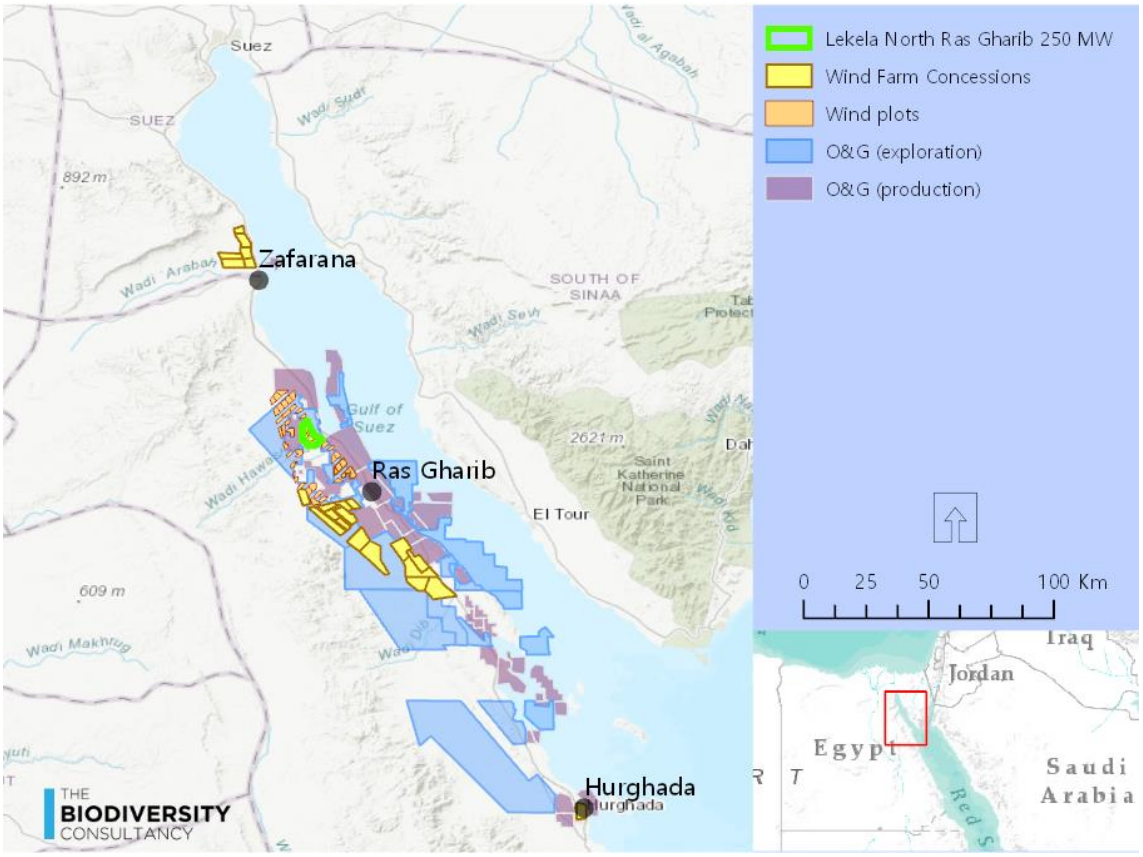

Figure 4: Location of wind farms and oil and gas concessions to the west of the Gulf of Suez, Egypt.

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 1.4 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. These potential impacts will be considered when determining the likelihood of effect in the risk assessment. 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 normal flight paths of 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.

Appendix 2 Detailed results for steps 1-3

See in the excel sheet.