Tafila Region Wind Power Projects
Cumulative Effects Assessment

IFC International Finance Corporation
WORLD BANK GROUP

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Table of Contents

Acronyms List

AC	Advisory Committee
Abour	Abour Wind Energy Company
AUM	American University of Madaba
BR	(Dana) Biosphere Reserve
CEA	Cumulative Effects Assessment
CIA	Cumulative Impact Assessment
CMS	Convention on the Conservation of Migratory Species of Wild Animals
CR	Critically Endangered (IUCN)
CRM	Collision Risk Model
CSR	Corporate Social Responsibility
E&S	Environmental and Social
EBRD	European Bank for Reconstruction and Development
EHS	Environment, Health and Safety
EIA	Environmental Impact Assessment
EIB	European Investment Bank
EN	Endangered (IUCN)
EOO	Extent of Occurrence
ERP	Expert Review Panel
ESIA	Environmental & Social Impact Assessment
ESMMP	E&S Mitigation and Monitoring Plan
GIIP	Good International Industry Practice
IBA	Important Bird and Biodiversity Area
IFC	International Finance Corporation
IFI	International Financing Institutions
IUCN	International Union for Conservation of Nature
JIC	Jordan Investment Commission
JWPC	Jordan Wind Project Company
KEPCO	Korea Electric Power Corporation
KOSPO	Korea Southern Power Corporation Ltd.
LAMSA	LAMSA Investments LLC
LC	Least Concern (IUCN)
LoE	Likelihood of Effect
MAB	UNESCO Man and the Biosphere Reserve
MEMR	Ministry of Energy & Mineral Resources
MMP	Mitigation and Monitoring Plan
MoENV	Ministry of Environment
MoTA	Ministry of Tourism and Antiquities

MSB	Migratory Soaring Bird
NBSAP	National Biodiversity Strategy & Action Plan
NNL	No Net Loss (of biodiversity)
NRP	Natural Research Projects Ltd
NT	Near Threatened (IUCN)
PBR	Potential Biological Removal
PS	IFC Performance Standard
PVA	Population Viability Analysis
RSCN	Royal Society for the Conservation of Nature
SEA	Strategic Environmental Assessment
SNH	Scottish Natural Heritage
SVI	Species Vulnerability Index
TRWPPs	Tafila Region Wind Power Projects
UoA	Unit of Analysis
VECs	Valued Environmental and Social Components
VP	Vantage Points
VU	Vulnerable (IUCN)
WPP	Wind Power Project

Foreword

The historic Paris agreement to combat climate change—signed by over 190 countries, including Jordan—came into force in November 2016. To make good on their commitments in Paris, countries around the globe will—more than ever before—be looking to renewable forms of energy as the world pivots toward a decarbonized energy supply. To catalyze this shift, IFC has become one of the largest renewable energy investors in the world. We have supported nearly 7 GW of hydropower, nearly 4 GW of wind power, and nearly 2 GW of solar power in emerging markets.

The Government of Jordan considers diversifying its energy sources a priority and was one of the first in the Middle East and North Africa region to initiate fundamental reforms in its power sector. The Government set an ambitious 10 percent target for renewable energy as part of the total energy mix by 2020 with a particular focus on the development of wind (600–1000 MW) and solar (300–600 MW) power plants. New legislation has paved the way for private sector investments making Jordan an attractive market in the region, with a conducive regulatory environment for renewable energy projects, strong government support, and competitive financing opportunities.

Jordan sits on the Rift Valley/Red Sea flyway, the second largest flyway for migratory birds in the world, and is home to highly charismatic raptor species that are susceptible to collision with wind turbines. Recognizing the potential impacts that an increasing number of wind power projects may have on the flora and fauna of the Rift Valley/Red Sea flyway, IFC sought to bring together developers, conservation organizations, and government representatives to produce this Cumulative Effects Assessment (CEA)—the first of its kind in the Eastern Europe, Middle East and North Africa region. We conducted this CEA through our Enhanced Client Support Program, which seeks to convene multiple stakeholders to address collective environmental and social challenges that are beyond the ability of any one company to solve alone.

We hope this CEA will facilitate more sustainable investments in the wind energy sector in Jordan not only by improved understanding of the highest environmental and social risks but also through aligned mitigation, monitoring, and management measures undertaken by developers and other stakeholders to manage those risks. We also hope that the six-step CEA Framework detailed herein, which considers migratory and resident bird populations, bats, and habitats can be applied more widely to the renewables sector across the Middle East and North Africa region where multiple projects may be sited in close proximity and in landscapes or seascapes with high biodiversity values.

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Acknowledgements

A number of parties helped make the Tafila Region Wind Power Projects Cumulative Effects Assessment (CEA) possible. IFC managed the technical direction of the CEA and developed the CEA Framework. The IFC technical team, led by Lori Anna Conzo, included Alvaro Camiña Cardenal and Marjanne Sevenant. We are grateful to John Graham for his technical review and Susan Holleran and Fiorella Facello for their editorial review and compilation of this document. We wish to acknowledge our IFC colleagues John Mantzavinatos, Jai Asnani, Elizabeth White, Robin Sandenburgh and Ahmed Attiga for their ongoing support throughout this process. We also recognize IFC's Environment, Social and Governance Department, its Infrastructure Department and its Middle East and North Africa Regional Department for their financial support.

IFC contracted multidisciplinary international and national experts and advisors to develop and prepare the CEA. Over the life of the CEA, the team included:

ECO Consult	A Jordanian development firm working in Jordan and the Middle East, across a number of sectors, and with extensive experience in social and environmental assessments, supported by international consultancy **Zyl Consulting Ltd.**	Laith El-Moghrabi Elizabeth Van Zyl Lana Al-Zu'bi Ra'ed Daoud
Natural Research Projects Ltd (NRP)	An international environmental consultancy based in the U.K. specializing in ornithology with extensive experience undertaking collision risk assessments for birds and other ornithological studies for the wind sector.	Simon Hulka Digger Jackson Blair Urquhart Simon Pinder Phil Whitfield
Claverton Associates Ltd	A U.K.-based environmental consultancy—led the initial phases of the CEA.[1]	Mark Mackintosh

The development of the CEA would not have been possible without the partnership and expertise of in-country experts. These especially included the continued technical review and inputs from an Expert Review Panel comprising Mr. Sharif Jbour from BirdLife International, Mr. Mohammed Za'rour and Mr. Tareq Qaneer from the Royal Society for the Conservation of Nature (RSCN), and Dr. Fares Khoury from American University of Madaba. The support of RSCN's Geographic Information Systems team in the preparation of figures used within the CEA, and the technical input on bats and habitats provided by Dr. Zuhair Amr is also acknowledged.

The CEA also would not have been possible without the willingness and contributions of the participating developers who agreed to pool their project-specific bird survey data so that this assessment could be conducted.

[1] Note that D'Appolonia S.p.A. (Italy) was the contract manager for the Scoping Phase.

This includes special recognition of Mr. Fereydoon Abtahi (Abour Wind Energy Company), Mr. Sean Miller (Jordan Wind Project Company), and Mr. Taeyong Lee (Korea Southern Power Company Ltd.) who were active participants throughout the CEA process. Their contributions ensured that the CEA recommendations put forth a practicable approach. For that, they are recognized as leaders in their fields on environmental and social matters.

The development of the CEA was an inclusive process with equal participation from international and national experts and developers. An Advisory Committee was formed through which bilateral and multi-lateral engagement was undertaken throughout the CEA process. Stakeholder groups represented in the Advisory Committee included:

- A developers' representative for the four participating wind power projects
- The Ministry of Environment of Jordan
- BirdLife International
- The Royal Society for the Conservation of Nature
- A representative of Jordanian academic ornithological community
- A representative of Jordanian independent consultant bird surveyors

Other contributors included the European Investment Bank and the European Bank for Reconstruction and Development, who were consulted during the initial phases of the CEA process. As the main Government agency responsible for the wind sector in Jordan, the Ministry of Energy and Mineral Resources was kept informed of the CEA process.

Executive Summary

In the Middle East, wind power is a rapidly growing renewable energy source because of its minimal carbon emissions and increasing cost competitiveness. In an initiative to reduce Jordan's high energy import costs, estimated at 13.5 percent of GDP, the government has set a target of obtaining 1,800 megawatts—10 percent of the country's energy supply—from renewable sources by 2020.

Although the renewable energy sector, including wind energy, is considered "green," adverse environmental and social (E&S) impacts of renewables also need to be considered and managed. Jordan sits on the Rift Valley/Red Sea flyway, the second largest flyway for migratory birds in the world. It also has a suite of protected areas of national and international significance. Jordan's largest nature reserve—the Dana Biosphere Reserve (BR) and the surrounding Dana Important Bird and Biodiversity Area (IBA)—is one of the few large areas in Jordan designated as important for its flora and fauna.

The IFC (International Finance Corporation) commissioned the Tafila Region Wind Power Project (TRWPP) Cumulative Effects Assessment (CEA) to help promote more sustainable wind energy investments in Jordan. Focusing on biodiversity, this innovative initiative is the first of its kind in the Eastern Europe, Middle East, and North Africa region. The overall management and technical direction of the CEA was undertaken by IFC, supported by a team of multidisciplinary international and Jordanian experts and advisors who were contracted to develop the CEA. The work was made possible through a partnership with developers, conservation bodies, finance institutions and government, along with the knowledge of in-country experts facilitated through an Advisory Committee and an Expert Review Panel (ERP).

Five wind farm developers agreed to share and pool their pre-construction environmental survey data, representing a remarkable resource. This collaborative approach, a key component of the CEA process, allows a consistent method for identifying and managing E&S risks when developers are working in close proximity. For energy companies operating in middle-income and developing countries, the CEA approach is especially pertinent in that it is risk-based and relies on survey data but can also be applied where regional data on biodiversity are limited. This is particularly relevant when assessing the effects of external stressors on biodiversity, as data on these effects are almost always either limited or nonexistent in the countries where IFC and other multilateral development banks operate.

The CEA study area, located approximately 200 km south of Amman, principally within the Tafila Governorate, covers the Dana BR/IBA and the Wind Power Project (WPP) sites. The temporal scope of the assessment was defined as three years from the start of operations at each WPP, following which an evaluation would be conducted to determine an appropriate ongoing level of biodiversity monitoring and adaptive management.

OBJECTIVES

The overall objective of the CEA was to identify the potential cumulative effects of the WPPs on biodiversity in the study area and propose mitigation, monitoring, and other management measures to address the highest risks.

Risks were identified with respect to Valued Social and Environmental Components (VECs). Cumulative effects also considered non-TRWPP-sources of mortality (external stressor effects) on VECs, although data on these aspects were severely limited. The CEA recommends both site-specific and joint mitigation and monitoring measures for developers, authorities, and other entities to consider as well as the management and institutional arrangements necessary to implement those measures.

CEA PROCESS

PHASE 1. SCOPING:

The scoping phase included an initial review of existing data, preliminary engagement with stakeholders, determining spatial and temporal boundaries of the CEA, and conducting a screening process to select VECs. Birds, bats and "habitats and other species" were identified as the three VEC categories potentially at risk, with the risk to birds from fatal collisions with wind turbines identified as the likely highest risk. Data gaps and inconsistencies were identified as a major challenge in conducting the CEA. Defining standardized bird survey methods and conducting surveys over a season at WPP sites in the study area was identified as a way to ameliorate these inconsistencies. Collision fatality thresholds for birds were identified as essential for informing the assessment of risks and identifying adaptive management solutions. The use of baseline flight activity monitoring data was considered a key requirement for specifying these thresholds. Post-construction monitoring of bird and bat mortality was determined to be essential for informing the adaptive management approach.

PHASE 2. SUPPLEMENTARY DATA AND CAPACITY BUILDING:

Field survey data on all WPPs were pre-existing, and Phase 2 focused on supplementary data collection and capacity building efforts in response to the Scoping Phase. Analyses of data were also conducted during this phase. Activities included a three-week ornithological training program and workshop to train Jordanian bird surveyors in standardized methods for conducting bird flight activity surveys at wind energy developments; standardized surveys at WPP sites during the spring of 2015 to augment collision risk model (CRM) suitable data, comparable across all WPP sites; a CRM analysis to obtain species-specific annual fatality rate estimates for at-risk bird populations; compiling of a common database of bird flight activity records from the various WPPs; a trends analysis using the common database to complement the CRM and allow better understanding of the flight behavior of Migratory Soaring Birds (MSBs) in the study area; and a reconnaissance site visit and rapid effects assessment for bats and for habitats and other species.

PHASE 3. CEA FRAMEWORK

A six-step CEA framework using a risk-based approach was developed for birds. The objective was to identify priority VECs at highest risk of cumulative effects from the WPP in the study area so that mitigation, monitoring, and management measures could be put in place to safeguard these populations. The identification of priority VECs applied commonly accepted concepts within risk assessment practice and aligned with IFC's Performance Standards on Environmental and Social Sustainability (the Performance Standards). The process identified those species populations potentially at risk (step 1), evaluated their sensitivity (relative importance and vulnerability) (step 2), and assessed the likelihood of cumulative effect (LoE) of WPPs on each species population (step 3). Those species with the highest risk ratings were determined to be priority VECs.

Fatality thresholds were then determined for each priority bird VEC using species-specific demographic information, CRM results, and ERP external stressor fatality estimates (step 4). A site-specific and joint Mitigation and Monitoring

Plan (MMP) was then created (step 5), and institutional and information management arrangements were proposed (step 6).

For bats, and for "habitats and other species," an initial 3-step process equivalent to that for birds was used to identify priority VECs. Fatality threshold targets were not determined for priority bat VECs due to a lack of information on the regional size and status of these populations. Similarly, limited data on habitats and other species meant that threshold setting would not have been possible. Mitigation and management measures were also proposed.

RESULTS

BIRDS

For birds, the initial list of 171 populations identified as potentially at risk was reduced to 13 priority bird VECs assessed to be at highest risk through a process that included data analysis, literature review, expert review, and reasoned evaluation of population sensitivity and likelihood of collision risk. Eleven were raptors comprising four MSB populations (Steppe Eagle – *Aquila nipalensis*, Egyptian Vulture – *Neophron percnopterus*, Eastern Imperial Eagle – *Aquila heliaca*, and Booted Eagle – *Hieraaetus pennatus*) that use the Rift Valley/Red Sea flyway and are present in the study area during their spring and autumn migration periods. Seven species were resident or summer breeding raptor populations (Short-toed Snake-eagle - *Circaetus gallicus*, Griffon Vulture – *Gyps fulvus*, Golden Eagle – *Aquila chrysaetos*, Verreaux's Eagle – *Aquila verreauxii*, Bonelli's Eagle – *Aquila fasciata*, Long-legged Buzzard – *Buteo rufinus*, and Lesser Kestrel – *Falco naumanni*) that may use the study area during, and outside, their respective breeding periods. In addition, two passerine species, Syrian Serin – *Serinus syriacus*, and Eurasian Goldfinch – *Carduelis carduelis*, were identified as priority bird VECs.

Populations of these 13 priority bird VECs were assessed to determine an annual threshold of fatalities that each could sustain without affecting their long-term viability. For all 13, the target was determined to be *zero fatalities*. In addition, an *extreme events threshold target* was recommended to alleviate the risk of multiple-fatality events to a small number of non-priority MSB populations that may migrate in large flocks in the vicinity of the WPP sites.

As well as identifying and putting in place safeguards for bird populations at greatest risk, the CEA has provided unique and valuable insights into general and species-specific bird use of WPP sites and the wider study area. In particular, it has confirmed that, despite being reasonably close to migration bottlenecks around the Red Sea coast, the WPP sites are located within a part of the flyway where MSBs migrate across a "broad front," and so these sites do not typically experience high concentrations of these species during the spring or the autumn migration periods.

Mitigation and monitoring measures for birds as well as institutional arrangements were included in the CEA Mitigation and Monitoring Plan (MMP) as described below.

BATS

For bats, an initial list of 18 species potentially present within the study area was reduced to two priority bat VECs (Desert Pipistrelle - *Hypsugo ariel* and Rüppell's Pipistrelle - *Pipistrellus rueppellii*) through a process that included spatial data review, literature review, and a reasoned evaluation of population sensitivity and likelihood of collision risk.

For bats, recommendations focused on monitoring and other considerations in project-specific Environmental and Social Impact Assessments (ESIAs) and Environmental and Social Mitigation and Monitoring Plans (ESMMPs).

HABITATS AND OTHER SPECIES

Four habitat types and four other species were identified as potentially at risk within the study area. Using spatial data reviews of habitat/species distributions and existing assessments of habitat conservation priority and species conservation status, all four species and three of the four habitats were scoped out of the assessment process during step 2 of the CEA process. The likelihood of effect of WPPs on Thorny Salt Brush (*Noaea mucronata*), the one habitat remaining in the process, was assessed as minor, based on a risk of habitat loss and degradation. As a consequence, no habitats were identified as priority VECs.

For habitats and other species, recommendations are focused on considerations in project-specific ESIAs and ESMMPs.

CEA MITIGATION AND MONITORING PLAN

The CEA MMP principally aims to avoid collisions of priority VECs, quantify post-construction fatality rates at WPP sites and ensure an adaptive management approach is undertaken. Three types of measures are proposed: (i) project-specific on-site measures focusing on monitoring of post-construction flight activity coupled with turbine-specific shutdown protocols and searches for carcasses of bird fatalities; (ii) inter-site monitoring activities and adaptive management; and (iii) joint management and action plans focused on priority bird VECs. Adaptive management will respond to a variety of scenarios such as exceeded thresholds, near-miss incidents, elevated-risk situations, pastoral or livestock movements, and deficiencies found in monitoring protocols. Exceeded thresholds will trigger immediate review and adaptive management response.

An innovation of the CEA MMP is to describe and propose a mechanism that facilitates inter-site data-sharing, which allows TRWPP-wide reviewing of incident reports and routine mitigation monitoring results. This mechanism will facilitate the efficient assessment of emerging cumulative issues, allow adaptive management response recommendations, and broaden mitigation and monitoring planning to encompass the whole of the study area. A key component of inter-site data sharing and management is that developers establish an Internal Committee to oversee a central data center for sharing data from bird and bat monitoring.

The CEA recommends that data shared and reviewed by the Internal Committee also be shared with the Ministry of Environment, given its regulatory role in environmental approvals and ongoing auditing role for Environmental Impact Assessment (EIA) commitments. The ministry is encouraged to engage with the RSCN, Birdlife International, and other conservation organizations and interested parties on the long-term implementation of the recommendations of the CEA, including adaptive management responses.

Another important recommendation within the MMP is the development of a corporate social responsibility (CSR) fund, which is the vehicle through which a proposed preemptive biodiversity offset might be undertaken, if needed. A CSR fund has already been established in Jordan for developers of photovoltaic solar energy projects clustered near Ma'an. Such a fund would be a useful way to pool resources among developers for collectively carrying out actions relevant not only to this CEA but potentially also to other environmental and social initiatives.

Future safeguarding of current and emerging high-risk populations is a key priority within the CEA. The iterative, comprehensive program of post-construction monitoring and adaptive management that was developed as part of the CEA is designed to provide the feedback necessary for a dynamic process that enables developers and authorities to respond to environmental and ecological changes that may affect the conservation status of bird VECs.

CONCLUSIONS

The process and methodology for this CEA was developed to promote more sustainable investments in the wind energy sector in Jordan through improved identification and management of the highest environmental risks. This is important work, given the multiple developments proposed near the Dana BR/IBA and the potential for more development elsewhere. Though the CEA focuses on Jordan, its process and methodology are likely to be relevant across middle-income and developing countries, many of which—like Jordan—have limited regional data on biodiversity. Likewise, the CEA Framework could be adapted to apply to other sectors.

The recommendations proposed in this CEA are in line with IFC's Performance Standards and analogous environmental and social standards of the European Bank for Reconstruction and Development (EBRD) and European Investment Bank (EIB). Their implementation would assist in the development of the ESIAs and ESMMPs, not only for the WPPs participating in the CEA, but also for other developments near the Dana BR/IBA or other important biodiversity areas in Jordan.

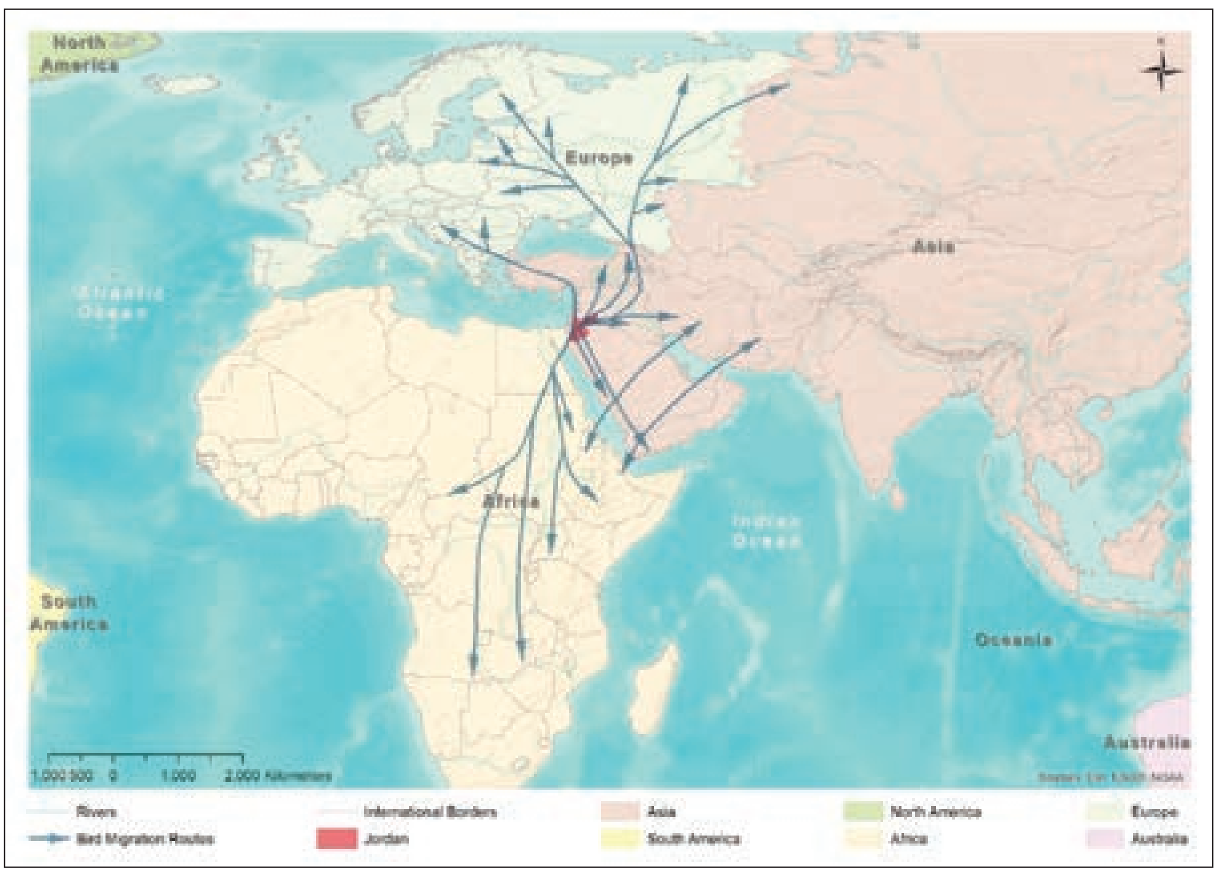
1. CEA Overview

1.1 BACKGROUND

Concerns about climate change and the use of fossil fuels, coupled with a drop in costs to install renewable energy sources, have bolstered the contribution of renewable energy technologies to energy generation. In the Middle East, wind power and solar photovoltaic arrays are a rapidly growing renewable energy source owing to their minimal carbon emissions and increasing efficiency. In 2010, the government of Jordan's Ministry of Energy and Mineral Resources estimated that the costs of the country's energy imports were nearing US$3.6 billion, or 13.5 percent of the country's gross domestic product. In response to this energy crisis, the government set a target to obtain 10 percent of the country's energy supply (1,800 megawatts [MW]) from renewable sources by 2020 (Hashemite Kingdom of Jordan, 2007).

Although the renewable energy sector, which includes wind energy, is considered "green," adverse environmental impacts of renewables also need to be considered. Jordan sits on the Rift Valley/Red Sea flyway, the second largest flyway for migratory birds in the world (Figure 1 and Section 1.7, Regional Environmental Context). It also has

FIGURE 1. RIFT VALLEY/RED SEA FLYWAY



a suite of protected areas of national and international significance, in particular its largest nature reserve, the Dana Biosphere Reserve (BR)[2] and the surrounding Dana Important Bird and Biodiversity Area (IBA),[3] one of the few large areas in Jordan designated as important for its flora and fauna.

In 2013, International Finance Corporation (IFC), European Investment Bank (EIB), and others invested in the first utility-scale wind power project (WPP) in the Middle East—the 117 MW WPP of the Jordan Wind Project Company (JWPC), also referred to as the Tafila project, for its location in the Tafila Governorate. Located 184 kilometers (km) south of the capital city of Amman, the JWPC's project is expected to produce 400 gigawatt-hours of electricity a year. Inaugurated in December 2015 under the patronage of His Majesty King Abdullah II, the project is now in operation.

While Tafila is a landmark project in Jordan and an example in the region, it is not without its challenges. The project is located within 5 km of the Dana BR and just outside the IBA, and safeguards for birds have been firmly integrated into the project's E&S management system. As part of the government's expansion of renewable energy sources, several other WPPs have been proposed around the Dana BR and IBA. The government has identified this part of the Jordan Valley as a focal area for wind energy development because of its high wind-resource potential.

To help promote the long-term sustainability of investments in the wind energy sector in Jordan, IFC commissioned the Tafila Region Wind Power Projects (TRWPP) Cumulative Effects Assessment (CEA), which focuses on WPPs located or proposed in the surroundings of the Dana BR and IBA (referred to as the CEA initiative; see location in Figure 2). This initiative, which focuses on the most at-risk biodiversity aspects of the landscape, is the first of its kind in the Eastern Europe, Middle East and North African region. Though the CEA focuses on Jordan, its process and methodology are likely to be relevant across middle-income and developing countries, many of which—like Jordan—have limited regional data on biodiversity.

Collaboration: Key to the CEA Process

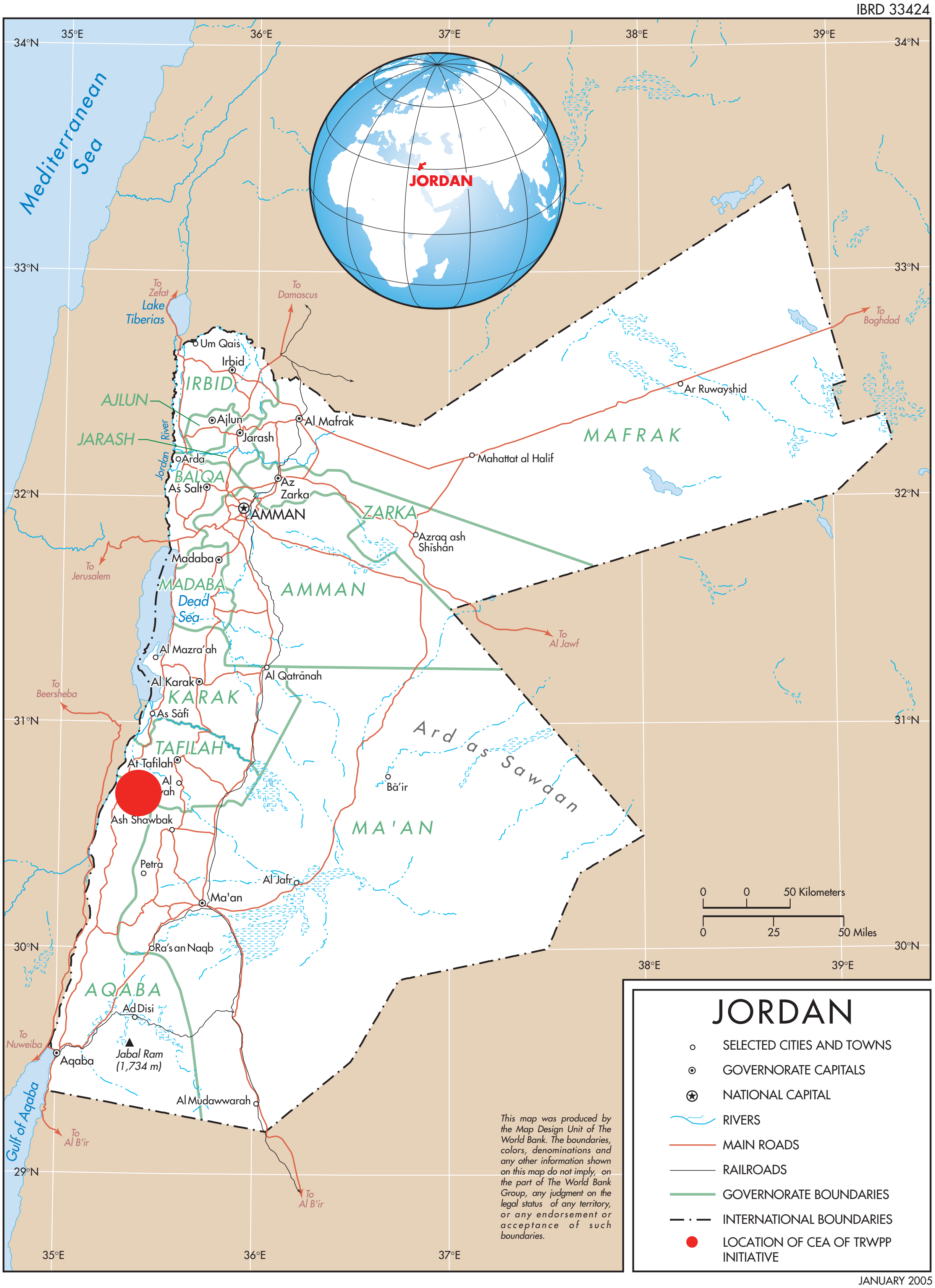
This CEA would not have been possible without strong collaboration among developers, government agencies, and international and national experts. The engagement, provision of expert opinion, and supportive participation in the CEA of developers, government authorities, conservation entities, and other entities was essential to identify the highest cumulative risks and practical solutions for the joint management of those risks. The development of the CEA was an inclusive process with equal participation from international and national experts and developers. The process benefited greatly from the establishment of two groups to guide the process: an Advisory Committee and an experienced in-country Expert Review Panel.

1.2 CEA OBJECTIVES

The objective of the TWRPP CEA is twofold: (i) identify the highest risks posed by the potential cumulative effects of the WPPs (Section 1.4) in the study area (Section 1.3) and by external stressors, and (ii) propose WPP-specific and joint mitigation, monitoring, and other management measures to help developers, authorities, and other entities, including Jordanian environmental conservation organizations, to address those risks.

[2] Designated by the UNESCO Man and the Biosphere program.
[3] IBAs are areas identified by the nongovernmental organization BirdLife International, using an internationally agreed set of criteria, as being globally important for the conservation of bird populations. See *http://www.birdlife.org/worldwide/programmes/sites-habitats-ibas.*

FIGURE 2. LOCATION OF TRWPP CEA INITIATIVE



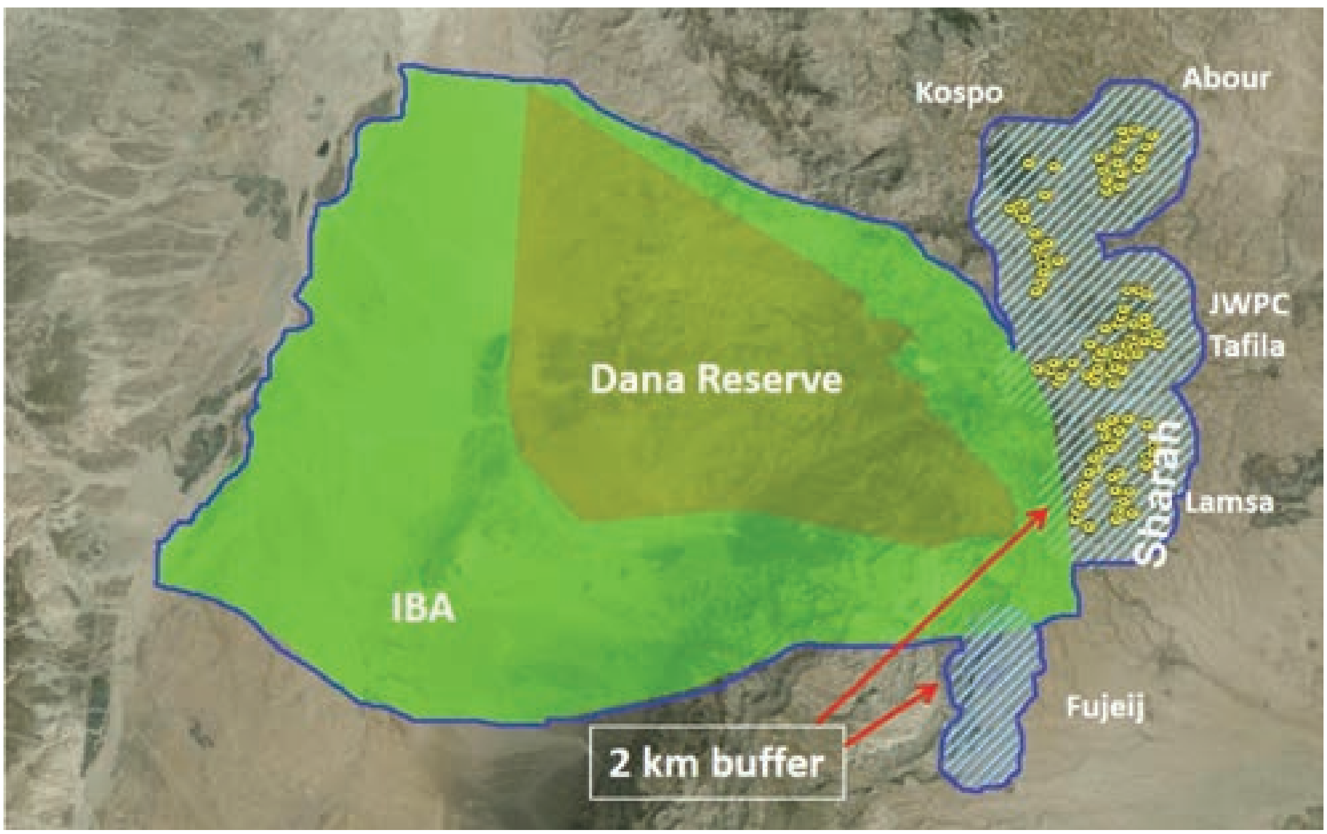
The outcomes of the CEA will assist these entities in planning the project-specific Environmental and Social Impact Assessments (ESIAs) and the adaptive management of the existing E&S Mitigation and Monitoring Plan (ESMMP) of the JWPC Tafila project. This CEA does not discuss individual WPP-specific impacts and does not include the raw data from the WPP-specific bird surveys; this information is the subject of the project-specific ESIAs.

It should be noted that the CEA does not aim to predict the significance of impacts of the WPPs over a defined time period as the potential impacts are not definitively known and were estimated through predictive modeling. Rather, the CEA is based on a risk assessment approach as identified in the CEA frameworks presented in this report. Priority valued environmental and social components (VECs)[4] were selected on the basis of risks rather than predicted impact.[5] Determining the VECs at the highest risk of cumulative effects was essential to help focus and align the efforts of the WPPs' developers and of other stakeholders.

1.3 STUDY AREA

The study area of the TRWPP CEA includes the Dana BR, the surrounding IBA, five WPPs, and a 2 km buffer area around each WPP (Figure 3). The 2 km buffer around each WPP relates to the survey area

FIGURE 3. TRWPP CEA STUDY AREA



[4] VEC is a term used in the practice of cumulative impact assessment to indicate an environmental or social attribute that is considered important in assessing risk. For example, VECs might be physical features, such as habitats and wildlife populations; social conditions (e.g., health or economics) or cultural aspects (e.g., archaeological sites). VECs may be directly or indirectly affected by a specific development or may be affected by the cumulative effects of multiple developments. For the VECs of the TWRPP CEA, see Section 2.2.5.
[5] It is for this reason that this assessment is called a cumulative effects assessment rather than a cumulative impacts assessment although it is recognized that IFC's Good Practice Handbook on Cumulative Impact Assessment and Management (IFC, 2013) uses these terms interchangeably.

limits used in the vantage-point (VP)[6] surveys conducted for birds and is therefore included within the study area.

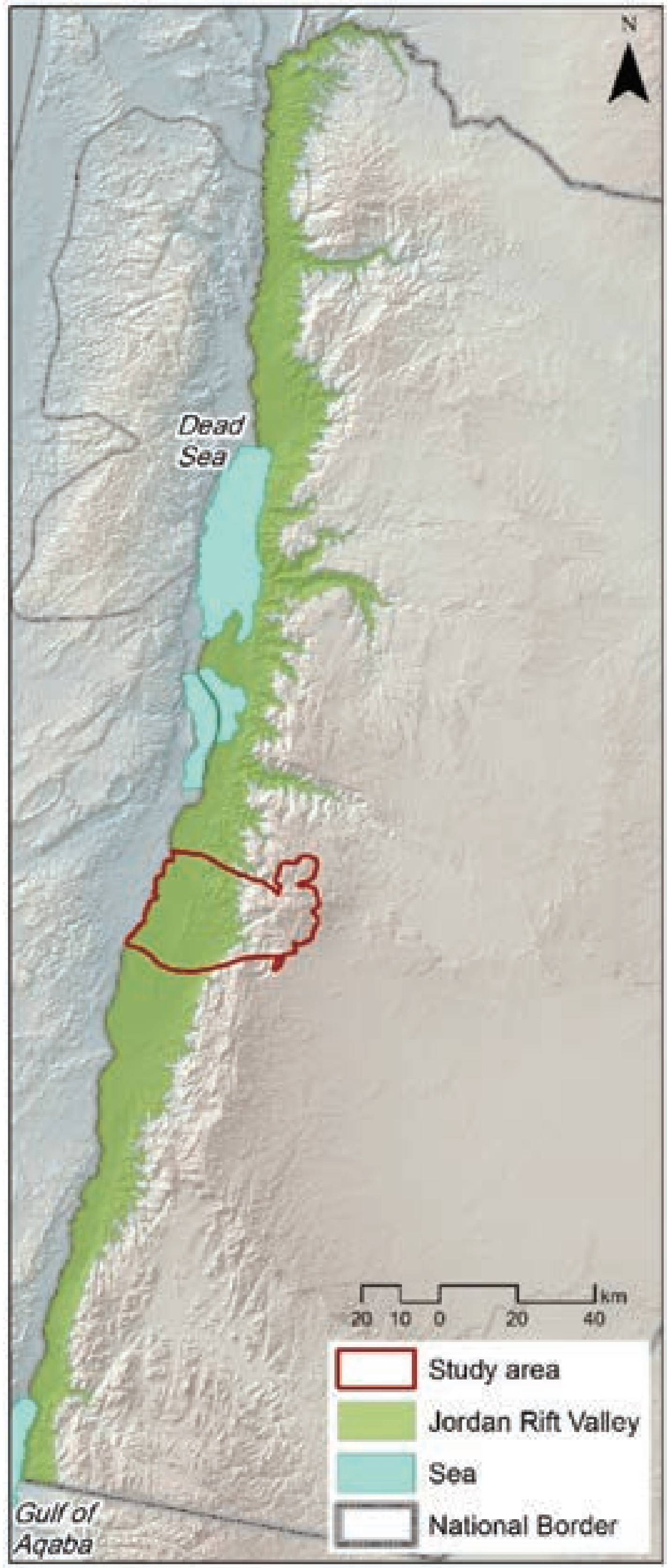
The study area is located within the Rift Valley/Red Sea flyway, situated to the south of the Dead Sea in the eastern part of the Rift Valley[7] (Figure 4). The WPPs lie adjacent to the Dana IBA, oriented approximately north–south along its eastern edge in the higher elevations of the Rift Valley margins. It was considered important to include the entire IBA in the TRWPP study area so that the potential cumulative effects on species relevant to its integrity could be considered.

The WPP projects are administratively located within Tafila Governorate,[8] with the exception of the WPP located farthest to the south, which is just within the adjoining governorate, Ma'an. Tafila is located 184 km south of the capital city of Amman and is bordered by Al Karak Governorate to the north and by Ma'an and Aqaba Governorates to the south.

1.4 OVERVIEW OF THE WIND POWER PROJECTS

This CEA provides an assessment of the potential cumulative effects on VECs of five WPPs and considers other external stressors. Of the five developers, only four are considered "participants" in the CEA in that they were actively involved in its development, including determining the mitigation,

FIGURE 4. THE RIFT VALLEY AND THE TRWPP CEA STUDY AREA



[6] Vantage points are survey site locations strategically positioned so that maximum airspace at a WPP can be effectively and efficiently monitored for bird flight activity. The buffer is a precautionary measure to reduce the risk of failure to record birds that only occasionally use the wind farm area.
[7] The Rift Valley in this report refers to the portion of the Great Rift Valley that stretches from the northwestern tip of Jordan to Aqaba in the south by the Red Sea. It can also be referred to as the Jordan Rift Valley, Jordan Valley, or Great Rift Valley.
[8] Tafila is also spelled Tafilah and Tafileh.

TABLE 1. SUMMARY OF WPPs INCLUDED IN THE TRWPP CEA

WIND POWER PROJECT	TOTAL INSTALLED CAPACITY	NO. OF TURBINES	STATUS	OTHER INFORMATION
JWPC Tafila	117 MW	38 turbines with an individual installed capacity of 3.075 MW	Operational	All WPPs are likely to include the following infrastructure and/or facilities of varying scale depending on the size, specific location, proximity to existing transmission infrastructure, and generating capacity of the individual project: • Wind turbine generators, which include a foundation, steel tower, nacelle, rotor blades, rotor hub, and transformer • Electrical substation, transmission structures, overhead transmission line to connect with the NEPCO system, and underground electrical power lines • New roads for access during operation and construction • Meteorological mast • Office and/or ancillary structures
Korea Southern Power Company Ltd. (KOSPO)	49.5 MW	15 turbines with an individual installed capacity of 3.3 MW	Approved by the government	
Abour Wind Energy Company (Abour)	50 MW	15 turbines with an individual installed capacity of 3.3 MW	Approved by the government	
LAMSA Investments LLC (LAMSA)	99 MW	30 turbines with an individual installed capacity of 3.3 MW	Unknown	
Korea Electric Power Corporation's (KEPCO) Fujeij[a]	90 MW	27 turbines with an individual installed capacity of 3.3 MW	Unknown	

a. The Fujeij WPP contributed raw data from the bird surveys to conduct this assessment but is not a participating WPP.

monitoring, and management actions represented in this report (see Sections 3, 4, and 5). Table 1 describes the five WPPs.

1.5 TEMPORAL SCOPE OF THE CEA

A challenge in determining the temporal scope of this CEA was that the WPPs were at different stages of development. JWPC's Tafila project, the only WPP operating in the CEA study area, began operations in September 2015 and has a design life of 20 years. The impacts of this project on birds are still in the early stages. The other WPPs are still to be constructed and, at the time of writing, the time frame for their construction and operation was unknown. It was also unknown whether all four proposed WPPs would be implemented. For the purposes of this CEA, using a precautionary approach, it was assumed that all five WPPs would be operational.

The temporal scope of the assessment might therefore be defined as the time frame during which the proposed mitigation, monitoring, and management measures will be implemented. It is during this time frame that monitoring results should reveal the impacts of the projects. An initial three-year time frame (from the start of each WPP 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.

Six-Step CEA Framework for Birds

A core innovation of the TWRPP CEA was the development of the CEA framework, which consists of a six-step process for assessing birds. The framework was designed to identify bird populations at the highest risk from cumulative effects of the WPPs in the study area and external stressors so that mitigation, monitoring, and management measures could be identified. Taking a risk-based approach, the framework is designed to be applied in middle-income and developing countries that often have little preexisting regional data on biodiversity.

1.6 UNIQUE ASPECTS OF THE CEA

This CEA was developed in the context of some unique circumstances, which in turn provided a number of opportunities.

- Though three of the four participating WPPs (see Section 1.4) were at the pre-ESIA stage at the time of writing of this report, data from substantial preconstruction bird surveys at the participating WPPs were available for the CEA. This presented a unique opportunity to understand how resident and migratory birds use the area, including the risk of collision.
- All five WPPs in the study area agreed to share their project-specific survey data. The sharing of biodiversity data is a notable aspect of the CEA: it allowed for in-depth review of data collection consistency between sites, leading to a robust analysis of likely effects on potentially at-risk populations. Data sharing also represented an opportunity to examine combined data for migratory soaring birds (MSBs). MSB flight activity data were pooled in a common database and analyzed to better understand factors that influence MSB behavior and collision risk.
- The pooling and analysis of WPP survey results provides a baseline resource for informing the management of the highest cumulative risks in the study area.
- The engagement, provision of expert opinion, and supportive participation in the CEA of developers, government authorities, conservation entities, and other entities was essential for identifying the highest cumulative risks and practical solutions for the joint management of those risks. The development of the CEA was an inclusive process with equal participation from international and national experts and developers. The process greatly benefited from the establishment of two groups to guide the process: the Advisory Committee (AC) and the Expert Review Panel (ERP) of experienced in-country specialists.
    - The AC provided a platform for bilateral and multilateral engagement throughout the process. Stakeholder groups represented in the AC included a developers' representative for the four participating WPPs, the Ministry of Environment (MoENV), BirdLife International, and the Royal Society for the Conservation of Nature (RSCN), as well as representatives of the Jordanian academic ornithological community and independent consultant bird surveyors.
    - The ERP, primarily a subgroup of the AC, comprised ornithological experts with knowledge and experience of the avifauna of Jordan and the Middle East. Collectively, through members' extensive experience-based knowledge of the Tafila region and the country, along with their access to and knowledge of a range of unpublished data and reports, the ERP represented the most extensive body of knowledge on ornithology in Jordan. The panel provided expert knowledge on the distribution of, status of, and threats to species

populations using the study area, especially useful where knowledge gaps existed. Throughout each stage of the CEA process, the ERP was iteratively engaged in the development and implementation of methods and the review of results.

- The CEA goes beyond national regulatory requirements and applies international standards and guidance, thus providing a resource for WPPs in the study area and others in the Jordanian wind sector to use in achieving compliance with international requirements. The process adopted some key aspects of international standards, including the application of the mitigation hierarchy concept, the identification of risks through VECs, and the application of good-practice approaches to the management of risks (e.g., shutdown on demand and adaptive management).

1.7 REGIONAL ENVIRONMENTAL CONTEXT

The Dana BR and IBA, located adjacent and to the west of WPP sites, together constitute the majority of the study area. Covering 300 square kilometers (km^2), the Dana BR is Jordan's largest nature reserve. The site is globally recognized as an area of high nature conservation importance—to date 25 IUCN Red-List Endangered and Vulnerable species have been recorded. In addition to its ecological importance, it is culturally important: about 100 archaeological sites have been identified on the site. The reserve is designated under the Man and the Biosphere (MAB) program of the United Nations Educational, Scientific and Cultural Organization (UNESCO). The program aims to establish a scientific basis for the improvement of relationships between people and their environments.[9]

[9] The MAB program draws on the natural and social sciences, economics, and education to improve human livelihoods and work toward the equitable sharing of benefits, and to safeguard natural and managed ecosystems, promoting innovative approaches to economic development that are both socially and culturally appropriate and environmentally sustainable (see http://www.unesco.org/new/en/natural-sciences/environment/ecological-sciences/man-and-biosphere-programme/about-mab/).

The Dana IBA covers 310 km^2, surrounding and partly overlapping with the Dana BR. In 2000, it was designated by the global nature conservation partnership Birdlife International as a key area for the conservation of the world's birds due to the diverse assemblage of breeding birds of unusually mixed biogeographical origins present in the area. The IBA has particular conservation importance for the Syrian Serin (*Serinus syriacus*) and the Griffon vulture (*Gyps fulvus*). Griffon vulture breeding sites are known to be located within the Dana IBA and nowhere else in Jordan.

Birdlife International has assigned the Dana IBA a "very high" MSB sensitivity rating, with records of 26 out of a total of 37 MSBs transiting Jordan. The importance of the IBA for MSBs is explained by its location within the Rift Valley/Red Sea flyway, the second most important flyway in the world for such birds (raptors, storks, pelicans, and ibises). An estimated 1.5 million birds of the 37 species use the flyway to migrate between their breeding areas in Eastern Europe and Western and Central Asia in spring and their wintering areas in Africa in autumn (BirdLife International, 2012, 2015). (For a detailed description of MSB migration along the flyway and over the study area, see Annex A, Regional Environmental and Social Context.) Overlapping with the southern edge of the Dana IBA and extending to the south of the Dana BR is the proposed Shoubak Nature Reserve.[10] Currently there is no timeline for establishing the proposed reserve as a protected area.

Topographically the study area ranges in altitude from 100 m below sea level in Wadi Araba on the west side to 1,600 m above sea level in the Sharah Mountains[11] on the east side. Wadi Araba is the name given to the section of the Jordan Valley that runs south from the Dead Sea to Aqaba. The study area is characterized by a network of tributary wadis that dissect it, running principally east–west down the Rift Valley slope into the Wadi Araba. These wadis are dry except during rainfall events, when they are typically subject to flash flooding. The altitudinal gradients in the study area give rise to unique biological and ecological features as well as a diversity of land use.

Vegetation in Jordan is divided into 19 types grouped into four biogeographical zones; Irano-Turanian, Mediterranean, Saharo-Arabian, and Sudanian Penetration. (For details about each zone, see Annex A, Regional Environmental and Social Context.) Boundaries between zones, particularly along the rift, are not always distinct and transitional areas can contain a mixture of adjacent zones. All but one of these zones (the Saharo-Arabian) are represented within the study area. WPPs and their surrounding buffer areas are generally located within the Mediterranean and Irano-Turanian zones, which contain four main vegetation types: Mediterranean nonforest batha, batha-steppe, *Artemisia herba-alba* steppe, and thorny saltwort (*Noaea mucronata)* brush.

1.8 REGIONAL SOCIAL CONTEXT

The Tafila Governorate has an estimated population of 87,500 (2011 figure), approximately 2 percent of the national total; it is one of the least populated of Jordan's 12 governorates. Tafila principally depends on tourism from other parts of the country to its nature reserves and hot springs. Archaeology and agriculture (fruit and olives) are the second and third largest sectors, respectively, by revenue.

[10] The proposed reserve is located mostly in the Aqaba Governorate, except for its northeastern part which is located in Ma'an Governorate. It has an area of approximately 77 km^2. Like the Dana BR, it represents three main biogeographical zones; the Mediterranean, Irano-Turanian, and Sudanian; the Irano-Turanian biogeographical zone covers more than 90 percent of the area. Five vegetation types are defined in the area: juniper, evergreen oak, water, steppe and acacia, and rocky Sudanian. During the rapid assessments carried out in the proposed area, 145 plant species, 44 bird species, 12 mammal species, 10 reptile species, and 1 amphibian species were recorded.
[11] The Sharah Mountains, also referred to as the Southern Highlands, extend along the Rift Valley in southern Jordan from Karak and southward to Aqaba. The Sharah Mountains also extend into northern Saudi Arabia.

There is a mixture of land ownership in the study area. The Dana BR is government land, whereas the areas outside the reserve are either privately owned or government lands. As is the case in most of Jordan, the land in the area is divided among tribes on the basis of watershed and pasture. Historic ownership of tribal lands, referred to as "tribal fronts," is still acknowledged and is based on formal agreements or semiformal understandings between tribal groups.

The movement of the Bedouin livestock owners follows the change in vegetation cover and the availability of pasture. Typically Bedouin livestock owners are present in the study area in their highest densities in the spring to autumn, from March/April until late September/October and spend the rest of the year in the east, although these movements may vary by year.

The development of WPPs in the study area will not restrict the use of land by livestock owners (either seminomadic or local communities). However, the CEA does take into account the effect of ongoing pastoralist land use on the activity of some species, notably vultures, in the vicinity of WPP sites. For details about tribal groups using the study area, see Annex A, Regional Environmental and Social Context.

Dana Biosphere Reserve

2. CEA Phases

2.1 SUMMARY OF CEA PHASES

The CEA was developed in three phases—stakeholder engagement was a cornerstone of each. Table 2 summarizes the CEA process. Stakeholder engagement activities conducted for the entirety of the CEA process are summarized in Table 3 and described in detail in Annex B.

TABLE 2. OVERVIEW OF CEA PHASES

	PHASE	ACTIVITIES	TIME FRAME
Stakeholder engagement critical throughout the CEA process	Phase 1: Scoping	• Initial data review • Identification of data gaps • Scoping assessment • Identification of temporal and geographic boundaries and VECs	January–February 2015
	Phase 2: Supplementary Data Collection and Capacity Building	• Standardized bird surveys (additional to preexisting data) • Collision risk modeling (CRM) • Database compilation • Trends analysis • Reconnaissance site visit and rapid assessment (bats, habitats and other species) • Ornithological training and workshop • AC established	February–June 2015
	Phase 3: Six-Step CEA Framework Development and Assessment	• Development of CEA frameworks for VECs • Application of CEA frameworks for priority VECs • Continuous review and feedback with ERP • Regular consultation with AC • Development of CEA findings and report	July 2015–March 2016

TABLE 3. SUMMARY TABLE OF CEA PROCESS

PHASE	ACTIVITY	SUMMARY	STAKEHOLDER ENGAGEMENT[a]

Phase 1:
Scoping
Also see:
Annex B Stakeholder Engagement
	Scoping	• A literature search was undertaken to identify guidance and references to inform the CEA methodology and provide information for the determination of likely VECs.
		• Stakeholders were identified and engagement begun.
		• The spatial and temporal boundaries of the CEA were identified.
		• The VEC screening process selected **birds, bats,** and **habitats and other species** as priority VECs.
		• Key issues were identified that informed subsequent phases of the CEA, including the following:
		  • Data gaps and inconsistences presented a major challenge to the CEA.
		  • The determination of thresholds for birds was essential to inform the assessment of risks and the identification of adaptive management solutions.
		  • Consultation was the route to obtaining all available baseline data to support the CEA.
		  • Through consultation, there was a need to define and agree on a standardized baseline methodology for bird surveys.
		  • Postconstruction monitoring of bird and bat mortality was essential to inform any adaptive management approach.
		  • The shortage of ornithologists and qualified surveyors and institutional capacity posed a problem.
		  • Data confidentiality was required for certain stakeholders.
			• A series of stakeholder meetings were held with developers, government departments, conservation organizations, and other entities to seek views on the CEA approach and scope. Overall, there was positive support for the CEA concept, and feedback was given in relation to the CEA approach and scope.

Phase 2: **Capacity Building and Supplementary Data Collection** *Also see:* *Annex B Stakeholder Engagement*	**Capacity Building**		
	Ornithological Training and Workshop	• A multistakeholder workshop was undertaken along with a field visit to the study area. The aim was to discuss the CEA initiative and gather support for standardizing some of the methods used during the individual WPP assessments and surveys. • Three weeks of in-field training for surveyors conducting the Spring 2015 Flight Activity Surveys for the TRWPP sites. The purpose of this training program was to build capacity in Jordan to plan and conduct bird surveys at WPPs using a standardized methodology and a consistent approach.	• Academics, conservation organizations, and other entities were engaged on the survey field methodology (including categorization of target species), the selected VECs, and the CEA approach. • The multistakeholder AC was established. The outcomes of the scoping phase were presented to the AC, and it was engaged on the next steps for the CEA.

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TABLE 3. SUMMARY TABLE OF CEA PROCESS (*continued*)

PHASE	ACTIVITY	SUMMARY	STAKEHOLDER ENGAGEMENT[a]
	Supplementary Data Collection – Birds		
Annex F Standardized Bird Survey	Standardized Bird Survey and Spring 2015 Flight Activity Surveys	• Because of the inconsistencies identified in the survey approaches reviewed during phase 1 (Scoping), the CEA process focused on the development of a standardized bird survey methodology. • The main objective of these bird surveys was to collect data suitable for calculating comparable mortality rates from wind-turbine collision for bird species populations vulnerable to collision risk at each WPP site, using collision risk modeling.	
	CRM	• The scoping phase identified the principal risk to bird VECs as colliding with turbine rotor blades. In order to assess this risk, collision risk modeling was conducted for the CEA using the spring 2015 flight activity data for three WPPs along with preexisting (comparable) survey data available from the other two WPPs.	
Annex D Database Development	Database Compilation	• The sharing of bird flight activity data with the CEA by the WPP developers allowed the compilation of a common database containing bird flight activity records for multiple WPP sites. This database provided the basis for additional analysis of collision risks to MSBs and supplemented the results of the CRM.	
Annex E Trends Analysis –Migratory Soaring Birds	Trends Analysis	• Using the common database, a trends analysis of MSBs was performed which helped inform the recommendations made in the CEA regarding mitigation and management strategies for the highest risks to MSB VECs.	
	Supplementary Data Collection – Bats		
	Reconnaissance Site Visit and Rapid Assessment	• Limited data were available in the TRWPP for bats. A site visit and rapid assessment, including a literature review, were therefore undertaken as part of the CEA scope.	
	Supplementary Data Collection – Habitat and Other Species		
		• The Dana BR area has been studied extensively; however, comparatively limited data on biodiversity were available (on aspects other than birds) for the WPP sites beyond the limited surveys undertaken by the developers for their ESIAs (some of which were not completed). A rapid assessment, including a literature review and limited field visit, was undertaken as part of the CEA scope.	

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TABLE 3. SUMMARY TABLE OF CEA PROCESS *(concluded)*

PHASE	ACTIVITY	SUMMARY	STAKEHOLDER ENGAGEMENT[a]
Phase 3:	**Bird, Bat, and Habitats and Other Species VECs**		
CEA Framework and Assessment *Also see:* *Annex B Stakeholder Engagement*	CEA Frameworks –Methods	• A six-step CEA framework was developed for birds and adapted for the other VECs to identify priority VECs at the highest risk from cumulative effects of the WPPs and external stressors so that mitigation, monitoring, and management measures could be identified. A key finding of the scoping phase was that bird VECs likely faced the highest risk of successive WPP developments in the study area and that the principal potential impact on bird VECs was the risk of fatal collisions with wind turbine rotors. Given the limitations on comparative data for bats and for habitats and other species, the frameworks for these VECs are simpler than the one for birds; those frameworks follow a four-step process. • The identification of priority VECs applied commonly accepted concepts in risk assessment practice and was designed to align with IFC's Guidance Note (GN) 6. It considered both the sensitivity of a receptor and/or species and the likelihood of effect (LoE) on that receptor and/or species. The species with the highest risk ratings were then determined to be priority VECs. • Using species specific measures of collision rate across all TRWPP and assessment of the likely effect of 'external stressors', it was possible to determine a threshold for fatalities for each priority bird VEC. These thresholds were considered important as they establish the point at which action should occur in an adaptive management response to operational monitoring. Thresholds of fatalities were not determined for priority bat VECs or VECs for habitat and other species. This decision was influenced by the lack of data along with consideration of the likely risk to these VECs. • Mitigation and monitoring measures were determined in consultation with the WPP developers. For birds, three types of measures are proposed: project-specific on-site mitigation and monitoring measures, intersite monitoring activities and adaptive management, and joint management and action plans. For bats and habitats and other species, recommendations are limited to monitoring for bats and consideration for project-specific ESIAs.	• Extensive multilateral consultation was undertaken through the AC and direct engagement with developers, the ERP, the MoENV, and other entities. • The ERP, which was central to phase 3, was formed under the umbrella of the AC. The contribution of the ERP was invaluable in reviewing and providing technical opinions on a continuing basis, which assisted in determining the priority bird VECs, the thresholds, and the mitigation and management strategies. • During this phase the developers were specifically engaged in detail on the proposed MMP. • Specific consultation was undertaken with the MoENV, RSCN, and other relevant entities in relation to informing the approach to institutional arrangements for implementing some of the recommendations with regard to the joint MMP. • Drafts of the CEA report were shared with the AC and ERP for comment before finalization.
	CEA Framework – Reporting	• This report on the CEA has been prepared by compiling information on the background; CEA process; CEA framework methods and results for birds, bats, and habitats and other species VECs; and recommendations for the Joint MMP, institutional arrangements, and information management. A draft report was developed for a three-week comment period. A final report was then developed.	

[a] *See Annex B, Stakeholder Engagement.*

2.2 PHASE 1 – SCOPING

2.2.1 APPROACH

IFC commissioned a two-month scoping assignment in January–February 2015 to assess the feasibility of a CEA[12] for the wind energy sector (and associated infrastructure) in the Tafila region and to propose a framework for its execution. Key findings of the scoping phase shaped the work plan for subsequent CEA phases.

PHASE 1	ACTIVITY	TIME FRAME
Scoping	• Initial data review • Identification of data gaps • Scoping assessment • Identification of temporal and geographic boundaries and VECs	January–February 2015

2.2.2 LITERATURE SEARCH

Published and gray literature was sourced and screened for relevancy. Resources in the public domain and those that proved to be most relevant for the CEA appear in Section 6, References.

The literature search focused on the following topics:

- The ecology of MSBs using the Rift Valley/Red Sea flyway and resident birds using the study area, and risks associated with WPPs
- Potential bat species in the study area and their ecology and risks with respect to WPPs
- Approaches to mitigation and monitoring of impacts on birds and bats
- Published guidance on cumulative impacts assessment for the wind sector
- Biodiversity surveys from WPPs in the study area
- Relevant national regulations, international policy, and guidance

A multitude of laws, regulations, and guidance and/or requirements from development finance institutions were used in shaping the scope, methodology, and process related to this CEA. (See Annex C, CEA Regulatory, Policy, and Guidance Framework.) The recommendations of the CEA can support a project developer in achieving compliance with such frameworks.

2.2.3 STAKEHOLDER IDENTIFICATION AND ENGAGEMENT

The scoping phase included a series of meetings with developers, government departments, conservation organizations, and other entities to seek views on the CEA approach and scope and to develop a shared understanding of requirements for individual ESIAs in lieu of a CEA.

- **Ministerial Meetings:** A series of meetings took place with the MoENV, the Ministry of Energy and Mineral Resources, the Ministry of Tourism and Antiquities, and the Jordan Investment Commission.

[12] Note that during the scoping phase, the initiative was referred to as a Cumulative Impact Assessment. The name changed to Cumulative Effects Assessment after the six-step framework was developed in phase 3, which is described in Section 2.4. For ease of reference, this report also uses CEA rather than CIA.

- **Developers Meeting:** A multilateral meeting took place with the following entities: EDAMA,[13] KOSPO, Abour, JWPC, and LAMSA.
- **Conservation Organizations, Civil Society Organizations, and Academia:** A multilateral meeting took place with the following entities: the American University of Madaba, Jordan BirdWatch, BirdLife International Middle-East, and RSCN.

Annex B provides a detailed outline of stakeholder engagement activities throughout the CEA initiative.

Overall, there was positive support for the CEA concept and recognition of its value to the sustainable development of Jordan's renewable industry. A number of issues identified by stakeholders informed the CEA approach, including the need for data confidentiality (see Table 4). Stakeholders also recommended that the CEA should assist in the location and planning of future wind farms in and around the study area.

Three issues in particular required action to move the CEA process forward.

TABLE 4. KEY ISSUES IDENTIFIED BY STAKEHOLDERS DURING THE SCOPING PHASE

ISSUE	DESCRIPTION
Data gaps	For the three selected VEC groups (bird, bats, and habitats and other species), stakeholders acknowledged a number of data gaps, with data on some VECs being of mixed quality. The quality and availability of bird data were dominant concerns of conservation organizations. For instance, although there are limited data regarding raptor nesting sites in Jordan, they are known to be concentrated along the Rift Valley margins.
Inconsistencies in bird survey methodologies	There were inconsistencies in the methodologies used and proposed by stakeholders in Jordan for conducting bird surveys at the wind farms. Issues included the lack of consensus on the level of survey effort and the data collection techniques required. This resulted in issues between certain stakeholders and developers. In addition, there was confusion related to the application of certain international guidance that was not directly applicable to the Jordanian context. For example, many stakeholders were referring to the Scottish Natural Heritage (SNH) bird survey guidelines; however, these focus on collecting representative flight activity data for resident, summer breeding, and wintering bird populations rather than for species migrating through WPP sites. As a consequence, the guidance is not fully applicable to collecting representative bird activity data for Rift Valley/Red Sea flyway migrants using WPP sites.
Supply of and demand for qualified ornithologists	The number of ornithologists qualified through academia or through training and/or knowledge was insufficient to support the evolving wind power industry in Jordan. Given the proposed and planned wind farm developments in Jordan and the Middle East and North Africa region, there will be a steady demand for office- and field-based ornithological services. Stakeholders made it clear that current capacity cannot fulfill the present or future demand.

As a consequence, one of the main recommendations of the scoping phase was to conduct a standardized bird survey for at least one season during the spring migration, so that effects could be assessed cumulatively. The development of the standardized bird survey was also relevant to the RSCN's Guidelines for Wind Energy Development in

[13] Edama, an Arabic word meaning sustainability, is a Jordanian business association that seeks innovative solutions for energy and water independence and productivity, and their positive impact on the environment. It provides a platform for a large number of public, private, and non-governmental organizations sector representatives to discuss the development of the energy and water sectors in Jordan with an emphasis on renewable energy. See http://www.edama.jo.

Jordan, which were in development during the CEA process. During the scoping phase, additional information was collected on related initiatives in progress, including Jordan BirdWatch projects and the MEGA-Jordan database[14] on archaeology.

2.2.4 IDENTIFICATION OF TEMPORAL AND GEOGRAPHIC BOUNDARIES

Defining the temporal and geographic boundaries was an iterative process that commenced during the Scoping Phase. The differences between the initial and final definitions are noted as follows:

- The WPP located farthest to the south of the study area (the Fujeij project) was not initially proposed in the geographic scope of the CEA. During phase 3 of the CEA (see below), the AC requested that the Fujeij project be included in some way, if possible. The project developer was contacted and kindly agreed to pool its bird survey data, although it is not considered a participating developer in the CEA.
- The initial geographic scope included only a limited portion of the Dana BR and IBA. During the development of the six-step CEA framework, the study area was enlarged to take a precautionary approach and account for all bird species in the Dana BR and IBA.
- The temporal boundaries were initially proposed to be the life of the project; however, this was later deemed unrealistic as the actual impacts on the VECs are not known. Instead, the temporal boundaries will be determined on the basis of monitoring, to take place during the first three years of project operations.

2.2.5 IDENTIFICATION AND PRIORITIZATION OF VECs

Priority VECs were selected through an iterative process in consultation with the stakeholders described above and in Annex B. For each VEC group and/or potential impact, the following elements were discussed and were reviewed in the literature:

- Sensitivities
- Available data sources
- Activities and/or drivers other than wind projects
- Data ownership and access
- Anticipated key data gaps and how these may be filled
- Key stakeholders

Priority VECs were selected on the basis of risks rather than predicted impact.[15] VEC groups are described in Table 5, with a brief justification of those selected or screened out.

[14] MEGA-Jordan is a geographic information system (GIS) built to inventory and manage archaeology sites in Jordan at a national level. For each site it contains details such as condition, threats, and other monitoring updates. The web-based system, which is available in both Arabic and English, will standardize and centralize data on sites throughout the kingdom.
[15] The CEA does not predict the significance of impacts over a defined time period, as the potential impacts of the WPPs are not definitively known and were estimated through predictive modeling.

TABLE 5. SUMMARY OF SCREENING ASSESSMENT FOR SELECTION OF VECs

INITIAL LIST OF VECs AND POTENTIAL IMPACTS	SUMMARY OF JUSTIFICATION FOR SELECTION OR SCREENING OUT
Bird populations (migratory, resident, or seasonally resident species)	• Potential for impact caused by collision with wind turbines and other infrastructure, such as power lines. • Potential for loss of, and displacement from, habitat used for breeding and feeding. • **This VEC was included in the CEA.**
Bats	• Potential for impact caused by collision with wind turbines or other type of impacts (barotrauma). • **This VEC was included in the CEA.**
Wildlife habitat and vegetation communities and/or other species	• Potential for habitat fragmentation owing to construction of project-related access roads. Restoration of single-track roads should minimize any barrier effects. • Habitat loss through land clearance for wind project and expanded access for herders. The land has a limited carrying capacity for animals. Although access to the area may be improved, grazing intensity is unlikely to increase. • **This VEC was included in the CEA.**
Visual amenity	• A number of communities may be able to see two or more wind projects, although there is uncertainty as to whether these result in more significant cumulative visual impacts. • This VEC was not included as the CEA was conducted before the ESIA and data regarding exact layouts were not available. It was recommended that this assessment be conducted as part of the project-specific ESIAs.
Shadow flicker and/or disturbance	• Localized impact, with shadow flicker restricted to an area of up to 1,500 m of a wind project and therefore a direct cumulative effect, is unlikely to occur when the WPPs are more than 3 km apart. • In some cases the WPPs are closer together (with wind turbines 1.7 km apart), so there is likely to be a limited cumulative effect in the area between them. • However, in both cases there appear to be no permanent residents in these areas. With respect to semi-nomadic Bedouin communities, stakeholder engagement and information boards could be erected to make them aware of this potential impact. • There was not considered to be sufficient evidence to warrant the inclusion of this VEC in the CEA.
Semi-nomadic herders and/or displacement	• Although herders will most likely be affected by noise and flicker (depending on the season and their tent placement in the wind project area), the outcome of the consultation during the ESIA for the JWPC Tafila WPP indicated that they were positive about the potential benefits from the presence of better access roads and pads to place their tents on, as well as the general socioeconomic benefits to the area. • These positive and negative impacts are restricted to a project. Assuming there is no displacement of the semi-nomadic herders, these impacts are not considered to be cumulative. • This assumption should be revisited once the JWPC Tafila WPP is operational and herders are in the area. Overall, it was concluded that evidence was insufficient to warrant the inclusion of this VEC in the CEA.
Archaeology and/or damage or degradation	• On the basis of the MEGA-Jordan database and discussions with stakeholders, the study area does not appear to have any linear or extensive archaeological sites that could be affected by several wind projects or any archaeologically significant sites where the setting would be compromised by the presence of multiple projects. Any impacts on archaeology, if they occur at all, are considered to be local and not cumulative.
Quiet and peaceful environment and/or noise	• Each developer will be required to consider noise impacts on the neighboring receptors and ensure that their development is designed to meet noise standards (as referenced in the World Bank Group's General Environmental, Health, and Safety Guidelines and Wind Energy Guidelines) at the adjacent sensitive receptors, such as residential houses and mosques. • The KOSPO, Abour, and LAMSA WPPs appear to be farther from any sensitive receptor potentially affected by the JWPC Tafila project, although they are upwind. Hence, the additional noise contribution will likely be negligible or nonexistent; therefore it is considered unlikely that there will be any cumulative effect resulting from noise.

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TABLE 5. SUMMARY OF SCREENING ASSESSMENT FOR SELECTION OF VECs (*continued*)

INITIAL LIST OF VECs AND POTENTIAL IMPACTS	SUMMARY OF JUSTIFICATION FOR SELECTION OR SCREENING OUT
Socioeconomic changes and/or impacts on tourism	• Stakeholders considered the overall impacts to be potentially positive, but a limited number of stakeholders identified some potentially negative aspects, notably with respect to impacts on nature tourism in the area. These impacts will vary between the construction and operational phases. • Following a review of the potentially related socioeconomic impacts and the potentially affected communities, it was concluded that any impacts of this nature are likely to be limited, given the low employment numbers. Socioeconomic impacts could be potentially positive if the developers undertake community investment. • With respect to impacts on tourism, there appears to be a limited amount of nature-based tourism and bird-watching that takes place to the east side of the Dana BR and IBA. Data were not available to assess the extent of this tourism in terms of revenues generated and the impact, if any, of the wind power projects. It was recommended that information of this nature be gathered as part of the project-specific ESIAs. • Some stakeholders also requested that the positive impact from the wind power projects be emphasized.
Road capacity and increased heavy traffic	• Although there could be a cumulative effect from several developments occurring at the same time, these are likely to be short term as traffic is not associated with the operational phases of the project. As the projects will be developed in different time frames, they were not considered to have a cumulative impact of this nature.

2.3 PHASE 2 – SUPPLEMENTARY DATA COLLECTION AND CAPACITY BUILDING

2.3.1 APPROACH

The CEA was conducted before ESIAs were completed for three of the four participating WPPs. Although substantial bird data were collected for multiple seasons and years for all participating WPPs, only a limited amount of survey data were collected for bat, flora and other fauna species, with the exception of the JWPC's Tafila WPP and information related to the Dana BR. The scoping phase identified key data gaps and capacity issues. To help address these issues, IFC commissioned and led an integrated team to undertake supplementary data collection and capacity-building activities as phase 2 of the CEA. This section describes such activities for each of the priority VECs.

PHASE 2	ACTIVITY	TIME FRAME
Supplementary Data Collection and Capacity Building	• Standardized bird survey and spring flight activity surveys • Collision risk modeling • Database compilation • Trends analysis • Reconnaissance site visit and rapid assessment (bats, habitats and other species) • Ornithological training and workshop • AC established	February–June 2015

2.3.2 CAPACITY BUILDING

Technical CEA Workshop—Birds and Bats

A multilateral workshop on birds and bats took place April 14–16, 2015. The workshop aimed to engage participants on the CEA initiative and to gather support for standardizing methods used during the individual WPP assessments and surveys. The workshop was facilitated by IFC and the CEA team. Annex B contains a list of participants.

The workshop included a number of sessions, summarized below, culminating with a field visit to the JWPC Tafila WPP, which was under construction at the time, and the Dana BR.

- Session 1: ESIA and CIA—Key Differences and Considerations
- Session 2: ESIA Scoping and Information Requirements
- Session 3: Birds—Priority Bird Species and Survey Design Principles
- Session 4: Bats—Priority Species and Survey Methods
- Session 5: Birds Survey Methods
- Session 6: Case Study—Migration Patterns in Spain
- Session 7: Impact Assessment
- Session 8: Lessons Learned: Griffon Vulture Case Studies (Spain)
- Session 9: Mitigation and Monitoring
- Session 10: Summary of CIA

Key discussion points raised in each session were recorded in the minutes of the workshop, and the conclusions of the workshop identified the next steps in the CEA: completing the standardized bird survey methodology, obtaining consultation on how to calculate the impacts of the TRWPP, and establishing a list of priority bird VECs.

In-field Ornithological Training

To provide flight activity data appropriate for the CRM, which was required for the CEA and to achieve consistency between the WPPs, a three-week in-field ornithological training was provided at several of the participating CEA WPP sites. The March 29–April 22, 2015, training was conducted for:

- Ornithological surveyors employed to survey the TRWPP sites
- Other stakeholders (RSCN, other consultants) who could either join future field surveys or use the information and techniques to improve monitoring protocols and guidance offered by their organizations

The training program was designed to provide participants with the skills and knowledge required to:

- Plan and conduct the VP surveys used to collect data on collision-risk flight activity.
- Fully understand the protocols, methods, and techniques associated with correctly recording flight observations during VP surveys.
- Identify the species likely to be seen during VP monitoring at the WPP sites.
- Avoid common pitfalls that lead to the recording of flight information unsuitable for collision risk modeling.

Bird surveyor at vantage point conducting monitoring during operations

These objectives were fulfilled using field-based, one-to-one teaching. Specifically, surveyors were shown how to:

- Design surveys, in particular how to choose and evaluate an adequate number of appropriately positioned VPs for a survey site.
- Methodically and consistently scan a survey site for flight activity.
- Make use of landscape features and a sighting compass to improve the accuracy of mapping of flight routes and recording the heights of flying birds.
- Correctly record, on appropriate field forms, flight data for primary and secondary target species and specifically for primary target species, record sample flight heights at 15-second intervals using a countdown timer.
- Record survey conditions and survey effort.

The ability of surveyors to correctly identify target species is an essential prerequisite for providing accurate species-specific measures of flight activity and collision risk. On-site field training coincided with the peak spring migration period, when there were moderate to high levels of flight activity by most resident and migratory species. During these training sessions, all surveyors were informally assessed on their bird identification skills and, where appropriate, additional shadowing by experienced field surveyors was employed to further improve these skills.

2.3.3 BIRDS – SUPPLEMENTARY ASSESSMENT

Standardized Bird Survey Methodology and Spring Flight Activity Surveys

When IFC began the CEA in January 2015, several seasons of bird surveys conducted during the spring and autumn migration periods had already been undertaken at each of the WPPs. Not all of the surveys could provide flight activity data suitable for predicting species-specific collision rates using a CRM for MSBs, resident or summer breeding raptors, and other potentially "collision-vulnerable" species. As part of the outcomes of the scoping phase and to address data inconsistencies, a standardized methodology for undertaking bird surveys was prepared. The methodology could be used to develop defensible collision impact and displacement assessments, while taking account of cost efficiencies. See Annex F for a summary of the standardized bird survey methodology.

NRP designed and supervised the spring 2015 VP surveys for the three TRWPP sites where surveys were still taking place, namely LAMSA, KOSPO, and Abour. Surveys were designed to provide data representative of the flight activity over each of the WPP sites for the spring survey period, defined as March 1 to May 31, 2015. It should be noted that the JWPC Tafila project and the Fujeij WPPs had already conducted extensive bird surveys over multiple seasons and did not require additional data. CRMs conducted at these sites were also of high quality and in a format that could be merged with the LAMSA, KOSPO, and Abour data.

Collision Risk Modeling

This CEA used the "Band" CRM (Ban, Madders, and Whitfield, 2007). This model is the most widely used model for assessing the collision risk to birds in the wind power industry. The Band Model, which predicts the fatality rates of birds due to collision with rotor blades at a wind farm development site, has two stages:

- Stage 1 estimates the number of bird transits through the airspace swept by the rotors. This stage uses data on time spent at rotor height within the wind farm footprint derived from flight activity surveys at a development site and from data on turbine size, number, and layout.
- Stage 2 calculates the probability of a bird colliding with a rotor when making a transit through this airspace. It uses turbine-specific information on rotor blade size, blade pitch, rotation period, and the anticipated proportion of time that turbines will be operational as well as species-specific information on the length and wingspan of the birds and their flight speed.

Multiplying together the outputs of stages 1 and 2 provides an estimate of the number of collisions that would occur per unit time, assuming that the birds exhibit no avoidance behavior.

It is widely accepted that flying birds, including raptors, can avoid wind turbines (and other tall artificial structures) (Band, 2000). Birds may exercise avoidance by detecting the wind farm or turbine at relatively long distances (tens to hundreds of meters) and modifying their flight paths to avoid the structures (commonly referred to as far-field or macro avoidance). At closer proximity to turbines (less than approximately 10 m), birds may see an oncoming rotor blade and undertake evasive action (commonly referred to as near-field or micro avoidance).

To provide a credible prediction of the number of collisions that might occur, the product from stages 1 and 2 of the Band Model is adjusted down by an avoidance rate to take account of the assumed level of behavioral avoidance shown by the species under consideration. There is considerable uncertainty regarding actual avoidance rates. Typically, avoidance rates for raptors are assumed to be in the 95–99 percent range, meaning they successfully avoid the turbines on 95–99 percent of the transits through the rotor swept area, which would lead to collision if no avoidance action were undertaken (Scottish National Heritage, 2010). The actual avoidance rate for some species could potentially be higher or lower than this range. This CEA applied a precautionary (low) value as an avoidance rate.

Once adjusted for the avoidance rate, the CRM results provide an estimate of the number of collisions predicted to occur over the time frame examined, typically a season or year, or for the intended lifetime of the wind farm.

In the CEA, CRM annual fatality estimates were obtained for each species at all WPP sites where CRM-suitable data were collected. These rates were then used to estimate an overall predicted annual collision fatality rate for each species ***for the WPP sites combined***. These combined estimates were then used to calculate an LoE score that was based on the annual collision risk per individual (Section 3.4.1, Part 1), to inform threshold setting for priority bird VECs (Section 3.5.1, Part 1) and to inform adaptive management strategies by acting as a baseline measure for assessing actual fatality rates from postconstruction monitoring.

Database Compilation and Trends Analysis

The CRM provides species-specific estimates of annual collision-related fatalities on the basis of recorded flight behavior but does not explicitly allow an understanding of how flight activity varies between individuals (e.g., flocking), in different weather conditions, and at locations with different topographies. Each of these variables has demonstrated effects on the flight behavior and potential collision risk to MSBs.

To allow a more robust assessment of the likely collision risks to MSBs, large amounts of flight activity baseline survey data available from WPP sites[16] covering multiple spring and autumn migration seasons in 2013 and 2014 were compiled into a common database (see Annex D) and analyzed (See Annex E).[17] Such analysis was made possible through the willingness of the developers to share these data with the CEA team.

Although it was not possible to merge all available data into the database because of differences in survey methods, data were sufficient to assess the following trends:[18]

[16] The data sets of one WPP were not entered in the database owing to differences in the survey data collection methods.
[17] This yielded a large amount of data on MSBs from a relatively small area (approximately 150 km^2).
[18] Two statistical packages, STATISTICA 8.0 (Statsoft, 1998) and "R" (R Core Team 2014), were used to reveal flight activity patterns and understand how flight activity varied in different weather conditions and relative to topographical features, in particular the Rift Valley ridge.

- **Flocking behavior**: All species do not migrate in the same way—some fly in flocks and others fly individually. The impact of a single collision of one individual is not comparable to tens or hundreds of collisions as a consequence of a migrating flock passing through.
- **Landscape (topography) and weather conditions**: Flights and flying heights of MSBs are affected by the landscape and by wind and/or weather conditions, especially wind direction and/or strength.

The results and conclusions of the trends analysis informed the recommendations in the CEA (Section 3.6).

2.3.4 BATS – SUPPLEMENTARY RAPID ASSESSMENTS

Available Data

Only limited surveys were available for bats. Three of the five WPPs (Abour, JWPC Tafila, and Fujeij) carried out specific bat surveys as part of their ESIA or other assessments. A bat monitoring survey was carried out during the construction phase of JWPC Tafila, from April to October 2014. There have been no comprehensive bat surveys for the Dana BR, other than an unpublished rapid assessment to determine bat diversity and activity in the reserve.[19] Several research publications on bats, including a comprehensive review of bat species and their distribution in the country (Benda et al. 2010), were reviewed during the CEA.

Survey methods ranged from point counts and line transects to visits to locations where bat species were expected to occur, such as caves and water sources. Surveys used different instruments to record bat species and their activity, including the Song Meter SM2BAT (Fujeij) and Anabat SD2 recorder (JWPC Tafila, LAMSA, KOSPO, and Abour).

Supplemental Rapid Assessment

The CEA literature search (see Section 2.2.2) included a review of materials regarding bats. This was followed by a reconnaissance visit and rapid assessment in September 2015 that covered three of the wind farms in the TRWPP area: Abour, KOSPO, and LAMSA. This rapid assessment included a literature review and a rapid field assessment that covered the biodiversity in those areas and was not restricted to bats.

2.3.5 HABITATS AND OTHER SPECIES—SUPPLEMENTARY RAPID ASSESSMENTS

Available Data

Over the past 20 years, the Dana BR has been studied extensively as part of the baseline ecological surveys carried out there during the first Global Environment Fund (GEF)–funded project in the reserve.[20] All major taxa that exist in the reserve were covered, including vascular plants, large and small mammals, reptiles and amphibians, and birds. These assessments were followed by a series of ecological monitoring programs that spanned various time frames. Some of these programs were species specific, while others were more generic and habitat oriented.

Outside the Dana BR, ecological surveys were limited either to scattered visits to some specific locations to check the presence or absence of a certain taxon or part of the ESIAs for the proposed WPPs in the TRWPP area.

[19] Amr et al. (unpublished). Z. S. Amr and a group of national experts, including RSCN, are in the process of publishing a national assessment of the IUCN Red List for the mammals of Jordan. The extent of occurrence for the bat species were obtained from RSCN.
[20] Integrating Conservation with Development in the Dana Wildlands (1994–1999). The first project funded by the World Bank and the Global Environment Facility in Jordan, the Conservation of the Dana Wildlands and Institutional Strengthening of RSCN project, supported improvements in the management of the Dana Wildlands Reserve.

All participating WPPs have carried out habitat, flora and fauna surveys to some degree, and assessments of their respective sites. However, the surveys were brief and covered limited periods of certain seasons only. See Annex A for biogeographic zones and vegetation types of the study area.

During the ESIAs, related studies (some of which are not complete) were carried out for the WPPs. The methods used in the flora surveys included line transects and quadrats. Fauna surveys were used as route transects in addition to some observational records.

Supplemental Rapid Assessment

The CEA included a rapid assessment of the habitats and other species in the WPP area, predominantly consisting of a literature and available data review with very limited field visits. The CEA also included a literature and data review of the entire study area. The assessment highlighted the contrast in diversity between the Dana BR and the rest of the study area—which is probably due to the significant differences in topography of the area. For example, about 800 plant species, 51 mammal species, and 33 reptiles and amphibians were recorded within the reserve (MoENV, 2009), while only about 100 plant species, 8 mammal species, and 14 reptile species were recorded in the area of the WPPs.

2.3.6 SUMMARY OF DATA USED TO CONDUCT THE CEA

Table 6 summarizes the existing and supplemental data for each VEC that were used to conduct the CEA.

TABLE 6. SUMMARY OF VEC INFORMATION AVAILABLE ON THE TRWPP STUDY AREA

BIRDS	BATS	HABITATS AND OTHER SPECIES
• Preconstruction baseline survey results from the WPP sites in the study area. These are almost entirely limited to VP flight activity surveys undertaken during the spring and autumn migration periods between 2013 and 2015 • CEA Spring 2015 standardized surveys • CRM results • Distribution, abundance, and breeding status reports for individual species or species groups undertaken principally by RSCN and focused on the Dana BR • BirdLife International MSB Sensitivity Map Tool and other BirdLife datasets (including Flyway Populations and Global Breeding Distribution Size Estimates) • Published literature (academic research results) and other various guidelines (such as the IUCN Red List) (see References in Section 6) • Ornithologists with expert knowledge of Jordan and the Middle East • Database compilation and trends analysis (refer to Annexes D and E)	• Three limited bats surveys by the individual WPPs (Abour, JWPC Tafila, and Fujeij) during ESIA preparation and a bat monitoring survey during the construction period at the JWPC Tafila WPP (April–October 2014) • An unpublished rapid assessment to determine bat diversity and activity in the Dana BR; however, no comprehensive bat surveys for the reserve are available • Amr (2012) • Benda et al. (2010) • RSCN (and other academic) experts with knowledge of the bats of Jordan and the Middle East region • CEA supplemental rapid assessment	• Ecological assessments and monitoring of the Dana BR mainly carried out there during the first GEF-funded project in the reserve and ecological monitoring programs that spanned various time frames • Preconstruction baseline survey results from the TRWPP development sites. These included limited duration and scope habitat, flora and fauna surveys and literature reviews for the WPP sites • RSCN data and available national data including mapping of biogeographic zones and vegetation types including RSCN (2008) • RSCN (and other academic) experts with knowledge of habitats of Jordan and indicative species of those habitats • CEA supplemental rapid assessment

2.4 PHASE 3—CEA SIX-STEP FRAMEWORK AND ASSESSMENT

PHASE	ACTIVITY	TIME FRAME
Phase 3: Six-Step CEA Framework and Assessment	• Develop the frameworks • Apply the CEA frameworks for priority VECs • Obtain continuous review and feedback from the ERP • Consult regularly with the AC • Develop CEA findings and report	July 2015–March 2016

2.4.1 APPROACH

A key output from the CEA initiative is the six-step framework for assessing cumulative risks to birds from the WPPs and other external stressors in the study area. Developed during this CEA process, the framework was specifically designed to address how a CEA might be applied to migratory and resident bird populations with respect to the wind energy sector. The CEA framework for bats and that for habitats and other species is adapted from the one developed for birds; however, owing to data limitations, it is a simpler four-step process rather than a six-step process.

The framework is based on internationally accepted approaches to risk assessment practices to identify priority VECs and aligns with IFC's GN6, as follows:

- Identify a list of **species populations/habitat** (i.e., receptors) in the study area (i.e., birds, bats, habitats and other species).
- Determine a relevant **unit of analysis (UoA)** by which effects can be measured.
- For each **receptor/species population** assess its **relative importance** in the TRWPP area.
- Assign the **vulnerability of each species population/habitat** at a national, regional, or international scale, depending on the UoA.
- Determine the likely **sensitivity** of each species population and/or habitat to potential cumulative effects at the TRWPP.
- Determine the **likelihood of effect** (LoE) on species population and/or habitat from the cumulative risks presented by the WPPs in the study area (e.g., the likelihood of bird populations colliding with TRWPP turbine rotors).
- Assign a risk rating (major, moderate, minor, or negligible) to each species population or habitat using an **ecological risk assessment matrix** to evaluate the sensitivity with the LoE scores for each species population/habitat.
- Identify priority VECs—these are the ones with a major or moderate risk rating.
- For priority bird VECs only, determine a "fatality threshold" appropriate to "maintaining and attaining long-term viability" of the species population.
- Identify mitigation, monitoring, and management measures to address the cumulative risks.
- Recommend institutional arrangements and information management proposals to support the implementation of the recommendations from the CEA.

The CEA frameworks are provided in detail in Section 3 for birds, in Section 4 for bats, and in Section 5 for habitats and other species. Figure 5 provides an overview of the frameworks as applied to the selected VECs.

The development of the methodology and the implementation of these steps followed an iterative process that incorporated key inputs at various stages from the ERP, the AC, and other stakeholders.

2.4.2 ASSUMPTIONS AND LIMITATIONS

Summarized in Table 7 are key limitations for the technical CEA assessments of birds, bats, and habitats and other species. Such limitations predominantly relate to knowledge and data gaps and deficiencies. Key gaps are noted along with a brief account of how they were addressed during the CEA process.

FIGURE 5. OVERVIEW OF CEA PROCESS FOR SELECTED VECs – BIRDS, BATS, AND HABITATS AND OTHER SPECIES

CEA FRAMEWORK STEPS: BIRDS	CEA FRAMEWORK STEPS: BATS	CEA FRAMEWORK STEPS: HABITATS AND OTHER SPECIES
Step 1: Develop species population list and identify unit of analysis	**Step 1:** Develop species list and identify unit of analysis	**Step 1:** Develop habitat map, other species list, and identify unit of analysis
Step 2: Identify species sensitivity	**Step 2:** Identify species sensitivity	**Step 2:** Identify habitat and other species sensitivity
Step 3: Conduct ecological risk assessment and identify priority bird VECs	**Step 3:** Ecological risk assessment matrix and identify priority bat VECs	**Step 3:** Ecological risk assessment matrix and identify priority habitats and other species VECs
Step 4: Identify thresholds for fatalities for each priority bird VEC		
Step 5: Identify mitigation and monitoring	**Step 4:** Identify mitigation and monitoring, and institutional arrangements and information management methods	**Step 4:** Identify mitigation and monitoring, and institutional arrangements and information management methods
Step 6: Determine institutional arrangements and information management		

TABLE 7. CEA SUMMARY OF KNOWLEDGE AND/OR DATA GAPS AND DEFICIENCIES – BIRDS, BATS, AND HABITATS AND OTHER SPECIES VECs

KNOWLEDGE AND/OR DATA GAP AND DEFICIENCY	HOW LIMITATION IS ADDRESSED WITHIN THE CEA
CEA Framework – Birds	
Relevant to MSB populations: Lack of up-to-date Rift Valley/Red Sea flyway population estimates based on systematic counts across the flyway using a standard methodology.	Flyway estimates were taken from BirdLife International. For each MSB these estimates are the maximum seasonal count recorded at any of the principal bottleneck sites in the Middle East spanning at least a 20-year period up to 2004/05. To safeguard against potential errors associated with changes to the size of flyway populations since they were established in 2004/05, MSB results related to relative importance in step 2 and thresholds in step 4 were moderated by the ERP and by reference to relevant research.
Relevant to year-round or summer resident breeding VEC species populations: Limited systematic and long-term survey species-specific information on Middle East, Jordan, or subnational population size, distribution, and population trends.	In the absence of this information, the ERP combined members' collective knowledge of each species. The ERP's extensive field-based knowledge of the birds within the Tafila region allowed a reasoned and informed approach to identifying birds most at risk from the cumulative effects in the study area in the absence of systematic census results.
Relevant to mortality rate from the CRM (CEA Step 3): • Limited or no flight activity data were available from outside the spring and autumn baseline monitoring periods (June–August and November–February). • Uncertainty about species-specific avoidance rates can lead to an over- or underestimate of the collision risk estimate.	Although populations are present at the study area during summer and winter periods, the CRM estimates are based only on data from spring and autumn migration periods, which may have biased the estimates. When a species population was known to be present during the nonsurvey periods, the CRM estimates were reviewed by the ERP and in some cases adjusted upward as a precautionary measure on the basis of additional qualitative evidence. The avoidance rate for raptors is typically 95–99 percent (i.e., raptors successfully avoid the turbines on 95–99 percent of transits through the rotor-swept airspace which would lead to collision if no avoidance action were undertaken). To safeguard against underestimating collision risk, a precautionary (low) avoidance rate was assumed for each raptor assessed for collision risk in step 3 of the CEA.
Relevant to the priority bird VECs threshold-setting process (CEA Step 4): Lack of quantitative information on external stressors—adverse impacts from other human activities in Jordan and elsewhere along the flyway; for example, illegal killing and power line electrocution.	Estimates of the magnitude of these effects were required to assess whether each priority bird VEC could sustain additional mortality from the WPPs in the study area and remain or become viable in the long term. The ERP provided very approximate indicative numbers for annual fatalities likely from each source.
CEA Framework – Bats	
Relevant to bat species population sizes and estimates: Lack of quantitative information about the population sizes and estimates of the bat species in the country.	After referring to national experts, it was agreed to avoid the use of population estimates for all bat species, and it was agreed to use the distribution of species in the country as the main reference point for all bat species. To produce that, the extent of occurrence for each species was calculated.
CEA Framework – Habitats and Other Species	
Relevant to habitat distribution in TRWPP and WPPs area: Several distribution maps for biogeographical zones and vegetation types have been referred to in national documents. These maps have been produced at different times using various approaches.	After referring to national experts in ecology and zoology, including RSCN, it was decided to use the latest digital version of the biogeographical zone map (NBSAP, 2015) and the latest digitized vegetation types map (Albert and Bore, 2003). It was agreed that although the precision and borders of the different zones and vegetation types are not accurate enough to produce solid conclusions without further field assessments, these maps were the best reference maps available at the time of writing the CEA report.

3. CEA Framework—Birds

3.1 OVERVIEW OF CEA FRAMEWORK FOR BIRDS

The CEA framework for bird VECs has two objectives:

- To determine which bird populations are at the highest risk from the potential cumulative effects of the TRWPP.
- To identify and propose mitigation, monitoring, and other management measures for developers and other stakeholders to address those risks and recommend institutional arrangements that facilitate a joint approach to managing the risks.

The CEA framework for birds follows the six-step process:

- **Steps 1–3**: The assessment part of the process. In step 1, a preliminary list of potentially at-risk populations is defined, and for each of these a relevant population scale (unit of analysis, UoA) on which to base an assessment is identified. In step 2, the *sensitivity* of each of these populations is evaluated and the least sensitive populations removed from the assessment process. *Sensitivity* comprises two components: *vulnerability*, a scoring of the conservation status at a scale relevant to the UoA; and *relative importance*, which is an estimate or judgment of the proportion of each population likely to use the study area. In step 3, the cumulative *likelihood of effect* (LoE) of the WPPs on each of the populations remaining in the process is estimated and those rated with the highest effect qualify as priority bird VECs. In this CEA, the LoE is measured and compared for each population principally using an estimate of the annual likelihood of collision per individual using WPP sites. The implementation of steps 1–3 incorporates key inputs at each stage from the ERP, the AC, and other stakeholders.
- **Step 4:** Determines a threshold of fatalities for each priority bird VEC, setting the point at which further loss is considered a risk to long-term viability of the population. Threshold setting takes into account species-specific biological and demographic parameters, the cumulative risk associated with WPPs, and the likely effects of external stressors on the population defined by the UoA. External stressors are human-derived effects not associated with WPPs and include illegal killing and electrocution by power line.
- **Step 5:** Identifies the measures recommended to form the Joint Mitigation and Monitoring Plan (MMP). Measures include on-site monitoring and mitigation activities; intersite monitoring activities, an adaptive management and response mechanism; and joint management and action plans focused on priority birds. The primary focus of monitoring and mitigation is to avoid fatalities of such birds and to accurately estimate their fatalities to facilitate compliance with thresholds and inform adaptive management responses. Measures to avoid fatalities include selectively shutting down turbines, identifying and responding to elevated-risk situations, and recording near-miss incidents, all of which trigger adaptive management responses.
- **Step 6:** Building on step 5, recommends institutional arrangements and information-sharing mechanisms.

The purpose and details of each step in the CEA framework for birds appear in Figure 6.

FIGURE 6. TRWPP CEA BIRD FRAMEWORK (DETAILED PROCESS FLOWCHART)

DATA AND EXPERT REVIEW PANEL (ERP) INPUTS	CEA BIRD FRAMEWORK STEPS	SCOPED "OUT"

Data and ERP inputs (Step 1, Part 1):

- TRWPP Survey results
- Dana and IBA List
- BirdLife Soaring Birds Sensitivity Mapping Tool

Data and ERP inputs (Step 1, Part 2):

- BirdLife flyway population
- ERP estimates of national population size
- BirdLife global breeding distribution size

Step 1: Develop Species Population List and Identify Unit of Analysis

Part 1: Develop Species Population List

- Determine a preliminary list of species populations.
- Scope species populations in or out of the preliminary list on the basis of survey data and expert review of each population in the TRWPP study area.

Part 2: Determine Species Population Categories and Identify Unit of Analysis

- Assign each population on Species Population List to one of four categories:
  Category 1 MSBs
  Category 2 Breeding and resident raptors
  Category 3 Other migrants and wintering
  Category 4 Other residents and summer breeding
- Identify unit of analysis (UoA) for each species population category.

Scoped "out": *Rarely occurring or locally extinct bird populations*

Bird Populations Scoped in move to step 2

Data and ERP inputs (Step 2, Part 1):

- UoA from step 1
- Percentage estimates of UoA overflying TRWPP sites & using TRWPP Study Area
- BirdLife global breeding distribution size estimates

Data and ERP inputs (Step 2, Part 2):

- Global IUCN Red List
- Arabian Regional Red List – Breeding populations (Draft, 2013)
- Conservation of Migratory Species – Category 2 List

Step 2: Identify Species Sensitivity

Part 1: Score *Relative Importance*

- Score *relative importance* for each species population in relation to UoA as high, moderate, low, or negligible.
- Consider biome-restricted species.

Part 2: Score *Vulnerability*

- Score *vulnerability* for each species population in relation to UoA. High, moderate, low, or negligible.

Part 3: Assign Species Sensitivity

- Assign *sensitivity* (high, medium, low, or negligible) rating according to *relative importance* versus *vulnerability* matrix.

Scoped "out": *Bird populations with negligible sensitivity*

Bird Populations with High, Medium, and Low Sensitivity move to step 3

Data and ERP inputs (Step 3):

- TRWPP CRM from selected TRWPP sites
- Trends analysis of more complete flight activity data set from TRWPP sites to highlight species with potentially higher collision risks than indicated by the CRM
- ERP assessment of collision risk

Step 3: Create Ecological Risk Assessment Matrix and Identify Priority Bird VECs

Part 1: Determine Likelihood of Effect

- Determine likelihood of effect (LoE) based on annual likelihood (in percent) per individual of colliding with TRWPP turbines.
- Use CRM to assess LoE for species population categories 1 and 2.
- Use ERP assessment of collision risk per individual for species population. categories 3 and 4, for which no CRM estimates are available.
- Adjust LoE for specific species populations based on trends analysis.

Part 2: Assign Risk Rating for Each Species Population

- Assign risk rating (major, moderate, negligible, low) according to *sensitivity* versus *LoE* matrix.

Part 3: Identify Priority Bird VECs of highest risk of impact

- Identify species with a **major or moderate** risk rating as **priority bird VECs**.

Scoped "out": *Species populations with negligible or low risk*

Priority Bird VECs move to Step 4

(*continued on next page*)

FIGURE 6. TRWPP CEA BIRD FRAMEWORK (DETAILED PROCESS FLOWCHART) (*continued*)

DATA AND EXPERT REVIEW PANEL (ERP) INPUTS	CEA BIRD FRAMEWORK STEPS	SCOPED "OUT"

Step 4: Identify Thresholds for Fatalities for each Priority Bird VEC

- Establish for each priority bird VEC a threshold of cumulative fatalities per year not to be exceeded.
- Identify actions and adaptive management efforts to be taken in response should thresholds be exceeded.

Inputs (to Part 1):

- BirdLife Flyway populations
- IUCN Red List information
- Species-specific biological and demographic parameters, e.g., survival rates, age of first breeding
- Estimated number of fatalities predicted at TRWPP sites
- Information on other stressors, e.g., poisoning, electrocution, hunting
- ERP assessments

Part 1: Threshold-Setting Process

- Review other approaches for setting thresholds.
- Data search and review on bird populations and external stressors.
- Review population size as determined by the relevant UoA.
- Identify additional mortality level that could impact the viability and/or sustainability of the population.
  - Stage 1 Test – Potential Biological Removal (PBR)
  - Stage 2 Test – Population Viability Analysis (PVA)
- Set thresholds based on ERP review informed by results of the PBR and PVA analysis and other relevant information.

Part 2: Decision Tree for Thresholds

- Review monitoring and mitigation measures, and define protocol for periodic review of fatalities and consequences for mitigation measures.
- Develop decision tree for the threshold system and the actions triggered as a consequence of exceeding thresholds. This decision tree forms the basis of the Adaptive Management Framework (step 5).

Step 5: Identify Mitigation and Monitoring

Develop Joint MMP, including

- **On-site:** on-site mitigation and monitoring activities, including shutdown protocol
- **Intersite Monitoring and Adaptive Management Framework:** coordinated intersite monitoring, including joint monitoring, considering the thresholds developed in step 4; description of collective actions recommended if thresholds for individual priority bird VECs are exceeded or an extreme event occurs that results in fatalities of a priority bird VEC beyond its threshold within a specific time frame or a high number of fatalities of more than one priority bird VEC within a defined time period
- **Joint Management and Action Plans:** focused on priority bird VECs

Step 6: Institutional Arrangements and Information Management

Outline recommendations for

- Institutional and governance arrangements for the implementation and monitoring of the CEA recommendations
- The MMP
- Proposed information management and information-sharing activities

3.2 STEP 1—DEVELOP SPECIES POPULATION LIST AND IDENTIFY THE UNIT OF ANALYSIS

3.2.1 METHODS

The purpose of step 1 is to identify all bird 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 should be measured.

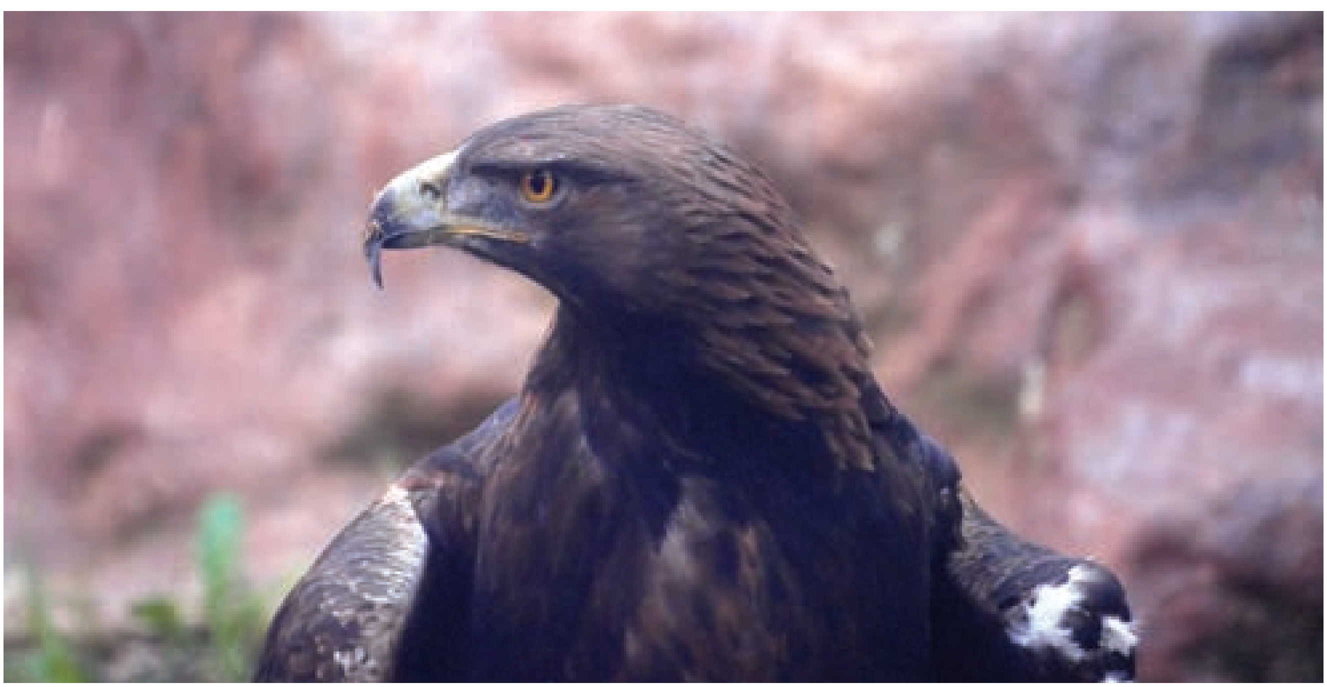
Part 1: Develop a Species Population List

Throughout the CEA the term "species population" identifies population groups within a species that use the study area. For example, a single species may be represented by both a population that migrates through the study area and another population that is resident in the study area.

Developing the Preliminary List of Bird Populations

At the outset, a preliminary list of bird populations was collated from three sources of information:

1. *Species populations recorded during the baseline surveys or identified as potentially occurring in a related report*: At the WPP sites within the study area, baseline surveys were conducted over a three-year period between 2013 and 2015, with each WPP site surveyed in at least one spring and one autumn season. Surveys prioritized the recording of detailed flight activity for species judged to be vulnerable to collision risk. In addition, occurrences of lower-risk species observed in flight over sites were recorded. Because the reasonably long period of preconstruction monitoring was conducted during seasons when the majority of species using the area are likely to be present, the number of species missing from the preliminary list is likely to be small. Species that may have been missed are likely to use the study area infrequently and/or be secretive and/or difficult to detect during surveys. For these reasons, the potential for this type of species to be identified as a priority bird VECs is likely to be low. Potential exceptions are species that may use the study area exclusively during a season or a time of day when no surveys were conducted.



Golden Eagle – *Aquila chrysaetos*

Lesser Kestrel – *Falco naumanni*

2. *Species present on the Dana IBA list*:
   As a precautionary measure, all species populations present on the Dana IBA list were included in the preliminary list.
3. *MSB species populations identified from running the Soaring Bird Sensitivity Map tool for the study area plus a 20 km buffer.*

The **Soaring Bird Sensitivity Map** tool allows users to define an area of interest and then returns a list of MSB species populations potentially occurring in the defined area, on the basis of a range of relevant datasets. The tool was run for the study area, buffered to 20 km, and the output list of species added to the preliminary list.

Screening of the Preliminary List

The ERP screened the preliminary list (see below). It was reviewed against studies and reports to identify species populations that were:

- Likely only to occur rarely as vagrants in the study area because either a migratory species did not use the Rift Valley/Red Sea flyway as its principal migration route or the distribution of a nonmigratory species did not include the study area.
- Originally listed as occurring in the Dana IBA but currently known to be locally extinct in the study area.
- Included in the bird survey reports of the individual WPPs as potentially present, but with no evidence to confirm that they were recorded.

Species populations fulfilling one or more of the above criteria were scoped out of the CEA process. Species populations not scoped out at this stage were assumed to be bird populations potentially at risk from the effects of TRWPP developments. This group of bird populations is referred to as the Species Population List and assessed for species sensitivity in step 2. For the Species Population List, see Annex G.

Part 2: Determine Species Population Categories and Identify the Unit of Analysis

Defining Species Population Categories

Recognizing that different species groups (e.g., large soaring birds and passerines) and different species ecologies (e.g., migrant and resident populations) in the Species Population List have different risk profiles in relation to effects from wind farms, species populations were classified into four categories as shown in Figure 7.

FIGURE 7. SPECIES POPULATION LIST CATEGORIES

Category 1: Migratory soaring bird populations	• MSB populations that migrate through the Rift Valley/Red Sea flyway, according to the BirdLife-UNDP Migratory Soaring Birds Project • MSB populations that could migrate through the WPP sites • Populations differentiated from other migrant populations (category 3) for their demonstrated or likely high vulnerability to collision with wind turbines
Category 2: Resident and summer breeding raptor populations	• Raptor (birds of prey) populations that are resident or summer breeding • Populations that may use the study area but do not migrate through the area • Populations differentiated from other resident populations (category 4) for their demonstrated or likely high vulnerabilty to collision with wind turbines
Category 3: Other migrants and wintering populations	• Populations that are not in categories 1 or 2 and do not breed in the study area but may migrate through or winter in the area
Category 4: Other resident and summer breeding populations	• Populations that are not in categories 1 or 2 and that potentially occur as resident or summer breeding populations • Populations that may use the study area but do not migrate through the area

Note: Category 2 raptors are diurnal raptors. Owls were assigned to category 4.

Identify the Unit of Analysis

The risk to bird populations on the Species Population List from the cumulative effects of WPPs within the study area varies, due in part to (i) the proportion of birds using the study area relative to a relevant reference population of which they are part and (ii) the conservation status of the population. In the CEA these factors are given the terms **relative importance** and **vulnerability**, respectively, and combine to give a measure of the **species sensitivity** (see step 2). Ideally the reference population UoA should be biogeographically determined; however, this was not possible because the origin of migratory birds using the study area is unknown, as is the biogeographical extent of resident and breeding populations (with the exception of the griffon vulture; (see box *Understanding the Unit of Analysis for Griffon Vulture* below). In the absence of this type of information, the UoA is defined at scales appropriate to spatially relevant conservation units (e.g., flyway, national, and global populations) and are at the same time relevant to the group characteristics of birds in each of the four categories. Based on review of the technical literature, availability of data, and the professional experience of the CEA team, UoAs were identified for the four categories as shown in Table 8.

TABLE 8. UNIT OF ANALYSIS FOR EACH SPECIES POPULATION CATEGORY

CATEGORIES OF SPECIES POPULATIONS	UNIT OF ANALYSIS	COMMENTARY
Category 1: **Migratory soaring bird populations**	Birdlife Rift Valley/Red Sea Flyway population	• Flyway estimates were taken from the BirdLife International document (Porter 2005). • The flyway estimate for a species population is defined as "the maximum seasonal count recorded at any of the monitored bottleneck sites" (Porter 2005).
Category 2: **Resident and summer breeding raptor populations**	National population (ERP estimate) Biogeographic population estimate for griffon vulture	• With the exception of the Griffon vulture, census-based national population estimates were not available for these species populations. • Minimum national population estimates relied on the judgment of the ERP based on their collective knowledge of each species.
Category 3: **Other migrants and/or wintering populations**	BirdLife global resident/breeding distribution size	• For migrant populations and wintering populations, there was little or no information on the origin of individuals occurring in the study area and—beyond presence and/or absence—no usable information about the number of birds likely to be present. As a consequence, BirdLife's global breeding distribution size[a] was used for each category 3 population to give a broad indication of the *relative importance* in step 2.
Category 4: **Other residents and summer breeding populations**	National population (ERP estimate)	• Census-based national population estimates were not available for these species populations. • Minimum national population estimates relied on the judgment of the ERP, based on their collective knowledge of each species.

a. Taken from Birdlife species fact sheets on http://www.birdlife.org/datazone/species/.

Understanding the Unit of Analysis for the Griffon Vulture

Unlike other species populations in the CEA, the south Jordan/Israel griffon vulture population is well studied and reasonably clearly defined. These studies have identified a griffon vulture population that uses breeding sites that extend from the Dana BR in the east, westward into the Judean and Negev desert in southern Israel. In addition, tagging studies demonstrate extensive adult foraging and chick provisioning ranges of this population. This understanding of the breeding distribution and movements of this population would reduce the relevancy of estimates of relative importance (step 2), threshold levels and external stressor effects (step 4) if these components of the CEA were measured against a UoA defined as the national population size. As a consequence, the CEA uses a biogeographically informed measure for the griffon vulture population size as its UoA.

3.2.2 RESULTS

The Preliminary List contained 196 species populations comprising 167 different species, of which 29 had 2 potential populations relevant to the study area.

After screening the Preliminary List, 25 species populations were removed. The Species Population List therefore comprised 171 species populations (Table 9). These were the populations regarded within the CEA as potentially at risk from the TRWPP and were therefore included within the scope of step 2. For the Species Population List and the list of 25 excluded species populations and the rationale for exclusion, see Annex G.

TABLE 9. SUMMARY RESULTS OF STEP 1

SPECIES POPULATIONS ON PRELIMINARY LIST	SPECIES POPULATIONS SCREENED OUT AT STEP 1	SPECIES POPULATION CATEGORIES	FINAL SPECIES POPULATION LIST
196	25	**Category 1:** MSB populations	24
		Category 2: Resident and summer breeding raptor populations	10
		Category 3: Other migrants and/or wintering populations	74
		Category 4: Other resident and summer breeding populations	63
		Total	171

3.3 STEP 2—IDENTIFY SPECIES SENSITIVITY

3.3.1 METHODS

The purpose of this step is to determine the species population sensitivity based on the relative importance of the study area to the population and its vulnerability at a national, regional, or international scale, depending on the UoA.

Part 1: Relative Importance Scoring

For each bird population, the relative importance proportional to the UoA was identified. The following section describes the process for identifying relative importance for the four species population categories.

Category 1: Migratory Soaring Bird Populations – Relative Importance

The *relative importance* for each MSB species population was defined as *an estimate of the proportion of the Rift Valley/Red Sea flyway population migrating through WPPs within the study area*. Owing to the practical difficulties of monitoring the entire flyway, the flyway population estimate for a species is given as the maximum seasonal count recorded at any of the Middle East bottleneck sites during the period of documented migration monitoring (Porter, 2005). To provide a comparable maximum seasonal count for birds overflying WPP sites, a seasonal survey at a single WPP was taken to be equivalent to a seasonal survey at a bottleneck location (a "watch-point survey"). Seasonal count estimates for individual WPPs were calculated using VP survey data. The highest count at any of the WPPs in any of the survey seasons was then compared with the flyway population estimate, as follows:

$$\text{Relative importance (\%)} = \frac{\text{Maximum seasonal count from single WPP site}}{\text{Maximum seasonal count from Rift Valley/Red Sea flyway bottleneck site}}$$

(i.e., flyway estimate from Porter [2005])

MSB "Broad Front" Migrant Exceptions

For some category 1 MSB populations, migration bottleneck counts have only limited relevance to the total number of birds using the flyway because these species often migrate singly or in small groups that are widely scattered across the width of the flyway corridor. They are also less averse to crossing areas of sea and so concentrate less at bottlenecks than do many of the larger raptor species.

For these MSB "broad front" migrants, the proportion of the flyway population relevant to the study area was determined slightly differently. If the maximum seasonal total for broad-front migrant species was below or approximately the same as the flyway estimate, it was assigned a low relative importance rating. If the maximum seasonal count was above the flyway estimate, the species was assigned a precautionary score of moderate for relative importance. The ERP corroborated this decision.

TABLE 10. RELATIVE IMPORTANCE SCORING FOR CATEGORY 1 MSB POPULATIONS

MAXIMUM ESTIMATED PERCENTAGE OF FLYWAY POPULATION PASSING OVER WPPs IN THE STUDY AREA (BASED ON HIGHEST SEASONAL COUNT AT ANY OF THE FIVE WIND FARM SITES), %	RELATIVE IMPORTANCE SCORE
≤ 1	Negligible
> 1 and ≤ 5	Low
> 5 and ≤ 10	Moderate
> 10	High

The *relative importance* for category 1 species populations was scored as negligible, low, moderate, or high using the criteria listed in Table 10.

Category 2: Resident and Summer Breeding Raptor Populations—Relative Importance
The *relative importance* of resident and summer breeding populations was defined as *the proportion of the national population using the study area*. Census-based national population estimates and detailed species

Griffon Vulture – *Gyps fulvus*

distributions do not exist for most species populations in this category in Jordan. To address this knowledge gap, the ERP provided minimum estimates of the national breeding population size, using expert opinion, and assigned an estimate of the proportion of the national population using the study area to one of four percentile ranges (Table 11, see column 1). Ranges were set with the intention that they would be appropriate for the level of accuracy provided by the ERP. Each proportional range was then assigned to one of four classes: high, moderate, low, or negligible.

TABLE 11. RELATIVE IMPORTANCE SCORING FOR CATEGORY 2—RESIDENT AND SUMMER BREEDING RAPTOR POPULATIONS

ERP ESTIMATE OF MAXIMUM PERCENTAGE OF NATIONAL POPULATION LIKELY TO BE USING STUDY AREA, %	RELATIVE IMPORTANCE SCORE
≤ 1	Negligible
> 1 and ≤ 5	Low
> 5 and ≤ 10	Moderate
> 10	High

For the griffon vulture, it was possible to define and estimate the size of a population whose breeding and foraging activities focused on southern Israel and southwest Jordan, using existing research (for example, Spiegel et al. 2015) and expert opinion (see box *Understanding the Unit of Analysis for Griffon Vulture*). This estimate was used instead of the national population to assess the *relative importance* of griffon vultures using the study area.

Biome-Restricted Considerations

Biomes are regions of the planet characterized by their vegetation (e.g., forests, grasslands, deserts) and controlled by their climate, latitude, geography, and topography. Birds, like other animals and plants, are to varying degrees adapted to specific biomes. Some species are so specialized in their adaptations to a biome's characteristics that they are not able to survive outside it. These "biome-restricted" species are also vulnerable to changes within their biome by reason of their restricted adaptations.[21] In line with this, the ERP recommended that biome-restricted species present within the Dana IBA[22] and occurring on the category 2 list (i.e., resident or summer breeding species populations) should have their *relative importance* scores adjusted to one level above the score determined (e.g., from negligible to low) by estimating the proportion of the national population using the study area. *Relative importance* scores were adjusted accordingly.

Category 3: Other Migrants and/or Wintering Populations—Relative Importance

For migrant and wintering populations, there is little or no information on the origin of individuals occurring at WPP sites and no usable information beyond the presence or absence of the number of birds in the study area. As a consequence, an estimate of *relative importance* for category 3 populations was derived from BirdLife estimates of global resident and/or breeding distribution size[23] (km^2). This necessarily crude approach was based on the reasoning that global breeding distribution size would give a broad indication of the *relative importance* of a migratory or wintering species occurring in the study area, in that populations with small distributions would get

[21] BirdLife International, at http://www.birdlife.org/datazone/sowb/casestudy/70.
[22] "Biome restricted species occurring in the Dana IBA, Jordan." Spreadsheet from BirdLife Middle East.
[23] http://www.birdlife.org/datazone/species/.

higher *relative importance* scores because their populations are likely to be more irreplaceable than populations with larger distributions.

The range size of global breeding distributions (Table 12, see column 1) was informed by the range of population distribution sizes documented by BirdLife,[24] with the exception of "restricted-range" species. For terrestrial vertebrates, a restricted-range species is one that has a global extent of occurrence of less than 50,000 km^2, as defined by IFC's GN6. Such species received a high *relative importance* score.

TABLE 12. RELATIVE IMPORTANCE SCORING FOR CATEGORY 3 RESIDENT AND SUMMER BREEDING RAPTOR POPULATIONS

BIRDLIFE GLOBAL RESIDENT AND/OR BREEDING DISTRIBUTION RANGE (KM^2)	RELATIVE IMPORTANCE SCORE
> 10,000,000	Negligible
> 1,000,000 and ≤ 10,000,000	Low
> 50,000 and ≤ 1,000,000	Moderate
≤ 50,000[a]	High

Notes: See species fact sheets at http://www.birdlife.org/datazone/species.
A number of guidance sources identify 50,000 km^2 as the upper limit for a "range-restricted" species.

Category 4: Other Resident and Summer Breeding Populations—Relative Importance

The *relative importance* for category 4 populations was determined using the same approach applied to determine *relative importance* for category 2 populations. The ERP provided a minimum estimate of the national breeding population size using expert opinion and assigned an estimate of the proportion of the national population using the study area to one of four ranges (Table 13, see column 1). Ranges were set to be appropriate to the level of accuracy that the ERP provided. Each proportional range was then assigned to one of four classes: high, moderate, low, or negligible.

TABLE 13. RELATIVE IMPORTANCE SCORING FOR CATEGORY 4 OTHER RESIDENTS AND/OR SUMMER BREEDING BIRD POPULATIONS

ERP ESTIMATE OF MAXIMUM PERCENTAGE OF NATIONAL POPULATION LIKELY TO BE USING STUDY AREA, %	RELATIVE IMPORTANCE SCORE
≤ 1	Negligible
> 1 and ≤ 5	Low
> 5 and ≤ 10	Moderate
> 10	High

Biome-Restricted Considerations

As with category 2 populations, any biome-restricted species in category 4 occurring in the Dana IBA had their *relative importance* scores adjusted to one level above the score determined (e.g., from negligible to low) by estimating the proportion of the national population that was using the study area.

[24] http://www.birdlife.org/datazone/species.

Part 2: Vulnerability Scoring

For each species population, *vulnerability* was scored using international and/or regional guidance on conservation status appropriate to its UoA and evidence of its vulnerability to wind farms. International guidance was applied to migrant and wintering species populations (categories 1 and 3) and regional guidance to the resident and summer breeding species populations (categories 2 and 4). Guidance used to assess *vulnerability* is summarized below. The criteria used to score *vulnerability* are summarized in Table 14.

- *IUCN Global Red List of Threatened Species*:[25] The IUCN Red List is globally recognized as the most comprehensive approach to assessing the conservation status of species, including birds. Individual species

TABLE 14. VULNERABILITY SCORING FOR EACH SPECIES POPULATION CATEGORY

	CATEGORY 1: MSB POPULATIONS	CATEGORY 2: RESIDENT AND SUMMER BREEDING RAPTOR POPULATIONS	CATEGORY 3: OTHER MIGRANTS AND/OR WINTERING POPULATIONS	CATEGORY 4: OTHER RESIDENT AND SUMMER BREEDING POPULATIONS
***Vulnerability* Guidance / Metrics**	• IUCN Global Red List of Threatened Species • Birdlife Species Vulnerability Index (SVI) • Convention on the Conservation of Migratory Species of Wild Animals (CMS) Category 2 Species	• IUCN Arabian Regional Red List for breeding bird populations • Birdlife SVI	• IUCN Global Red List of Threatened Species	• IUCN Arabian Regional Red List for breeding bird populations
		Vulnerability Scoring		
Negligible	• LC on IUCN Global Red List **and** SVI of 6 or below	• LC on IUCN Regional Red List **and** SVI of 6 or below	• LC on IUCN Global Red List	• LC on IUCN Regional Red List
Low	• VU or NT on IUCN Global Red List **and** SVI of 6 or below; or • LC on IUCN Global Red List and SVI of 7 or 8; or • CMS Category 2 Species **and** SVI of 6 or below	• VU or NT on IUCN Regional Red List **and** SVI of 6 or below; or • LC on IUCN Global Red List **and** SVI of 7 or 8	• NT on IUCN Global Red List	• NT on IUCN Regional Red List
Moderate	• VU or NT on IUCN "Global" Red List **and** SVI of 7 or 8; or • LC on IUCN Global Red List **and** SVI of 9 or 10; or • CMS Category 2 Species **and** SVI of 7 or 8	• VU or NT on IUCN Regional Red List **and** SVI of 7 or 8; or • LC on IUCN Global Red List **and** SVI of 9 or 10	• VU on IUCN Global Red List	• VU on IUCN Regional Red List
High	• CR or EN on IUCN Global Red List; or • 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 Regional Red List; or • VU or NT on the IUCN Global Red List **and** SVI of 9 or 10	• CR or EN on IUCN Global Red List	• CR or EN on IUCN Regional Red List

Notes: LC = Least Concern; NT = Near Threatened; VU = Vulnerable, EN = Endangered, CR = Critically Endangered.

[25] www.iucnredlist.org.

Egyptian Vulture – *Neophron percnopterus*

are assigned an extinction risk category: least concern (LC); near threatened (NT); vulnerable (VU); endangered (EN); critically endangered (CR). These risk ratings are one of the components used to assess *vulnerability* for migratory and wintering populations (categories 1 and 3) as they provide the most spatially relevant conservation status category for these populations.

- *Convention on the Conservation of Migratory Species of Wild Animals (CMS), Category 2 Species*: The Convention[26] (also known as the Bonn Convention) recognizes that the regional threat level to migratory raptors is not always captured by the IUCN Global Red List extinction risk categories. To address this issue, the "Memorandum of Understanding on the Conservation of Migratory Birds of Prey in Africa and Eurasia"[27] identifies species considered to have unfavorable conservation status at the regional level in Africa and Eurasia (see Annex 3 on category 2 species in the Memorandum of Understanding). This information was used in the CEA to better reflect the regional threat to migratory raptors occurring at the WPPs in the study area. In the CEA, MSB populations (category 1) that are on the Annex 3 list of category 2 species of the Memorandum of Understanding were treated in the same way as a species with a Vulnerable Global IUCN Red List category rating (thereby overruling their Global Red List category of Least Concern, if so classed). The only exception to this rule was steppe eagles. This species appears on the Annex 3 category 2 list of the Memorandum of Understanding but has recently been recategorized on the Global IUCN Red List as Endangered. In this case, therefore, the CEA used the global category to assess the vulnerability of this species in the CEA.

- *BirdLife Species Vulnerability Index (SVI)*: This index scores MSBs and other raptors on the basis of their vulnerability to the adverse effects of wind energy developments and power lines. Scores are informed by scientific literature and other relevant evidence relating to species behavior and documented effects at existing developments. The index uses a 10-point scale, with species at the highest vulnerability scoring 10. MSBs (category 1) and resident and summer breeding raptors (category 2) were assessed using this index. The relevant SVI score was determined using the output from the BirdLife-UNDP Soaring Bird Sensitivity Map tool.[28]

- *IUCN Regional Red List of breeding bird populations of the Arabian Peninsula*: This IUCN Regional Red List (Symes et al., 2015) was used to score *vulnerability* for resident and breeding bird populations (i.e., categories 2 and 4). It provides regional extinction risk categories for species that breed in Arabia and therefore gives a more geographically applicable assessment of vulnerability than the IUCN Global Red List.

[26] www.cms.int.
[27] http://www.cms.int/raptors/en. Accessed September 2015.
[28] http://www.migratorysoaringbirds.undp.birdlife.org/en/sensitivity-map.

Part 3: Assign Species Sensitivity

A matrix (Table 15) was used to determine *sensitivity* for each species population in step 2 using their *relative importance* and *vulnerability* scores.

TABLE 15. SPECIES SENSITIVITY MATRIX

VULNERABILITY	RELATIVE IMPORTANCE			
	High	Moderate	Low	Negligible
High	High	High	Medium	Low
Moderate	High	Medium	Low	Negligible
Low	Medium	Low	Low	Negligible
Negligible	Low	Negligible	Negligible	Negligible

3.3.2 *RESULTS*

From 171 species populations assessed for sensitivity in step 2, 130 were scored as negligible and scoped out, leaving 41 to be assessed for LoE in step 3. Table 16 summarizes the findings of step 2. Annex H provides full details of the species sensitivity results for each of the 171 species populations.

TABLE 16. SUMMARY RESULTS OF STEP 2

SPECIES POPULATION CATEGORIES	FINAL SPECIES POPULATION LIST FROM STEP 1 (SEE ANNEX G)	POPULATIONS SCOPED OUT AT END OF STEP 2 (NEGLIGIBLE SENSITIVITY)	SPECIES POPULATIONS SCOPED INTO STEP 3
Category 1: **MSB populations**	24	4	20
Category 2: **Resident and summer breeding raptor populations**	10	1	9
Category 3: **Other migrants and/or wintering populations**	74	74	0
Category 4: **Other resident and summer breeding populations**	63	51	12
Totals	**171**	**130**	**41**

3.4 STEP 3 – ECOLOGICAL RISK ASSESSMENT AND IDENTIFY PRIORITY BIRD VECs

3.4.1 *METHODS*

The purpose of this step is to identify priority bird VECs from the 41 candidate species populations scoped into step 3. Priority bird VECs are identified by evaluating the species sensitivity output from step 2 with the LoE output from this step, which is based on the annual likelihood of an individual colliding with TRWPP turbines for each of the candidate species populations.

Part 1: Determine Likelihood of Effect

LoE assesses WPP-related effects on species populations scoped into step 3. Collision with turbine blades is assumed to be the primary risk associated with WPPs for these populations. Recognizing this, the LoE was based on species-specific estimates of the annual likelihood of collision per individual bird for all WPP sites included in the CEA. Other demonstrated effects on birds from wind energy developments, specifically any direct habitat loss from building turbines and wind farm infrastructure and any effects of displacement and disturbance, were considered likely to have only small or negligible effects on populations because of their small effects on migration routes and the availability of large expanses of similar habitat adjacent to the WPP sites. The specific methods for determining the LoE for each species population category are detailed in the following subsections.

Category 1: MSB Populations and Category 2: Resident and Summer Breeding Raptor Populations

Collision with turbine blades is assumed to be the only potentially significant adverse effect for both migrating and resident raptor populations within each WPP site.

The LoE was determined using three factors:

1. An estimate of the *annual probability of collision per individual for all WPPs included in the CEA* was calculated by summing species-specific CRM estimates from the WPPs in the study area to obtain a number of predicted fatalities per year for all five sites combined. For category 1 MSB populations this number was divided by an estimate of the number of individuals migrating through the WPP sites. For category 2 resident and summer breeding raptor populations the summed CRM estimate was divided by the number of individuals estimated to be using WPP sites for foraging or other activities. Estimates of the number of MSB individuals were derived from analysis of spring 2015 baseline monitoring results. The number of resident or summer breeding individuals using WPPs was estimated by expert ornithological opinion (see Annex I for a more detailed explanation of how the LoE was calculated).
2. The results of the trends analysis using preconstruction survey data from the five WPPs were merged into a single database to enable the team to assess trends (see Annexes D and E).
3. A review by the ERP and ornithologists on the CEA team.

For each species population, the annual probability of an individual colliding with TRWPP turbines was assigned to categories (negligible, low, medium, and high) on the basis of the range of values in Table 17. Recognizing uncertainty surrounding the attribution of a single value to any collision risk estimate (Madders and Whitfield, 2006), these results were compared with the broader trends analysis (see Annex E). Where the trends analysis

TABLE 17. LIKELIHOOD OF EFFECT SCORING—CATEGORIES 1 AND 2 OF SPECIES POPULATIONS

ANNUAL LIKELIHOOD (PER INDIVIDUAL) OF COLLIDING WITH TRWPP TURBINE ROTORS, BEFORE ANY ADJUSTMENTS (%)	LoE SCORE
≤ 0.05	Negligible
> 0.05 and ≤ 0.1	Low
> 0.1 and ≤ 1	Medium
> 1	High

indicated that the *annual probability of an individual colliding with TRWPP turbines* may be higher than the calculated CRM results suggested, the LoE was increased by one level (e.g., from negligible to low) as a precautionary measure. The LoE rating was reviewed by the ERP and CEA team ornithologists. If the ERP provided additional information indicating that the CRM and trends analysis may not have adequately reflected the collision risk to a population, the LoE rating was adjusted. For example, the CRM results and trends analysis were based on very few data from the winter period, so if additional evidence provided by the ERP suggested the presence of resident raptor species during this period, the LoE category would be adjusted upwards.

Category 3: Other Migrants and/or Wintering Populations and Category 4: Other Resident and Summer Breeding Populations

For categories 3 and 4 species populations, no survey data were available for calculating CRM outputs. To obtain an assessment of the LoE similar to that for the categories 1 and 2 species, the ERP—guided in particular by those with extensive field experience of these populations within the study area—was asked to assess the annual likelihood per individual of colliding with TRWPP turbine rotors. To guide this assessment, the ERP first considered the likely number of individuals present in the study area, the number of months that the species was likely to be present, the proportion of flying time spent at turbine height, and the likelihood of a bird flying at turbine height avoiding collision. On the basis of these judgments, the ERP made an informed, qualitative assessment, assigning an annual likelihood per individual of collision for each species to one of four categories (negligible, low, medium, or high).

Part 2: Assign Risk Rating for Each Species Population

The matrix in Table 18 was applied to each species population scoped into step 3. It evaluated the species *sensitivity* score from step 2 with the LoE score from step 3 to determine a final risk rating, categorized as negligible, minor, moderate, or major.

TABLE 18. RISK RATING MATRIX

SPECIES SENSITIVITY	LIKELIHOOD OF EFFECT			
	High	Medium	Low	Negligible
High	Major	Major	Moderate	Minor
Medium	Major	Moderate	Minor	Negligible
Low	Moderate	Minor	Minor	Negligible

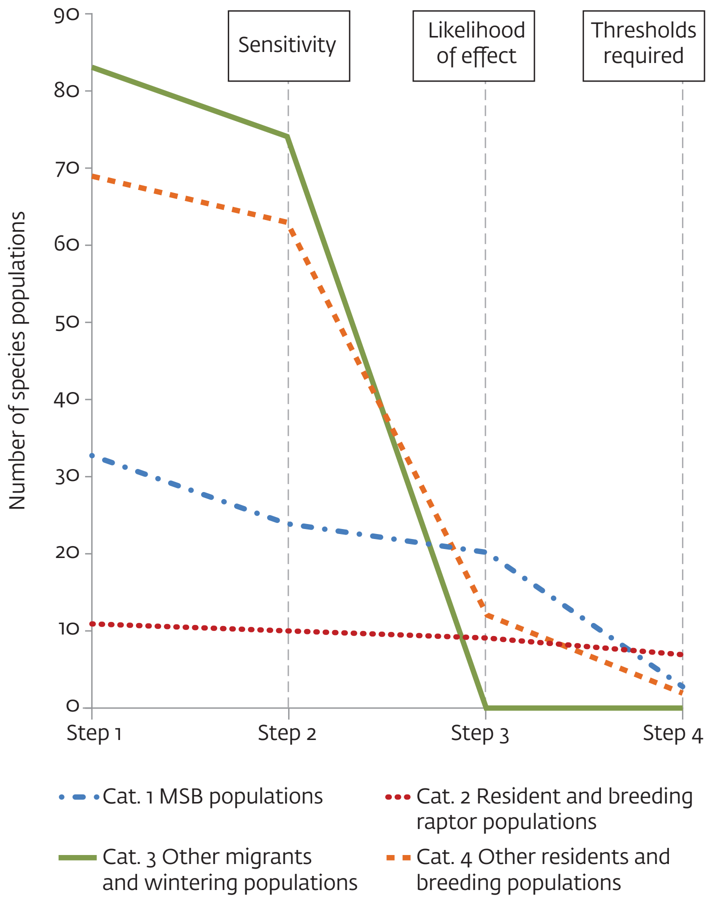
Part 3: Identifying Priority Bird VECs

Priority bird VECs were those species populations that were assigned major or moderate risk rating scores when their *species sensitivity* and *LoE* category scores were applied to the matrix in Table 18. Species populations with either a negligible or minor risk rating were not considered priority bird VECs. However, monitoring and mitigation protocols require postconstruction carcass searches around turbines for all species populations (see step 5), thus allowing for an iterative review of risks to all species populations that occur at WPPs in the study area.

3.4.2 RESULTS

Of the 41 species populations assessed in step 3, the CEA process identified 13 priority bird VECs: 4 MSB populations (category 1), 7 resident and/or summer breeding raptor populations (category 2), and 2 other resident

FIGURE 8. SCOPING OUT OF SPECIES POPULATIONS IN STEPS 1 TO 3 OF THE CEA



and summer breeding populations (category 4). Figure 8 illustrates the scoping out of bird species populations during steps 1 to 3 of the CEA process, from the initial 171 populations to the final 13, listed in Table 19. Annex J provides complete details of the *LoE* and final risk rating results. These 13 species populations are assessed as being at the highest risk from the cumulative effects of the WPPs in the study area. In step 4, each priority bird VEC population is assessed to determine the number of TRWPP-related fatalities that can be sustained without compromising its long-term population viability.

3.5 STEP 4 – IDENTIFY THRESHOLDS FOR FATALITIES FOR EACH PRIORITY BIRD VEC

3.5.1 *METHODS*

The purpose of step 4 is to determine for each priority bird VEC a threshold of TRWPP-related fatalities that should not be exceeded to avoid having an impact on the viability and sustainability of the species population. The threshold represents the "limits of acceptable change" that establish the trigger for adaptive management measures.

TABLE 19. PRIORITY BIRD VECs

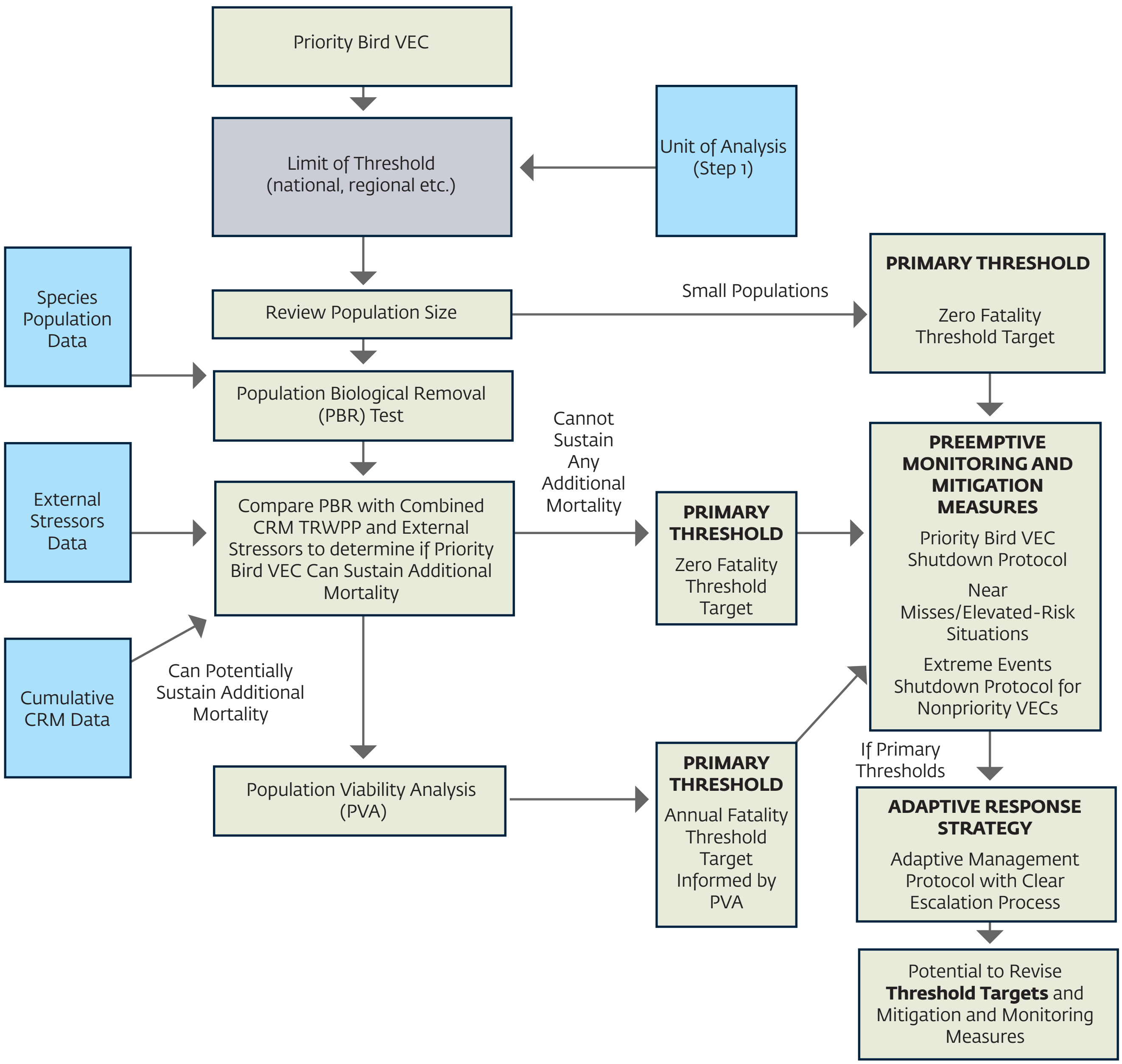
SPECIES POPULATION CATEGORY	SPECIES NAME	SPECIES SCIENTIFIC NAME
Category 1: MSB populations	Steppe eagle	*Aquila nipalensis*
	Egyptian vulture	*Neophron percnopterus*
	Eastern imperial eagle	*Aquila heliaca*
	Booted eagle	*Hieraaetus pennatus*
Category 2: Resident and summer breeding raptor populations	Short-toed snake-eagle	*Circaetus gallicus*
	Griffon vulture	*Gyps fulvus*
	Golden eagle	*Aquila chrysaetos*
	Verreaux's eagle	*Aquila verreauxii*
	Bonelli's eagle	*Aquila fasciata*
	Long-legged buzzard	*Buteo rufinus*
	Lesser kestrel	*Falco naumanni*
Category 3: Other migrant and wintering populations	No priority bird VECs	
Category 4: Other resident and summer breeding populations	Syrian Serin	*Serinus syriacus*
	European goldfinch	*Carduelis carduelis*

Step 4 has two parts: Part 1 identifies, for each priority bird VEC, a threshold number of TRWPP-related fatalities appropriate for maintaining or attaining the long-term viability of the population. Part 2 explains the threshold system and the actions triggered as a consequence of passing thresholds. These actions are summarized as a decision tree in Figure 9. The decision tree forms the basis of the adaptive management framework, described in detail in step 5.

Part 1: Threshold-Setting Process

The threshold-setting process was guided by related concepts within European and U.S. legal frameworks, specifically criteria underpinning "Favourable Conservation Status" (EC Habitats Directive, Council Directive 92/43/EEC) and "Optimal Sustainable Population" (pursuant to 16 USCS § 1362).

FIGURE 9. DECISION TREE FOR PRIORITY BIRD VECs




Wind power project in the construction phase

Approaches applied elsewhere in the wind sector for setting bird fatality thresholds were reviewed to evaluate their validity and appropriateness for assessing priority bird VEC thresholds at WPPs in the study area. Informed by this, a threshold-setting process was developed for this CEA. Thresholds were assessed for each priority bird VEC relative to the population size determined by their UoA. For example, for the MSB population of Eastern imperial eagle (category 1), the fatality threshold was assessed against the Rift Valley/Red Sea flyway estimate, whereas for the resident breeding population of Bonelli's eagle (category 2), the threshold was assessed against an estimate of the national population (see Table 8 in Section 3.2.1 for UoA for each species population category).

Threshold-setting process

1. **Small populations:** For each priority bird VEC, the estimated number of individuals in the UoA was reviewed. Where the minimum population size estimate for a species was small (20 individuals or less), it was assumed that any mortality from the TRWPP would adversely affect its population viability and a *zero fatality threshold target* was applied. To take a precautionary approach, this was the case even when the study area was not known to be an especially important habitat for such species.

2. **Larger populations:** For each priority bird VEC where the UoA population was greater than 20 individuals, the annual number of fatalities that could be sustained without compromising long-term viability was determined using a simple "potential biological removal" (PBR) analysis (see Box). This annual fatality estimate was then compared with the combined annual number of fatalities predicted from collision risk estimates at WPPs in the study area and from the effects of principal external stressors on the population, in particular illegal killing, power-line electrocution, and the taking of live birds.[29] (For more detail, see Annex K.) When these two fatality estimates combined exceeded the PBR level, an annual threshold of *zero fatality threshold target* was applied. When the PBR level was not exceeded, the ERP and CEA team ornithologists used their knowledge of the conservation status of the population to assess whether the result was (a) sufficiently close to the PBR to imply no WPP-related mortality was possible without an adverse effect on the population or (b) sufficiently below the PBR level to indicate that some WPP-related mortality was possible without an effect on population viability.[30] When the results of this effort were best described by (a), a *zero fatality*

[29] Information on the number of fatalities from external stressors is scarce for both the study area and Jordan as a whole, and typically relates to "incidental" reports of fatalities and their apparent causes. To address this information gap and make it possible to incorporate external stressors into an assessment of the viability of each population, the ERP identified principal stressors for the priority bird VECs and then gave approximate range estimates of the annual number of fatalities attributable to each stressor individually and all external stressors combined. Range estimates for annual fatalities were < 1, ≥ 1 and < 5, ≥ 5 and < 10, ≥ 10. (For details on procedures used, see Annex K).

[30] It is important that the PBR level is understood to be a crisis point for the population and not a threshold that can be adopted to maintain a viable population or to recover a declining population. The number of annual deaths that can be incurred by a population while maintaining its viability will be some way below the number of deaths predicted by the PBR level and cannot be predicted by this simple analysis.

threshold target was applied to the species. When it was best described by (b), a more complex population viability analysis (PVA) was conducted to inform the setting of an appropriate *annual fatality threshold target*.

3. **Populations where wind farm–related mortality may be possible without affecting viability:** For priority bird VEC populations where expert review informed by PBR analysis concluded that some additional mortality may be possible, a more complex PVA was available to assess future population trends under different scenarios for wind farm and external stressor mortality. For these species, *annual fatality threshold targets* (i.e., greater than zero birds per year) were set, using the judgment of the ERP informed by the results of the PVA analysis.

Potential Biological Removal (PBR) and Population Viability Analysis (PVA)

Potential Biological Removal analysis is a simple, robust, and precautionary test developed for situations in which information on species population biology is limited (see Wade, 1998; Neil and Lebreton, 2005; Dillingham and 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.

Population Viability Analysis is a more sophisticated modeling procedure that makes use of a wider range of species-specific biological and demographic parameters to model future population trends and therefore inform judgments about future population viability. The PBR and PVA methods have both been used to assess the effects of wind energy developments on birds. For example, PBR levels have been used to assess the effect of collision risk on red kite (*Milvus milvus*) populations at wind farms in Germany (Bellebaum et al., 2013); PVA has been used to assess the effects of wind energy developments on breeding Egyptian populations (Carrete et al., 2009) and to assess the impact of offshore wind farms on birds (Maclean, Frederikson, and Rehfisch, 2007; Wildfowl and Wetlands Trust (Consulting) Limited, 2012).

Primary Threshold Targets

- ***Zero Fatality Threshold Targets***
  Priority bird VEC populations that were assigned a *zero fatality threshold target* are subject to monitoring, mitigation plans and adaptive management designed to minimize the contact of these species with WPPs in the study area, and conservation actions designed to reduce the number of fatalities from other stressors. For these priority bird VECs, an adaptive management response is triggered when there is an elevated-risk situation or a near-miss incident (page 50 – Adaptive Management) or if a fatality occurs.

- ***Annual Fatality Threshold Targets***
  Priority bird VECs assigned an *annual fatality threshold target* are subject to the same monitoring and mitigation plans and adaptive management as *zero fatality threshold* populations. For these priority bird VECs, an adaptive management response is triggered when periodic review of the results of postconstruction carcass searches shows that the *annual fatality threshold target* has been exceeded.

Other Threshold Targets

- ***Extreme Events Threshold Targets***
  In addition to thresholds set for priority bird VECs, thresholds are required to alleviate the risk of multifatality events to a small number of populations that are not priority bird VECs. This is particularly relevant to WPPs in the study area because of the potential for flocks of specific nonpriority MSBs to occur in the area. For practical

Bedouin grazing livestock under wind turbines

reasons, such as the need for a quick decision in the field to avoid this type of extreme event, thresholds should be set to a standard flock size (regardless of species) and should be broadly informed by PBR levels of flocking species and estimates of external stressor fatality rates.

Adaptive Management

Adaptive management is triggered when target thresholds are exceeded and when new evidence acquired over time shows an increased or decreased risk to a priority bird VEC or an increased risk to a nonpriority population. Increased risk to priority birds requires that mitigation and management measures be revised to uphold thresholds and promote the long-term viability of the population. For priority bird VECs that exhibit a decreased risk over time, their primary threshold target may be reassessed, and revised or reassigned to reflect the reduced risk to their long-term population viability. Nonpriority populations that exhibit evidence of increased risk may be assigned as priority bird VECs, may have an appropriate threshold determined and may be subject to associated adaptive management response strategies. Adaptive management is a key component of threshold setting within the CEA as it provides a mechanism for dealing with the uncertainty associated with determining priority bird populations and with predicting thresholds for priority bird VECs.

Adaptive management strategies 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.

3. If needed, define a revised threshold target or limit of acceptable change.
4. Define the actions that will be taken if the new threshold or limit of acceptable change is exceeded.

This process is iterative, and the breaching of successive thresholds should be matched by an increase in the measures to protect and promote the viability of priority bird VEC populations.

Adaptive management responses are not limited to exceeded thresholds. Adaptive management may also be triggered in response to other events:

- Evidence of an increased risk to a population from other non-TRWPP sources that indirectly affects the threshold for TRWPP-related fatalities. For example, evidence of increased persecution during the operational phase of the WPPs may lead to reassigning a priority bird VEC with an *annual fatality threshold target* to a *zero fatality threshold target*.
- An elevated risk situation, in which a temporary increase in the level of risk to priority birds in the vicinity of turbines occurs as a consequence of changes in human behavior or environmental conditions. For example, increased activity of sheep grazing around turbines may result in an observed increase in vultures in the area, triggering an increase in monitoring effort and engagement with livestock owners.
- A near-miss incident, in which no fatality occurred but monitoring and mitigation protocols failed to alleviate the risk of collision; for example, where a request to shut down a turbine in response to an approaching priority bird was not completed before the bird flew through the rotor-swept area, leading to a review and revision of monitoring and mitigation protocols.

Part 2: Decision Tree for Thresholds

Shown in Figure 9, the decision tree explains the threshold system and actions triggered as a consequence of passing a threshold. In addition, the decision tree and proposed thresholds from step 4 provide the basis for developing mitigation and monitoring protocols, the adaptive management framework, and joint management and action plans for developers and other stakeholders (see step 5), as well as potential institutional arrangements (see step 6).

3.5.2 RESULTS

All 13 priority bird VECs were assigned to a *zero fatality threshold target* as a result of applying the threshold-setting protocol in step 4. Table 20 gives input data and results of the PBR analysis. Tables 21–33 summarize the outcomes of steps 1–3, the results of the threshold-setting process and a threshold target for each species.

Biological and demographic parameters required to conduct threshold-setting analyses were taken from existing species-specific studies for each priority bird VEC. Parameters derived from studies of populations within the Middle East region were used where they existed; otherwise the results of studies from the most appropriate population outside the region were used. Using surrogate parameters from different populations of the same species should provide reasonably similar parameter values, as was the case here. The two populations are similar in other aspects of their biology, e.g., migratory, nonmigratory populations. For the long-legged buzzard, steppe eagle, booted eagle, and short-toed snake-eagle, no species-specific parameter values were available so typical values for raptors of similar mass were used to give an indication of a likely threshold. Adult survival and age of first breeding are related to body mass in raptors (Newton, 1979; Newton, McGrady, and Oli, 2016); therefore, using surrogate species with similar mass should allow approximate predictions about the amount of mortality these priority bird VEC populations can sustain.

TABLE 20. POTENTIAL BIOLOGICAL REMOVAL ANALYSIS: INPUT DATA AND RESULTS FOR PRIORITY BIRD VECs, CATEGORY 1, MSBs, AND CATEGORY 2, RESIDENT AND SUMMER BREEDING RAPTORS

CATEGORY	SPECIES NAME	SPECIES SCIENTIFIC NAME	UNIT OF ANALYSIS	POPULATION ESTIMATE SOURCE	POPULATION ESTIMATE (NO. OF INDIVIDUALS)	IUCN CONSERVATION STATUS (GLOBAL RATING FOR CATEGORY 1, REGIONAL RATING FOR CATEGORY 2)	DEMOGRAPHIC PARAMETERS				
							SOURCE	AGE AT FIRST BREEDING	ANNUAL ADULT SURVIVAL (%)	RECOVERY FACTOR USED IN PBR	PBR LEVEL ESTIMATE, ANNUAL NO. OF FATALITIES
Category 1. MSB Bird Populations	Egyptian vulture	*Neophron percnopterus*	Flyway population	Porter, 2005	1,200	EN	Sanz-Aguilar et al., 2015 (Spain)	5	93%	0.1	5.2
	Steppe eagle[a]	*Aquila nipalensis*	Flyway population	Porter, 2005	76,600	EN	Katzner et al., 2006 (Kazakhstan)	4	92%	0.1	395
	Eastern imperial eagle	*Aquila heliaca*	Flyway population	Porter, 2005	556	VU	Katzner et al., 2006 (Kazakhstan)	4	92%	0.1	2.9
	Booted eagle[b]	*Hieraaetus pennatus*	Flyway population	Porter, 2005	2,000	LC	Newton, Davis, and Davis, 1989	4	96%	1	79
Category 2. Resident or Summer Breeding Raptor Populations	Short-toed Snake-eagle[b]	*Circaetus gallicus*	National population	Expert review	100	VU	Newton, Davis, and Davis, 1989	4	96%	0.1	0.4
	Griffon vulture	*Gyps fulvus*	Biogeo-graphic population	Expert review[c]	86	EN	Gouar et al., 2008 (France)	4	97%	0.1	0.3
	Golden eagle	*Aquila chrysaetos*	National population	Expert review	2	EN	No PBR analysis conducted. National population size estimate: small.				
	Verreaux's eagle	*Aquila verreauxii*	National population	Expert review	2	EN	No PBR analysis conducted. National population size estimate: small.				
	Bonelli's eagle	*Aquila fasciata*	National population	Expert review	22	LC	Hernández-Matías et al., 2011 (France)	4	91%	1	1.2
	Long-legged buzzard[d]	*Buteo rufinus*	National population	Expert review	200	LC	Kenward et al., 2000 (UK)	3	90%	1	14
	Lesser kestrel	*Falco naumanni*	National population	Expert review	200	NT	Hiraldo et al., 1996 (Spain)	2	71%	0.3	8.7

[a] No species-specific biological or demographic parameters available. Analysis uses an estimate of adult survival rate and age of first breeding for the Eastern imperial eagle (Katzner et al., 2006).

[b] No species-specific biological or demographic parameters available. Analysis uses an estimate of adult survival rate and age of first breeding for the red kite (*Milvus milvus*) (Newton, Davis, and Davis, 1989).

[c] Based on unpublished data from Israeli research ("International Workshop on the Future of Vultures in the Middle East," 19–21 October 2011. Organized by the National Parks and BirdLife Israel at Kibbutz Kfar Blum).

[d] No species-specific biological or demographic parameters available. Analysis uses an estimate of adult survival rate and age of first breeding for Eurasian (*Buteo buteo*) (Kenward et al., 2000).

TABLE 21. PRIORITY BIRD VEC (CATEGORY 1 MSB POPULATION) – EGYPTIAN VULTURE (*NEOPHRON PERCNOPTERUS*): REVIEW OF CEA STEPS 1 TO 3 AND RESULTS OF STEP 4 IDENTIFYING THRESHOLDS

STEP 2 (SENSITIVITY)	
% estimate of flyway population migrating through WPPs in the study area	5.6
CEA *relative importance* category score	Moderate
BirdLife Species Vulnerability Index (SVI) (wind farms and power lines)	10
IUCN global conservation status	EN
CEA *vulnerability* category score	High
Sensitivity category score	**High**
STEP 3 (LIKELIHOOD OF EFFECT)	
Annual likelihood (%) of collision per individual from CRM estimates	0.1
LoE category score, based on annual collision risk per individual	Low
LoE category adjustment, based on trends analysis and expert review	0
LoE category score adjusted	**Low**
Final Risk Category Rating for Priority Bird VECs	**Moderate**
STEP 4 (THRESHOLDS)	
PBR level (annual fatality estimate)	5.2
Cumulative non–wind farm effects based on (i)–(iii) (annual fatality estimate)	≥1 and <5
(i) Power line electrocution/collision (annual fatality estimate)	≥1 and <5
(ii) Illegal killing (annual fatality estimate)	≥1 and <5
(iii) Collection of live birds of prey (annual fatality estimate)	≥1 and <5
CRM estimate (annual fatality estimate)	0.07
Additional supporting information	
Primary Threshold Target	**Zero Fatality**

TABLE 22. PRIORITY BIRD VEC (CATEGORY 1 MSB POPULATION)—STEPPE EAGLE (*AQUILA NIPALENSIS*): REVIEW OF CEA STEPS 1 TO 3 AND RESULTS OF STEP 4 IDENTIFYING THRESHOLDS

STEP 2 (SENSITIVITY)	
% estimate of flyway population migrating through WPPs in the study area	0.4
CEA *relative importance* category score	Negligible
BirdLife Species Vulnerability Index (SVI) (wind farms and power lines)	9
IUCN global conservation status	EN
CEA vulnerability category score	High
Sensitivity category score	Low
STEP 3 (LIKELIHOOD OF EFFECT)	
Annual likelihood (%) of collision per individual from collision risk model estimates	0.1
LoE category score based on annual collision risk per individual	Low
LoE category adjustment based on trends analysis and expert review	2
LoE category score adjusted	**High**
Final Risk Category Rating for Priority Bird VECs	**Moderate**
STEP 4 (THRESHOLDS)	
PBR level (annual fatality estimate)[a]	395
Cumulative non–wind farm effects based on (i)–(iii) (annual fatality estimate)	>10
(i) Power line electrocution and/or collision (annual fatality estimate)	>10
(ii) Illegal killing (annual fatality estimate)	>10
(iii) Collection of live birds of prey (annual fatality estimate)	>10
CRM estimate (annual fatality estimate)	1
Additional supporting information	see below
Primary Threshold Target	**Zero Fatality**

a. No species-specific biological or demographic parameters available. PBR is based on parameters typical of large raptors.

A primary threshold of zero fatalities is recommended despite an apparent low collision risk estimate and a theoretically high PBR level if based on the flyway estimate (Porter, 2005). This decision was informed by the following species-specific uncertainties not accounted for in steps 2 or 3, and additional external stressor effects not accounted for by the three principal external stressor components used in step 4 to provide a standard measure of cumulative non–wind farm effects.

i. Records of Steppe Eagles in the study area and more widely in the south of Jordan during the winter period suggest that this species may be present as an early migrant and/or wintering in this area. The evidence for early migrant activity is corroborated by analysis of steppe eagle migration data at Eilat, Israel, that has identified a trend for increasingly early migration passage of this species (Zduniak et al., 2010). The preconstruction monitoring for all but one of the WPPs in the study area was not conducted during the late winter; consequently the overall number of individuals present may be higher than those recorded in the data available for the CEA. In addition, lower temperatures during the winter period are suboptimal for thermal development. Soaring raptors, including Steppe Eagles, which principally use thermals to aid flight on migration, may therefore make more use of near-ground turbulence in these cooler conditions. As a consequence, soaring raptors may fly at collision risk height for proportionately more time in winter than during the warmer spring and autumn periods when the majority of flight data for calculating CRM estimates were collected (Mallon, Bildstein, and Katzner, 2015).

ii. The PBR level for this species is likely to have substantially overestimated the annual number of individuals that if removed would result in a nonviable population in the long term. This is because more recent evidence suggests a significant decline in the Steppe Eagle flyway population since the figure used for the flyway estimate was recorded. Specifically, analysis of spring passage totals for Steppe Eagles at Eilat, Israel between 1977 and 2008 (Mallon, Bildstein, and Katzner, 2015) indicated a significant decrease in adults and juveniles, with totals reduced by at least 50 percent between the 1980s and mid-1990s. For long-lived species with a low reproductive rate such as large raptors, this potential rate of decline leads to a high level of uncertainty and risk about the number of human-derived fatalities that can be sustained by the population.

iii. A potentially substantial risk to the steppe eagle flyway population from power line–related electrocution (see references in BirdLife International, 2016a) in areas beyond the flyway (Levin and Kurkin, 2013) raises the possibility that the annual number of fatalities due to this type of risk may have a substantial effect on the steppe eagle flyway population.

iv. Other external stressors relevant to steppe eagle mortality have recently been demonstrated as a potential threat to the species. Specifically, the veterinary drug *diclofenac* responsible for large-scale declines in *Gyps* vultures in South Asia has recently been implicated in the death of steppe eagles (Sharma et al., 2014). The findings suggest that, as facultative scavengers potentially present in areas where *diclofenac* may be used as a veterinary drug,[31] steppe eagle populations may be exposed to and consequently adversely affected by *diclofenac* residues in carcasses. The population-level effects on the steppe eagle population as a consequence of *diclofenac* ingestion are unknown, unpredictable, but potentially substantial as multiple fatalities can occur at a single carcass.

TABLE 23. PRIORITY BIRD VEC (CATEGORY 1, MSB POPULATION) – EASTERN IMPERIAL EAGLE (*AQUILA HELIACA*): REVIEW OF CEA STEPS 1 TO 3 AND RESULTS OF STEP 4 IDENTIFYING THRESHOLDS

STEP 2 (SENSITIVITY)	
% estimate of flyway population migrating through WPPs in the study area	38.5
CEA *relative importance* category score	High
BirdLife Species Vulnerability Index (SVI) (wind farms and power lines)	9
IUCN global conservation status	VU
CEA *vulnerability* category score	High
Sensitivity category score	**High**
STEP 3 (LIKELIHOOD OF EFFECT)	
Annual likelihood (%) of collision per individual from CRM estimates	0.1
LoE category score based on annual collision risk per individual	Medium
LoE category adjustment based on trends analysis and expert review	0
LoE category score adjusted	**Medium**
Final Risk Category Rating for Priority Bird VECs	**Major**

(*continued on next page*)

[31] See information in BirdLife International. 2016b. Species factsheet: *Gyps coprotheres*. Downloaded from http://www.birdlife.org on January 27, 2016.

TABLE 23. PRIORITY BIRD VEC (CATEGORY 1, MSB POPULATION) – EASTERN IMPERIAL EAGLE (*AQUILA HELIACA*): REVIEW OF CEA STEPS 1 TO 3 AND RESULTS OF STEP 4 IDENTIFYING THRESHOLDS (*continued*)

STEP 4 (THRESHOLDS)	
PBR level (annual fatality estimate)	2.9
Cumulative non–wind farm effects based on (i)–(iii) (annual fatality estimate)	≥5 and <10
(i) Power line electrocution and/or collision (annual fatality estimate)	≥5 and <10
(ii) Illegal killing (annual fatality estimate)	≥1 and <5
(iii) Collection of live birds of prey (annual fatality estimate)	≥1 and <5
CRM estimate (annual fatality estimate)	0.11
Additional supporting information	
Primary Threshold Target	**Zero Fatality**

TABLE 24. PRIORITY BIRD VEC (CATEGORY 1, MSB POPULATION) – BOOTED EAGLE (*HIERAAETUS PENNATUS*): REVIEW OF CEA STEPS 1 TO 3 AND RESULTS OF STEP 4 IDENTIFYING THRESHOLDS

STEP 2 (SENSITIVITY)	
% estimate of flyway population migrating through WPPs in the study area	1.6
CEA *relative importance* category score	Low
BirdLife Species Vulnerability Index (SVI) (wind farms and power lines)	9
IUCN global conservation status	LC
CEA *vulnerability* category score	High
Sensitivity category score	**Medium**
STEP 3 (LIKELIHOOD OF EFFECT)	
Annual likelihood (%) of collision per individual from collision risk model estimates	0.1
LoE category score based on annual collision risk per individual	Low
LoE category adjustment based on trends analysis and expert review	1
Likelihood of Effect category score adjusted	**Medium**
Final Risk Category Rating for Priority Bird VECs	**Moderate**
STEP 4 (THRESHOLDS)	
PBR level (annual fatality estimate)	79
Cumulative non–wind farm effects based on (i)–(iii) (annual fatality estimate)	≥1 and <5
(i) Power line electrocution and/or collision (annual fatality estimate)	≥1 and <5
(ii) Illegal killing (annual fatality estimate)	≥1 and <5
(iii) Collection of live birds of prey (annual fatality estimate)	≥1 and <5
CRM estimate (annual fatality estimate)	0.05
Additional supporting information	see below
Primary Threshold Target	**Zero Fatality**

A primary threshold of zero fatalities is recommended despite an apparent low collision risk estimate and in theory, a moderately high PBR level, if based on the flyway estimate (Porter, 2005). This decision was informed by the following species-specific uncertainties not accounted for in steps 2 or 3, and additional external stressor effects not accounted for by the three principal external stressor components used in step 4 to provide a standard measure of cumulative non–wind farm effects.

i. Many of the fatality risks for the flyway population of booted eagles are poorly known and difficult to quantify, meriting a generally cautious approach.

ii. BirdLife International highlights power line electrocution as a major mortality factor that is threatening the booted eagle populations using the Rift Valley/Red Sea flyway with extinction, regionally or at a larger scale (BirdLife International, 2015).

iii. Habitat degradation, direct persecution, and human disturbance have caused declines in booted eagle populations in Europe (BirdLife International 2016c). It is likely that some if not all of these threats are present in parts of the Asian breeding range and African wintering range potentially occupied by individuals from the flyway population. The adverse effects of these threats were not included in the ERP assessment of fatalities due to the principal external stressors. As a result, the annual fatality estimate provided of between ≥ 1 and < 5 booted eagles may be a substantial underestimate of the actual annual mortality rate.

TABLE 25. PRIORITY BIRD VEC (CATEGORY 2, RESIDENT AND SUMMER BREEDING RAPTOR POPULATIONS) – SHORT-TOED SNAKE-EAGLE (*CIRCAETUS GALLICUS*): REVIEW OF CEA STEPS 1 TO 3 AND RESULTS OF STEP 4 IDENTIFYING THRESHOLDS

STEP 2 (SENSITIVITY)	
% estimate of national breeding population using the study area	>10
CEA *relative importance* category score	High
BirdLife Species Vulnerability Index (SVI) (wind farms and power lines)	7
IUCN regional conservation status	VU
CEA *vulnerability* category score	Medium
Sensitivity category score	**High**
STEP 3 (LIKELIHOOD OF EFFECT)	
Annual likelihood (%) of collision per individual from CRM estimates	15.9
LoE category score based on annual collision risk per individual	High
LoE category adjustment based on trends analysis and expert review	0
Likelihood of Effect category score adjusted	**High**
Final Risk Category Rating for Priority Bird VECs	**Major**
STEP 4 (THRESHOLDS)	
PBR level (annual fatality estimate)	0.4
Cumulative non–wind farm effects based on (i)–(iii) (annual fatality estimate)	≥5 and <10
(i) Power line electrocution and/or collision (annual fatality estimate)	≥1 and <5
(ii) Illegal killing (annual fatality estimate)	≥1 and <5
(iii) Collection of live birds of prey (annual fatality estimate)	≥5 and <10
CRM estimate (annual fatality estimate)	0.42[a]
Additional supporting information	
Primary Threshold Target	**Zero Fatality**

[a] Assuming half of flights through rotors relate to the resident population.

TABLE 26. PRIORITY BIRD VEC (CATEGORY 2 RESIDENT AND SUMMER BREEDING RAPTOR POPULATIONS)—GRIFFON VULTURE (*GYPS FULVUS*): REVIEW OF CEA STEPS 1 TO 3 AND RESULTS OF STEP 4 IDENTIFYING THRESHOLDS

STEP 2 (SENSITIVITY)	
% estimate of national breeding population using the study area	>10
CEA *relative importance* category score	High
BirdLife Species Vulnerability Index (SVI) (wind farms and power lines)	10
IUCN regional conservation status	EN
CEA *vulnerability* category score	High
Sensitivity category score	**High**
STEP 3 (LIKELIHOOD OF EFFECT)	
Annual likelihood (%) of collision per individual from CRM estimates	17
LoE category score based on annual collision risk per individual	High
LoE category adjustment based on trends analysis and expert review	0
LoE category score adjusted	**High**
Final Risk Category Rating for Priority Bird VECs	**Major**
STEP 4 (THRESHOLDS)	
PBR level (annual fatality estimate)	0.3
Cumulative non–wind farm effects based on (i)–(iii) (annual fatality estimate)	>10
(i) Power line electrocution and/or collision (annual fatality estimate)	≥1 and <5
(ii) Illegal killing (annual fatality estimate)	≥5 but <10
(iii) Collection of live birds of prey (annual fatality estimate)	≥5 but <10
CRM estimate (annual fatality estimate)	2.5
Additional supporting information Unpublished PVA analysis from Israeli study of the South Israel–Jordan population predicts population declines over the period 2015–2055.[a]	
Primary Threshold Target	**Zero Fatality**

[a] "International Workshop on the Future of Vultures in the Middle East," 19–21 October 2011. Organized by the National Parks and Birdlife Israel at Kibbutz Kfar Blum.

TABLE 27. PRIORITY BIRD VEC (CATEGORY 2, RESIDENT AND SUMMER BREEDING RAPTOR POPULATIONS): GOLDEN EAGLE (*AQUILA CHRYSAETOS*)—REVIEW OF CEA STEPS 1–3 AND RESULTS OF STEP 4, IDENTIFYING THRESHOLDS

STEP 2 (SENSITIVITY)	
% estimate of national breeding population using the study area	>10
CEA *relative importance* category score	High
BirdLife Species Vulnerability Index (SVI) (wind farms and power lines)	9
IUCN regional conservation status	EN
CEA *vulnerability* category score	High
Sensitivity category score	**High**
STEP 3 (LIKELIHOOD OF EFFECT)	
Annual likelihood (%) of collision per individual from CRM estimates	0.4
LoE category score based on annual collision risk per individual	Medium
LoEcategory adjustment based on trends analysis and expert review	0
LoE category score adjusted	**Medium**
Final Risk Category Rating for Priority Bird VECs	**Major**
STEP 4 (THRESHOLDS)	
PBR level (annual fatality estimate)	no PBR
Cumulative non–wind farm effects based on (I)–(iii) (annual fatality estimate)	≥1 and <5
(I) Power line electrocution and/or collision (annual fatality estimate)	≥1 and <5
(ii) Illegal killing (annual fatality estimate)	≥1 and <5
(iii) Collection of live birds of prey (annual fatality estimate)	≥1 and <5
CRM estimate (annual fatality estimate)	0.02
Additional supporting information A *zero fatality threshold target* is recommended. The national population of Golden Eagles is estimated at approximately two individuals. Consequently, any number of fatalities annually will adversely affect the viability of the population within Jordan.	
Primary Threshold Target	**Zero Fatality**

TABLE 28. PRIORITY BIRD VEC (CATEGORY 2, RESIDENT AND SUMMER BREEDING RAPTOR POPULATIONS)—VERREAUX'S EAGLE (*AQUILA VERREAUXII*): REVIEW OF CEA STEPS 1 TO 3 AND RESULTS OF STEP 4, IDENTIFYING THRESHOLDS

STEP 2 (SENSITIVITY)	
% estimate of national breeding population using the study area	>10
CEA *relative importance* category score	High
BirdLife Species Vulnerability Index (SVI) (wind farms and power lines)	10
IUCN regional conservation status	EN
CEA *vulnerability* category score	High
Sensitivity category score	**High**
STEP 3 (LIKELIHOOD OF EFFECT)	
Annual likelihood (%) of collision per individual from CRM estimates	
LoE category score based on annual collision risk per individual	Low
LoE category adjustment based on trends analysis and expert review	0
LoE category score adjusted	**Low**
Final Risk Category Rating for Priority Bird VECs	**Moderate**
STEP 4 (THRESHOLDS)	
PBR level (annual fatality estimate)	no PBR
Cumulative non–wind farm effects based on (i)–(iii) (annual fatality estimate)	≥1 and <5
(i) Power line electrocution and/or collision (annual fatality estimate)	≥1 and <5
(ii) Illegal killing (annual fatality estimate)	≥1 and <5
(iii) Collection of live birds of prey (annual fatality estimate)	≥1 and <5
CRM estimate (annual fatality estimate)	no CRM
Additional supporting information A *zero fatality threshold target* is recommended. The national population of Verreaux's eagle is estimated at approximately two individuals. Consequently, any number of fatalities annually will adversely affect the viability of the population within Jordan.	
Primary Threshold Target	**Zero Fatality**

TABLE 29. PRIORITY BIRD VEC (CATEGORY 2, RESIDENT OR SUMMER BREEDING RAPTOR POPULATIONS)—BONELLI'S EAGLE (*AQUILA FASCIATA*): REVIEW OF CEA STEPS 1 TO 3 AND RESULTS OF STEP 4, IDENTIFYING THRESHOLDS

STEP 2 (SENSITIVITY)	
% estimate of national breeding population using the study area	>10
CEA *relative importance* category score	High
BirdLife Species Vulnerability Index (SVI) (wind farms and power lines)	9
IUCN regional conservation status	LC
CEA *vulnerability* category score	Medium
Sensitivity category score	**High**
STEP 3 (LIKELIHOOD OF EFFECT)	
Annual likelihood (%) of collision per individual from CRM estimates	0.3
LoE category score based on annual collision risk per individual	Medium
LoE category adjustment based on trends analysis and expert review	0
LoE category score adjusted	**Medium**
Final Risk Category Rating for Priority Bird VECs	**Major**
STEP 4 (THRESHOLDS)	
PBR level (annual fatality estimate)	1.2
Cumulative non–wind farm effects based on (i)–(iii) (annual fatality estimate)	≥5 and <10
(i) Power line electrocution and/or collision (annual fatality estimate)	≥1 and <5
(ii) Illegal killing (annual fatality estimate)	≥5 and <10
(iii) Collection of live birds of prey (annual fatality estimate)	<1
CRM estimate (annual fatality estimate)	0.01
Additional supporting information	
Primary Threshold Target	**Zero Fatality**

TABLE 30. PRIORITY BIRD VEC (CATEGORY 2, RESIDENT OR SUMMER BREEDING RAPTOR POPULATIONS)—LONG-LEGGED BUZZARD (*BUTEO RUFINUS*): REVIEW OF CEA STEPS 1 TO 3 AND RESULTS OF STEP 4, IDENTIFYING THRESHOLDS

STEP 2 (SENSITIVITY)	
% estimate of national breeding population using the study area	>10
CEA *relative importance* category score	Low
BirdLife Species Vulnerability Index (SVI) (wind farms and power lines)	7
IUCN regional conservation status	LC
CEA *vulnerability* category score	Low
Sensitivity category score	**Low**
STEP 3 (LIKELIHOOD OF EFFECT)	
Annual likelihood (%) of collision per individual from CRM estimates	36.9
LoE category score based on annual collision risk per individual	High
LoE category adjustment based on trends analysis and expert review	0
LoE category score adjusted	**High**
Final Risk category rating for Priority Bird VECs	**Moderate**
STEP 4 (THRESHOLDS)	
PBR level (annual fatality estimate)	14
Cumulative non–wind farm effects based on (i)–(iii) (annual fatality estimate)	>10
(i) Power line electrocution and/or collision (annual fatality estimate)	≥1 and <5
(ii) Illegal killing (annual fatality estimate)	≥5 and <10
(iii) Collection of live birds of prey (annual fatality estimate)	>10
CRM estimate (annual fatality estimate)	1.5
Additional supporting information	
Primary Threshold Target	**Zero Fatality**

TABLE 31. PRIORITY BIRD VEC (CATEGORY 2 RESIDENT OR SUMMER BREEDING RAPTOR POPULATIONS)—LESSER KESTREL (*FALCO NAUMANNI*): REVIEW OF CEA STEPS 1 TO 3 AND RESULTS OF STEP 4, IDENTIFYING THRESHOLDS

STEP 2 (SENSITIVITY)	
% estimate of national breeding population using the study area	>1 and ≤5
CEA *relative importance* category score	High
BirdLife Species Vulnerability Index (SVI) (wind farms and power lines)	6
IUCN regional conservation status	NT
CEA *vulnerability* category score	Low
Sensitivity category score	**Medium**
STEP 3 (LIKELIHOOD OF EFFECT)	
Annual likelihood (%) of collision per individual from CRM estimates	21.7
LoE category score based on annual collision risk per individual	High
LoE category adjustment based on trends analysis and expert review	0
Likelihood of Effect category score adjusted	**High**
Final Risk Category Rating for Priority Bird VECs	**Major**
STEP 4 (THRESHOLDS)	
PBR level (annual fatality estimate)	8.7
Cumulative non–wind farm effects based on (i)–(iii) (annual fatality estimate)	≥5 and <10
(i) Power line electrocution and/or collision (annual fatality estimate)	<1
(ii) Illegal killing (annual fatality estimate)	≥1 and <5
(iii) Collection of live birds of prey (annual fatality estimate)	≥5 and <10
CRM estimate (annual fatality estimate)	2.2[a]
Additional supporting information Additional potential sources of mortality highlighted but not quantified by the ERP include indirect effects of pesticides affecting prey availability and disturbance to breeding sites (see also Liven-Schulman, Leshem, and Yom-Tov, 2004).	
Primary Threshold Target	**Zero Fatality**

a. Assuming half of flights through rotors relate to the resident population.

TABLE 32. PRIORITY BIRD VEC (CATEGORY 4 OTHER RESIDENT AND SUMMER BREEDING POPULATIONS)—SYRIAN SERIN (*SERINUS SYRIACUS*): REVIEW OF CEA STEPS 1 TO 3 AND RESULTS OF STEP 4, IDENTIFYING THRESHOLDS

STEP 2 (SENSITIVITY)	
% estimate of national breeding population using the study area	>10
CEA *relative importance* category score	High
IUCN regional conservation status	EN
CEA *vulnerability* category score	High
Sensitivity category score	**High**
STEP 3 (LIKELIHOOD OF EFFECT)	
Abundance at WPPs in the study area	common
Approximate number of months present	5
% of total flying time that the species likely to be flying at turbine height	1–10
Likelihood of Effect category score adjusted	**Low**
Final Risk Category Rating for Priority Bird VECs	**Moderate**
STEP 4 (THRESHOLDS)	
PBR level (annual fatality estimate)	no PBR
Cumulative non–wind farm effects based on (i)–(iii) (annual fatality estimate)	>10
(i) Power line electrocution and/or collision (annual fatality estimate)	<1
(ii) Illegal killing (annual fatality estimate)	>10
(iii) Collection of live birds of prey (annual fatality estimate)	>10
CRM estimate (annual fatality estimate)	no CRM
Additional information	see below
Primary Threshold Target	**Zero Fatality**

No PBR analysis was conducted for the Syrian Serin, and no flight data were available on which to base a collision risk estimate. In general, small passerines are not regarded as particularly sensitive to collision mortality at wind farms unless they perform elaborate aerial displays and are breeding within the wind farm footprint. This finch species does engage in complex flight behaviors but is not believed to breed within WPP development sites owing to a lack of suitable habitat. However, the Syrian Serin is known to occur in the vicinity of and within WPP sites during the postbreeding and early winter period (Khoury, 1998). There is therefore potential for birds to be displaced and/or disturbed as a consequence of activities associated with the construction and operation of turbines and the use of wind farm infrastructure. This, combined with evidence described below identifying additional pressures on the species within Jordan, implies that any additional TRWPP-related adverse effects incurred by the resident and/or breeding population should be minimized to ensure the long-term viability of the population. As a consequence, a *zero fatality threshold target* is suggested for Syrian Serin.

The following is noted:

i. The known core Jordan breeding population, predominantly located within the Dana BR, has apparently declined by about 20 percent to 500 breeding pairs, and its area of occupancy has declined by 25 percent since 1996 (Khoury, 2000), suggesting that the population is under environmental stress (likely habitat loss and/or degradation). As a result, the population is less likely to sustain additional mortality from WPPs in the study area.

ii. Overgrazing and indirect effects of drought conditions leading to reduced food availability could adversely affect the health of the Syrian Serin population in the study area (BirdLife International, 2016d).

iii. According to BirdLife International, the Syrian Serin is a biome-restricted species. Habitat degradation within its biome is likely to exert pressure on suitable habitat and potentially reduce the population carrying capacity of the area.

iv. Trapping of birds is an additional pressure on the population in Jordan.

Unlike raptor priority bird VECs, the Syrian Serin has relatively higher reproductive rates and can recover from population declines more quickly when adverse environmental or human-related effects abate or are rectified. The *zero fatality threshold target* for the Syrian Serin is therefore primarily intended as an adaptive management response trigger to appraise and enhance population health away from WPP sites rather than a trigger for turbine shutdown. Nonetheless, if the zero fatality threshold is exceeded for this species, adaptive management strategies to avoid further collisions should always be considered and implemented.

TABLE 33. PRIORITY BIRD VEC (CATEGORY 4, OTHER RESIDENT AND SUMMER BREEDING POPULATIONS)—EUROPEAN GOLDFINCH (*CARDUELIS CARDUELIS*): REVIEW OF CEA STEPS 1 TO 3 AND RESULTS OF STEP 4, IDENTIFYING THRESHOLDS

STEP 2 (SENSITIVITY)	
% estimate of national breeding population using the study area	>10
CEA *relative importance* category score	High
IUCN regional conservation status	EN
CEA *vulnerability* category score	High
Sensitivity category score	**High**
STEP 3 (LIKELIHOOD OF EFFECT)	
Abundance at WPPs in the study area	uncommon
Approximately number of months present	6
% of total flying time that the species likely to be flying at turbine height	1–10
Likelihood of Effect category score adjusted	**Low**
Final Risk Category Rating for Priority Bird VECs	**Moderate**
STEP 4 (THRESHOLDS)	
PBR level (annual fatality estimate)	no PBR
Cumulative non-wind farm effects based on (i)–(iii) (annual fatality estimate)	>10
(i) Power line electrocution and/or collision (annual fatality estimate)	<1
(ii) Illegal killing (annual fatality estimate)	>10
(iii) Collection of live birds of prey (annual fatality estimate)	>10
CRM estimate (annual fatality estimate)	no CRM
Additional supporting information	see below
Primary Threshold Target	**Zero Fatality**

No PBR analysis was conducted for the European goldfinch, and no flight data were available on which to base a collision risk estimate. In general, small passerines are not seen as particularly sensitive to collision mortality at wind farms unless they perform elaborate aerial displays and are breeding within the wind farm footprint. This finch species does engage in these complex flight behaviors, but its breeding status within WPP sites is unknown. Although this species does not have traits that are likely to result in collision having an adverse effect on population viability, a primary *zero fatality threshold target* is suggested. This is a precautionary measure based on evidence that the principal adverse effect documented for this species within Jordan relates to high live-trapping pressure that has resulted in a perceived decline of 50–70 percent of the population since 2000. It has been suggested that the situation may be worse than these figures suggest, with the breeding population in the Arabian Peninsula approaching the IUCN Critically Endangered category (Symes et al., 2015).

Unlike raptor priority bird VECs, the European goldfinch has relatively high reproductive rates and can recover from population declines more quickly when adverse environmental or human related effects abate or are rectified. The *zero fatality threshold target* for the European goldfinch is primarily intended as an adaptive management response trigger to appraise and enhance population health away from WPPs rather than a trigger for turbine shutdown. Nonetheless, if the *zero fatality threshold* is exceeded for this species, adaptive management strategies to avoid further collision should be considered and implemented.

3.6 STEP 5 – IDENTIFYING MITIGATION AND MONITORING

3.6.1 METHODS

The purpose of this step is to identify the potential joint mitigation and monitoring measures for developers and other stakeholders to consider. The joint program focuses on the 13 priority bird VECs determined by steps 1 to 3 of the CEA to be at highest risk from the cumulative effects of the TRWPP.

The Joint MMP is structured around three areas:

- **On-Site Mitigation and Monitoring Measures**, including a protocol for shutdown on demand.
- **Inter-Site Monitoring and Adaptive Management**, through coordinated monitoring, including joint monitoring considering the thresholds and decision tree developed in step 4 (see Figure 9), and a description of collective actions recommended if thresholds are exceeded or an extreme event results in high fatalities well beyond a threshold target.
- **Joint Management and Action Plan** for **developers and other actors and/or stakeholders** focused on priority bird VECs as determined by the CEA process.

3.6.2 RESULTS

As part of the CEA, an MMP is proposed, to be implemented by the developers with recommended actions for other stakeholders (Table 34). This joint plan is designed to complement the project-specific ESMMPs developed for individual WPPs. Whereas each ESMMP contains commitments relevant to the individual WPP sites, the joint CEA MMP contains actions that require collaboration between the developers to be carried out together. The joint CEA MMP focuses on the highest-risk issues—the potential cumulative effects on birds—with some measures also being applicable in the CEA for priority bats (see Section 4). The joint approach presents cost-saving opportunities for developers.

TABLE 34. PROPOSED MMP—PRIORITY BIRD VECs[a]

NO.	RECOMMENDATION MEASURE	EXPLANATORY NOTES	KEY AIMS AND OBJECTIVES	PROPOSED RESPONSIBLE ENTITY	TIME FRAME FOR IMPLEMENTATION	OTHER INVOLVED ENTITIES
		WORKSTREAM 1: ON-SITE MITIGATION and MONITORING MEASURES				
1.1	**Protocol development and design**	Before the start of on-site mitigation and monitoring activities, detailed and clear protocols should be defined for all relevant components detailed in recommendations 1.2–1.5 and integrated into the project-specific ESMMP. Protocols should be designed by an ornithologist experienced in assessing bird risk at wind farm developments. They should be based on good practice guidelines for the wind energy industry and informed by preconstruction survey results and any other relevant information.	To provide consistent methods for monitoring and mitigation that provide results that are temporally and spatially comparable	Developers	Approved protocols three months prior to operations	Protocols should be reviewed and agreed with IFC.
1.2	**In-flight monitoring of priority birds**	In-flight monitoring is a bird surveillance program that is designed to monitor activity and track the flight paths of priority birds relative to operational wind turbines. Birds are monitored by trained and experienced bird field observers. The principal aim of in-flight monitoring is to avoid collisions of priority birds with turbine blades. To achieve this, field observers identify flight paths that are likely to result in collision and prevent collision by initiating a temporary shutdown of one or more turbines (see 1.3) until the birds are no longer at risk. Additional aims are to (i) record levels of flight activity and flight paths of priority birds and (ii) document evidence relating to all elevated-risk situations in which individual birds may be at risk of collision in the future if behavior patterns persist. **Guidance relating to the implementation of in-flight monitoring:** **Priority Bird Focus:** Monitoring is recommended to focus on priority bird VECs. If there is doubt about identifying a priority bird VEC during monitoring, the observed bird should be treated as a priority bird VEC as a precautionary measure. The opportunity should be taken to also record other species. **Vantage Points:** Suitable VPs should be established at strategic locations at each wind farm site. The numbers and location of VPs will be informed by the size of the site, topography, turbine number and layout, and the known activity patterns of priority bird VECs at the site. **Field Observers:** Field observers/surveyors should use VPs but be "mobile," i.e., move around the site on the basis of their observations and judgment, especially with respect to griffon vulture movements, which will likely follow livestock. The number of field observers depends on the wind farm size, topography, number of turbines, and turbine layout, and may vary between the migration and nonmigration seasons. Field observers should also consider the presence of Bedouin flocks of sheep within and near the wind farm area; presence of either could result in greater presence of certain priority bird species (e.g., griffon vultures)—see 1.6 and 3.2 on the monitoring of griffon vultures relative to livestock movements. **Survey Effort/Schedule**: A survey schedule should be designed before the start of monitoring. The monitoring effort should be adaptive, as described in 1.7. During the spring (i.e., late February to mid-May) and autumn (i.e., late August to mid-November) migration seasons, field observers should be on site undertaking daily in-flight monitoring. As many of the priority birds are resident or summer breeders in the study area, in-flight monitoring is also recommended outside the migration seasons. A similar level of effort to that undertaken during the migration season is recommended during the summer months, when these priority birds may forage in the area. The level of effort of monitoring may be lower during the winter period. **Survey Times:** The timing of survey windows during a day should be open to the judgment of the field team coordinator. Survey windows should be targeted to occur at likely periods of peak activity, based on knowledge of temporal and diurnal flight activity patterns of migratory and nonmigratory priority bird VECs in the study area, environmental conditions, and feedback from previous survey sessions. **Training:** Field observer training should principally focus on (i) identification of priority birds; (ii) priority bird behaviors; (iii) guidance on survey protocols and recording of flight activity information, and (iv) turbine shutdown request protocols (see 1.3). It is likely that external bird specialist field observers will be required on site as part of the migration season monitoring program. Trained wind farm staff could augment the monitoring teams during the migration season and undertake the role of field observer during the summer and winter seasons outside the migration seasons, as long as appropriate training is provided. Identifying bird species in flight requires skill and considerable practice. When more than one wind farm is operational, there may be an opportunity for developers to consider a joint program of training field observers, which could form part of the Joint Management and Action Plan (i.e., under Recommendations **Workstream 3**).	To avoid collisions of priority birds with wind turbines by identifying flight activity and elevated-risk situations likely to result in collision and using this information to inform appropriate the temporary shutdown of individual turbines.	Developers	**Workstream 1** of this MMP will be in effect for an initial three-year period and will be evaluated after this time to assess its effectiveness and determine ongoing needs. See recommendation 1.7 of this MMP for a description of the adaptive management review process during this initial three-year period.	Lenders: Operational monitoring will form part of the ESMMP for a wind project. Lenders will monitor the adequacy of implementation and outcomes. MoENV: The MoENV has a regulatory audit function to verify that ESMMP measures within the project ESIAs are implemented.

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TABLE 34. PROPOSED MMP—PRIORITY BIRD VECs[a] (*continued*)

NO.	RECOMMENDATION MEASURE	EXPLANATORY NOTES	KEY AIMS AND OBJECTIVES	PROPOSED RESPONSIBLE ENTITY	TIME FRAME FOR IMPLEMENTATION	OTHER INVOLVED ENTITIES
		Recording Elevated-Risk Situations: As there is a zero threshold for all of the priority birds, developers should record elevated-risk situations in which a shutdown is not immediately required (see 1.3) but bird activity or changes in environmental conditions could result in a future fatality if they persist. Recording these situations will enable developers to act before the bird is in imminent danger and make necessary adjustments to the in-flight monitoring and/or undertake other adaptive management measures to reduce the risk of collision (see also 1.7). For the purpose of this MMP, elevated-risk situations are defined as those circumstances in which increased priority bird activity is observed in the vicinity of one or more turbines and/or where environmental or ecological conditions elevate the risk of priority bird collision. This may occur as a consequence of local changes in human activity (e.g., grazing of livestock around turbines that attracts vultures); specific environmental conditions (e.g. precipitation or low cloud resulting in increased priority bird activity at turbine height); ecological conditions (e.g., improved foraging habitat and/or increased prey availability leading to an area around turbines becoming a favored foraging area for priority bird populations, and/other changes in the landscape (e.g., waste disposal sites attracting birds to wind farm).				
1.3	**Observer-led Shutdown On-Demand for Priority Birds**	Observer-led shutdown on demand is an established method for mitigating the risk to birds of colliding with rotating wind turbine blades. It involves a coordinated team of field observers identifying situations in which birds are at risk of colliding with turbines and initiating a temporary shutdown of one or more turbines. Typically shutdown requests are made by members of the field team or the field team coordinator to the wind farm operator using a communication device (e.g., mobile phones, two-way radios). The same means of communication is then also used by field observers to assist shutdown decision making. **Observer-led Shutdown On-demand Protocols for Priority Birds**: Shutdown protocols should be developed for wind farms on the basis of flight activity information for priority birds from preconstruction surveys and other relevant sources. Protocols should include (i) conditions for shutdown and resumption of operation, (ii) mode of communications between field observers and wind farm operator, (iii) time frame required to initiate shutdown, and (vi) aspects to record in the event a shutdown occurs (e.g., wind farm operations response time). Rapid communication is critical to the success of shutdown mitigation. It can be a matter of minutes from shutdown to restart. Shutdown records should be reviewed by the developer (see 2.3) to see if there is a pattern or issues with specific turbines. **Conditions for Shutdown** When one or more individuals of a priority bird VEC is observed, the field observer should consider shutdown of specific turbines on the basis of 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 • distance from bird to turbine (i.e., distance within which a priority bird could be at risk)	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	Developers	The shutdown on-demand protocols of **Workstream 1** will be in effect for an initial three-year period and will be evaluated after this time to assess their effectiveness and determine ongoing needs. See 1.7 for a description of the adaptive management review process during this initial three-year period.	
1.4	**Carcass Search Surveys**	Carcass search programs use well-established methods for assessing fatalities at operational wind farms. They involve regular systematic searches of the ground surface around the base of turbines. The defined search distance from the turbine base is dictated by the distance that birds are thrown from the turbine after being struck and is based on the results of existing studies to determine fatality distribution around turbines, extrapolated to the specific dimensions of the turbines at the site. **General Guidance on Carcass Search Surveys for the TWRPP Sites** Carcass Search Surveys should be adapted, as needed, in response to the results of the calibration tests (see 1.5). **During the Spring and Autumn Migration Seasons:** The whole wind farm (i.e., area around all turbines plus buffer around turbine) should be searched for carcasses within a **one-week** period. The search program should aim to schedule a repeat survey of each turbine within seven days of the previous survey. **Outside the Spring and Autumn Migration Seasons** (i.e., during summer and winter): The area around all wind farm turbines (i.e., area of all turbines plus buffer around turbine) should be searched for carcasses during each **two-week** period. The search program should aim to schedule a repeat survey of a turbine within 14 days of the preceding survey. • The search distance around each turbine is recommended to be a radius equivalent to the height of a turbine blade plus 25 m. • The rationale for reduced effort outside migration season is that there are likely to be fewer carcasses during this period, given the reduced amount of bird flight activity.	To monitor and quantify collision fatalities of priority birds and other bird species so compliance with CEA fatality thresholds for priority birds can be assessed and fatality rates of nonpriority species can be monitored	Developers	**Initial three-year program**. Evaluated at the end of three years to assess its effectiveness, identify possible improvements, and recommend protocols and survey effort for carcass search surveys beyond the initial three year program.	

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TABLE 34. PROPOSED MMP—PRIORITY BIRD VECs[a] (*continued*)

NO.	RECOMMENDATION MEASURE	EXPLANATORY NOTES	KEY AIMS AND OBJECTIVES	PROPOSED RESPONSIBLE ENTITY	TIME FRAME FOR IMPLEMENTATION	OTHER INVOLVED ENTITIES
		• Results from carcass search surveys should be recorded on standardized forms and include the date, time, and search duration at each turbine as well as species and location details of any carcasses found. It is critical that a qualified ornithologist is involved to aid with the identification of carcasses, especially as only remnants of a bird may be available (e.g., feathers).				
1.5	**Calibration Tests for Carcass Search Surveys**	Calibration tests (or "correction factors") for carcass searches (1.4) are recommended as standard good practice for wind farm developments. These correction factors are required because of differences between actual and observed numbers of fatalities. Two tests are recommended for the TWRPP study area—*searcher efficiency trials and carcass removal trials*. If designed correctly, both trials can be conducted using the same carcasses. The type of carcass used should, within practical constraints, be as similar as possible to the type of expected fatalities—otherwise the estimate of carcasses removed can be substantially biased. It is recommended that game birds (e.g., chickens) not be used for the tests; options for other species could be discussed with the RSCN. The number and distribution of carcasses depends on a number of parameters, including the types of habitats and land uses within the site and topography. Generally, a bird consultant /ornithologist experienced in assessing bird risk at wind farms should plan and oversee the calibration tests and prescribe recommendations on the basis of the results. Both tests should be conducted in an area adjacent to and with similar characteristics as the wind farm site to avoid attracting priority bird VECs to turbines. **Searcher Efficiency Trial**: This trial tests the ability of searchers to detect carcasses on the ground. Marked carcasses are positioned across the trial plot by an experienced consultant without the knowledge of the searchers. Searchers examine the trial plot as if they were conducting carcass searches for wind turbine fatalities, and the number of carcasses they find is compared with the number of carcasses placed, to estimate the proportion of carcasses likely to be missed during the actual carcass search surveys. **Carcass Removal Trial:** This trial tests the rate of carcass scavenging in the vicinity of wind farm sites. In these trials marked carcasses are distributed across the trial plot and monitored until they disappear. The average carcass removal time is then used to correct fatality estimates. At TWRPP sites a key factor affecting carcass persistence is the removal of carcasses by dogs belonging to Bedouins using the area. Therefore, it is recommended that carcass removal trials in particular be designed to quantify the removal rate with and without the presence of Bedouin. Given that Bedouin use the TWRPP sites on a seasonal basis, it is recommended to conduct this trial biannually.	To calibrate the results of the carcass searches and determine a correction factor to account for potential numbers of missed fatalities due to searcher efficiency factors and removal of carcasses from the site (e.g., by dogs and/or other scavengers)	Developers	**Initial three-year program** as a component of carcass search program. Conducted at six-month intervals. Evaluated at the end of three years to assess its effectiveness in calibrating carcass search results and identify ongoing needs.	
1.6	**Baseline Understanding of Pastoral Movements**	The presence of livestock, which may include weak and/or injured animals, is known to directly increase attraction of certain priority birds (e.g., griffon vultures). Building on the findings of the in-flight monitoring (1.2) and the engagement (3.2), developers should seek to i. Develop an understanding of the pastoral/livestock movements around and within their sites during the different seasons. ii. Review and identify measures to encourage and/or incentivize owners and/or shepherds to inform the wind farm about presence of carcasses. It is recommended that developers periodically review with their in-flight monitoring team any noticeable trends in the presence of griffon vultures within the site or the vicinity of the site and/or study area, as well as observations of livestock movements (1.2).	To reduce the attraction of certain priority birds (e.g., griffon vultures) to the wind farm area and therefore reduce the likelihood of collisions occurring To inform shutdown on demand and the on-site flight activity monitoring design on the basis of knowledge of livestock presence within the TWRPP area	Developers	**Initial three-year program** running alongside the in-flight monitoring and carcass search programs	

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TABLE 34. PROPOSED MMP—PRIORITY BIRD VECs[a] *(continued)*

NO.	RECOMMENDATION MEASURE	EXPLANATORY NOTES	KEY AIMS AND OBJECTIVES	PROPOSED RESPONSIBLE ENTITY	TIME FRAME FOR IMPLEMENTATION	OTHER INVOLVED ENTITIES

1.7	**Adaptive Management**	**Adaptive management** will be based on a series of reviews to take place in different time frames, including an immediate response in the event of a fatality of a priority bird VEC.
		• **Monthly review of carcass search results:** Based on the standardized carcass search forms, a monthly report of carcasses and type of bird species will be compiled.
		• **Biannual reviews of in-field findings:** Results from in-flight monitoring, elevated-risk situations, near-miss incidents, monthly carcass search results, and incident reports (see below) should be compiled to evaluate and improve the effectiveness of monitoring and protocols, identify collision risk hotspots, evaluate adaptive management options and, where appropriate, implement those that are practical and most likely to be effective in reducing identified collision risks. Adaptive management responses emerging from the biannual review may include adaptions to monitoring and/or protocols but may also include other actions to take in the landscape, such as further engagement with Bedouin and/or the MoENV on other non-WPP landscape factors that might pose enhanced risks to birds (e.g., an increase in the number of waste management sites).
		• **Immediate action in the event of a fatality of a priority bird:** In this situation, the following should take place:
		  ◦ The incident should immediately be escalated to management, and an investigation of the likely cause of the fatality should take place. The investigation should review the implementation of in-flight monitoring and shutdown protocols, near-miss incidents, and the potential correlation with environmental factors and/or elevated-risk situations, among other factors. The investigation should be carried out by the developer's consultant and/or external ornithologists.
		  ◦ Once the investigation is completed, findings should be reviewed with site management and the developer-contracted ornithological specialist.
		  ◦ Corrective and/or remedial actions should be identified in relation to in-flight monitoring, shutdown protocols, and/or the need to address other elevated risks.
		  ◦ An incident report should be developed and shared with the MoENV, lenders, and the Internal Committee (see Workstream 2).
		It should be noted that **surpassing a threshold does not necessarily mean the shutdown of a turbine or turbines. The first action should be investigation into the in-flight monitoring and adjustment of it to reduce the risk of future collision events /fatalities.** Where a threshold is exceeded, it is likely that compensatory measures will be required to offset the loss to biodiversity. Such measures would need to be discussed with lenders and other relevant entities/regulators.
		• **Biannual reviews of protocols and integration into the project-specific ESMMP:** On the basis of the biannual reviews, protocols (see 1.2–1.5) should be reviewed to ensure that they incorporate lessons learned and are designed to minimize risks to priority birds. Updated protocols should be integrated as part of the project's overarching ESMMP.
		All of the above actions should be completed by a competent developer-contracted ornithological specialist and/or external specialist with substantial regional experience.
			To ensure that lessons learned are incorporated into protocols and that the project-specific ESMMP is designed to minimize risks to priority bird VECs
			Priority bird fatalities and/or exceeding of a fatality threshold could represent an incident of noncompliance with IFC Performance Standard 6.
				Developers		Lenders: Notification to lenders should occur between one to three days after detection of a fatality. See 2.1 for other reporting requirements.
						MoENV: See 2.1 for other reporting requirements.

1.8	**Recommendations for ESIA Studies – Birds**	Recommendations for project-specific ESIA studies are as follows: • Focus impact assessment and mitigation and monitoring measures for birds on avoiding collisions and reducing risks to *priority birds*. • Use the results of CEA and preconstruction survey data to inform the *micro-siting and layout of the wind farm* to avoid/reduce collision risks (along with other technical data and community issues such as land titles). • Building on the regional and social context (Section 1.8 and Annex A) of this CEA, the ESIAs should research further the social baseline context and specifically, land ownership and use of the WPP site and vicinity. This should include developing a greater understanding of pastoral movements (1.6). • On-site transmission lines at the wind farm should be buried. Developers should encourage NEPCO to design any transmission lines between the wind farm and the (offsite) substation to be in line with the avian and bat collision and electrocution protection measures presented in the World Bank Group's Environmental, Health, and Safety Guidelines for Electric Power Transmission and Distribution (2007).[b]	Avoidance of risk of collision in the micro-siting and layout of wind farms	Developers	During ESIA and/or planning of the layout of the wind farm	

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TABLE 34. PROPOSED MMP—PRIORITY BIRD VECs[a] *(continued)*

NO.	RECOMMENDATION MEASURE	EXPLANATORY NOTES	KEY AIMS AND OBJECTIVES	PROPOSED RESPONSIBLE ENTITY	TIME FRAME FOR IMPLEMENTATION	OTHER INVOLVED ENTITIES
		WORKSTREAM 2: INTER-SITE MONITORING ACTIVITIES and ADAPTIVE MANAGEMENT				
2.1	**Establishment and Operation of an Internal Committee**	It is recommended that an **Internal Committee** of developers be established to oversee a Central Data Center where data from the wind farms would be shared (see 2.2). The Internal Committee would be composed of representatives from each of the participating WPPs in the TWRPP study area. It is recommended that the **Internal Committee meet quarterly**. The Internal Committee would review immediate incident reporting, as well as monthly and biannual reporting (see 2.2) to assess cumulative issues and provide recommendations in relation to adaptive management responses and trends to inform planning of forward mitigation and monitoring, considering the whole of the study area. Reporting requirements that would be centralized in the Central Data Center are described under the next measure. **Biannual (two per year) meetings of the Internal Committee and the MoENV** are recommended to review reporting outcomes and adaptive management response proposals. These meetings could also be a forum to discuss progress and outcomes of Joint Management Plans (see Workstream 3). *The Internal Committee would require the participation of **competent developer-contracted ornithological specialists and/or external specialists with substantial regional experience.** It is also recommended that the Internal Committee maintain a dialogue with relevant conservation organizations to build relationships and provide a channel for input by external experts.*	To improve knowledge of priority bird activity across TRWPP sites and enable cumulative effects to be monitored and adaptive management responses to be determined	**Developers** – Internal Committee would convene to discuss the cumulative impact and adaptive response.	It is recommended that an Internal Committee be established when two of the wind farms are operational.	
2.2	**Data Sharing, Centralized Reporting, and Intersite Adaptive Management**	The reviews described in 1.7 and 2.1 will be collated into the reports (see below) and submitted to a Central Data Center accessible by all developers, which would be used for identifying any cumulative trends (see 2.1). The following reporting into the Central Data Center, is recommended: • **Monthly review of carcass search results** (see 1.7) • **Biannual reporting of in-field findings[c] and adaptive management responses, if any** (see 1.7) • **Incident reports of fatalities** (see 1.7) • **Updated protocols and/or updated ESMMP, as needed** (see 1.7) The MoENV has a regulatory function to audit whether ESMMP measures within the ESIA are implemented. Therefore, it is recommended that the Internal Committee (2.1) submit biannual reports (i.e., in December and June) and any incident report on fatality of priority birds to the MoENV and lenders. Where fatalities have been recorded through incident reports, the Internal Committee should evaluate adaptive management options and consider implementing those that are most likely to be effective in minimizing impacts across the study area. The number and distribution of all fatalities should also be used, along with in-flight monitoring information, to evaluate and improve the effectiveness of monitoring and to identify collision-risk hot spots. Where elevated-risk situations identified in the landscape are beyond the ability of one WPP developer to address on its own (e.g., waste disposal sites attracting birds to wind farm), the Internal Committee through the Stakeholder Forum (3.2) is encouraged to engage with other entities/stakeholders to encourage remedial and/or control measures and/or solutions. Last, the Internal Committee would also conduct an annual review of the priority bird list to ensure that it is based on the most current data available. For example, a change in a species' status on the IUCN Red List or additional data on external stressors might result in a species being added to or removed from the priority bird list.		**Developers** – to produce and share reports with Internal Committee **MoENV** – regulatory function and review of submitted data and/or biannual meeting with Central Data Center to discuss findings and any adaptive management responses required **Lenders** – oversight function to review biannual reports and to discuss findings and any adaptive management responses required	Data sharing to commence once at least two wind farms are operational. Initially data sharing should be agreed for a period of three years.	
		WORKSTREAM 3: JOINT MANAGEMENT and ACTION PLAN				
		Developer Lead and/or Contribution (with Some Other Entities Involvement):				
3.1	**Development of a CSR Fund**	• It is recommended that the developers contribute to a CSR fund in order to finance the planning and implementation of the Joint Management and Action Plan recommendations—such as 3.1(a) and 3.2. • These joint measures would afford an opportunity to the developers to manage issues in the landscape which attract priority birds and assist in managing the cumulative risks of WPP sites to priority bird VECs. There may also be financial economies of scale with the developers working together in this way to address certain risks. • It is recommended the CSR fund is used to procure a third-party consultant to establish, set up, and support the implementation of the Joint Management and Action Plan. • It is recommended that a **biodiversity offset (3.1(a))** be considered as part of a joint initiative to be funded by the CSR fund—*such an offset would be agreed to and financed by the developers **but** likely to be implemented by the RSCN and/or another conservation organization.*	CSR fund is to implement the CEA Joint Management and Actions Plans for developers and address other environmental and social issues In line with the precautionary principle, to help offset potential effects of wind farm fatalities of priority birds if exceedance of a threshold is likely to result in a net loss of biodiversity	Developer Lead—fund used to procure a third-party consultant to establish, set up, and support the implementation of the Joint Management and Action Plan Third-party consultant—establish a timed plan Time frame for the establishment of a Joint Management and Action Plan likely determined on the basis of when wind farms are operational **Offset measures considered only if a periodic review of fatalities at TRWPP sites concludes that an exceeded threshold is likely to result in a net loss of biodiversity**		

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TABLE 34. PROPOSED MMP—PRIORITY BIRD VECs[a] (*continued*)

NO.	RECOMMENDATION MEASURE	EXPLANATORY NOTES	KEY AIMS AND OBJECTIVES	PROPOSED RESPONSIBLE ENTITY	TIME FRAME FOR IMPLEMENTATION	OTHER INVOLVED ENTITIES
	3.1(a) Biodiversity Offsets	A "biodiversity offset" is a compensatory measure undertaken by a developer, usually implemented off site, to mitigate significant residual impacts on biodiversity (in this case, on birds). It is a last resort that is undertaken after all forms of on-site avoidance and mitigation have been pursued. Biodiversity offsets are on-the-ground benefits that would accrue to the affected biodiversity (e.g., birds) over time and therefore offset the impacts of the project. As such they are an important measure for achieving no net loss of biodiversity when all other mitigation measures have been exhausted. The thresholds in this report (Section 3.5,2) are designed to ensure that there is no net loss of priority bird VECs. They were developed taking a precautionary approach, as data on the breeding numbers of each priority bird were not available. Therefore, according to the modeling performed as part of this assessment and based on data available at that time, if a threshold is exceeded due to collision with a WPP in the study area, then the no net loss requirement for priority bird VECs will not be met. In these circumstances, in addition to adaptive management (as described in 1.7), biodiversity offsets should be considered. Biodiversity offsets would be targeted at breeding priority birds and focus on schemes to improve the health of these populations. Offset schemes would need to be undertaken in areas away from and unaffected by WPP sites (so as to not attract birds to the WPPs); they might, for example, be population recovery actions for priority species, achieved by improving reproductive output as a consequence of restoring degraded foraging habitat. In this example, increased productivity and survival resulting from improving habitat would offset losses at WPP sites. Biodiversity options should be considered in consultation with relevant stakeholders. Given the high-risk environment, it is recommended that developers take into account the costs involved in implementing biodiversity offsets during long-term project planning as they may be needed during the lifetime of WPPs. **If an offset were to be considered one of the first steps would be the following:** • **Joint Survey of Breeding Status of Priority Birds:** Understanding the extent to which priority birds are breeding in areas relevant to the WPP sites in the study area would help with two aspects: (i) to obtain further information which might refine the thresholds, and (ii) to identify areas of importance to priority birds that are off-site, which would aid in the identification of a relevant biodiversity offset activity. The initial survey would identify breeding areas relevant to WPP sites, and annual monitoring efforts would be minimal (several days or years). The survey would need to be carried out in cooperation with RSCN.				
3.2	**Establishment and Operation of a TRWPP Stakeholder Forum**	• WPPs would be required to collaborate to ensure International Lender compliance and to manage social risks to their project by establishing and implementing an engagement process with stakeholders. It is therefore recommended that the developers consider supporting the establishment of a TRWPP Stakeholder Forum, which could be used as the key communication mechanism with local and national level stakeholders. • The forum would enable routine, transparent, and coordinated engagement with Bedouin, local communities, and/or livestock owners who use the TRWPP area for grazing. It could be a mechanism to help build trust and support an ongoing dialogue to help manage related issues within the landscape (at wind farms and in the surrounding area) which may attract priority birds and therefore increase the potential for collisions to occur. • Engagement should be undertaken with livestock owners and/or shepherds to gather information and discourage leaving carcasses of *livestock* within the area of the wind farm and/or to encourage the owners and/or shepherds to inform the wind farm when a livestock carcass is present (see 1.5). • Regular meetings of stakeholder forums could be established, on a monthly, bimonthly, or quarterly basis. • This forum could also be used by law enforcement stakeholders (i.e., RSCN, the MoENV, and Jordan's Royal Department for Environmental Conservation) and local stakeholders (e.g., civil society organizations, public figures such as tribal leaders, and schools) to take action on illegal hunting. • Presenting the collective image of WPP sites in the Tafila region to the public and specifically to local communities may encourage a sense of ownership of and support for the projects. • The forum should be developed in conjunction with key local stakeholders (namely the mayor and community leaders such as tribal leaders) and the local MoENV governorate officer (part of the Environment Protection Directorates and Offices in governorates in the TRWPP study area).	To build greater trust with stakeholders in the TRWPP area			

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TABLE 34. PROPOSED MMP—PRIORITY BIRD VECs[a] *(continued)*

NO.	RECOMMENDATION MEASURE	EXPLANATORY NOTES	KEY AIMS AND OBJECTIVES	PROPOSED RESPONSIBLE ENTITY	TIME FRAME FOR IMPLEMENTATION	OTHER INVOLVED ENTITIES
		Recommendations for other entities				
3.3	**Education Program with Bedouin, Local Communities, and Other Stakeholders on Illegal Hunting**	• A program of education in relation to the effects of illegal hunting of priority birds (i.e., illegal killing and capture of live birds) is recommended by the CEA in order to address one of the external stressors to these species. • This is a key CEA recommendation that if implemented could positively influence the health of priority bird species populations using the study area. There is a consensus among experts in Jordan that the collection of live animals and the poaching of birds of prey are major threats to those species in Jordan in general and in southern Jordan specifically.	To help offset potential effects of wind farm fatalities of priority birds by reducing illegal killing and taking of live birds	Relevant conservation organizations in Jordan, including the RSCN		
3.4	**Encouragement of Transmission Line Protection Measures to Prevent Electrocution and Collision**	Efforts should be made to raise awareness among relevant governmental departments and commercial companies of the demonstrated adverse effects of unsafe transmission lines on large birds of prey. This could include advising power companies on safe pylon and power line design and the measures that could be taken to minimize fatalities after construction (i.e., in line with the avian and bat collision and electrocution protection measures presented in the World Bank Group's Environmental, Health, and Safety Guidelines for Electric Power Transmission and Distribution [2007]).	Developers	Developers encouraged during their standard project engagements and/or development processes to do this awareness raising when appropriate.		
3.5	**Improvement of Legal Framework for the Protection for Priority Birds**	Improvements to the legal framework are recommended and may comprise the following actions: • Reviewing the existing regulatory framework for the approval and operation of wind energy projects in Jordan • Identifying known and potential weaknesses and/or omissions relevant to the safeguarding of bird populations, as well as good practice from elsewhere • Drafting and developing improved guidance and legislative implements Consideration should also be given to • Improvements in the capacity of regulatory authorities to monitor effects on priority birds and enforce threshold breaches • Development of guidance and actions to improve the current status of certain priority bird populations (e.g., development of a Griffon Vulture National Action Plan)	To improve protection for priority bird VECs (and other vulnerable bird populations in Jordan)	The MoENV is the key party to pursue this action.		

Protocol for shutdown on demand for extreme events involving a collision risk to flocks of specific nonpriority MSBs: Flight activity surveys reviewed for the CEA have recorded very occasional large flocks (e.g., >1,000 individuals) of nonpriority MSBs, in particular, honey buzzard, steppe buzzard, white stork, black stork, and common crane. Available data suggest that the potential for a large nonpriority MSB to be at direct risk of collision with WPP turbines in the study area is very low. Nonetheless, following a precautionary approach, the CEA suggests that developers implement a shutdown on-demand protocol for specific nonpriority MSB flocks, triggered when a predetermined flock size is at risk of colliding with WPP turbines in the study area to safeguard against collision events involving multiple birds. As with priority birds, shutdown protocols that trigger a request to shut down one or more turbines should be comprehensive, unambiguous, and precautionary and allow the field observer to take decisive action based on knowledge of the protocols and their experience and judgment. Potential shutdown requests should be principally guided by the flying height, the predicted flight path of the bird(s) potentially at risk, and the number of individuals in the flock.

[a] Establishing vulture feeding stations ("vulture restaurants") was considered as a suggested action within the Joint MPP but is not currently included. This decision was based on the very limited use of two vulture feeding station trial sites in the Dana BR that were established as part of the JWPC Tafila WPP, and the likelihood that numerous vulture restaurants in the Negev desert to the southwest may be diverting griffon vulture activity away from the TRWPP sites. However, the distribution and foraging areas of this species will vary over time and likely result in periods of greater activity at TRWPP sites.

[b] http://www.ifc.org/wps/wcm/connect/66b56e00488657eeb36af36a6515bb18/Final%2B-%2BElectric%2BTransmission%2Band%2BDistribution.pdf?MOD=AJPERES&id=1323162154847.

[c] Reporting of in-flight monitoring results should include the date and time of observation, species name, number of individuals, flying height, flight direction in degrees when first detected, and identification of the nearest turbine.

The measures were developed and presented in a standard format for an Environmental Mitigation and Monitoring Plan. They are based on good practice in the wind energy sector and focused on the priority bird VECs. The MMP includes recommendations for actions to take if a fatality of a priority birds VEC should occur or if other threshold targets should be exceeded. Surpassing a threshold does not necessarily mean the shutdown of a turbine or turbines. The first action should be to investigate in-flight monitoring and adjust it to reduce the risk of future collision events and/or fatalities.

3.7 STEP 6 – INSTITUTIONAL ARRANGEMENTS AND INFORMATION MANAGEMENT

3.7.1 METHODS

This step recommends management and institutional arrangements to implement the Joint MMP. It provides a recommended framework for enhanced partnerships between developers, government, and other key stakeholders in relation to the priority bird VECs (and other priority VECs) and supports awareness and capacity building at a national level, including developing local capacity to assess and manage bird risk in the wind energy sector.

The management program to implement the Joint MMP for birds should outline the following aspects:

- Developer and other stakeholder recommended actions, roles, and responsibilities
- Institutional roles in and responsibilities for monitoring of the program and a centralized independent resource group focused on conducting governance of fatality monitoring, reviewing cumulative losses, and overseeing the Adaptive Management Framework
- Communications required to implement the joint program and specifically the escalation procedure should a threshold be breached
- A time-phased structure for implementing joint MMP actions, recognizing that wind projects will come online progressively over a period of time
- Information sharing and management recommendations

3.7.2 RESULTS

The joint MMP (step 5 results) makes recommendations with regard to institutional arrangements and information sharing between the WPP developers. The key recommendations are as follows:

- **Central Data Center:** Establishment of the Central Data Center to share and collate data that would be accessible to all developers and managed by the Internal Committee (MMP recommendations 2.1 and 2.2).
- **Internal Committee:** Establishment and operation of an Internal Committee by developers (MMP recommendation 2.2) to share and review data, review reports provided, and provide recommendations relating to
  - Adaptive management responses—a core part of which is the response process that must be triggered if a fatality of a priority bird occurs or an unexpected event occurs
  - Mitigation and monitoring planning informed by identified trends in bird activity arising from the periodic review of TRWPP postconstruction monitoring results
  - Landscape issues that are contributing to priority bird fatalities

- **Liaison and Sharing of Data with the MoENV:** Sharing of data by the Internal Committee with the MoENV. The MoENV has a regulatory function to audit that ESMMP measures within the project ESIAs are implemented. Therefore, it is recommended that the Internal Committee submit biannually (i.e., December and June) to the MoENV a six-month summary of in-flight monitoring, monthly reports on carcass searches and any incident reports on fatalities of priority birds. It is recommended that the Internal Committee and the MoENV undertake a semi-annual review meeting to discuss adaptive management.
- The purpose of Internal Committee engagement with the MoENV is to provide a mechanism for compliance and an external audit-type function of the cumulative environmental issues with respect to wind energy developments and specifically those identified by the CEA.

3.8 SUMMARY OF OUTCOMES OF BIRDS CEA

The CEA framework for birds has confirmed that despite being reasonably close to the migration bottleneck sites around the Red Sea coast, the location of the WPP sites within the study area do not typically have high concentrations of MSBs migrating through during either the spring or the autumn migration periods.

Throughout the process, a central element has been stakeholder engagement activities, including the establishment of an AC as a platform for bilateral and multilateral engagement and an experienced in-country ERP for continued technical review and input. The ERP especially was engaged through in-person, technical review meetings on the completion of each one of the steps in the CEA framework. Engagement activities were a cornerstone of each phase of the CEA process.

From an initial list of 171 species populations, steps 1 to 3 of the CEA process identified 13 priority bird VECs at highest risk in the study area. With two exceptions, priority bird VECs were raptors comprising four MSB populations (steppe eagle, Egyptian vulture, Eastern imperial eagle, and booted eagle) that use the Rift Valley/ Red Sea flyway and are present in the study area during their spring and autumn migration periods, and seven resident or summer breeding raptor populations (short-toed snake-eagle, griffon vulture, golden eagle, Verreaux's eagle, Bonelli's eagle, long-legged buzzard, and lesser kestrel) that may use the study area during and outside their respective breeding periods. In addition, two passerine species—the Syrian Serin, and the Eurasian goldfinch—were identified as at highest risk.

Each of these 13 priority bird VECs populations was assessed to determine an annual threshold of fatalities that each could sustain without affecting their long-term viability using biological and demographic parameters relevant to the population and estimates of fatalities resulting from external stressor effects. All were assessed as requiring a *zero fatality threshold target*. In addition to thresholds set for priority bird VECs, an *extreme events threshold target* was recommended to alleviate the risk of multiple-fatality events to a small number of nonpriority MSB populations with a tendency to migrate in large flocks in the vicinity of WPP sites in the study area.

The principal mitigation in the CEA framework for birds is a program of on-site postconstruction monitoring aimed at (i) avoiding collision of species populations subject to threshold targets by detecting individuals that are likely to enter the rotor-swept area at any of the WPP sites, and following an observer-led shutdown on-demand protocol to shut down turbines for the length of time that the individuals are at risk of collision; and (ii) quantifying postconstruction fatality rates at WPP sites by conducting a time-structured program of carcass searches in the vicinity of turbines, calibrated for carcasses that may have been missed by search teams or removed by scavengers. Carcass search feedback provides the principal information for identifying exceeded thresholds.

Adaptive management is informed by regular review of postconstruction monitoring results and will respond to a variety of scenarios including, but not limited to, exceeded priority bird/extreme event thresholds, near-miss incidents, elevated-risk situations, pastoral/livestock movements, and deficiencies in monitoring protocols. Exceeded thresholds will trigger immediate review and adaptive management response.

The iterative review process of the CEA is also designed to allow adaptive management responses to changes in relative importance, vulnerability, likelihood of effect and overall risk to species populations during the lifetime of WPPs. These changes may be identified through postconstruction on-site flight activity monitoring and carcass search results as well as changes in species conservation status and new information on the effects of external stressors. As a consequence, additional priority bird VECs may be added to or removed from the current list on the basis of expert ornithological review of new information from these sources. With time, and as data in Jordan or elsewhere become available, the results and recommendations in this report may be identified as too precautionary and unnecessarily conservative. If that is the case, updated information will be reviewed in consultation with ornithological experts to determine the most appropriate course of action.

Dana Biosphere Reserve

In addition to outcomes specifically relating to postconstruction monitoring and mitigation, the CEA for birds provides guidance and information to inform WPP-specific ESIAs; for example, the use of guidance on key monitoring and mitigation issues and CEA survey results to inform the micro-siting of turbines and wind farm layout to preempt and reduce bird collision risks for WPPs at the preconstruction stage.

To facilitate an integrated monitoring, mitigation, and adaptive management strategy across WPPs, the CEA for birds has developed and recommends a range of measures aimed at coordinating intersite monitoring and adaptive management, including mechanisms for data sharing, collective reviewing of data, centralized reporting, and developing joint management and action plans.

4. CEA Framework—Bats

4.1 OVERVIEW OF CEA FRAMEWORK FOR BATS

The objectives of the CEA framework for bats are as follows:

- To determine which bat species are at the highest risk from the cumulative effects of wind farm development
- To identify potential joint mitigation and monitoring measures to be undertaken by developers if priority bat VECs are identified

The CEA framework for bats is adapted from the one developed for birds and is summarized in Figure 10. It is a four-step rather than a six-step process due to data limitations: Step 4 in the CEA framework for birds has not been carried out and steps 5 and 6 have been merged. This CEA is being conducted before ESIAs were completed for three of the four participating WPPs. Whereas substantial bird survey data were available from each of the WPPs, only a limited amount of bat survey data were collected, with the exception of JWPC's Tafila WPP, the only WPP in operation. For this reason, the results of the CEA for bats are largely to inform the project-specific ESIAs and operational monitoring. Thresholds may be developed, if needed, at a future point when additional data are available.

4.2 STEP 1. DEVELOP SPECIES LIST AND IDENTIFY UNIT OF ANALYSIS

4.2.1 METHODS

The purpose of step 1 is to identify all bat species that could be at risk from the cumulative effects of the TRWPP and to determine a relevant UoA by which any effects should be measured.

Part 1: Develop List of Bat Species in Study Area

A national list of bat species was created by going through relevant literature. From this national list, a list of bat species for the study area was compiled. This list included the following:

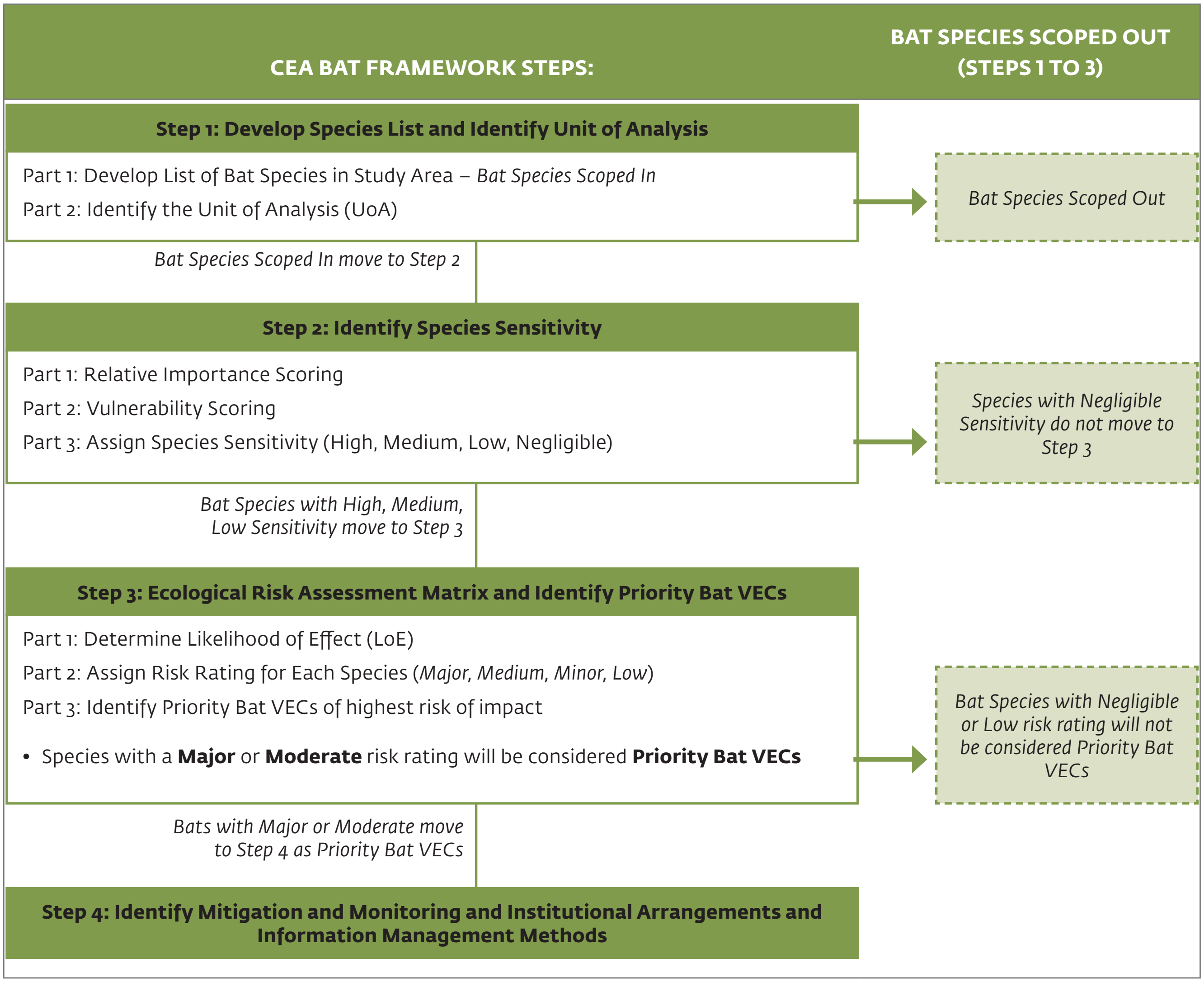
- Species that were recorded in the study area, based on literature
- Species that were recorded in the study area, based on surveys that were carried out in the WPPs
- Species that were recorded in habitats similar to the ones present at the study area

Part 2: Identify the Unit of Analysis

The main reference point for all bat species is the distribution of the species in the country. No population estimates were available for bat species in Jordan because the records are not based on comprehensive surveys. The absence of confirmed figures of the population size of any of the species recorded in the study area or national figures for Jordan presented a challenge to the assessment. The UoA was therefore considered to be the extent of occurrence (EOO) for each species of the national list identified as occurring within the study area.[32] EOO is defined as "the area contained within the shortest continuous imaginary boundary which can

[32] Z. S. Amr along with a group of national experts, including the RSCN, are in the process of publishing a national assessment of the IUCN Red List for the mammals of Jordan. The EOOs for the bat species were obtained from the RSCN (Amr et al., in press).

FIGURE 10. TRWPP CEA BAT FRAMEWORK



be drawn to encompass all the known, inferred or projected sites of present occurrence of a taxon, excluding cases of vagrancy" (Amr 2012).

4.2.2 RESULTS

Part 1: Develop List of Bat Species in Study Area

Species that were recorded in the study area based on literature

The national list of bat species of Jordan, based on literature and as compiled by Amr (IUCN Standards and Petitions Subcommittee, 2010), includes 26 species, as shown in Table 35.

Species Recorded in Study Area on the Basis of Surveys in the WPPs

On the basis of surveys conducted at WPPs, two more species were recorded in the study area that were not on the national list of species of Jordan (Table 35):

TABLE 35. NATIONAL LIST OF BAT SPECIES OF JORDAN[a]

NO.	COMMON NAME	SCIENTIFIC NAME	NO.	COMMON NAME	SCIENTIFIC NAME
1	Egyptian fruit bat	*Rousettus aegyptiacus*	14	European free-tailed bat	*Tadarida teniotis*
2	Blasius's horseshoe bat	*Rhinolophus blasii*	15	Schreiber's bent-winged bat	*Meniopterus pallidus*
3	Geoffroy's horseshoe bat	*Rhinolophus clivosus*	16	Asian barbastelle	*Barbastella leucomelas*
4	Mediterranean horseshoe bat	*Rhinolophus euryale*	17	Botta's serotine bat	*Eptesicus bottae*
5	Lesser horseshoe bat	*Rhinolophus hipposideros*	18	Desert pipistrelle	*Hypsugo ariel*
6	Greater horseshoe bat	*Rhinolophus ferrumequinum*	19	Lesser mouse-eared bat	*Myotis blythii*
7	Mehely's horseshoe bat	*Rhinolophus mehelyi*	20	Long-fingered bat	*Myotis capaccinii*
8	Trident leaf-nosed bat	*Asellia tridens*	21	Notch-eared bat	*Myotis emarginatus*
9	Lesser mouse-tailed bat	*Rhinopoma cystops (hardwickii)*	22	Natterer's bat	*Myotis nattereri*
10	Greater mouse-tailed bat	*Rhinopoma microphyllum*	23	Hemprich's long-eared bat	*Otonycteris hemprichii*
11	Egyptian tomb bat	*Taphozous perforatus*	24	Kuhl's pipistrelle	*Pipistrellus kuhlii*
12	Naked-bellied tomb bat	*Taphozous nudiventris*	25	Common pipistrelle	*Pipistrellus pipistrellus*
13	Egyptian slit-faced bat	*Nycteris thebaica*	26	Northeast African long-eared bat	*Plecotus christii*

[a] The scientific names used for the bat species followed the taxonomic checklist presented in Wilson et al. (2005).

- Serotine bat (*Eptesicus seritinus)*—In available literature this species was not previously recorded in Jordan. It was referenced as being recorded during the construction monitoring at the JWPC Tafila WPP. However, after reviewing this reference with the author of the survey report (EcoConsult, 2014), it was confirmed that this species had most likely been misidentified and that the correct species was Botta's serotine bat *(Eptesicus bottae)*. Therefore, the serotine bat species was not included in the list of bat species occurring in the study area. Botta's serotine bat was included.
- Ruppell's pipistrelle *(Pipistrellus rueppellii)*—In the available literature, this species was not previously recorded in Jordan. It was referenced as being recorded during the construction monitoring at the JWPC Tafila WPP. After reviewing this reference with the author of the survey report,[33] it was confirmed this is a new species record for Jordan that is still to be published. Therefore, this species was included in the list of bat species occurring in the TRWPP area.

Species Recorded in Habitats Similar to Those in Study Area

Two species (Egyptian tomb bat and naked-bellied tomb bat) that did not occur within the study area but were recorded in similar habitats were added to the list of bat species in the study area (Benda et al., 2010).

List of Bat Species in Study Area

From the national list and on the basis of the localities of the records available at the national level, a list of the 18 species recorded in the study area was produced, as shown in Table 36.

[33] EcoConsult. 2014. Bats Monitoring for the Tafileh Windfarm Project, September 2014. Prepared by Z.S. Amr.

TABLE 36. LIST OF BAT SPECIES IN STUDY AREA

COMMON NAME	SCIENTIFIC NAME	NOTES ON REASON FOR INCLUSION
Egyptian fruit bat	*Rousettus aegyptiacus*	Arid to moist tropical and subtropical biomes In the study area, it occurs in Wadi Feynan
Blasius's horseshoe bat	*Rhinolophus blasii*	Small caves In the study area, it occurs in Wadi Feynan
Geoffroy's horseshoe bat	*Rhinolophus clivosus*	Deserts and dry habitats Occurs in Dana, Fidan, and Finan
Trident leaf-nosed bat	*Asellia tridens*	Migratory, adapted to desert habitats, east of Dana
Lesser mouse-tailed bat	*Rhinopoma cystops (hard-wickii)*	Occurs in Wadi Fidan, Wadi Dana
Egyptian tomb bat	*Taphozous perforates*	Not recorded in the study area but recorded in adjacent areas with similar habitat phenology to the north of TRWPP area
Naked-bellied tomb bat	*Taphozous nudiventris*	Not recorded in the study area but recorded in adjacent areas with similar habitat phenology to the north of TRWPP area
Egyptian slit-faced Bat	*Nycteris thebaica*	Occurs in Wadi Fidan
European free-tailed bat	*Tadarida teniotis*	Widespread in all habitats
Asian barbastelle	*Barbastella leucomelas*	Recently recorded in Jordan in a few locations
Botta's serotine bat	*Eptesicus bottae*	Jordan Rift Valley and Southern Highlands
Desert pipistrelle	*Hypsugo ariel*	Southern Highlands
Natterer's bat	*Myotis nattereri*	Mountainous north and south
Hemprich's long-eared bat	*Otonycteris hemprichii*	Mountains, arid habitats.
Ruppell's pipistrelle	*Pipistrellus rueppellii*	In the available literature, not recorded in Jordan; mentioned as recorded at the JWPC during construction monitoring (EcoConsult, 2014); after contacting report author, confirmed as a new record for the country that has not been published yet
Kuhl's pipistrelle	*Pipistrellus kuhlii*	Most common species in Jordan, recorded in the TRWPP area
Common pipistrelle	*Pipistrellus pipistrellus*	Highlands and along arid rift valley
Northeast African long-eared bat	*Plecotus christii*	Sandstone and arid regions

Part 2: Identify the Unit of Analysis

As explained above, the EOO in Jordan for each of the bat species listed in Table 36 was used as the UoA. EOOs for all bat species were obtained from RSCN. RSCN is in the process of publishing the national IUCN Red List of mammals of Jordan.

4.3 STEP 2. IDENTIFY SPECIES SENSITIVITY

4.3.1 METHODS

The purpose of this step is to determine the likely sensitivity of each bat species to potential effects of the TRWPP. The sensitivity is determined from the *relative importance* attributed to the TRWPP area for each species population and the *vulnerability* of the species at a regional or international scale.

Part 1: Relative Importance Scoring

For each bat species, the relative importance in relation to the UoA was identified. This was done by calculating the percentage of the surface area of the EOO of the species that is inside the study area with respect to the total area of the EOO in the country:

Portion of EOO (km^2) within TRWPP study area / EOO (km^2) in Jordan × 100 = Relative Importance (%)

The relative importance for the species was scored as negligible, low, moderate, or high using the criteria in Table 37.

TABLE 37. RELATIVE IMPORTANCE CRITERIA FOR BAT SPECIES

PERCENTAGE OF EOO (IN KM^2) THAT FALLS WITHIN TRWPP STUDY AREA (%)	RELATIVE IMPORTANCE SCORE
≤ 1	Negligible
1 > and ≤ 5	Low
> 5 and ≤ 10	Moderate
> 10	High

Part 2: Vulnerability Scoring

For each bat species, vulnerability was scored using international and/or regional guidance relating to the conservation status and vulnerability of the species, as shown in Table 38. No national scale was used in the scoring, as a National Red List of the Mammals of Jordan is under development and no other national references were available. The following guidance was used:

- **IUCN Global/Regional Red List of Threatened Species** for the scoring for all species. An IUCN Global Red List assessment is available for all species; the **IUCN Regional Red List Assessment** was used when available. The highest category in any of the two assessments was taken into consideration during the vulnerability scoring.

TABLE 38. VULNERABILITY SCORING

VULNERABILITY SCORE	IUCN GLOBAL/REGIONAL RED LIST OF THREATENED SPECIES
Negligible	• Species that are LC on IUCN Global/Regional Red Lists
Low	• Species that are NT or DD on IUCN Global/Regional
Moderate	• Species that are VU on IUCN "Global/Regional" Red List
High	• Species that are CR or EN on IUCN Global/Regional Red List

Note: LC = Least Concern, NT = Near Threatened, DD = Data Deficient, VU = Vulnerable, EN = Endangered, CR = Critically Endangered.

Part 3: Assign Species Sensitivity
The matrix in Table 39 was used to assign the species sensitivity using the relative importance and vulnerability scores for each species population.

Bat species with a negligible sensitivity did not move forward into step 3 and were scoped out of the CEA process.

TABLE 39. SPECIES SENSITIVITY MATRIX

VULNERABILITY	RELATIVE IMPORTANCE			
	High	Moderate	Low	Negligible
High	High	High	Medium	Low
Moderate	High	Medium	Low	Negligible
Low	Medium	Low	Low	Negligible
Negligible	Low	Negligible	Negligible	Negligible

4.3.2 RESULTS

The sensitivity (part 3) of each species scoped in to step 3 was determined on the basis of its relative importance (part 1) and vulnerability (part 2), applying the method explained above. The results of the process are provided in Table 40.

It was not possible to score the EOO in the study area for two species on the list: the Egyptian tomb bat and the naked-bellied tomb bat. These were scored as zero relative importance as they had not been recorded previously inside the study area.

Step 2. Summary of Sensitivity and Species Populations Progressing to Step 3
Of the 18 species on the list of bat species in the study area, 9 with a negligible score were scoped out of the CEA. The following nine species were scoped in and proceeded to step 3:

- Egyptian fruit bat *(Rousettus aegyptiacus)*
- Blasius's horseshoe bat (*Rhinolophus blasii)*
- Geoffroy's horseshoe bat (*Rhinolophus clivosus)*
- Trident leaf-nosed bat *(Asellia tridens)*
- Egyptian slit-faced bat *(Nycteris thebaica)*
- Asian barbastelle *(Barbastella leucomelas)*
- Desert pipistrelle *(Hypsugo ariel)*
- Ruppell's pipistrelle *(Pipistrellus rueppellii)*
- Northeast African long-eared bat *(Plecotus christii)*

TABLE 40. SPECIES RELATIVE IMPORTANCE, VULNERABILITY, AND SPECIES SENSITIVITY

		PART 1: RELATIVE IMPORTANCE SCORING				PART 2: VULNERABILITY SCORING				PART 3: SPECIES SENSITIVITY
SPECIES NAME	SPECIES SCIENTIFIC NAME	EOO IN COUNTRY (KM²)	PORTION OF EOO IN THE TRWPP STUDY AREA (KM²)	SHARE OF EOO IN TRWPP (%)	RELATIVE IMPORTANCE SCORE	IUCN GLOBAL RED LIST CATEGORY	IUCN REGIONAL (EUROPEAN-E/ MEDITERRANEAN-M) RED LIST CATEGORY	IUCN RED LIST CATEGORY USED FOR SCORING	VULNERABILITY SCORE	SENSITIVITY PER SPECIES (BASED ON MATRIX OF RELATIVE IMPORTANCE AND VULNERABILITY)
Egyptian fruit bat	*Rousettus aegyptiacus*	7,537	682	9.1	Moderate	LC	NT	NT	Low	Low
Blasius's horseshoe bat	*Rhinolophus blasii*	4,657	392	8.4	Moderate	LC	VU (M)	VU	Moderate	Medium
Geoffroy's horseshoe bat	*Rhinolophus clivosus*	3,346	531	15.6	High	LC	VU (E)	VU	Moderate	High
Trident leaf-nosed bat	*Asellia tridens*	275	155	56.4	High	LC	LC (M)	LC	Negligible	Low
Lesser mouse-tailed bat	*Rhinopoma cystops (hardwickii)*	6,911	351	5.1	Moderate	LC	LC (M)	LC	Negligible	Negligible
Egyptian tomb bat	*Taphozous perforatus*	660	0	0	Negligible	LC	LC (M)	LC	Negligible	Negligible
Naked-bellied tomb bat	*Taphozous nudiventris*	194	0	0	Negligible	LC	LC (M)	LC	Negligible	Negligible
Egyptian slit-faced bat	*Nycteris thebaica*	461	30	6.5	Moderate	LC	DD (M)	DD	Low	Low
European free-tailed bat	*Tadarida teniotis*	40,422	1,048	2.6	Low	LC	LC (E&M)	LC	Negligible	Negligible
Asian barbastelle	*Barbastella leucomelas*	2,070	268	12.9	High	LC	NA (M)	LC	Negligible	Low
Botta's serotine bat	*Eptesicus bottae*	8,046	687	8.5	Moderate	LC	LC (M)	LC	Negligible	Negligible
Desert pipistrelle	*Hypsugo ariel*	3,497	373	10.7	High	DD	DD (M)	DD	Low	Medium
Natterer's bat	*Myotis nattereri*	1,727	113	6.5	Moderate	LC	LC (E&M)	LC	Negligible	Negligible
Hemprich's long-eared bat	*Otonycteris hemprichii*	30,047	567	1.9	Low	LC	LC (M)	LC	Negligible	Negligible
Ruppell's pipistrelle	*Pipistrellus rueppellii*	4	4	100	High	LC	LC (M)	LC	Negligible	Low
Kuhl's pipistrelle	*Pipistrellus kuhlii*	30,273	1,034	3.4	Low	LC	LC (E&M)	LC	Negligible	Negligible
Common pipistrelle	*Pipistrellus pipistrellus*	5,014	396	7.9	Moderate	LC	LC (E&M)	LC	Negligible	Negligible
Northeast African long-eared bat	*Plecotus christii*	6,185	688	11.1	High	DD	DD (M)	DD	Low	Medium

Note: Species outlined in red proceed to step 3. LC = Least Concern, NT = Near Threatened, DD = Data Deficient, VU = Vulnerable, EN = Endangered, CR = Critically Endangered.

4.4 STEP 3. DEVELOP ECOLOGICAL RISK ASSESSMENT MATRIX AND IDENTIFY PRIORITY BAT VECs

4.4.1 *METHODS*

The purpose of this step is to identify the priority bat VECs. These are determined using sensitivity assessments from step 2 and the LoE.

Part 1 – Determine LoE

The LoE for bat species was determined on the basis of the level of collision risk in Eurobats' guidelines for consideration of bats in wind farm projects (Rodrigues et al., 2015).

As no information is available about the collision risk of the species from the study area specifically and from the country in general, the collision risk level for European bat species (Rodrigues et al., 2015) was used to assess the LoE, where possible. The LoE was scored as Negligible, Low Medium or High using 'level of collision risk' using criteria in Table 41. This approach could not be applied to three non-European species.

Part 2 – Assign Risk Rating for Each Species

The matrix in Table 42 assigns the risk rating for each species population using the "Species Sensitivity" and "LoE" scores for each species population.

Part 3 – Identify Priority Bat VECs

Priority bat VECs are those species with major or moderate risk ratings according to the matrix in Table 42. These priority bat species passed through to step 4 of the CEA process. Species populations with a risk rating of either negligible or low did not proceed to step 4 as they were not considered priority bat VECs. Results of Step 3 of the CEA for bats are presented in Table 43.

TABLE 41. LIKELIHOOD OF EFFECT SCORING FOR BATS

LIKELIHOOD OF EFFECT SCORING	EUROBATS LEVEL OF COLLISION RISK (RODRIGUES ET AL., 2015)
Negligible	• Species and/or genus with low level of collision risk
Low	• Species with unknown level of collision risk
Medium	• Species with medium level of collision risk
High	• Species with high level of collision risk

4.4.2 *RESULTS*

Of the nine species in this step, seven were scoped out and two remaining species were selected as priority bat VECs – the desert pipistrelle *(Hypsugo ariel)* and the Ruppell's pipistrelle *(Pipistrellus rueppellii)*.

TABLE 42. RISK RATING FOR BATS

SPECIES SENSITIVITY	LIKELIHOOD OF EFFECT			
	High	Medium	Low	Negligible
High	Major	Major	Moderate	Minor
Medium	Major	Moderate	Minor	Negligible
Low	Moderate	Minor	Minor	Negligible

TABLE 43. STEP 3 RESULTS

SPECIES NAME	SPECIES SCIENTIFIC NAME	STEP 2:	STEP 3:		
		SPECIES SENSITIVITY	EUROBATS LEVEL OF COLLISION RISK	LIKELIHOOD OF EFFECTS SCORE	RISK RATING
Egyptian fruit bat	*Rousettus aegyptiacus*	Low	Unknown	Low	Minor
Blasius's horseshoe bat	*Rhinolophus blasii*	Medium	Low	Negligible	Negligible
Geoffroy's horseshoe bat	*Rhinolophus clivosus*	High	Low	Negligible	Minor
Trident leaf-nosed bat	*Asellia tridens*	Low	Unknown	Low	Minor
Asian barbastelle	*Barbastella leucomelas*	Low	Medium	Medium	Minor
Desert pipistrelle	*Hypsugo ariel*	Medium	High	High	Major
Ruppell's Pipistrelle	*Pipistrellus rueppellii*	Low	High	High	Moderate
Northeast African long-eared bat	*Plecotus christii*	Medium	Low	Negligible	Negligible
Egyptian slit-faced bat	*Nycteris thebaica*	Low	Unknown	Low	Minor

4.5 METHODS FOR MITIGATION AND MONITORING, INSTITUTIONAL ARRANGEMENTS, AND INFORMATION MANAGEMENT

The purpose of these steps is to (i) identify mitigation and monitoring measures for priority bat VECs at highest risk of potential cumulative effects, to inform project-specific ESIAs and operational monitoring; and (ii) recommend institutional arrangements for implementation of mitigation and monitoring.

It is recommended that additional data on bat species' presence and distribution in the study area be collected as part of the preconstruction surveys for the ESIAs for the three WPPs and as part of operational monitoring for the JWPC Tafila WPP. Intersite monitoring and adaptive management recommendations should be made, as needed, on the basis of the results of monitoring. Recommendations are listed below.

Recommendations for ESIA and/or ESMMP:

Preconstruction survey:

- All WPPs should carry out preconstruction bat surveys to establish the presence or absence of any bat species and specifically the priority species identified in this assessment.

Alternatives analysis:

- The results of the preconstruction survey should be used in the alternatives analysis of the WPP.

Operational Monitoring and/or Carcass Searches:

- Carcass searches for priority bats could take place with those carried out for birds. The following is a recommended approach:

- Search plot size: Ideally, the search process should take place around the wind turbine, within a radius equal to the total height of the wind turbine, as bats that collide can be blown away from the turbine by high winds.
- Number of sampled wind turbines: If possible, every wind turbine in the wind farm should be sampled during each survey visit.
- Monitoring schedule: The entire activity cycle should be assessed. Fatality monitoring should start as soon as bats become active after hibernation and last until they return to hibernation.
- Search methods and recording results: The searcher should walk each transect at a slow and regular pace, looking for fatalities on both sides of the line.
- Fatality estimates are beneficial, to provide a better estimation of the actual number of bat fatalities. Like the estimation of bird fatalities, this is done through carcass removal trials and searcher efficiency trials. Findings of carcass removal trials and searcher efficiency trials for birds should be reviewed to inform the priority monitoring of mortality.

4.6 SUMMARY OF OUTCOMES OF BATS CEA

The CEA framework for bats was adapted from the CEA framework for birds. It followed a four-step process to identify the priority bat VECs. A list of 18 species potentially present within the study area was compiled out of the national list of 26 bat species in Jordan. The UoA selected was the EOO of these species on the national level. The *relative importance* of the species was calculated by setting scores for the percentage of the EOO for each species that falls within the study area. As for the *vulnerability* score, it was based on the conservation status, being global and/or regional, depending on the availability of that status for each species. The *sensitivity* of each species scoped in to step 3 was determined based on *Relative Importance* and *vulnerability*. This resulted in scoping out nine species, while scoping in the other nine species. The LoE was based on the collision risk for these selected species using the EUROBATS (2014) guidelines, where available. Risk ratings were determined on the basis of a *sensitivity* and *likelihood of effect* matrix.

Two species with a risk rating of moderate or high were identified as priority bat VECs: the desert pipistrelle *(Hypsugo ariel)* and the Ruppell's pipistrelle *(Pipistrellus rueppellii)*.

The principal mitigation recommended in the CEA Framework for Bats comprises a program of on-site-monitoring aimed at reducing risks to Priority Bat VECs, and informing Adaptive Management strategies through an improved understanding of bat behavior and risk at WPPs. Specifically the CEA recommends (i) surveys as part of all forthcoming CEA WPP ESIAs to establish the presence/absence of any bat species and to improve understanding of the use of WPP sites by priority species and (ii) a bat carcass search survey program informed by bat ecology and calibrated using searcher efficiency and carcass removal trails.

5. CEA Framework—Habitats and Other Species

5.1 OVERVIEW OF CEA FRAMEWORK FOR HABITATS AND OTHER SPECIES

The objectives of the CEA framework for habitats and other species are as follows:

- Determine which habitats and other species are at the highest risk from the cumulative effects of the WPPs.
- Identify potential joint mitigation and monitoring measures to be undertaken by developers and other stakeholders if priority habitats and other species VECs are identified.

The focus of this framework is the habitats that exist in the area of the WPPs, including the 2 km buffer, and not all habitats that exist in the broader study area, which includes the Dana BR and IBA. While the study area is relevant to the Bird and Bat CEA frameworks, the area around the WPPs is considered appropriate for this framework (see Figure 11).

Like the bat framework, the framework for habitats and other species follows a four-step process, summarized in Figure 12. This process was developed in consultation with stakeholders in the field of habitats and species research and conservation in Jordan.

The habitat types in this framework align with the vegetation type classification by Albert and Bore (2003.) (See Figure 13 and Annex A for more detail on habitat and vegetation cover in the study area).

FIGURE 11. WIND POWER PROJECTS AREA WITHIN THE STUDY AREA

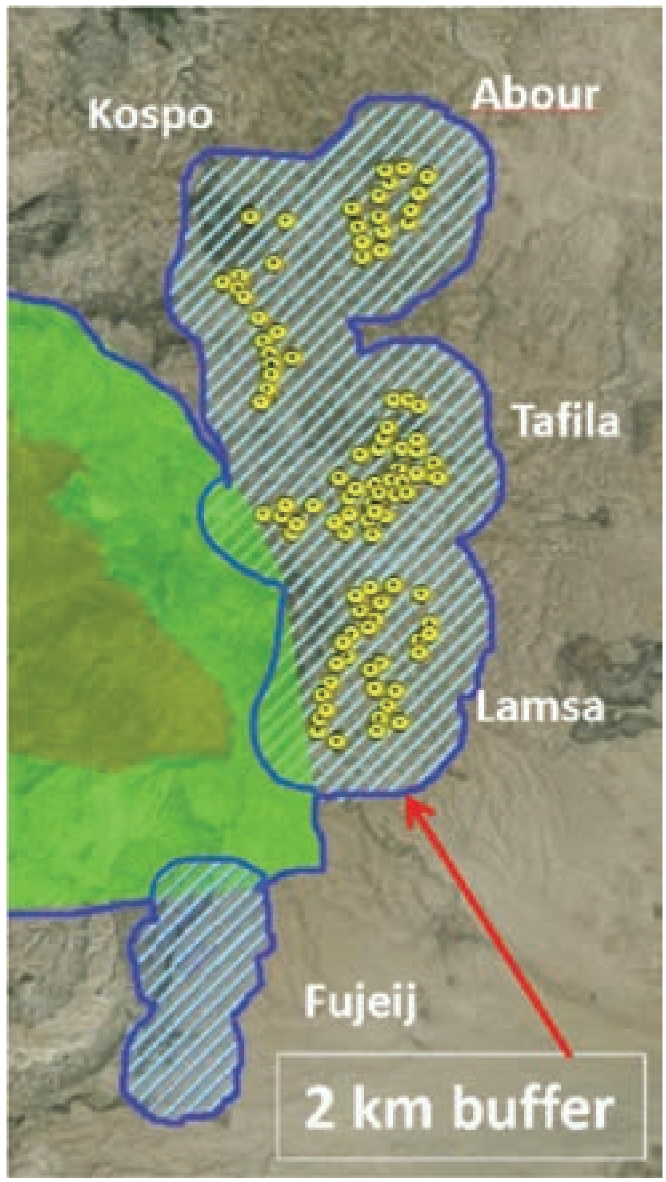


FIGURE 12. CEA FRAMEWORK HABITATS AND OTHER SPECIES

CEA HABITAT AND OTHER SPECIES FRAMEWORK STEPS:	HABITATS AND OTHER SPECIES SPECIES SCOPED OUT
Step 1: Develop Habitat Map, Other Species List and Identify the Unit of Analysis	
Part 1: Habitat and Other Species List Part 2: Identify the Unit of Analysis (UoA)	
Habitats and Other Species move to Step 2	
Step 2: Identify Habitat and Other Species Sensitivity	
Part 1: Relative Importance Scoring Part 2: Vulnerability Scoring Part 3: Assign Habitat and other Species Sensitivity (*High/Medium/Low/Negligible*)	→ *Habitats and other species with "Negligible" Sensitivity, do not move to Step 3*
Habitats and other Species with High/Medium/Low Score move to Step 3	
Step 3: Ecological Risk Assessment Matrix and Identify Priority Habitats and Other Species VECs	
Part 1: Determine Likelihood of Effect (LoE) Part 2: Assign Risk Rating (*Major/Moderate/Minor/Negligible*) Part 3: Identify Priority Habitats and other Species of highest risk of impact • Habitats and (other) species with a **Major** or **Moderate** risk rating will be considered "**Priority VECs**"	
Habitats and other species with Major or Moderate risk rating move to Step 4	
Step 4: Identify Mitigation and Monitoring and Institutional Arrangements and Information Management Measures	

5.2 STEP 1 – DEVELOP HABITAT MAP AND SPECIES LIST, AND IDENTIFY RELEVANT UNIT OF ANALYSIS

5.2.1 *METHODS*

The purpose of step 1 is to identify all habitat types and other species that could potentially be at risk from the cumulative effects of the TRWPP and to determine a relevant UoA by which any effects should be measured.

Step 1 of the framework comprises two parts, as described below.

Part 1: Habitats and Other Species List

Habitats were mapped using the biogeographical zones of Jordan and the available vegetation type maps. The habitats within the WPP area were then identified. Other species known to represent these habitats were identified using available literature (including Albert and Bore 2003). As only limited literature and survey data (see Section 2.3.5) were available for the WPP area, it was not possible to identify species that would be unique or restricted to these habitats. This would generally be part of a project-level ESIA.

Part 2: Identify the UoA
A relevant UoA for habitats and species was identified for use in the assessment.

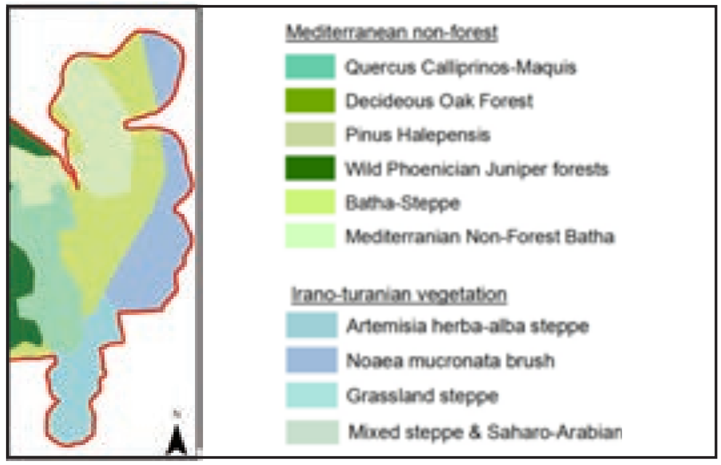
5.2.2 RESULTS

Part 1: Habitat and Other Species List
The habitats in the WPP area were identified from the mapping of vegetation types within the study area as shown in Figure 13.

The WPP area is set within two of the biogeographical zones—the Mediterranean zone and the Irano-Turanian zone. The following habitats are present in the WPP area:

- Mediterranean nonforest batha
- Batha-steppe

FIGURE 13. HABITATS (VEGETATION TYPES) WITHIN THE WPP AREA WITHIN THE STUDY AREA



Tragopogon collinus DC

- Artemisia herba-alba steppe
- *Noaea mucronata* brush

After consultations with national experts in ecology and zoology, four species were identified that could be considered as representative for these habitats but not limited to any one habitat. These species are relatively widespread. They are as follows:

- Tristram's jird (*Meriones tristrami)*
- Wagner's gerbil (*Dipodillus dasyurus)*
- Starred agama (*Stellagama stellio)*
- Spur-thighed tortoise (*Testudo graeca)*

Part 2: Identify the UoA
Habitats UoA: For the habitats in the WPP area, the UoA was identified as the national coverage of these habitats, measured in square kilometers.

Species UoA: No national population estimates were available for the four species identified in step 1. The UoA was therefore considered to be the EOO for each species of the national list identified as occurring within the study area (Amr, 2012; Ahmad et al, 2001).

5.3 STEP 2 – IDENTIFY HABITAT AND OTHER SPECIES SENSITIVITY

5.3.1 METHODS

The purpose of this step is to determine the sensitivity of each habitat and other species to potential effects of the TRWPP. The sensitivity is determined from the *relative importance* attributed to the TRWPP area for each habitat and other species population and the *vulnerability* of these habitats and species at a regional or international scale.

Part 1: Relative Importance Scoring
For each habitat and other species, the *relative importance* in relation to the UoA was identified.

Habitats Relative Importance
For habitats, this was done by calculating the percentage of the surface area of the vegetation type inside the area of the WPPs to the total surface area of the vegetation type in Jordan. The *relative importance* for the habitats was scored as negligible, low, moderate, or high, using the criteria shown in Table 44.

TABLE 44. RELATIVE IMPORTANCE SCORE FOR HABITATS

SURFACE AREA OF HABITAT INSIDE THE WPP STUDY AREA AS SHARE OF NATIONAL COVERAGE (%)	RELATIVE IMPORTANCE SCORE
≤ 5	Negligible
> 5 and ≤ 10	Low
> 1 and ≤20	Moderate
>20	High

Species Relative Importance
As for species, the *Relative Importance* was calculated as a percentage:

Portion of EOO (km^2) within TRWPP study area / EOO (km^2) in country × 100 = Relative Importance (%)

TABLE 45. RELATIVE IMPORTANCE SCORE FOR SPECIES

SHARE OF EOO (IN KM²) WITHIN TRWPP STUDY AREA (%)	RELATIVE IMPORTANCE SCORE
≤ 5	Negligible
> 5 and ≤ 10	Low
> 10 and ≤ 20	Moderate
> 20	High

TABLE 46. HABITATS VULNERABILITY SCORING

PERCENTAGE OF HABITAT PRESENT WITHIN PROTECTED AREAS (%)	VULNERABILITY SCORE (%)
≤ 5	Negligible
> 5 and ≤ 10	Low
> 10 and ≤ 20	Moderate
> 20	High

TABLE 47. SPECIES VULNERABILITY SCORING

VULNERABILITY GUIDANCE/ METRICS	IUCN GLOBAL/ REGIONAL RED LIST OF THREATENED SPECIES
Negligible	• Species that are LC on IUCN Global/Regional Red Lists
Low	• Species that are NT or DD on IUCN Global/Regional
Moderate	• Species that are VU on IUCN "Global/Regional" Red List
High	• Species that are CR or EN on IUCN Globa/Regional Red List

Note: LC = Least Concern, NT = Near Threatened, DD = Data Deficient, VU = Vulnerable, EN = Endangered, CR = Critically Endangered.

The *relative importance* for the species was scored as negligible, low, moderate, or high, using the criteria shown in Table 45.

Part 2: Vulnerability Scoring

Habitat Vulnerability

For each habitat, vulnerability was scored on the basis of the national status of priority for conservation of each habitat (RSCN, 2008). This was calculated by the percentage of the habitat that is present inside protected areas in the country and scored in line with the criteria listed in Table 46.

Species Vulnerability

Vulnerability was scored using international and/or regional guidance relating to the conservation status and vulnerability of the species. No national scale was used in the scoring because a National Red List of the Mammals and Reptiles of Jordan is in development and no other national references were available to inform this scoring. The guidance used to determine the vulnerability of the species was the IUCN Global and Regional Red Lists of Threatened Species (where available). The highest category in any of these assessments was taken into consideration for the vulnerability scoring. Vulnerability for species was scored with a negligible, low, moderate, or high score using the criteria listed in Table 47.

Part 3: Assign Habitats and Other Species Sensitivity Score

The following matrix in Table 48 was used to assign the habitat and other species sensitivity using the relative importance and vulnerability scores for each habitat and other species.

Habitats and other species with negligible sensitivity did not move forward to step 3 and were scoped out of the CEA process.

TABLE 48. HABITATS AND OTHER SPECIES SENSITIVITY SCORING

VULNERABILITY	RELATIVE IMPORTANCE			
	High	Moderate	Low	Negligible
High	High	High	Medium	Low
Moderate	High	Medium	Low	Negligible
Low	Medium	Low	Low	Negligible
Negligible	Low	Negligible	Negligible	Negligible

5.3.2 RESULTS

The sensitivity (part 3) of each habitat and other species scoped into step 2 was determined based on relative importance (part 1) and vulnerability (part 2) applying the method explained above. The results of the process are provided in Tables 49 and 50.

Step 2 – Habitats and Other Species Progressing to Step 3

Three of the four habitats were scoped out during step 2, with only the *Noaea mucronata* brush proceeding to step 3. As for species, all were scoped out because they were all determined to have negligible sensitivity.

TABLE 49. HABITAT RELATIVE IMPORTANCE, VULNERABILITY, AND SENSITIVITY

HABITAT NAME	PART 1: RELATIVE IMPORTANCE		PART 2: VULNERABILITY		PART 3: HABITAT SENSITIVITY
	SHARE OF SURFACE AREA IN WPP AREA (%)	RELATIVE IMPORTANCE SCORE	SHARE OF SURFACE AREA INSIDE PROTECTED AREAS (%)	VULNERABILITY SCORE	
Mediterranean non-forest batha	4.5	Negligible	2.1	Low	Negligible
Batha-steppe	0.6	Negligible	2.2	Low	Negligible
Artemisia herba-alba steppe	0.3	Negligible	0.0	Negligible	Negligible
Noaea mucronata brush	24.2	High	0.0	Negligible	Low

TABLE 50. SPECIES RELATIVE IMPORTANCE, VULNERABILITY, AND SENSITIVITY

SPECIES NAME	SCIENTIFIC NAME	PART 1: RELATIVE IMPORTANCE		PART 2: VULNERABILITY		PART 3: SPECIES SENSITIVITY
		% OF EOO IN WPP	RELATIVE IMPORTANCE SCORE	IUCN RED LIST CATEGORY	VULNERABILITY SCORE	
Spur-thighed Tortoise	*Testudo graeca*	0.05	Negligible	Vulnerable	Moderate	Negligible
Starred Agama	*Stellagama stellio*	0.01	Negligible	Least Concern	Negligible	Negligible
Wagner's Gerbil	*Dipodillus dasyurus*	0.01	Negligible	Least Concern	Negligible	Negligible
Tristram's Jird	*Meriones tristrami*	0.01	Negligible	Least Concern	Negligible	Negligible

5.4 STEP 3 – ECOLOGICAL RISK ASSESSMENT MATRIX AND IDENTIFICATION OF PRIORITY HABITATS AND OTHER SPECIES

5.4.1 *METHODS*

The purpose of this step is to identify the priority habitat and other species VECs. These are determined using sensitivity assessments from step 2 and the LoE.

Part 1 – Determine LoE

The LoE for habitats and other species was determined on the basis of the likelihood of habitat loss and degradation occurring from the cumulative WPPs in the Tafila area.[34] This likelihood was based on expert review from the CEA team and knowledge of the likely direct effects that would occur to specific habitats and species.

LoE scoring is based on the criteria listed in Table 51.

Part 2 – Assign Risk Rating for Each Habitat and Other Species

The matrix in Table 52 was used to assign the risk rating for each habitat and other species using the "sensitivity" and "Likelihood of Effect" scores.

Part 3 – Identify Priority Habitats and Other Species VECs

Priority VECs are those habitats and/or other species that are assigned major or moderate risk rating categories when their sensitivity and likelihood of effect category scores were applied within matrix, above. Habitats and other species with either a negligible or low risk rating are not considered as Priority VECs.

TABLE 51. LIKELIHOOD OF EFFECT SCORING FOR HABITATS AND OTHERS SPECIES

LIKELIHOOD OF EFFECT SCORING	CRITERIA
Negligible	• Negligible risk from habitat loss and degradation due to the cumulative effects of the WPPs.
Low	• Low risk from habitat loss and degradation due to the cumulative effects of the WPPs.
Medium	• Medium risk from habitat loss and degradation due to the cumulative effects of the WPPs.
High	• High risk from habitat loss and degradation due to the cumulative effects of the WPPs.

TABLE 52. RISK RATING FOR HABITATS AND OTHER SPECIES

SENSITIVITY	LIKELIHOOD OF EFFECT			
	High	Medium	Low	Negligible
High	Major	Major	Moderate	Minor
Medium	Major	Moderate	Minor	Negligible
Low	Moderate	Minor	Minor	Negligible

5.4.2 *RESULTS*

Only one habitat proceeded to step 3, the *Noaea mucronata* brush. The assessment of LoE (part 1) and assignment of risk rating (part 3) is summarized in Table 53.

[34] The LoE score was necessarily qualitative because, as this CEA was done pre-ESIA for three of the four participating WPPs, the footprints were not available.

TABLE 53. RISK RATING FOR NOAEA MUCRONATA BRUSH

HABITAT NAME	STEP 2: SPECIES SENSITIVITY	STEP 3: LIKELIHOOD OF EFFECT ASSESSMENT (NARRATIVE)	LIKELIHOOD OF EFFECTS SCORE	RISK RATING
Noaea Mucronata Brush	Low	This habitat is generally within the 2 km buffer zone applied by the CEA in the WPP area. Therefore, the risk of habitat loss and degradation due to the cumulative effects of the WPPs is considered to be low overall assuming standard mitigation measures to limit vegetation clearance and prevent damage to habitats are implemented in the project-level ESMMPs.	Low	Minor

Part 3 – Identify Priority Habitats and Other Species VECs

No priority habitat or species VECs were identified during the CEA as being at a cumulative risk of significant impacts from the TRWPPs, assuming standard mitigation measures are implemented. However, project-level ESIAs will need to undertake the necessary habitats and species surveys and impact assessments to inform project-specific ESMMPs.

5.5 STEP 4 – IDENTIFY MITIGATION AND MONITORING AND INSTITUTIONAL ARRANGEMENTS AND INFORMATION MANAGEMENT

No priority VECs for habitats and other species were identified in the CEA process. Therefore, no specific measures are identified for priority VECs for habitats and other species (limited to those covered in the CEA scope).[35]

Given the number of WPPs to be developed in the area, it would be beneficial if the individual projects considered a unified method for habitat monitoring in their ESIAs (or ESMPPs), namely:

- Surveys to record species; vegetation cover; dominant vegetation; and presence of mammals' tracks/signs using 20 x 20 m sample plots, randomly located within, and representative of the different vegetation types within the WPP study area.
- Consider sharing habitat survey and/or monitoring data with the other projects to provide an improved understanding of the habitats and species within the WPP area.

5.6 SUMMARY OF OUTCOMES OF HABITATS AND OTHER SPECIES CEA

The CEA framework for habitats and other species followed four steps to identify potential priority VECs. Four main habitats and species were identified within the WPP area. The UoA used to determine the relative importance for the habitats was the percentage of surface area within the WPP as compared with its national scale. The UoA

[35] Site-specific habitat and species surveys were not undertaken as part of the CEA scope; therefore only species representative of the habitats in the WPP area were considered. The project-specific ESIAs and studies should identify habitats and species within the project-affected areas and undertake the necessary impact assessment on them. This may identify the presence of other potentially sensitive habitats and/or species that would need to be considered at an individual project level in the mitigation and management planning.

Tragopogon collinus DC

used to determine the relative importance for the other species was the EOO of these species at the national level. For each habitat, vulnerability was scored on the basis of the national status of priority for conservation of each habitat. Vulnerability scores for the other species were based on global and/or regional conservation status, depending on the availability of that information for each species. The sensitivity of each species scoped in to step 3 was determined on the basis of relative Importance and vulnerability. This resulted in scoping out of all other species and scoping in only one habitat—*Noaea mucronate* brush.

The LoE of *Noaea mucronata* brush was based on an assessment of the risk of habitat loss and degradation from the WPPs cumulatively. The risk rating for this habitat was determined on the basis of a sensitivity and likelihood of effect matrix.

The risk rating for the *Noaea mucronata* brush was determined to be minor and therefore it was not identified as a priority VEC at high risk from the TRWPP.

The principal recommendation for the CEA Framework for Habitats and Other Species is to develop and conduct standardized habitat monitoring surveys as part of WPP ESIAs /ESMMPs and to ensure that mitigation measures within these that limit vegetation clearance and prevent damage to habitats are implemented.

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Annex A. Regional Environmental and Social Context

ENVIRONMENTAL CONTEXT

TOPOGRAPHY AND LANDSCAPE

The study area, situated on the eastern Jordan Valley, is topographically diverse. It extends from Wadi Araba at 100 m below sea level and rises eastward to 1,600 m in the Sharah Mountains (also referred to as the Southern Highlands). The WPP sites are located in the eastern part of the study area on an approximate north–south orientation, along the higher-altitude parts of the Rift Valley margins, adjacent to the Dana BR. The remainder of the study area extends from the Dana BR westward across desert lowlands within the Jordan Valley (Figure A1). Altitudinal gradients (Figure A2) in the study area give rise to its unique biological and ecological features as well as a diversity of land uses.

FIGURE A1. TOPOGRAPHICAL MAP OF TRWPP STUDY AREA

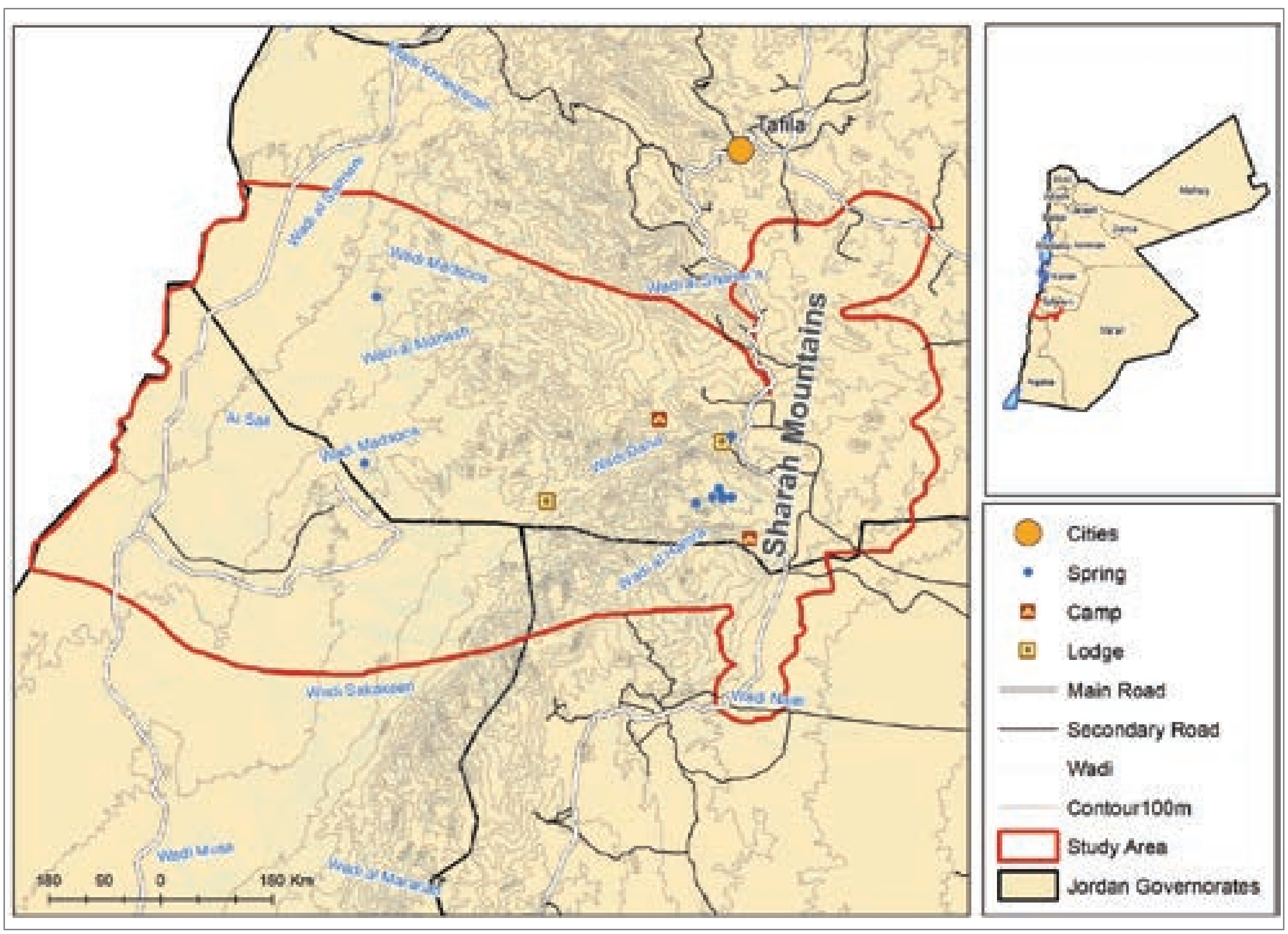
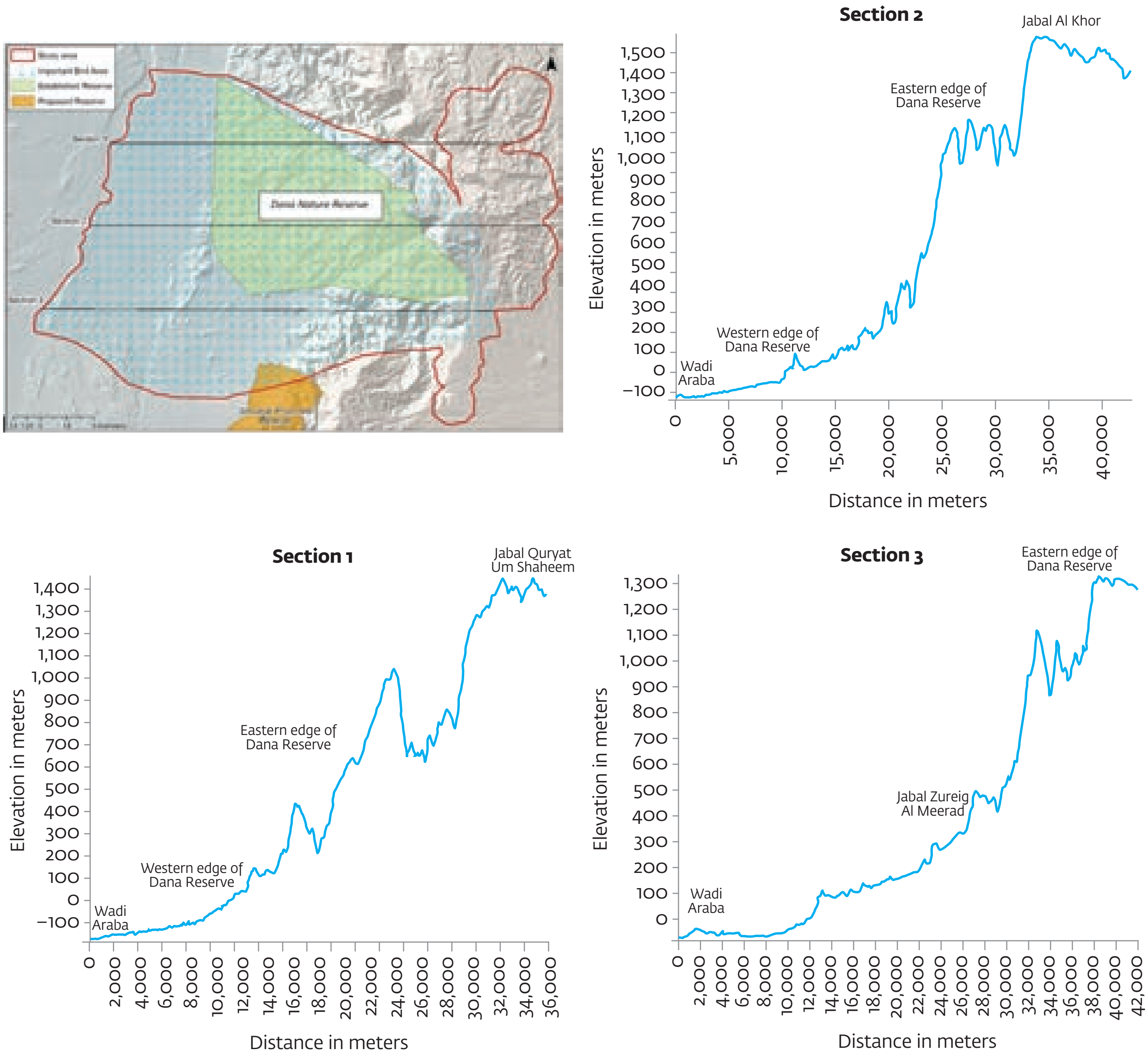


FIGURE A2. TRWPP CEA STUDY AREA AND SECTIONS



Habitat and Vegetation Cover

Biogeographical Zones

Jordan is divided into four main biogeographical zones: Irano-Turanian, Mediterranean, Saharo–Arabian, and Sudanian Penetration (Figure A3). Vegetation cover, soil texture, altitude, and annual rainfall are among the major factors that shaped these biogeographical regions. The figure indicates the zones; however, the transitions between the zones are not always distinct and the transitional areas can be a mixture of the adjacent zones. This is especially the case along the rift.

The study area is located within all but one of these biogeographical zones (the Saharo-Arabian zone). The WPP project area, including the buffer areas, is generally located on the eastern side of the Dana BR and IBA within the Mediterranean and Irano-Turanian biogeographical zones, described below.

- ***The JWPC Tafila, LAMSA, Abour, and KOSPO WPPs*** are generally in the Mediterranean zone (Mediterranean nonforest with sparse shrub). The Mediterranean region is represented by the mountain ranges extending from near Irbid in the north to Ra's an Naqb in the south. It consists of forested vegetation, with typical species including Phoenician juniper (*Juniperus phoenicea),* white broom *(Retama raetam), Pistacia atlantica,* Aleppo pine *(Pinus halepensis), Quercus calliprinos*, and Vallonea oak (*Quercus ithaburensis)*. Open areas are characterized by high cover of *Sarcopoterium spinosum* and *Artemisia herba-alba*. The altitude varies from 700 to 1,500 m above sea level, and average annual rainfall is 400 to 600 millimeters (mm). The soil consists of several types—terra rosa, sandy, and sandy-loamy—owing to erosion of the Nubian sandstone that dominates much of the southern part of Jordan, and calcareous soil in the center and north.
- **The Fujeij WPP** is located in a mixture of the two zones, which includes the transition with the Irano-Turanian zone.[36] This zone is increasingly arid, and the landscape becomes more Mediterranean nonforest toward the rift. This region is represented by a narrow strip that surrounds the Mediterranean biogeographical zone except in the far north. The Irano-Turanian region extends to the northeast, joining the Syrian Desert. The vegetation is dominated by jointed anabasis (*Anabasis articulata*), *Artemesia herba-alba*, *Astragulus spinosum*, white broom (*Retama raetam*), *Urginea maritima*, lotus jujube *(Ziziphus lotus*), bushy bean-caper (*Zygophyllum dumosum*), and scattered Atlantic pistachio (*Pistacia atlantica)* trees. The altitude ranges from 400 to 700 m above sea level, and average annual rainfall is 50 to 100 mm. The layer of surface soil is very thin or absent in some areas, and surface rockiness is very high.

FIGURE A3. MAIN BIOGEOGRAPHICAL ZONES OF JORDAN

Vegetation Types

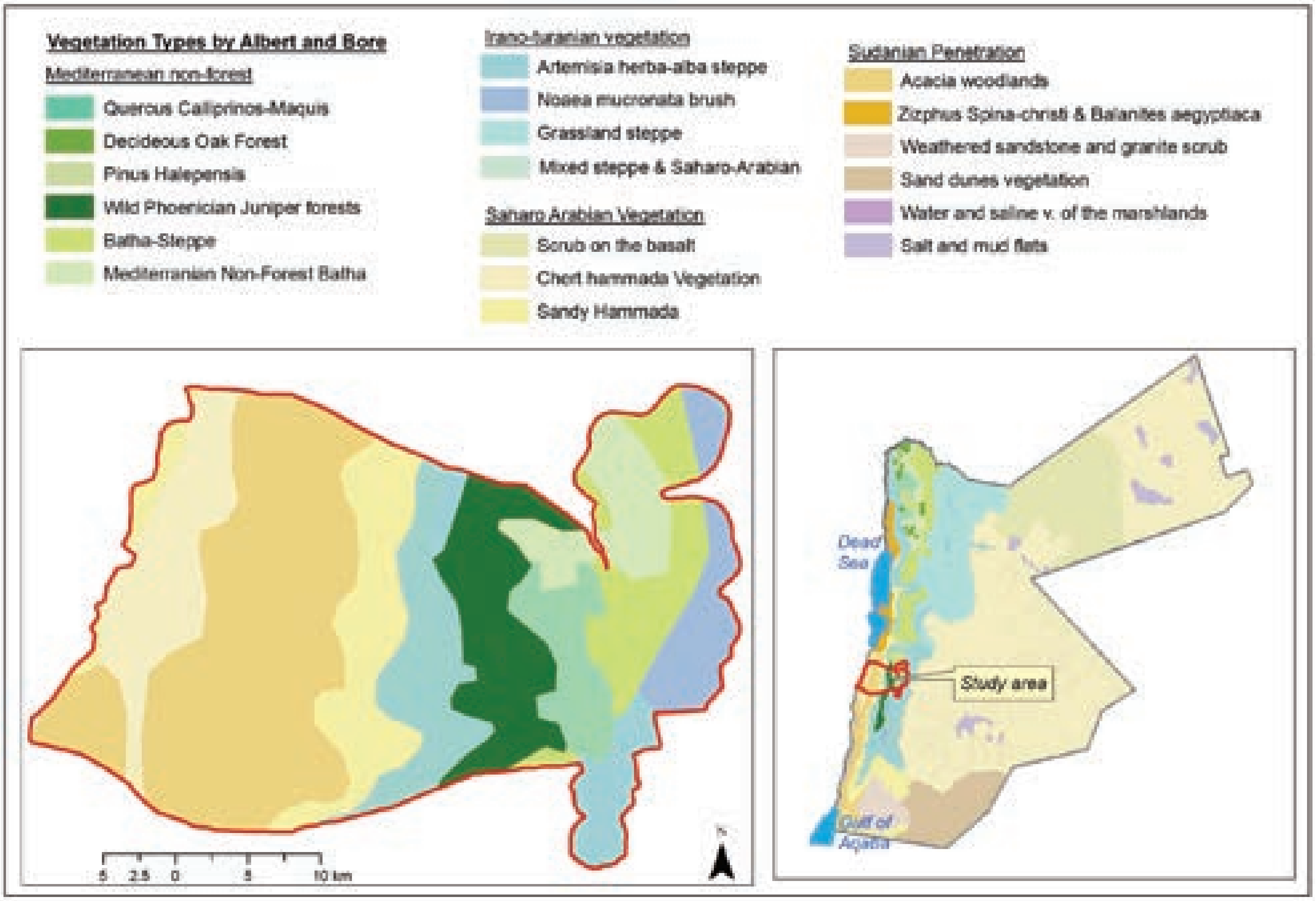
Jordan has 19 vegetation types (Albert and Bore, 2003), (Figure A4), 12 of which are present in the study area. Within the WPP sites, only four of these vegetation types are represented: Mediterranean nonforest batha, batha-steppe, *Artemisia herba-alba* steppe, and thorny saltwort (*Noaea mucronata)* brush.

Wadi System

Running along the western side of the study area is the Wadi Araba. Wadi Araba is to the west of the Dana BR and is the name given to the section of the Jordan Valley that runs south from the Dead Sea to Aqaba. Tributary wadis run down from the rift, east to west, into the Wadi Araba. These tributaries include Wadi Dana; those within the Dana BR are indicated in Figure A5. These wadis are dry except during rainfall events and generally flow only as a result of flash floods.

[36] This transition zone is not shown on the main biogeographical zones of Jordan in Figure A3 as the map is at a coarse scale.

FIGURE A4. VEGETATION TYPES IN THE TRWPP STUDY AREA



Dana Biosphere Reserve and Important Bird and Biodiversity Area

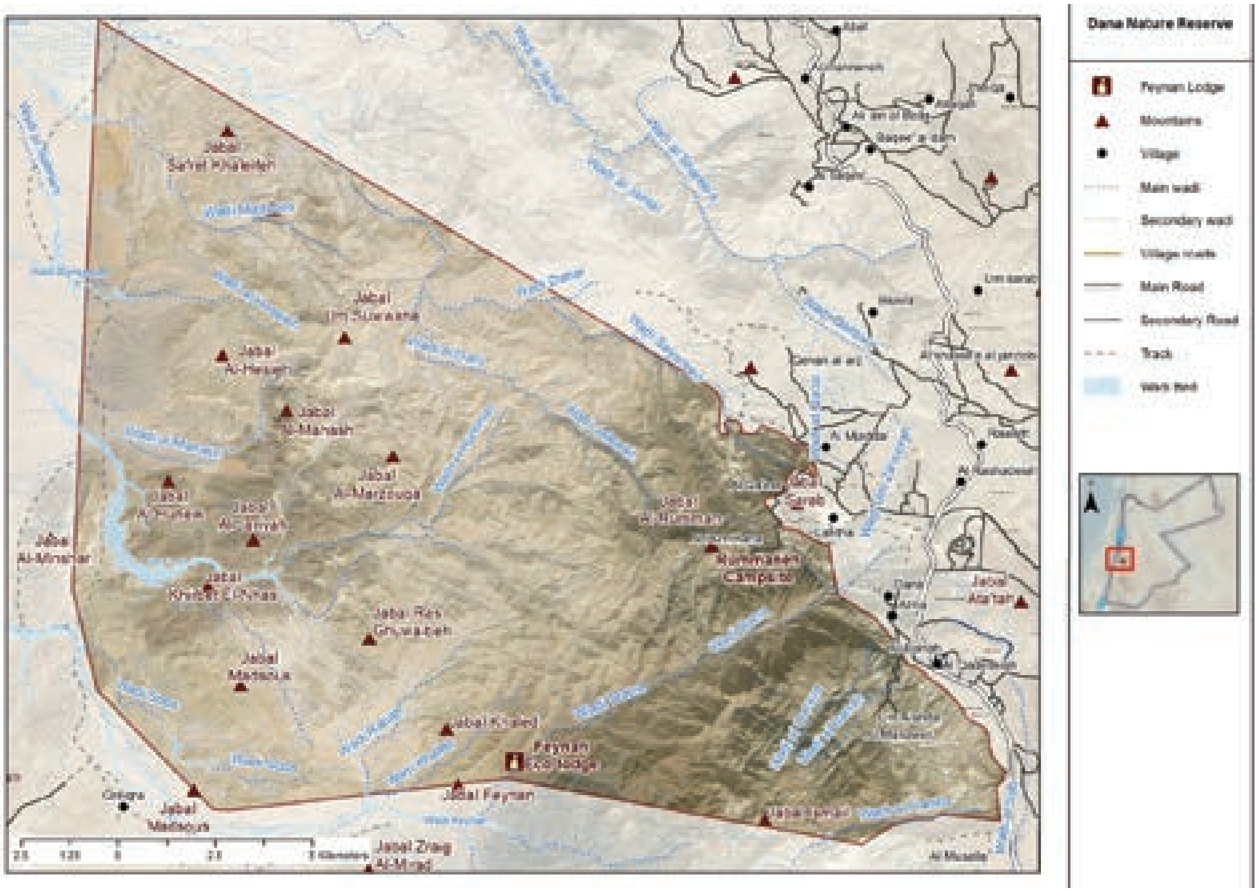
The Dana BR is Jordan's largest nature reserve, covering approximately 300 square kilometers (km^2). It was designated as a nature reserve in 1989. It is a system of mountains and wadis, extending from the top of the eastern Rift Valley to the desert lowlands of Wadi Araba, with an elevation drop of more than 1,600 meters.

The Dana BR contains three bio-geographical zones and four distinct vegetation zones (see Figures A3 and A4). This condensed variety of landforms and habitats, combined with dramatic changes in elevation, results in vast biological diversity. The total number of species recorded so far consists of 800 plant species, of which 3 were new to science, 51 mammal species, and 33 reptile species.[37] Wildlife includes the sand cat (*Felis margarita*), the wolf (*Canis lupus*), and the Egyptian spiny-tailed lizard (*Uromastyx aegyptia*). So far, 25 IUCN Red-List Endangered and Vulnerable animals have been found in the Dana BR, making it an area of global importance. One unique vegetation type in the reserve is the Phoenician juniper (*Juniperus phoenicea*). The most important tree species found is the Mediterranean cypress (*Cupressus sempervirens)*, the last such trees remaining in the region.

The Dana BR is a key example of significant major geological processes in the development of landforms. Rock and soil formations found in the BR demonstrate the geological stages of the area. It features about 100 archaeological

[37] MoENV figures, 2009.

FIGURE A5. WADIS IN THE DANA NATURE RESERVE



sites, including the ancient copper mines in Wadi Feinan, which are considered the most important archaeological complex in southern Jordan outside of Petra.

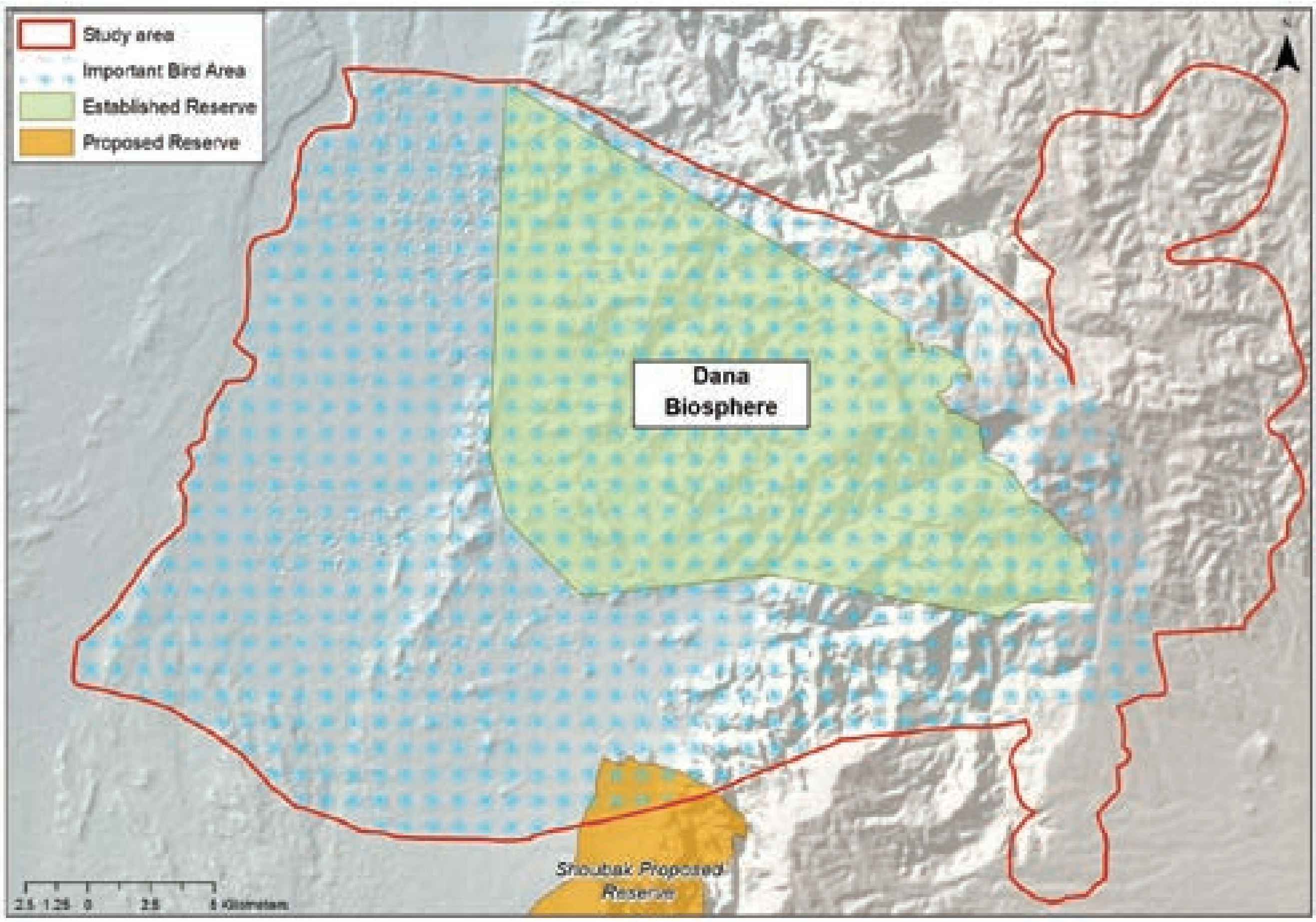
Global environmental organizations also recognize the importance of the Dana BR and surrounding areas. In 1998 UNESCO designated the Dana BR under the Man and the Biosphere program, which aims to establish a scientific basis for the improvement of relationships between people and their environments.[38] In 2000, BirdLife International identified the Dana IBA,[39] which covers 310 km^2, as a key area for the conservation of the world's birds due to the diverse assemblage of breeding birds of unusually mixed biogeographical origins present in the area. The Dana IBA overlaps with the Dana BR by approximately 29.2 km^2.

The Dana IBA (Figure A6) is important for resident and summer breeding species and has particular conservation significance for the Syrian Serin (*Serinus syriacus*) and the griffon vulture (*Gyps fulvus*). Griffon vulture breeding sites are known to be located within the Dana IBA and nowhere else in Jordan. BirdLife International also assigned the Dana IBA a "very high" soaring bird sensitivity rating, with records of 26 of the country's total 37 MSBs. As the

[38] The Man and the Biosphere program draws on the natural and social sciences, economics, and education to improve human livelihoods and obtain the equitable sharing of benefits, and to safeguard natural and managed ecosystems, promoting innovative approaches to economic development that are socially and culturally appropriate, and environmentally sustainable (http://www.unesco.org/new/en/natural-sciences/environment/ecological-sciences/man-and-biosphere-programme/about-mab/).

[39] IBAs are identified as being globally important for the conservation of bird populations by the nongovernmental organization BirdLife International, using an internationally agreed set of criteria.

FIGURE A6. DANA IMPORTANT BIRD AND BIODIVERSITY AREA (IBA)



WPPs lie directly adjacent to the Dana IBA, it was considered important to include the IBA area in the TRWPP study area so that the potential cumulative effects on species relevant to the integrity of the Dana IBA could be considered.

Overlapping with the southern edge of the Dana IBA and to the south of the Dana BR is the proposed Shoubak Nature Reserve[40] (Figure A6). Currently there is no timeline for establishing this as a protected area.

The Rift Valley/Red Sea Flyway and MSBs

The Rift Valley/Red Sea flyway is the second most important flyway in the world for MSBs (raptors, storks, pelicans, and ibises). An estimated 1.5 million birds of 37 species use this flyway to migrate between their breeding areas in Eastern Europe and Western and Central Asia in spring and to their wintering areas in Africa in autumn (BirdLife International, 2012, 2015). Tributary routes originating in these wintering and breeding areas converge at migration bottlenecks as birds enter or leave Africa by routes that avoid crossing large expanses of open water (Hilgerloh, 2009;

[40] The proposed Shoubak protected area is located mainly in Aqaba Governorate, except for its northeastern part which is located in Ma'an Governorate. It has an area of approximately 77 km^2. Like the Dana BR, the proposed Shoubak protected area represents three main biogeographical zones: Mediterranean, Irano-Turanian, and Sudanian, with the Irano-Turanian zone covering more than 90 percent of the total area. As for vegetation types, five are identified in the area: juniper, evergreen oak, water, steppe and acacia, and rocky Sudanian. During the rapid assessments carried out in the proposed area, 145 plant species, 44 bird species, 12 mammal species, 10 reptile species, and 1 amphibian species had been recorded, as of the drafting of the CEA report.

Shirihai et al., 2000; Zalles and Bildstein, 2000; Bildstein, 2009) (see Box).

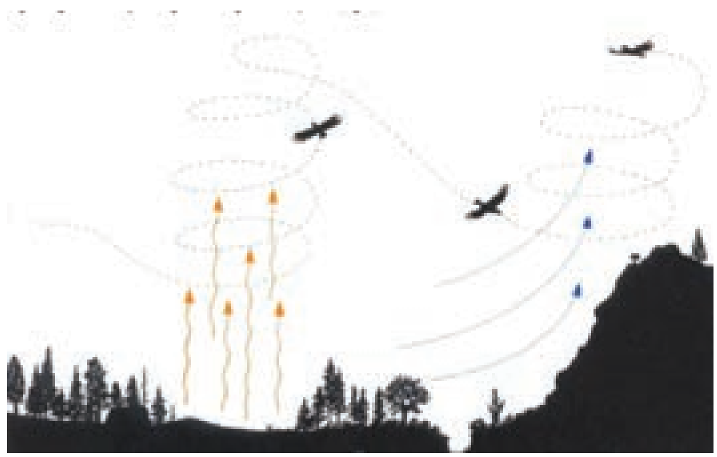
Away from bottleneck sites, flyway migration routes vary between the spring and autumn seasons and according to the origin and destination of individual species (Figure A8). In autumn, many of the migrants breeding west of the Ural Mountains (e.g., the lesser spotted eagle, Levant sparrowhawk, and honey buzzard) funnel through the Bosphorus in Turkey, and then head southeast, passing along the eastern edge of the Mediterranean Sea. Species that breed further east (e.g., the steppe buzzard, steppe eagle, and black kite) use routes between the Black and Caspian Seas or routes to the south of the Caspian Sea, continuing on a broad front through Arabia and crossing into Africa at the southern end of the Red Sea. In spring, most species avoid this crossing and instead head up the west side of the Red Sea, cross the Gulf of Suez and the Sinai Peninsula to Eilat. From here, the majority of birds head northward following the Jordan Rift Valley, with more easterly breeding species heading eastward across the top of the Arabian Peninsula.

Evidence from migration studies at Eilat suggests that migration through southern Jordan is likely to involve larger numbers of birds during the northward spring migration than the southward autumn migration (Shirihai et al., 2000; Shirihai and Christie, 1992; Leshem and Yom-Tov, 1998).[41] However, due to a lack of observational data from the south of Jordan, this supposition cannot currently be verified.

MSB Behavior and Migration Bottlenecks

For raptors and large soaring birds that optimize their energy expenditure during migratory flight by making use of columns of rising air (thermals and/or updrafts) (Figure A7) that develop over land, traveling over water is energetically demanding and risky.

FIGURE A7. DIAGRAM OF A BIRD USING A THERMAL (LEFT) TO GAIN ALTITUDE, EXITING THE THERMAL, LOSING ALTITUDE, AND THEN REGAINING ALTITUDE BY TAKING ADVANTAGE OF AN UPDRAFT (RIGHT)



Source: unknown, obtained from http://www.paulnoll.com/Oregon/Birds/flight-soaring-diagram.html (Accessed January 2017).

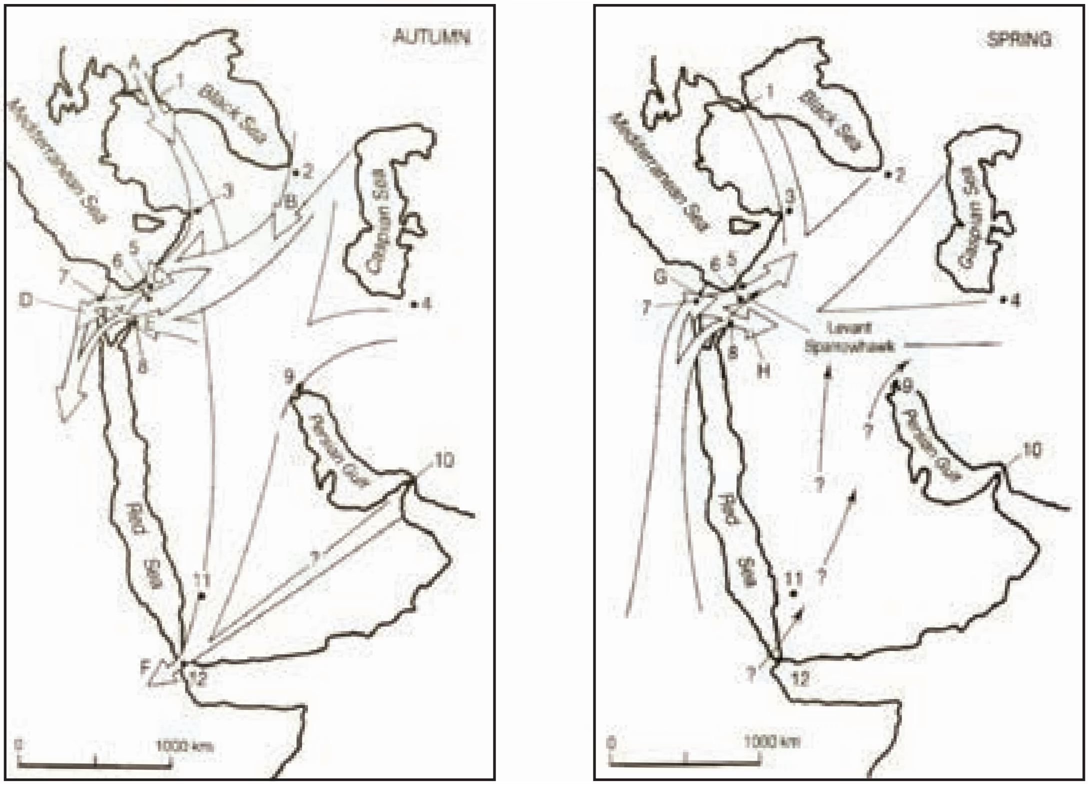
As a consequence, MSBs, in particular those species that largely rely on moving between thermals to migrate, avoid crossing large areas of water whenever possible. This results in these species funneling toward migration bottlenecks. These are locations along a migration route where sea crossings are minimal, or narrow land bridges between areas of sea occur (Newton, 2008). During the spring and autumn migrations, birds are concentrated at these locations due to both the funneling effect of birds from disparate origins arriving at these crossing points and because good thermal conditions are needed to enable these species to gain adequate height before making even a short sea crossing. Examples of migration bottlenecks away from the Middle East include the Strait of Gibraltar (Spain) between Europe and Africa, and the Bosphorus (Turkey) between Europe and Asia (Zalles and Bildstein, 2000; Bildstein, 2009).

Soaring Bird Migration over TRWPP Area

The key migration bottlenecks along the Rift Valley/Red Sea flyway are located along the Red Sea coast, the Gulf of Suez, and the Gulf of Aqaba (Porter, 2005). Eilat, the bottleneck nearest to the study area, is approximately 100 km south of the study area in Israel. The moderate distance from Red Sea bottleneck locations and favorable thermal conditions throughout the study area result in low to moderate levels of MSB migratory activity depending on the time of day, season, and other environmental conditions.

[41] Birdlife International. Soaring bird sensitivity map, a users' guide. http://migratorysoaringbirds.undp.birdlife.org/en/sensitivity-map-instructions. (Accessed March 2015).

FIGURE A8. MIGRATION ROUTES OF RAPTORS (SPRING VS. AUTUMN) AND MAJOR WATCH POINTS IN THE MIDDLE EAST



Source: Shirihai et al. 2000.
Routes: A: black kite, honey buzzard, buzzard, lesser spotted eagle, and Levant sparrowhawk. B: black kite, honey and steppe buzzards, a few steppe and lesser spotted eagles, and Levant sparrowhawk. C: honey buzzard, lesser spotted eagle, and Levant sparrowhawk. D: lesser spotted and steppe eagles. E: steppe eagle. F: steppe eagle, steppe buzzard, and black kite. G: lesser spotted eagle, steppe eagle, steppe buzzard, and black kite. H: Steppe eagle, steppe buzzard, black kite, and Levant sparrowhawk.
Vantage points: 1- Bosphorus, 2-East Pontics, 3-Iskenderun, 4-Southeast Caspian, 5-Kfar Quassem and Northern Valleys, 6-North Negev and Dead Sea, 7-Suez, 8-Eilat, 9-Kuwait, 10-Strait of Hormuz, 11-North Yemen, 12-Bab el Mandab.

On a given day, the species composition and number of individuals of each species observed will relate to species-specific migration schedules and the migratory behavior of the species (Shirihai et al., 2000). For MSBs that typically migrate dispersed across a broad front (e.g., Egyptian vulture, harriers, and some falcons), the proportion of a flyway population flying through the study area is likely to be small because the migration corridor is wide. Movements of these species through an area like the TRWPP will typically involve single or small groups of birds. Conversely, narrow-front migrants (e.g., the common crane, black and white stork, honey buzzard and steppe buzzard), which restrict themselves to relatively narrow migration corridors, tend to move in larger flocks and thus may constitute a higher proportion of the flyway population.

Social Context

The majority of the study area is within the Tafila Governorate, with areas in the south in the Governorates of Aqaba and Ma'an (Figure A9); however, topographically and socially the study area is more linked to the Tafila Governorate. The WPP sites are located in the Tafila Governorate,[42] with the exception of Fujeij, which is located in the Ma'an Governorate.

[42] Tafila is also spelled Tafilah and Tafileh.

Summary of Tafila Governorate

The Tafila Governorate is one of 12 governorates in the Hashemite Kingdom of Jordan. Located 184 km south of Amman, it is bordered by the Al Karak Governorate to the north and the Ma'an and Aqaba Governorates to the south. It covers an area of approximately 2,209 km^2, equal to 2.5 percent of the total area of Jordan. The population of Tafila in 2011 was estimated at 87,500, approximately 2.5 percent of Jordan's population. The governorate is one of the least populated in the country, with the population spread among 35 towns and villages.

FIGURE A9. GOVERNORATES OF THE TRWPP STUDY AREA

The governorate depends mainly on tourism from other parts of the country visiting the nature reserves and hot springs. Agriculture is considered to be the third largest sector in the governorate after tourism and archeology. Fruit and olive cultivation, covering 42 km^2, predominates, with 31 km^2 occupied by olive farms.

Key employment sectors in the governorate include the service sectors (education, vocational training, health, and local government), productivity sectors (agriculture, tourism, and archaeology) and infrastructure sectors (irrigation, public works, and electricity). The majority of employment comes from the service sectors. Unemployment rates are high in Tafila, at 17.5 percent compared with the national average of 13.5 percent. According to the Tafila Directorate of Social Development (2012), the poverty rate is one of the highest in the country at 17.2 percent, with approximately 10.4 percent of the population receiving subsidies from the Directorate of Social Development.

Land Ownership and Use

There is a mixture of land ownership in the study area. The Dana BR is government land whereas the areas outside the reserve are either privately owned or government lands. As is the case in most of Jordan, the land in the area is divided among tribes on the basis of watershed and pasture. Historic ownership of tribal lands, referred to as *tribal fronts*, is still acknowledged and is based on formal agreements or semiformal understandings between tribal groups. Private ownership also follows the distribution of the tribes that have inhabited the area over centuries.

Local Communities and/or Tribes and Land Uses

Tribes can be divided into three groups on the basis of their distribution in the study area and their seasonal movements and land uses:

- *TRWPP Eastern Part*: The eastern part of the study area is inhabited by the semi-nomadic tribe of *Al-Hajaya*. The landscape in this area, including areas around some of the WPPs, is moderately hilly and rocky with sparse vegetation. Sheep and goats graze in WPP areas, and there is some small-scale, low-intensity agriculture (e.g., wheat, cereals). Dwellings in the study area are limited to small towns and villages, including those of Gharandal, Bsaira, Al-Ees, and Al-Qadisiyyeh. In addition, semi-nomadic Bedouin settlements, mainly tents, are present seasonally.

- *TRWPP Northern Part:* The northern part of the TRWPP, in particular around Gharandal and Al-Ees, is inhabited by the *Saudiyyeen* tribes, whereas the areas around Al-Qadisiyyeh to the south are owned by members of the *Atatah* tribes. Tribes use land located in the study area to grow cereal crops and allow their livestock to graze. Their livestock is present in the WPP areas during spring and summer, and moves westward into the Dana BR from winter to early spring. They are allowed access to the Dana BR on the basis of an agreement signed with the RSCN, the managing entity of the BR.
- *TRWPP Western Part*: The western lower part of the study area in Wadi Araba is inhabited by a mix of semi-nomadic Bedouin tribes that include *Saidiyyeen*, *Ammarin*, *Rashaydeh*, and *Azazmeh*. These tribes do not extend into the WPP areas and mainly use the westernmost part of the study area during winter, accessing the Dana BR during spring and summer on the basis of an agreement signed with the RSCN. Over the past several decades, the government has encouraged members of these tribes to abandon their nomadic lifestyle, and as a result, these tribes are becoming semi-nomadic. Villages present in this part of the TRWPP have been established for specific tribes. For example, Gregra, the oldest village in the area, is inhabited by the Ammarin and Saidiyyeen. The recently established Feynan village is inhabited by the Rashaydeh, and Ghwebbeh is inhabited by the Azazmeh. The Azazmeh are originally from the Negev and moved into Wadi Araba after the establishment of the Israel on their lands in 1948. The Azazmeh are therefore the only tribe in the area that does not "own" a tribal front.

Movement of Semi-nomadic Bedouin Livestock Owners

The movement of the Bedouin livestock owners follows the change in vegetation cover and the availability of pasture. They are generally present in their highest densities in the study area in the spring to autumn, from March/April until late September/October. They spend the rest of the year in the east. Movements of Bedouin and their livestock may vary from year to year and are dependent on the timing of seasonal changes. In some years, depending on rainfall and onset of cold weather, the eastward movement can take place in early September or in late November. Similarly, movements in spring are likely to be determined by the availability of pasture in wintering areas and/or summering areas.

Land Uses and the Wind Power Projects in the CEA

It should be noted that, as is the case for many wind energy projects, the WPPs in the CEA will not restrict the use of land by livestock owners (whether semi-nomadic or local communities). This is considered to be a benefit of the WPP, as land use is not restricted. That said, ongoing pastoralist land use influences how some birds, notably vultures, use the area. This is described further in Section 3 in this report.

Annex B. Stakeholder Engagement

INTRODUCTION AND STAKEHOLDER LIST

This annex summarizes the stakeholder engagement activities that were undertaken throughout the CEA process. All stakeholder interactions were recorded in stakeholder consultation logs and meeting minutes, a summary of which is provided here.

SUMMARY OF STAKEHOLDERS ENGAGEMENT PER CEA PHASE

Stakeholder engagement, which took place both bilaterally and multilaterally, was the cornerstone of the CEA process. Table B1 summarizes the main stakeholder engagement activities per each CEA phase[43] and the outcomes per engagement. For details on the attendees, see Tables B2, B3, and B4 in this annex.

Verreaux's Eagle – *Aquila verreauxii*

[43] The CEA phases are described in Section 2 of the main body of this report.

TABLE B1. SUMMARY OF STAKEHOLDER ENGAGEMENT ACTIVITIES PER CEA PHASE

CEA PHASE	DATE(S)	TYPE OF ORGANIZATION	ORGANIZATION NAME	BILATERAL OR MULTILATERAL	SCOPE OF THE MEETING	OUTCOMES
Phase 1: Scoping	19 January 2015	Ministries and government departments	MoEnv	B	To present the CEA concept and approach and seek stakeholder views, opinions and data on the development and scope of the CEA	Summary of Outcomes: • Overall, there was positive support for the CEA concept and feedback was given in relation to the CEA approach and scope. • The scoping phase engagement highlighted some key issues that informed the CEA approach, including the shortage of ornithologists and qualified surveyors, capacity issues, and the need for data confidentiality for certain stakeholders. • The potential VECs were identified and discussed in addition to existing data and data needs.
	19 January 2015		Ministry of Energy and Mineral Resources (MEMR)	B		
	20 January 2015		Department of Antiquities (DoA) in Ministry of Tourism and Antiquities (MoTA)	B		
	21 January 2015		Jordan Investment Commission (JIC)	B		
	20 January 2015	Developers	EDAMA	M		
			KOSPO			
			Abour			
			Tafila			
			LAMSA			
	20 January 2015	Conservation organizations, academia and civil society organizations	American University of Madaba (AUM) and Jordan BirdWatch	M		
			BirdLife International Middle East			
			BirdLife International HQ (Cambridge) *via teleconference*			
			RSCN			
Phase 2: Supplementary Data Collection and Capacity Building	14–16 April 2015	TRWPP CEA workshop focused on birds and bats including bird survey training		M	Three weeks of in-field training of bird surveyors to build capacity	• The workshop comprised a number of sessions, culminating with a field visit to the JWPC Tafila WPP, which was under construction at the time, and the Dana BR. • Key discussion points raised in each session were recorded in minutes of the workshop and have been considered in the CEA process. • See 'TRWPP CEA workshop focused on birds and bats including bird survey training', which provides details on the workshop and the in-field training provided to surveyors.
	19 April 2015	Conservation organizations, academia and civil society organizations	AUM and Jordan BirdWatch	B	To discuss field methodology, VECs, and the preliminary Significance and Sensitivity Matrix	• Provide input on the field methodology, e.g., categorization of primary and/or secondary species and field survey species. • Discuss the concern that the new access roads for the wind farm may provide access for hunters to areas that had formerly been hard to reach. • Review habitat VECs, e.g., discuss the concern for potential issues related to creating barriers for north–south movement of tortoise. • Verify the apparent absence of griffon vultures in the TRWPP area. • Agree on the boundaries of the TRWPP area for the CEA.

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TABLE B1. SUMMARY OF STAKEHOLDER ENGAGEMENT ACTIVITIES PER CEA PHASE *(continued)*

CEA PHASE	DATE(S)	TYPE OF ORGANIZATION	ORGANIZATION NAME	BILATERAL OR MULTILATERAL	SCOPE OF THE MEETING	OUTCOMES
	20 April 2015	Conservation organization	BirdLife International Middle East	B		• Provide input on the field methodology, e.g., categorization of primary and/or secondary species field survey species, survey stratification approach, discussion of peak and nonpeak effort and suggested durations, the maximum distance of observation (2 km) from the VP. • Provide input into the preliminary Significance and Sensitivity Matrix, e.g., classifications used and relation with BirdLife Soaring Birds Sensitivity Map. • Verify the apparent absence of griffon vultures in the TRWPP area.
	20 April 2015	Conservation organization	RSCN	B		• Input in the field methodology, e.g., effort and issues around adjacent VP (chance of double-counting). • Discuss suggestions for postconstruction monitoring, e.g., involve Bedouin, employ dogs to detect dead raptors). • Discuss concern that the new access roads for the wind farm may provide access for hunters to areas that had formerly been hard to reach easily. • Planning the next meeting in Jordan around the timing of events for World Migratory Bird Day 2015. • Verify the apparent absence of the griffon vulture in the TRWPP area.
	23 April 2015 7 May 2015 28 May 2015	Conservation organizations, academia, and civil society organizations	AUM and BirdWatch Jordan	B	Follow-up meetings to discuss field methodology, VECs, and a preliminary Significance and Sensitivity Matrix	• Final comments on the issues discussed in a meeting on 20 April 2015. The AUM (Dr. Khoury) provided a document on sensitive resident and/or breeding bird populations in TRWPP: ◦ Likely to be affected will be those species breeding along the adjacent rift margins and frequently or occasionally foraging on hilly mountain plateaus beyond (east of) the ridge ◦ Sensitive species include the griffon vulture, short-toed eagle, long-legged buzzard, and Bonelli's eagle ◦ Factors related to WPPs affecting these populations are described (including habitat loss, loss of ecological connectivity, increased disturbances, various developments, and hunting)
	23 April 2015 1 May 2015 7 May 2015 8 May 2015	Conservation organizations	BirdLife International Middle East	B		• Obtain formal feedback on the documents on field methodology, VECs, and the preliminary Significance and Sensitivity Matrix • Address the concern about increase in hunting, given the increased access as a result of the WPP access roads. • Add inputs related to the habitat VEC. • Discuss the apparent absence of griffon vultures in the TRWPP area.
	23 April 2015 7 May 2015 28 May 2015	Conservation organizations	RSCN	B		• Obtain formal feedback on the documents on field methodology, VECs, and the preliminary Significance and Sensitivity Matrix. • Obtain formal comments on postconstruction monitoring. • Address the concern about the increase in hunting, given the greater access resulting from the WPP access roads. • Discuss the apparent absence of the griffon vulture in the TRWPP area.

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TABLE B1. SUMMARY OF STAKEHOLDER ENGAGEMENT ACTIVITIES PER CEA PHASE (*continued*)

CEA PHASE	DATE(S)	TYPE OF ORGANIZATION	ORGANIZATION NAME	BILATERAL OR MULTILATERAL	SCOPE OF THE MEETING	OUTCOMES
	11 June 2015	Ministries and government departments	MoEnv	M	Kick-off meeting of the AC: • To present and agree on the outcomes of the scoping (phase I) • To agree on next steps	• Clarified the AC members' role, i.e., to discuss and feedback information from AC with their respective stakeholder groups • AC members agreed on • CEA objectives • The current geographic scope of the CEA (WPPs: Abour, KOSPO, JWPC Tafila, and LAMSA), and that Fujeij will be approached for possible inclusion in the geographic scope • Definitions of what the CEA is and is not • The CEA process and the intervention points expected from them • All selected VECs • Next steps, provisional milestones, and next meetings of the AC
		Developers	Abour (developers' representative)			
		Conservation organizations, academia, and civil society organizations	RSCN BirdLife International Middle East AUM and Jordan BirdWatch			
		IFIs	EIB (Eva Mayerhofer) via teleconference IFC (In addition to the CEA team, investment officers Jaikishin Asnanai and John Mantzavinatos via teleconference, country officer Dr. Ahmed Attiga			• On the AC member's suggestion to include tourism (including visual impact), it was agreed that the literature examples of wind farms on tourism would be explored, the possibility of a joint evaluation of this for all projects would be explored by the AC, with the understanding that IFC PSs do not cover this aspect. • Selection of priority bird species to be included in the CEA will be distributed to the AC in July. • An update of spring fieldwork for birds was presented. • Results of additional analysis (in addition to project-specific data and beyond the CEA projects' direct area of influence) to support the CEA were presented.
Phase 3: CEA Framework and Assessment	7 October 2015	Ministries and government departments	MoEnv	M	2nd AC Meeting: • To present and discuss the proposed CEA Framework • To present and discuss initial results • To review the approach for moving forward	• Fujeij WPP agreed to contribute data to the CEA. • AC members agreed on • Categories of species populations used for CEA framework • Steps 1–5 of CEA framework • Having further bilateral meetings with experts on the AC to discuss the results of each step and refined the approach • That monitoring will happen for all species and adaptive management will be undertaken
		Developers	Abour (developers' representative)			
		Conservation organizations, academia, and civil society organizations	RSCN BirdLife International Middle East AUM and Jordan BirdWatch			• The following suggestions were made by AC members and taken on board: • Information management and sharing to be covered in step 5 • Addition of step 6, "Institutional Arrangements/ Information Management/Management Program" to the CEA Framework
	14 October 2015	Conservation organizations	RSCN	B	To discuss in more detail the Framework that was presented in the AC meeting of 7 October 2015	Discussion with members of the ERP. • The RSCN provided distribution maps of all resident bird species that it had prepared in cooperation with Dr. Fares Khoury. • The RSCN was invited to participate in discussions of steps 1–2 (categories 2 and 4) with BirdLife International and Dr. Fares Khoury.

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TABLE B1. SUMMARY OF STAKEHOLDER ENGAGEMENT ACTIVITIES PER CEA PHASE *(continued)*

CEA PHASE	DATE(S)	TYPE OF ORGANIZATION	ORGANIZATION NAME	BILATERAL OR MULTILATERAL	SCOPE OF THE MEETING	OUTCOMES
	19 October 2015	Conservation organizations	RSCN BirdLife International Middle East	M	To discuss "Consultation Package #1" for the Master List (Step 2, Category 2–4)	Discussion with members of the Expert Review Panel: • Agreement on the master list for categories 1 and 2 • Adjustments to the master list for categories 3 and 4 • Adjustments to "downlist" or "uplist" species on the basis of available estimates from the RSCN and/or BirdLife for category 2 species. • Category 4 species: not possible to provide population estimates for these species but the team provided an estimate of the national population percentage occurring in the TRWPP area (including the Dana BR and IBA).
	3 November 2015	Conservation organizations	RSCN BirdLife International Middle East	M	To discuss "Consultation Package #2" (Step 2, Category 1)	Discussion with members of the Expert Review Panel: • Agreement on the consultation sheet (importance plus vulnerability scores) sent by the CEA team, except for the Levant sparrowhawk, European honey buzzard, steppe buzzard, for which clarification was given by the NRP.
	16 November 2015	Conservation organizations	RSCN	B	Meeting with RSCN GIS Unit team to discuss the possibility of cooperation in providing data and maps for the CEA framework regarding habitats	• The RSCN agreed to vegetation and biogeographical maps that show the coverage of the habitats and zones inside TRWPP.
	18 November 2015	Conservation organizations	RSCN BirdLife International Middle East	M	To discuss "Consultation Package #3" (Step 3, Categories 1, 3, and 4)	Discussion with members of the Expert Review Panel: • The logic behind the rating and categorization of the different grades was not clear to the stakeholders (likelihood of effect plus risk rating). Stakeholders requested follow-up meeting with CEA team on this aspect. This was covered in the meeting on 29 November 2015.
	25 November 2015	Conservation organizations	RSCN	B	Meeting with RSCN GIS Unit team to discuss the possibility of cooperation in providing data and maps for the CEA framework regarding bats and to review the habitat maps that were provided earlier	• The RSCN agreed to provide distribution maps for bat species in the TRWPP.
	29 November 2015	Conservation organizations, academia and civil society organizations	RSCN BirdLife International Middle East AUM and Jordan BirdWatch	M	To discuss "Consultation Package #3" (Step 3, Categories 1, 3, and 4) (second meeting)	Discussion with members of the Expert Review Panel: • Agreement on rating (likelihood of effect plus risk rating), except for steppe eagle, for which clarification was asked from CEA team • Discussion of consultation packages #1 and #2: request to CEA team for more clarification on Levant sparrowhawk, European honey buzzard, steppe buzzard
	2 December 2015	Conservation organizations	RSCN	B	Meeting with the RSCN fauna research team to discuss the availability of data on bats in the Dana BR and IBA	• Overview of available data in the Dana BR and IBA, and plans for bat survey there

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TABLE B1. SUMMARY OF STAKEHOLDER ENGAGEMENT ACTIVITIES PER CEA PHASE (*continued*)

CEA PHASE	DATE(S)	TYPE OF ORGANIZATION	ORGANIZATION NAME	BILATERAL OR MULTILATERAL	SCOPE OF THE MEETING	OUTCOMES

	17 December 2015	Ministries and government departments	MoEnv	M	3rd AC Meeting:
					• Presentation of the results of step 1–3
					• Discussion of the thresholds approach
					• Review of methods and outcomes of step 4
					• To present preliminary mitigation and monitoring (step 5)
					• To discuss ideas for management program and institutional arrangements (step 6)
						• AC members agreed on
						• Meeting with ERP to
						  • Identify thresholds (threshold decision tree in step 4) using practical knowledge and inputs from various stakeholders
						  • Identify potential measures to address external stressors for the Mitigation and Monitoring Strategy (step 5).
						  • Propose a working mechanism for step 6 focused on a potential "central reporting mechanism and/or adaptive management" to be incorporated within the CEA
						• IFC will develop a draft Mitigation and Monitoring Strategy to be proposed for review by the developers focus group.
						• AC members will provide feedback and comments to the draft RSCN Guidelines for Wind Energy.
						• The proposed bats and habitats and other species frameworks.

		Developers	Abour (developers' representative)			
		Conservation organizations, academia, and civil society organizations	RSCN			
			BirdLife International Middle East			
			AUM and Jordan BirdWatch		• To present the bats and habitats and other species frameworks, to present the RSCN National Guidelines for Wind Energy	• Timeline for draft final report, next AC meeting, final report, and launching event of CEA report
	14 December 2015	Developers	Abour, KOSPO, and JWPC Tafila	M	To review preliminary ideas on mitigation and monitoring (step 5) with the developers	• Developers gained familiarity with the preliminary three-pronged approach for mitigation and monitoring (on-site, intersite, and joint measures) • Developers agreed to review a draft framework and provide comments, once it was developed by the CEA team.

	27 December 2015
	28 December 2015
		Conservation organizations, academia, and civil society organizations	RSCN	M	To discuss "Consultation Package #4" (step 4: thresholds)	• The ERP requested clarification from the CEA team on
						  • How potential biological removal (PBR) figures were calculated
						  • The threshold for the booted eagle
						  • Adding other external stressors for the lesser kestrel
						  • Why the steppe eagle was scoped out and did not reach step 4 despite its passage in relatively large numbers in Jordan in general and the perception that more individuals are probably wintering in the country and around Tafila
						• The ERP agreed that all raptor species face at least a low impact of each of the stressors.
						• The ERP supports the idea of a study on other stressors as one has never been done in the country.

			BirdLife International Middle East			
			AUM and Jordan BirdWatch			

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TABLE B1. SUMMARY OF STAKEHOLDER ENGAGEMENT ACTIVITIES PER CEA PHASE *(continued)*

CEA PHASE	DATE(S)	TYPE OF ORGANIZATION	ORGANIZATION NAME	BILATERAL OR MULTILATERAL	SCOPE OF THE MEETING	OUTCOMES
	12 January 2016	Conservation organizations, academia, and civil society organizations	RSCN BirdLife International Middle East	M	To discuss "Consultation Package #5" (step 5: mitigation and monitoring)	Discussion of proposed mitigation and monitoring measures and suggestions made with the Expert Review Panel: • Need for another look at the VECs that were dropped earlier so as to be considered in the future (including intrinsic appeal of wind farms and archaeology) • Prepare a conservation action plan for the griffon vulture since it is one of the most important VECs in the area and all recommended actions and monitoring could be put under this conservation action plan. • Vulture restaurants do not seem to be a valid option for the future since the preliminary results from the established ones in the Dana BR/IBA do not show any significant activity. • Hunting control, livestock and/or grazing management, and a local communities outreach plan are the three main pillars of monitoring and actions that need to be carried out to ensure the safety of the major VECs in the area. • Habitat monitoring and its relation to livestock grazing and urban development is important. • Agreed document would be amended and shared for review again.
	End of January 2016	Developers	Abour, KOSPO, and JWPC Tafila	M	To review and discuss the draft Mitigation, Monitoring, and Management Plan	Developers met without the CEA team and sent comments to the team.
	20 January 2016 18 February 2016	Ministries and government departments	MoEnv	B	To discuss options for step 6 (institutional arrangements and information management)	Draft, Concept Note on Enhancement of the MoEnv's Compliance and Audit Function for the Wind Energy Sector
	29 February 2016	Developers	Abour, KOSPO, and JWPC Tafila	M	To review and discuss developers' comments on the draft Mitigation, Monitoring, and Management Plan	The CEA team and developers discussed all aspects of the draft plan. The CEA team incorporated agreed comments.
	2 March 2016	Ministries and government departments Developers Conservation organizations, academia, and civil society organizations	MoEnv (excused) Abour (developers' representative) RSCN BirdLife International Middle East AUM and Jordan BirdWatch (excused)	M	4th AC Meeting: • Presentation of CEA Report progress • Summary of outcomes • Focus on step 5 (Mitigation, Monitoring, and Management Plan) and step 6 (Management Program and Institutional Arrangements)	AC members agreed on • The necessity to train new personnel for in-flight monitoring of priority birds in response to the current limited number of trained experts in the field. • Monitoring to be undertaken during both summer and winter. • Shutdown on demand for priority birds with a clearly defined protocol is a very efficient and effective mitigation measure with clear communication as a condition for success. • Having a clear process for carcass searches that is based on good practice and learned lessons is important. • Vulture restaurants might be considered as mitigation measures in the future based on more documentation of their activity. Suggested biodiversity offset of development of a special conservation area within the study area will be removed from the MMP due to the possibility of attracting birds to the WPP sites, which is undesirable. • Developers working together is considered a best practice as they could learn from each other and have consistent review. • Potential cooperation between the Developers' Internal Committee and BirdLife will be discussed in a separate bilateral meeting between these groups.

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TABLE B1. SUMMARY OF STAKEHOLDER ENGAGEMENT ACTIVITIES PER CEA PHASE (*continued*)

CEA PHASE	DATE(S)	TYPE OF ORGANIZATION	ORGANIZATION NAME	BILATERAL OR MULTILATERAL	SCOPE OF THE MEETING	OUTCOMES
						• Potential for establishing a joint survey of breeding birds jointly funded by the developers—the RSCN will provide a rough estimate of the program and cost. • IFC supports the RSCN's Guidelines for Wind Energy and could express that to the government. • IFC will explore donor funding opportunities to build MoEnv capacity and then to develop a connection between the MoEnv with technical AC (probably RSCN and BirdLife) with respect to the CEA management program. • IFC will explore the possibility of translating the Final CEA to Arabic. • Next steps: review the process of the draft CEA report, finalizing, editing and publishing, launching event. • The final CEA report will be considered for use as best practice by BirdLife and will be presented on as many occasions as possible, including The IUCN Congress 2016 (Hawaii).
	March 2016	All of the above	BirdLife International Middle East, RSCN, AUM and Jordan BirdWatch, MoENV, Abour, KOSPO, LAMSA, and JWPC Tafila, EBRD, EIB	B	Comment period for CEA and Response to Comments	Comments on the CEA received and responded to

STAKEHOLDER LIST

The following individuals were represented in the various stakeholder meetings that took place over the life of the project.

TABLE B2. STAKEHOLDERS CONSULTED—MINISTRIES AND GOVERNMENT DEPARTMENTS

MINISTRIES AND GOVERNMENT DEPARTMENTS		
MoEnv	H.E. Dr. Taher Al Shakhshir	Minister for Environment
	Ezzat Abu Hamra	Director of Licensing and Permitting Directorate
	Abdul Kareem Ashalabi	EIA Head of Section
	Ahmad Qatarneh	Secretary General
	Belel Qtishat	Nature Protection Directorate
Ministry of Energy and Mineral Resources (MEMR)	Omar Momani	Director of RE and EE Directorate
	Yacoub Marar	Head of Solar Energy Section
Department of Antiquities (DoA) in the Ministry of Tourism and Antiquities (MoTA)	Aktham O. Abbadi	Director of Excavations and Surveys
	Khalil Hamdan	Director of Museums
Jordan Investment Commission (JIC)	Dr. Khaled Al-Momani	Director of Urban Planning and Infrastructure

TABLE B3. STAKEHOLDERS CONSULTED—DEVELOPERS

DEVELOPERS		
EDAMA	Yara Abdel Samad	CEO
KOSPO	Tae Yong Lee	Electrical I&C Manager
	Abdullah Thabah Al-Jamal	Electrical Engineer
Abour	Dr. Naser Hasweh	Abour Wind Energy Company
	Fereydoon Abtahi	Abour Wind Energy Company
JWPC Tafila	Sean Miller	Project Manager
LAMSA	Adam Pringle	Project Manager
KEPCO[a]	(various)	

[a] Note that the engagement with KEPCO took place on a bilateral basis with IFC only. This developer was not present at any of the formal stakeholder engagement meetings.

TABLE B4. STAKEHOLDERS CONSULTED—CONSERVATION ORGANIZATIONS, ACADEMICS, AND CIVIL SOCIETY ORGANIZATIONS

CONSERVATION ORGANIZATIONS, ACADEMICS, AND CIVIL SOCIETY ORGANIZATIONS		
AUM and Jordan BirdWatch	Fares Khoury	AUM Biology and Biotechnology Faculty
BirdLife International Middle East and Headquarters (Cambridge)	Osama Al Nouri	Project Coordinator, Migratory Soaring Birds
	Sharif Jbour	CEPF RIT Project Officer for Middle East
	Marcus Kohler	Senior Program Manager (Flyways), BirdLife International, Cambridge
Royal Society for the Conservation of Nature (RSCN)	Rasha Haymour	Conservation Technical Officer
	Tareq Qaneer	Bird Researcher
	Abdul Razzaq Hmoud	Head of Wildlife Law Enforcement Section and National Project Manager of the UNDP BirdLife migratory soaring birds project
	Mohammed Za'rour	Director of Strategic Development
	Nashat Hamidan	Manager of Ecological Research Centre/Department
	Natalia Boulad	RSCN GIS Unit
	Qamar AlMimi	RSCN GIS Unit
	Omar Abed	RSCN Fauna Research Unit
	Thabet Sharee	RSCN Fauna Research Unit

TWRPP CEA Workshop focused on Birds and Bats including Bird Survey Training (April 14–16, 2015)

In April 2015, IFC organized a three-day workshop and associated in-field training, which was led by Natural Research Projects Ltd. and supported by other ornithological, bat, and impact assessment specialists. Training comprised three days of workshop sessions (14–16 April 2015), focusing primarily on best practice in ornithological and bat survey methods for wind energy impact assessments, combined with one-to-one in-field training in applying best practices at the TRWPP sites conducted over the period 29 March to 22 April 2015.

TABLE B5. WORKSHOP TRAINERS AND ORNITHOLOGICAL SPECIALISTS

TRAINER/ SPECIALIST	PROFESSIONAL POSITION
D. Jackson	Director and Senior Research Ecologist, Natural Research Projects Ltd
S. Pinder	Research Ecologist, Natural Research Projects Ltd
A. Camina Cardenal	IFC Technical Adviser
M. Mackintosh	Director, Claverton Associates Ltd
Zuhair Amr	Professor, Jordan University of Science and Technology
Laith El-Moghrabi	Independent bird expert

TABLE B6. ATTENDEES AT THE TAFILA WIND FARM CEA WORKSHOP FOCUSED ON BIRDS AND BATS (APRIL 14–16, 2015)

MINISTRIES AND GOVERNMENT DEPARTMENTS		
MoEnv	Ezzat Abu Hamra	Director of Licensing Directorate
	Hanin Abu Hamra	Green Economics
	Belal Qtishat	Natural Protection Directorate – Biodiversity
Ministry of Energy and Mineral Resources (MEMR)	Ali Khawaldah	Renewable Energy and EE Directorate
	Arwa Abukashef	Renewable Energy and EE Directorate
DEVELOPERS		
EDAMA	Yara Abdel Samad	CEO
KOSPO	Lee Ju-Mong	Senior Manager/Business Development Department
	Abdullah Al Jamal	Electrical Section Head
Abour	Fereydoon Abtahi	Abour Wind Energy Company
JWPC Tafila	Sean Millar	Project Manager
LAMSA	Adam Pringle	Project Manager
CONSERVATION ORGANIZATIONS, ACADEMICS, AND CIVIL SOCIETY ORGANIZATIONS		
BirdLife International Middle-East	Osama Al Nouri	Project Coordinator, Migratory Soaring Birds
	Sharif Jbour	CEPF RIT Project Officer for Middle East
	Tareq Qaneer	Bird Researcher
Royal Society for the Conservation of Nature (RSCN)	Abdel Razzaq Al-Hmoud	Head of Wildlife Law Enforcement Section and National Project Manager of the UNDP BirdLife MSB Project
	Mohammad Zarour	Director of Strategic Development
Dana Nature Reserve	Malik Awaji	Ecologist
American University of Madaba	Fares Khoury	Professor
JUST	Zuhair Amr	Professor
Independent Bird Expert	Laith El-Moghrabi	N/A
Independent Bird Expert	Ibrahim Hasani	N/A
BirdWatch	Roberto Massis	Jordan BirdWatch, Jordan Tour Guides Association
CONSULTING COMPANIES		
Enviromatics	Majdi Salameh	Director and Lead Consultant
Arabtech Jardaneh	Khaled Nassar	Head of Environment
	Ashraf Ma'ani	Senior Environment Engineer
	Rasha Tomaira	Senior Environmentalist
DONORS/INTERNATIONAL FINANCIAL INSTITUTIONS		
EBRD	Omonullah Sadullakhujaev	Associate Banker

TABLE B7. WORKSHOP SESSIONS AND TOPICS COVERED

DAY 1	
Session 1: ESIA and CIA – Key Differences and Consideration • Defining the CIA and how it differs from an ESIA • The importance of delivering an assessment that embraces the past, present, and future condition of the social and environmental components • The range and importance of stakeholder involvement in the process • The need to recognize that there is no "one right way" of assessment and mitigation	*Dr. D. Jackson*
Session 2: ESIA Scoping and Information Requirements • Types of baseline information used in the CIA • The importance of consulting with developers and the existing ESIA for the Tafila Wind Energy Project to address knowledge gaps relating to wind farm design, siting, area of influence, and plausible mitigation measures • Positive and negative impacts on VECs (birds, bats, habitats, and people) • The potential range of impacts on VECs affected • Introduction to international best practice guidelines for assessing the effects of wind energy developments on wildlife	*Dr. D. Jackson*
Session 3(a): Priority Bird Species • The types of bird species populations (e.g., migratory, breeding) using the TRWPP area and the characteristic level of risk for each of these population groups • The characteristics and scale of the Rift Valley/Red Sea flyway and its relevance to the TRWPP area • The criteria that define a priority bird field survey list	*Dr. D. Jackson*
Session 3(b): Survey Design Principles • Types of baseline survey • Baseline survey program design, and balancing data quality and affordability • Types of survey effort required to conduct collision risk modeling • Spatial survey effort (geographical survey coverage from VP) – recommended approach, guidance, and potential pitfalls • Temporal survey effort (duration and timing of VP watches) recommended approach, guidance, and potential pitfalls	*Dr. D. Jackson*
Session 4: Bats: Priority Species and Survey Methods • Global conservation status of bats • Characteristics of bat movements and migration within Jordan • Reasons why bats are attracted to wind farms • Review of the scale of effects on bats of the TRWPP • Best practice guidelines for conducting bat surveys in the Tafila area	*Dr. D. Jackson*

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TABLE B7. WORKSHOP SESSIONS AND TOPICS COVERED (*continued*)

DAY 2	
Session 5: Bird Survey Methods • Flight activity VP field survey method and best practice • Field data entry of survey effort, weather, occurrence of target species, and flight activity for "primary target species" using standard recording forms • Techniques for mapping flight routes for primary target species • The "Band" collision risk model—explaining the method	*Dr. D. Jackson*
Session 6: Case Study: Migration Patterns in Spain • Characteristics of migration patterns in Spain, with particular emphasis on raptor migration • Relationship between collision rate and passage rate of migrant raptors	*Alvaro Camina Cardenal*
Session 7: Impact Assessment • The importance of assessing the long-term sustainability of each VEC at each stage of the project • The aims of an impact assessments • Concepts of acceptable change, mitigation, offsetting, and residual impact	*Dr. D. Jackson*
Session 8: Lessons Learned: Griffon Vulture Case Studies (Spain) • The effectiveness of vulture restaurants in reducing mortality at wind farms • The need to account for changing vulture foraging patterns relating to macro-environmental change and changes in prey type and availability	*Alvaro Camina Cardenal*
Session 9: Mitigation and Monitoring • The importance of postconstruction analysis to check if predicted assessments are realized and if proposed mitigation is adequate • Types of mitigation and the extent to which they may be effective in Jordan	
Session 10: Summary of CIA • Review of achievements so far, in particular developers using unified migration survey methods • Next steps including developing a standardized bird survey, consulting on how to calculate impacts for TRWPP, and establishing a list of priority bird VECs	
DAY 3	
Tafila Wind Energy Project. Field Study Visit • On site introduction to the history associated with developing the Tafila wind farm • Breeding raptor survey at the adjacent Dana BR • Levels of hunting and/or shooting at the wind farm site • Protocol on finding bird fatalities at site Due to time and weather constraints, a demonstration of survey techniques was not possible during the field visit.	*VESTAS Environment, Health and Services Manager; Malik Alawaji (RSCN)*
MARCH 29–APRIL 22, 2015	
Three weeks of in-field training applying best practices at the TRWPP sites conducted An additional one-to-one in-field training was conducted, aimed at the surveyors identified to undertake the Spring 2015 Flight Activity Surveys for the TRWPP sites. Eight bird surveyors were trained as part of this program. The objective was to support the development of capacity in Jordan to plan and conduct bird surveys, applying a standardized methodology in order to provide consistency in approach.	*Simon Pinder, Laith El-Moghrabi*

ANNEX C. CEA Regulatory, Policy, and Guidance Framework

NATIONAL REQUIREMENTS AND GUIDANCE

REGULATIONS ON ENVIRONMENTAL IMPACT ASSESSMENT (EIA)

The Jordanian EIA Regulation (No. 37, 2005)[44] requires EIAs to describe the project and environmental baseline, impacts to be assessed, and mitigation measures to be developed. The Regulation, which in part reflects international practice on EIAs, provides screening criteria and guidance on projects that require a comprehensive EIA, a preliminary EIA study, or no EIA. Although international EIA practice and some legal frameworks[45] have evolved to consider cumulative effects, Jordan's EIA Regulation presently does not require such a consideration—therefore, cumulative effects tend not to be assessed in Jordan. This CEA is the first to be conducted in any sector in Jordan.

Strategic Environmental Assessment (SEA), which relates to potential impacts of government-wide or sector-wide policies, plans, or programs, is in its infancy in Jordan. It is being piloted as a tool in some development zones and special economic areas. SEA is not covered fully within the national regulations, and no SEA of the wind sector in Jordan has been undertaken to date.

THE NATIONAL BIODIVERSITY STRATEGY AND ACTION PLAN

Jordan has a long-standing commitment to biodiversity. The country became a signatory to the Convention on Biological Diversity in 1993 and in 2001 to the Convention on Migratory Species (1979). As part of its commitments to the Convention on Biological Diversity, Jordan published its second National Biodiversity Strategy and Action Plan (NBSAP) (2015–2020) in 2014.[46] The NBSAP, which sets out Jordan's strategic approach to conserving biodiversity, notes the challenges to biodiversity conservation in the country, namely:

- Habitat destruction (as a result of uncontrolled overgrazing, urban expansion, water use etc.)
- Wildlife persecution
- Alien and exotic species invasion
- Inadequate tourism development
- Recent challenges with the influx of refugees
- Underlying issues of the low awareness of biodiversity, weak governance, lack of connections between science and development, inadequate knowledge systems, and an absence of sustainable financing for biodiversity-related programs

The CEA acknowledges the importance of biodiversity in Jordan as outlined in the NBSAP. Table C1 shows how the CEA is aligned with the NBSAP and indicates how CEA proposals could assist, in part, in supporting NBSAP implementation.

[44] Except for within the Aqaba Special Economic Zone, which has its own regime for enterprise permitting and environmental appraisal.
[45] European Union, EIA Directive 2014/52/EU.
[46] https://www.cbd.int/doc/world/jo/jo-nbsap-v2-en.pdf.

TABLE C1. SUMMARY OF CEA ALIGNMENT AND POTENTIAL CONTRIBUTION TO THE NBSAP (2015–2020)

NBSAP PRIORITIES AND KEY PERFORMANCE INDICATORS (KPIs)	TRWPP CEA ALIGNMENT AND/OR POTENTIAL CONTRIBUTION TO DELIVERY OF NBSAP PRIORITY/KPIs
Jordan's biogeographical regions and representative ecosystems and vegetation types (pp. 18–20)	The CEA habitats assessment used updated maps of the biogeographical regions and vegetation types from the RSCN.
The NBSAP states that the proportion of threatened species to the total number of species is very high, especially for mammals, where 13 out of 83 mammals (15.6 percent) are considered globally threatened (pages 21 and 29).	The CEA considers IUCN threat levels to identify species sensitivity for the identification of priority bird VECs.
The NBSAP Jordan states that "Jordan's location by the Great Rift Valley makes the country one of the most important flyways and resting points for migratory birds in the spring and autumn. Hundreds of thousands of birds cross the area yearly...." (pp. 21 and 28 (regarding the IBA)).	This CEA was undertaken precisely because of the importance of the Great Rift Valley.
Protected Area Networks (p. 23)	The CEA recognizes the Protected Areas Network and has considered the Dana BR within its geographical scope.
Threats to biodiversity (p. 32)	The CEA acknowledges the threats to biodiversity and, specifically, habitat destruction and/or degradation due to the development of infrastructure and to overgrazing and persecution of wildlife (i.e., illegal hunting and trading of species). These external threats in the landscape are reflected in the methods applied in the assessment of cumulative risks for bird species in the CEA.
Illegal hunting (p. 34)	The CEA addresses illegal hunting by explicitly considering it as one of the external stressors to wildlife.
Threat of climate change (p. 35)	The CEA addresses the threat of climate change to biodiversity (p. 35) by helping support more sustainable investments in the wind sector.
Stakeholder engagement, public participation and raising awareness, including the following: raising awareness and mobilizing stakeholders in the conservation of biodiversity (p. 36); improved public participation in environmental processes and decision-making frameworks (p. 37); public awareness of biodiversity as one of the underlying causes of biodiversity loss (p. 37); improved involvement of civil society in the decision making process with regard to biodiversity (p. 38); and NBSAP implementation arrangements through stakeholder engagement (p. 83).	By engaging stakeholders from nongovernmental organizations and the scientific communities as well as the private sector, the CEA is aligned with the NBSAP principles of improving public participation, mobilizing stakeholders to be more involved in decision-making processes related to biodiversity, and raising awareness on biodiversity issues related to the wind sector.
Addressing the underlying causes of biodiversity loss, including: • Lack of connection between scientific and development agendas (p. 38) • Inadequate knowledge management (p. 39)	The approach of linking the scientific community (e.g., the RSCN, BirdLife, and academics) and the wind power project developers as part of the AC for the CEA contributes to improving connections between the scientific and development agendas with regard to the wind sector. The CEA recommendations for data sharing and centralized reporting as part of the joint mitigation and monitoring strategy, along with the proposals for institutional arrangements and information sharing, could also contribute to addressing these NBSAP priorities.
Strategic directions toward an improved NBSAP global alignment (p. 51)	The CEA is aligned in this regard with the NBSAP requirement to e.g., "Encourage and facilitate the interinstitutional collaboration in the various fields of biodiversity while allowing for more specialization; Enhance the participation and involvement of national stakeholders—and particularly local communities—in the design, implementation, and evaluation of national biodiversity strategies and programs at the central and site-based levels."

(*continued on next page*)

TABLE C1. SUMMARY OF CEA ALIGNMENT AND POTENTIAL CONTRIBUTION TO THE NBSAP (2015–2020) (*continued*)

NBSAP PRIORITIES AND KEY PERFORMANCE INDICATORS (KPIs)	TRWPP CEA ALIGNMENT AND/OR POTENTIAL CONTRIBUTION TO DELIVERY OF NBSAP PRIORITY/KPIs
Setting the National Targets (p. 54)	The CEA addresses some of the identified key factors influencing biodiversity (e.g., weak governance systems and structures related to biodiversity, ongoing disconnect between scientific research and development programs, lack of adequate documentation).
The 2050 Vision (p. 55)	The principles behind the CEA are aligned with the 2050 Vision statement in the NBSAP.
The 2020 Strategic Goals (p. 56)	The CEA is aligned with the 2020 Strategic Goals, more specifically: goal VI on the strengthening of participative planning approach; goal VII on the response to human-induced pressures; goal VIII on protected areas, priority species, and genetic resources; and goal X on knowledge management and monitoring.
NBSAP KEY PERFORMANCE INDICATORS (KPIs)	**THE CEA IS ALIGNED WITH THE NBSAP, AND THE RECOMMENDATIONS PRESENTED WITHIN THE CEA COULD CONTRIBUTE TO A NUMBER OF THE NBSAP KPIs, INCLUDING THE ITEMS BELOW.**
• KPI 1.2, Biodiversity integrated into key development sector strategies • KPIs 2.1–2.2, National Biodiversity Committee NBC • KPI 4.2, Nature Conservation Directorate at the MoEnv: implement a human resources training program • KPI 4.4, National biodiversity monitoring system • KPIs 5.1–5.3, Participative national biodiversity planning protocol • KPI 6.1, Biodiversity program portfolio established and maintained • KPI 9.3, National database for biodiversity hotspots updated • KPI 9.5, All impacts of development projects associated with biodiversity hotspots eliminated or at least minimized • KPI 11.1, Biodiversity conservation articles integrated into the new rangeland strategy • KPI 11.2, Key wild and/or native rangeland species conservation programs initiated • KPI 12.1, Renewable energy wind regulations adequately address biodiversity conservation • KPI 14.1, Status of key wildlife and game species assessed • KPI 14.2, Wildlife hunting regulations reviewed • KPIs 16.1–16.6, KPIs on protected areas • KPI 18.1, Status of key terrestrial and freshwater fauna assessed and conservation action plans implemented • KPI 18.2, National database for terrestrial and freshwater fauna red list established, updated, and addressed in all relevant strategies and action plans • KPIs 21.1–21.3, Ecosystem benefits • KPI 23.1, Understanding of climate change impacts on biodiversity • KPI 26.1, National initiatives on biodiversity information systems harmonized and integrated within the CHM Central Clearing House Mechanism • KPI 26.2, NBC working group on biodiversity knowledge and comprehensive map of Jordan's biodiversity • KPI 26.3, Series of scientific research protocols on biodiversity research developed and updated regularly	

NATIONAL LEGAL FRAMEWORK ON HUNTING

Jordan is a leader in wildlife conservation in the Middle East. The country ratified laws and regulations to address wildlife hunting not long after the kingdom was established in 1946 and subsequently ratified several international and regional environmental agreements.

The MoEnv is the principal governmental entity specializing in environmental protection and is responsible for international multilateral environmental agreements.[47] In 2006, Jordan established the Royal Department for Environmental Protection within the MoEnv to implement and enforce environmental protection and wildlife conservation laws and regulations. This ministry works with Jordan's RSCN to prepare and implement wildlife conservation laws and regulations. The Ministry of Agriculture produces most laws related to wildlife hunting,[48] provisions licenses for import and export of animals and plants, and licenses zoos.[49]

The approach to hunting control has evolved from the first hunting law in 1934, issued by Prince Abdullah before independence, to Agriculture Law No. 44 of 2002, which details in 72 articles species, hunting seasons, and regions where species can be hunted; to a 2008 bylaw that outlines species banned from being hunted. The 2008 bylaw covers more than 250 bird species, 30 mammals, and 10 reptile species in three appendices[50] organized according to threat levels, with those species most severely threatened in Appendix I. The severity of hunting penalties corresponds to the appendix in which the species is listed. The highest penalty is imprisonment for a period of four months and a fine of JD 2,000 for each bird/animal shot.

The CEA highlights and addresses the effects of illegal hunting on wildlife in Jordan by explicitly incorporating estimates of the magnitude of these external stressor effects into the assessment of species-specific long-term viability for priority VECs.

RSCN GUIDELINES FOR WIND ENERGY DEVELOPMENT IN JORDAN

The RSCN is dedicated to the conservation of biological diversity in Jordan. As a nongovernmental organization with a governmental mandate to establish protected areas and as BirdLife International's local partner in Jordan, the RSCN has focused significantly on conservation of bird populations. In recognition of the growing demand for wind energy in Jordan and its potential impact on migratory and resident bird species, RSCN is developing guidelines for wind energy development in cooperation with BirdLife International's Middle East Division and national experts.[51] The guidelines, which focus on bird monitoring during the preconstruction, construction, and postconstruction phases of wind projects, build on experience from across the world and refer to several national and international guidelines, including the World Bank Group's Environment, Health, and Safety (EHS) Guidelines for Wind Energy (2015).

[47] These agreements and conventions, to which many countries are signatories, such as the Convention on Migratory Species, the Convention on Biological Diversity, and the Convention on the International Trade of Endangered Species of Flora and Fauna. For details, see *http://www.unep.org/delc/MEAImplementationSupport/tabid/54401/Default.aspx.*
[48] Agriculture Law No. 44 of 2002, http://www.ecolex.org/details/legislation/agriculture-law-no-44-of-2002-lex-faoc046440/.
[49] The Ministry delegated responsibility for wildlife conservation laws, regulations, and by-laws to the RSCN.
[50] Appendix I includes 36 bird species, including 17 soaring bird species such as the griffon vulture (*Gyps fulvus*), Egyptian vulture (*Neophron percnopterus*), and Eastern imperial eagle (*Aquila heliaca*). This appendix also includes 13 mammal species, including Nubian ibex (*Capra nubiana*) and 4 marine turtle species. Appendix II lists 103 bird species, including 15 soaring birds such as golden eagle (*Aquila chrysaetos*), short-toed snake-eagle (*Circaetus gallicus*), and long-legged buzzard (*Buteo rufinus*). The list also includes 9 mammal species and several reptiles and amphibian species. Appendix III includes 134 bird species, 12 mammal species, and 10 reptile species.
[51] The CEA team contributed comments to the RSCN.

The main focus of the RSCN Guidelines is bird monitoring during the preconstruction, construction, and postconstruction phases of a project. The Guidelines were in development when the CEA was being prepared.

INTERNATIONAL REQUIREMENTS AND GUIDANCE DOCUMENTS

IFC PERFORMANCE STANDARDS ON ENVIRONMENTAL AND SOCIAL SUSTAINABILITY

The IFC Performance Standards (PS) on Environmental and Social Sustainability (2012)[52] set out the E&S requirements for investment and advisory projects financed by IFC. They are recognized as an international benchmark for achieving E&S sustainability in private sector projects in emerging markets. The PS also serve as the backbone of the "Equator Principles,"[53] E&S standards that have been voluntarily adopted by more than 80 financial institutions, including commercial banks and export credit agencies.

Each of the eight PSs is supported by an accompanying Guidance Note (GN):

- PS1: Assessment and Management of Environmental and Social Risks and Impacts
- PS2: Labor and Working Conditions
- PS3: Resource Efficiency and Pollution Prevention
- PS4: Community Health, Safety, and Security
- PS5: Land Acquisition and Involuntary Resettlement
- PS6: Biodiversity Conservation and Sustainable Management of Living Natural Resources
- PS7: Indigenous Peoples
- PS8: Cultural Heritage

PS 1 and PS 6 are directly relevant to this CEA and are summarized in the following sections.

PS1—Assessment and Management of Environmental and Social Risks

The objectives of PS1 are as follows:

- To identify and evaluate the E&S risks and impacts of the project
- To adopt a mitigation hierarchy to anticipate and avoid, or where avoidance is not possible, minimize, and, where residual impacts remain, compensate and/or offset for risks and impacts to workers, affected communities, and the environment
- To promote improved environmental and social performance of clients through the effective use of management systems
- To ensure that grievances from affected communities and external communications from other stakeholders are responded to and managed
- To promote and provide means for adequate engagement with affected communities throughout the project cycle on issues that could affect them and to ensure that relevant E&S information is disclosed and disseminated.

52 http://ifc.org/sustainabilityframework.
53 http://www.equator-principles.com/.

PS1 addresses cumulative impacts. Paragraph 8 states that "…environmental and social risks and impacts will be identified in the context of the project's area of influence." It also states that the project's area of influence encompasses "[c]umulative impacts that result from the incremental impact, on areas or resources used or directly impacted by the project, from other existing, planned or reasonable defined development at the time the risks and impact identification process is conducted."

Where multiple projects occur or are proposed for a geographic area, IFC may require clients to conduct a cumulative impact assessment (CIA[54]) as part of the identification of risks and impacts to inform MMPs. GN1 recognizes that in certain instances, where multiple projects (existing and future) are planned by different third parties over a long period, a cumulative assessment by one individual project developer may not be appropriate and a more regional or sectoral assessment may be more applicable.

The TRWPP CEA has been developed to address the cumulative effects of the five WPPs. The cumulative effects have been considered in determining the area of influence for the CEA, to inform the geographical scope. The CEA objectives, as outlined in Section 1.2, align directly with the PS1 objective of identification and evaluation of E&S risks and impacts of a project. The other PS1 objectives and requirements pertaining to mitigation hierarchy, use of management systems to improve environmental and social performance, engagement, and disclosure of information also informed the approach to the CEA and to which the CEA is aligned. The recommendations of the CEA would support a project developer in achieving PS1 requirements.

PS 6—Biodiversity Conservation and Sustainable Management of Living Natural Resources
The objectives of PS6 are as follows:

- To protect and conserve biodiversity
- To maintain the benefits that arise from ecosystem services
- To promote sustainable management of living natural resources through the adoption of practices that integrate conservation needs and development priorities

PS6 reinforces the mitigation hierarchy introduced in PS1 (avoid, minimize, restore, compensate and/or offset) and outlines requirements related to biodiversity offsets, which may be considered only after other options have been exhausted.

The participating WPPs within the TWRPP study area would be subject to the natural habitat requirements of PS6, which require "no net loss" (NNL) of biodiversity, where feasible. GN6 defines NNL as "the point at which project-related impacts on biodiversity are balanced by measures taken to avoid and minimize the project's impacts, to undertake on-site restoration and finally to offset significant residual impacts, if any, on an appropriate geographic scale (e.g., local, landscape-level, national, regional)." NNL is implemented in practice through the identification of biodiversity values that are monitored through time with respect to the NNL goal. The identified priority VECs in the CEA would be considered the focus of NNL in the TWRPP study area.

[54] As noted in Section 1.2, priority VECs were selected on the basis of risks rather than on the significance of predicted impacts over a defined time period. It is for this reason that the term "cumulative effects assessment" was chosen for this initiative. IFC's publication *Cumulative Impact Assessment and Management: Guidance for the Private Sector in Emerging Markets Good Practice Handbook* recognizes the interchangeability of these two terms. See http://www.ifc.org/wps/wcm/connect/topics_ext_content/ifc_external_corporate_site/ifc+sustainability/learning+and+adapting/knowledge+products/publications/publications_handbook_cumulativeimpactassessment.

WORLD BANK GROUP ENVIRONMENTAL, HEALTH, AND SAFETY GUIDELINES FOR WIND ENERGY

IFC's PSs are supported by the World Bank Group general and industry-specific EHS Guidelines.[55] These are technical reference documents containing general and industry-specific examples of good international industry practice (GIIP) that provide a performance benchmark for new facilities at a reasonable cost. In 2015, a revised EHS Guidelines for Wind Energy was published, covering both onshore and offshore wind energy facilities. The Guidelines present a summary of the EHS issues for wind power projects, along with recommended mitigation measures and monitoring performance indicators. Of the many aspects relevant to this CEA, three are highlighted here:

- Where multiple wind farm facilities are located in the same geographical area and near areas of high biodiversity value, developers are encouraged to implement a coordinated approach to surveys and monitoring. The Guidelines mention that a common survey methodology and approach lends itself to cumulative impact assessment, as data collection methods and the level of effort could be standardized. The TWRPP CEA takes this approach. The Guidelines encourage cumulative impact assessments in cases where multiple wind farms are located near areas of high biodiversity value. In the case of the TWRPP CEA, the area of high biodiversity value is the Dana BR and IBA.
- Where multiple wind farm facilities are located in the same geographical area and close to areas of high biodiversity value, the Guidelines encourage wind project developers to implement common postconstruction monitoring procedures so that results can be assessed cumulatively. This aligns with the TWRPP CEA recommendations on monitoring. The Guidelines suggest that a common data-sharing and reporting mechanism would facilitate this process. The TWRPP CEA recommends an approach that involves the government of Jordan.
- Wind farm developers are also encouraged to make postconstruction monitoring results available to relevant stakeholders.

IFC'S CUMULATIVE IMPACT ASSESSMENT AND MANAGEMENT: GUIDANCE FOR THE PRIVATE SECTOR IN EMERGING MARKETS, GOOD PRACTICE HANDBOOK

IFC's Good Practice Handbook C*umulative Impact Assessment and Management: Guidance for the Private Sector in Emerging Markets* (2013) guided the TWRPP CEA process. The Handbook refers to a six-step process for cumulative assessments, drawing primarily from good practice established in the United States and Canada. The CEA provided a good opportunity to test elements of the 2013 Handbook with respect to the reaches of private sector biodiversity management.

Though the TWRPP CEA process generally aligns with the process outlined in the Handbook, there are some differences, largely due to the limited data on migratory and resident soaring birds. For instance, although Jordan's regulatory framework on hunting control is strong, there are very limited data on this and other external stressors in Jordan.

The approach recommended in the Handbook for assessing the expected "future condition of the VEC" (Handbook Step 4, "Assess cumulative impacts") was not possible in the context of the TWRPP CEA due to limited data regarding biodiversity values.[56] This will often be the case in many middle-income and developing countries where regional biodiversity data are scarce. The Handbook's Step 5 ("Assess significance of predicted cumulative impacts") also differs from the CEA: the TWRPP CEA uses a risk assessment methodology, whereas the Handbook estimates impacts over a defined period of time.

[55] http://ifc.org/ehsguidelines.
[56] The lack of biodiversity values for developing countries is a common issue.

EUROPEAN BANK FOR RECONSTRUCTION AND DEVELOPMENT E&S PERFORMANCE REQUIREMENTS

E&S requirements for EBRD investments include its Environmental and Social Policy (2014),[57] 10 Performance Requirements (PRs), plus national legislation and relevant EU directives, regardless of a project's jurisdiction. The EBRD is committed to promoting European Union environmental standards as well as the European Principles for the Environment, to which it is a signatory, and which are also reflected in the PRs.

The two PRs directly relevant to this CEA are summarized in the following subsections.

PR1: Assessment and Management of Environmental and Social Impacts and Issues
PR1 establishes the importance of

- integrated assessment to identify the environmental and social impacts and issues associated with projects and
- environmental and social performance throughout the life of a project.

PR1 objectives are largely aligned with IFC PS1.[58] Para. 9 of PR1 addresses cumulative impacts. It states that "Additionally, the assessment process will consider **cumulative** impacts of the project in combination with impacts from other relevant past, present, and reasonably foreseeable developments as well as unplanned but predictable activities enabled by the project that may occur later or at a different location…." The CEA has been developed in alignment with PR1, and the recommendations of the CEA, if implemented, would support a project developer in achieving PR1 requirements.

PR6: Biodiversity Conservation and Sustainable Management of Living Natural Resources
PR6 recognizes that the conservation of biodiversity and sustainable management of living natural resources are fundamental to environmental and social sustainability. Para. 8 of PR6 addresses the topic of cumulative impacts on biodiversity. It states that "The assessment should also consider direct, indirect and **cumulative** impacts and evaluate the effectiveness and feasibility of the mitigation measures to be applied to the project." PR6 also emphasizes the importance of the mitigation hierarchy concept with the aim of achieving NNL of biodiversity, and where appropriate, a net gain of biodiversity, as does IFC PS6. The CEA identifies priority VECs, which would be considered the focus of NNL and would be defined as "priority biodiversity features" in PR6. The TWRPP CEA sets threshold values for each priority VEC and recommends a set of mitigation and management measures. Monitoring measures are designed to determine long-term compliance with the NNL goal. The CEA was developed generally in line with the principles outlined in PR6, and, if implemented, would support a project developer in achieving PR6 requirements.

EUROPEAN INVESTMENT BANK

The EIB's lending strategy is underpinned by the promotion of sustainable development and specifically the preservation for future generations of environmental and social capital that exists today. The EIB Statement on Environmental and Social Principles and Standards (2009[59]) sets out the bank's policy context for the protection of the environment and human well-being. The EIB Environmental and Social Handbook[60] provides an operational translation of those standards across 10 thematic areas, including "assessment and management of environmental

[57] Available at http://www.ebrd.com/downloads/research/policies/esp-final.pdf.
[58] The EBRD's PR10 addresses stakeholder engagement.
[59] http://www.eib.org/attachments/strategies/eib_statement_esps_en.pdf.
[60] http://www.eib.org/attachments/strategies/environmental_and_social_practices_handbook_en.pdf.

and social impacts and risks," "stakeholder engagement," and "biodiversity and ecosystems"—with which the CEA is generally aligned.

BIRDLIFE INTERNATIONAL'S MSB PROJECT

BirdLife International is working with the United National Development Program and the Global Environment Facility on the MSB Project to conserve soaring birds during migration along the Rift Valley/Red Sea flyway. The MSB Project aims to integrate conservation of visiting birds into five key sectors: agriculture, energy, hunting, tourism, and waste management. The MSB project is working with 11 countries within the flyway, including Jordan.

The CEA incorporates many of the tools and approaches offered by the project. The project's Soaring Bird Sensitivity Map, which provides information on the distribution of soaring birds along the Rift Valley/Red Sea flyway, was used to identify priority bird VECs in this CEA. In addition, the CEA is aligned with MSB wind sector guidance[61] to help donors, partners, governments, and developers integrate bird and biodiversity concerns into wind projects:

- The MSB guidance recommends an assessment of cumulative impacts during planning and construction phases of a wind power project. The guidance highlights that the cumulative effects of successive wind power projects may exceed the capacity of the population to regenerate, in which case the bird population will go into decline. The CEA's Framework for Birds (Section 3) considers the cumulative effects of the five WPPs on a species population's viability and capacity to regenerate.
- The CEA recognizes the MSB recommendation of using shutdown on demand as an effective tool for safeguarding MSB populations transiting through wind energy developments sited along the Rift Valley/Red Sea flyway. Shutdown on demand for priority bird VECs is a key element of the mitigation approach proposed in the CEA (Section 3.6).
- Other mitigation and monitoring actions recommended in the CEA align with those proposed within the MSB guidance, such as VP surveys, carcass searches, and the implementation of an adaptive management approach based on monitoring results.
- The CEA reflects additional MSB guidance for developers and donors, including the following:
    - Consulting ornithological and conservation experts regarding the assessment methodology
    - Committing to adaptive management of wind farm operations
    - Recognizing that ongoing monitoring data should be used to inform mitigation activities
    - Ensuring that mitigation measures are implemented according to expert opinion
    - Working with other developers in the region to reduce cumulative impacts—the novel approach in the CEA of the developers participating in this process together demonstrates alignment with the approach encouraged in the MSB guidance
    - Recommending making data available in a centralized source—as an investor, IFC has advocated the sharing of data during the CEA initiative and the participating developers have shared data on their WPPs

[61] http://migratorysoaringbirds.undp.birdlife.org/en/documents.

- Engaging developers, government representatives, conservation organizations, academia, and other civil society groups during the CEA directly aligns with the approach recommended in the MSB guidance
- Providing funding (by IFC and developers) for the generation of new and additional survey data and collision risk modeling to improve knowledge and identify the highest risks of the TRWPP in order to inform MMPs—this directly aligns with recommendations within the MSB guidance

Annex D. Database Development

This annex describes the steps to merge the MSB field survey data from five WPPs in the TRWPP study area into one common database. This annex describes how project-specific datasets were compiled into the common database rather than how survey data were collected in the field. Annex E describes the trends analysis conducted using the database and how this analysis informed the TRWPP CEA.

The MSB species in the study area included in the database were as follows:

- Common crane
- Black stork
- White stork
- Osprey
- European honey-buzzard
- Short-toed snake-eagle
- Lesser spotted eagle
- Steppe eagle
- Egyptian vulture
- Eastern imperial eagle
- Booted eagle
- Western marsh-harrier
- Hen harrier
- Pallid harrier
- Montagu's harrier
- Levant sparrowhawk
- Eurasian sparrowhawk
- Black kite
- Steppe buzzard

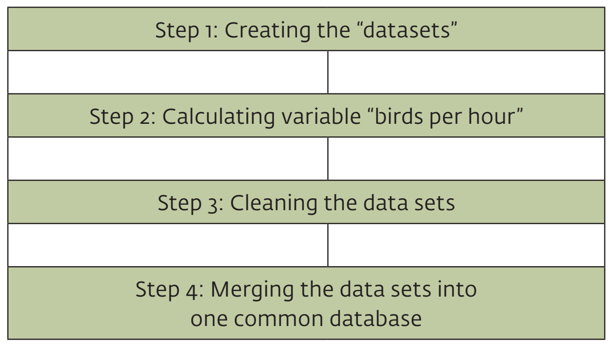
This list broadly aligns with category 1 MSB populations (as defined in Section 3.2 of the main body of the report and in Annex G, Table G1) with some differences, as noted and with explanation.[62]

[62] Note that the database was created before the development of the CEA framework that resulted in the bird species population categories.

- The red-footed falcon and the Eurasian hobby appear as a category 1, MSB population in the CEA (see Annex G), but these are not soaring birds and do not rely on thermals or updrafts at the Rift Margins in the same way that other species do. They were therefore not included in the database.
- The common and lesser kestrel are considered category 1 MSB population, and category 2 resident and summer breeding raptor populations, in the CEA (see Annex G). For the reasons identified above, these species were also not included in the database.
- The Lanner falcon is considered a category 1 MSB population (see Annex G), but it was not included in the database due to its very low occurrences. In the CEA, its inclusion in step 2 was regarded as a precautionary measure. It was scoped out of step 3.
- The griffon vulture was not included in the database. It was consistently treated as category 2, resident and summer breeding raptor population, in the CEA (see Annex G), given its association with the biogeographical population in the study area. It was also excluded because this species' movements are more influenced by human activities than by the factors considered in the trend analysis (i.e., weather conditions) for which this database was created.

The database was compiled using the steps in Figure D1.

FIGURE D1. DATABASE COMPILATION APPROACH



STEP 1: CREATING THE DATA SETS

The raw survey bird data from WPPs collected during the spring and/or autumn seasons in the years 2013, 2014, and/or 2015 were entered into one Excel spreadsheet using the same format (described below). One data set or Excel spreadsheet was created per season per WPP.

Because this CEA was developed before the ESIAs for the majority of the participating WPPs, the number of survey days and seasons for each bird survey at each WPPs are not provided in this report—this information will be provided in ESIAs for the project-specific WPPs when they are developed.

All available survey data could not be compiled in the database because of (i) differences in collection methods and (ii) lack of on-site meteorological data from meteorological masts. Therefore, certain data sets had to be excluded, although the one common database (see step 4) included at least two seasons of field surveys for each of the participating WPPs. The variables entered for each observation record were as shown in Table D2.

STEP 2: CALCULATING VARIABLE "BIRDS PER HOUR"

The probability of recording more birds in the field usually increases with an increased amount of observation activity. Over the span of 2013–2015, the amount of observation activity differed from project to project due to the different consultancy companies engaged by the projects. Hence, using the absolute number of observed individual birds (variable 2.7) alone may result in incorrect estimation of abundances. Instead, the metric "birds per hour" was calculated using variables 2.7 (number of individual birds) and the surveyor's observation activity (variable 2.2) and added as a new variable. With this variable, passing rates can be compared from data collected at different WPPs with observation periods and using different methods.

TABLE D2. LIST OF VARIABLES INCLUDED IN THE SPREADSHEET FOR EACH OBSERVATION RECORD

VARIABLE	DESCRIPTION
1. Wind Power Project (WPP)	Name of the WPP where the observation took place
2. Variables per species	
2.1 Date of the observation	• Recorded using DD/MM/YY format • Observation of single bird or multiple birds
2.2 Start and finish time of the survey	The surveyor's observation activity (time spent) in the field for one day; yields the daily observation time
2.3 The time of sunrise and sunset[a] on the day of the observation	This yields the daylight hours per day (i.e., hours available for diurnal bird flight activity)
2.4 The time of the observation[b]	The time at which the bird(s) were first seen during the surveys
2.5 The time of the observation in relation to sunrise or sunset	As calculated in minutes from sunrise or from sunset. With midday being set at 13:00, an observation before midday would be recorded as the difference of minutes between that observation time and sunrise. If an observation is made after midday, it would be recorded as the difference in minutes between that observation time and sunset.
2.6 Species name	2.6.1 Species common name 2.6.2 Scientific name
2.7 The number of individual birds	Number of bird(s) observed
2.8 Flying height	Flying height was recorded in three categories: (1) < 30 m, (2) at 30–120 m, (3) >120 m, which corresponds to "below," "at," and "above" the rotor-swept area, respectively. This information was recoded in the database into two categories: combining (1) and (2) into one "high-risk" category and keeping (3) separate.
Weather data	Obtained directly from developers' meteorological mast stations, which provides data in 10-minute intervals
3.1 Wind speed	Meters/second
3.2 Wind direction	In degrees
3.3 Temperature	Degrees Celsius
3.4 Tailwind	Calculated using variables 3.1 (wind speed) and 3.2 (wind direction)
3.5 Crosswind	

a. As derived from www.timeanddate.com for Amman, Jordan.

b. On the field survey forms, the total time the bird was observed was recorded in 15-second intervals. In the database, the start time of the first 15-second interval was used as the time of the observation.

c. The reason for this is to take a conservative approach, as it can be difficult in the field to identify the heights when observing birds at a distance with the lack of a clear point of reference (e.g., a turbine). It also helps to account for large bird species that often change flying height and enter the rotor-swept area at quick speeds.

STEP 3: CLEANING THE DATA SETS

Before the database could be used for the analysis, several steps were needed to "clean" the data. The database was verified for potential inconsistencies, summarized below.

ACCOUNT FOR THE "ZERO COUNTS"

The zero counts refer to those periods during observation activity when no birds are passing. If the zero counts are not reflected in the database, abundance indexes might be inflated. Therefore, zero counts were added as new records in the database, with variable 2.7 (number of individual birds) equal to 0. This was done for all the species and every monitoring day for each project.

CLEANING THE DATA FOR DOUBLE-COUNTING

Counts of the same individuals at the same time by different surveyors could inflate the real numbers of birds migrating in a certain area. In the study area, two possible types of double-counting errors may occur:

- When surveyors are located at different projects within close proximity to one another.
- When surveyors are located within the same project where there are multiple VP or counted in a vantage point following a previous count in another VP.

The second of these two errors is more likely in the study area, as the earlier surveys conducted at some of the WPPs had multiple observers in the same area, with some overlap between them.

To trace double counts, the original data sets for each WPP were examined in detail. Dates and times of the observation, species, and individuals recorded and the location of VP were all checked. If there were counts of the same species and very similar numbers at the same observation time for different VP, they were considered as a double count and were deleted in merged database. The simultaneous observations at different VP with large differences in the number of birds passing were not considered as double counts.

Overall, the numbers of double counts at different VP and/or by different observers over the years was generally low. Species that were more frequently double counted were the steppe buzzard, honey buzzard, common crane, and griffon vulture.

COMPARING SPECIES ACCUMULATION CURVES PER WPP AND SEASON

As mentioned above, differing levels of survey effort (and observation activity) at each WPP during different seasons may result in differences in the number of species observed. Before merging data sets from WPPs, it was necessary to assess the potential effect of lower survey efforts on the total number of species observed. To account for this, species accumulation curves were prepared for each WPP and for each season. The curves were compared with one another and compared with the one that was obtained from the most comprehensive field survey (in terms of observation activity in the field). From these comparisons, it was determined that the surveys conducted at all WPPs observed similar numbers of species and therefore could be merged into the common database.

STEP 4: MERGING THE DATA SETS INTO ONE COMMON DATABASE

After cleaning the individual data sets for double-counting and other possible inconsistencies, two common databases were created, containing the data for the spring and autumn seasons of the four WPPs. The data were transformed into the file formats using statistical software packages STATISTICA 8.0 (Statsoft 1998), "R" (R Core Team 2014), and SPSS.

Annex E. Trends Analysis – Migratory Soaring Birds

This annex describes the objectives and types of analyses performed on MSBs using the database described in Annex D. The findings of this trends analysis informed the following steps in the CEA framework for category 1, MSB populations (as described in Section 3.2 of the main body of this report):

- **Step 3 – Ecological Risk Assessment Matrix and Identify Priority Bird VECs**
  The LoE was used to assess ecological risk in step 3 of the CEA framework for birds. The LoE was primarily determined using the CRM estimates (see Section 3.4.1), which are based on one spring survey season for multiple WPPs. This trends analysis supplements the CRM as it is based on data pooled over multiple years with the aim of identifying specific environmental and topographic conditions that may present a high risk of collision to specific MSBs.

- **Step 4 – Identify Thresholds for Fatalities for each Priority Bird VEC**
  Apart from the primary threshold targets (for priority bird VECs), extreme event threshold targets were set for nonpriority birds, particularly nonpriority MSBs occurring in the TRWPP area, due to the potential for unpredictable presence of flocks of migratory populations (see Section 3.5.1). The latter was evidenced by the results below in the section on flocking behavior of MSBs in the TRWPP study area.

- **Step 5 – Identify Mitigation and Monitoring**
  The results of the trends analysis helped to define and refine the mitigation measures, in particular measure 1.1 on in-flight monitoring of priority birds, measure 1.2 on the protocol for shutdown on demand for priority birds, and measure 2.3 on the adaptive management response.

FLOCKING BEHAVIOR OF MSBs IN THE TWRPP STUDY AREA

MSBs migrate in different ways. Some fly in flocks whereas others fly individually. The impact of a single collision of one individual is not comparable with that of tens or hundreds of collisions as a consequence of a migrating flock passing through.

METHODS

- For each species, the average number of birds per observation was calculated using variable 2.7 ("number of individual birds" (per observation), see Annex D, Table D2). This was done for the spring and autumn seasons separately (Table E1).
- For the MSBs that are also resident and summer breeding in the area (short-toed snake-eagle), the average flock size (as observed from the survey data) may not reflect the flock size for migrating birds because for this species it was not possible to separate individuals that were migrating from resident and/or summer breeding individuals that were also present in the TRWPP area.

RESULTS

- The observed MSB species show a similar flocking behavior at all WPP sites per season.
- For some species, flocking behavior differs between spring and autumn seasons: e.g., European honey-buzzard, steppe eagle, Levant sparrowhawk.
- The steppe buzzard and European honey-buzzard account for most of the bird observations (see number of observations in Table E1). They also show large average numbers of birds per observation, which means that they frequently fly in large flocks through the TWRPP area. However, as illustrated by the high variances and the minimum and maximum flock sizes, flocks of these species can have divergent sizes.
- A second group consists of gregarious species that are less frequently observed through the TWRPP study area (see number of observations in Table E1): the white stork, black stork, common crane, Levant sparrowhawk (in autumn), and steppe eagle (in spring). If they are observed, they fly in flocks (the ending number of the ±95 percent confidence intervals is > 3), yet the (relatively) high variances and the minimum and maximum flock sizes illustrate the variability of flock sizes.
- The other species typically migrate individually, in pairs or up to three individuals at the maximum (the ending number of the ±95 percent confidence intervals is < 3).

CONCLUSIONS

- Evidence from the bird surveys in the TRWPP area illustrate the potential risk of multiple individuals colliding with turbines due to a demonstrated tendency to migrate through the area in flocks.
- However, the observed flock sizes are overall relatively small and extremely big flocks do not frequently occur.
- That said, the observation that nonpriority MSB species (such as European honey-buzzard and steppe buzzard) may fly over the study area in large flocks justifies the need to set extreme event threshold targets for nonpriority birds in step 4 of the CEA framework (see Section 3.5.1). The values in Table E1 can help to identify the MSB species populations to which these thresholds should apply.

TABLE E1. FLOCKING BEHAVIOR PER MSB SPECIES IN THE TWRPP AREA

MSB SPECIES	AVERAGE NO. OF BIRDS PER OBSERVATION	CONFIDENCE INTERVALS (+95 PERCENT)	NO. OF OBSERVATIONS	VARIANCE	MINIMUM FLOCK SIZE	MAXIMUM FLOCK SIZE
SPRING MIGRATION						
Common crane	—	—	—	—	—	—
Black stork	—	—	—	—	—	—
White stork	3	0–8	6	18.7	1	12
Osprey	—	–	—	—	—	—
European honey-buzzard	89	30–148	180	158,805.5	1	2,886
Egyptian vulture	1	–	7	0	1	1
Short-toed snake-eagle	1	1	70	0.1	1	3

(*continued on next page*)

TABLE E1. FLOCKING BEHAVIOR PER MSB SPECIES IN THE TWRPP AREA (*continued*)

MSB SPECIES	AVERAGE NO. OF BIRDS PER OBSERVATION	CONFIDENCE INTERVALS (+95 PERCENT)	NO. OF OBSERVATIONS	VARIANCE	MINIMUM FLOCK SIZE	MAXIMUM FLOCK SIZE
Lesser spotted eagle	2	1–3	14	3.4	1	7
Steppe eagle	3	0–5	109	176.9	1	140
Eastern imperial eagle	2	0–3	10	4.8	1	8
Booted eagle	1	–	11	0	1	1
Western marsh-harrier	1	–	4	0	1	1
Hen harrier	—	–	—	—	—	—
Pallid harrier	1	–	19	0	1	1
Montagu's harrier	—	–	—	—	—	—
Levant sparrowhawk	4	0–11	2	4	1	225
Eurasian sparrowhawk	—	–	—	—	—	—
Black kite	2	2–3	99	14.4	1	34
Steppe buzzard	12	10–15	576	1,249.3	1	431
AUTUMN MIGRATION						
Common crane	58	13–103	10	3,951.29	4	168
Black stork	38	2–75	13	3,591.06	1	220
White stork	19	1–64	5	1,335.2	1	84
Osprey	1	–	3	0	1	1
European honey-buzzard	8	1–10	108	139.02	1	60
Egyptian vulture	2	1–4	8	3.27	1	5
Short-toed snake-eagle	1	1	83	0.07	1	2
Lesser spotted eagle	1	1–2	17	0.97	1	5
Steppe eagle	1	1	196	0.37	1	6
Eastern imperial eagle	1	1	26	0.15	1	3
Booted eagle	1	1	13	0.08	1	2
Western marsh-harrier	1	1	70	0.23	1	4
Hen harrier	1	1	55	0.21	1	4
Pallid harrier	1	1	62	0.25	1	4
Montagu's harrier	1	1	10	0.1	1	2
Levant sparrowhawk	209	0–433	9	84,436.03	1	700
Eurasian sparrowhawk	1	–	3	0	1	1
Black kite	2	1–2	74	1.07	1	5
Steppe buzzard	16	10–21	337	2,554.61	1	500

Note: **Average number of birds per observation:** average flock size; **confidence intervals ±95 percent:** confidence intervals ±95 percent for the average flock size; **number of observations:** number of records per species regardless the number of birds per record (**Bold:** species defined as priority bird VECs in the CEA).

EFFECT OF TOPOGRAPHY AND ENVIRONMENTAL CONDITIONS ON MSB FLIGHT BEHAVIOR IN THE TRWPP STUDY AREA

The trends analysis identified environmental and topographic conditions that may present a high risk of wind farm-related collision to specific MSBs. This information supports the LoE calculation (step 3) and other steps of the CEA. For each MSB the effect of topographic and environmental variables on collision risk were tested for collision risk relating to several variables, as described here.

Distance from the Rift Valley Ridge

MSBs migrate predominantly by gliding between thermals or soaring along slopes using "lift" from air currents rising over ridges. The strength of these ascending air currents will influence the flying height of MSBs, resulting in higher- or lower-height flights (Klaassen et al., 2010). Thus, the distance of the WPP site to the Rift Valley ridge is likely to be relevant to the flying height of MSBs over the site. For this purpose, ArcGIS® was used to calculate the distances from the ridge to the averaged center of each WPP using the estimated locations of the turbines: projects were classified as (A) < 1 km, (B) 1–5 km, and (C) > 5 km from the ridge. The ridge was considered as the point at which the slopes start descending toward the Jordan Rift Valley.

Time of day, specifically the hours around dawn and sunset compared with the middle hours of the day

Thermals develop as land surface warms, typically during morning, and reduce in strength as the land surface cools toward evening. The flying height of MSBs that predominantly rely on thermals to migrate is therefore likely to be associated with thermal strength through the day, with lower flying heights and greater collision risk likely to be associated with periods of low thermal development in the morning and evening. To test for differences in collision risk likelihood through the day, the trends analysis examined flying height of MSBs in the period after dawn and before dusk compared with during the middle part of the day.

Air temperature

Air temperature is likely to affect the flying height of MSBs because it is associated with thermal development. In addition to affecting flying height throughout the day, temperature is also likely to affect flying height through the migration season. In the TRWPP this should correspond to higher flying heights during the later parts of the spring migration and the earlier parts of the autumn migration; i.e., during those parts of the migration period closest to the warmer summer months.

Wind direction and wind speed

Wind strength and direction may be utilized to aid MSB migration, with birds optimizing travel distance by drifting away from their intended migration route in stronger winds at higher altitudes and then compensating for this displacement in weaker winds at lower altitudes (Alerstam, 1979). In addition, migrating raptors may adjust their flying height to maximize assistance from tail winds (Mateos-Rodríguez and Liechti, 2012).

METHODS

Collision risk was assessed by assigning each flying height record (variable 2.8, see Annex D) to one of two categories according to whether flights were at collision risk height or not. Flying height records were categorized as either (1) at or below turbine height or (2) above turbine height. Categorized flight observations were then used in *Classification and Regression Tree* (CART) analysis to examine, through the use of simple predictive models, how collision risk varied according to the four "flying height relevant" variables. CART analysis was considered suitable for this type of data because it allows the following:

- The effect of each of the four variables on all species to be analyzed while preserving the detail for individual species
- Use of *all variables within the model* no matter how interrelated they are—given the small number of available variables, it was important to keep them all in the model
- *Different types of variables* (binomial, continuous, categorical) to be included in the model
- *Clear partitioning* of the data set and the fitting of a simple prediction model within each partition, which helps evaluators to make clear decisions for mitigation on the basis of birds' behavior

CARTs were run separately for the spring and autumn seasons. Cross-validation was applied to estimate how accurately the predictive models matched actual data, by repeating the analysis using independent samples that were not used to build the model.

The collision risk output from the CART analysis was assigned to the following three categories (Tables E2 and E3):

- *Low collision risk* (green color): the predicted number of bird observations at collision risk flying height is smaller than the predicted number of observations not at collision risk flying height.
- *Moderate collision risk* (orange color): the predicted number of observations at collision risk flying height is equal to the predicted number of observations not at collision risk flying height.
- *High collision risk* (red color): the predicted number of observations at collision risk flying height is higher than the predicted number of observations not at collision risk flying height.

RESULTS

Spring Migration Period

The validation test to assess how well the model in the CART analysis predicted the actual flight height data indicated that the majority (74 percent) of the bird observations in the field were correctly predicted by the model. The proportion of observations that were wrongly predicted as either above turbine height when they should have been below or vice versa were approximately equal and in most cases were for the same two species (steppe and honey buzzard). The model results from the CART analysis were therefore considered valid. Table E2 shows (1) the overall collision risk level (low, moderate, or high) for each species, and (2) the collision risk level relevant to environmental and topographic factors tested. For the variable *1. Distance to the Rift Valley ridge,* distance categories B and C were merged to become a *>1 km from the ridge* category because the results in B and C did not differ.

The results from the spring model showed no clear effect of wind direction and/or wind speed or temperature on collision risk likelihood. A high collision risk level was detected <1 km from the Rift Valley ridge in the early morning and evening for the steppe eagle, Eastern imperial eagle, Egyptian vulture, booted eagle, black kite, and steppe buzzard and during the central hours of the day for the white stork, European honey buzzard, lesser-spotted eagle, and pallid harrier. There was no clear evidence of a time of day effect for any species >1 km from the Rift Valley ridge. Overall the results indicate that MSBs tend to fly lower and are therefore at greater risk of collision with turbines when they are close to the Rift Valley ridge and fly higher as they move away from the ridge as they progress east and/or northeast on their northbound migration.

TABLE E2. OVERALL COLLISION RISK PER SPECIES AND FACTORS INFLUENCING COLLISION RISK AT DIFFERENT DISTANCES FROM RIFT VALLEY RIDGE (SPRING SEASON)

Autumn Migration Period

The validation test to assess how well the model in the CART analysis predicted the actual flight height data indicated that the majority (81 percent) of the bird observations in the field were correctly predicted by the model, indicating that the results from the model are generally valid. Seven percent of observations wrongly predicted birds as being above turbine height when they should have been below. This included records of booted eagle, lesser spotted eagle, imperial eagle, steppe eagle, common crane, Levant sparrowhawk, black stork, steppe buzzard, and Montagu's harrier. For these species, the output from the autumn model will tend to slightly underestimate levels of collision risk.

For the variable *1. Distance to the Rift valley ridge*, distance categories B and C were merged to become a > *1 km from the ridge* category because the results in B and C did not differ.

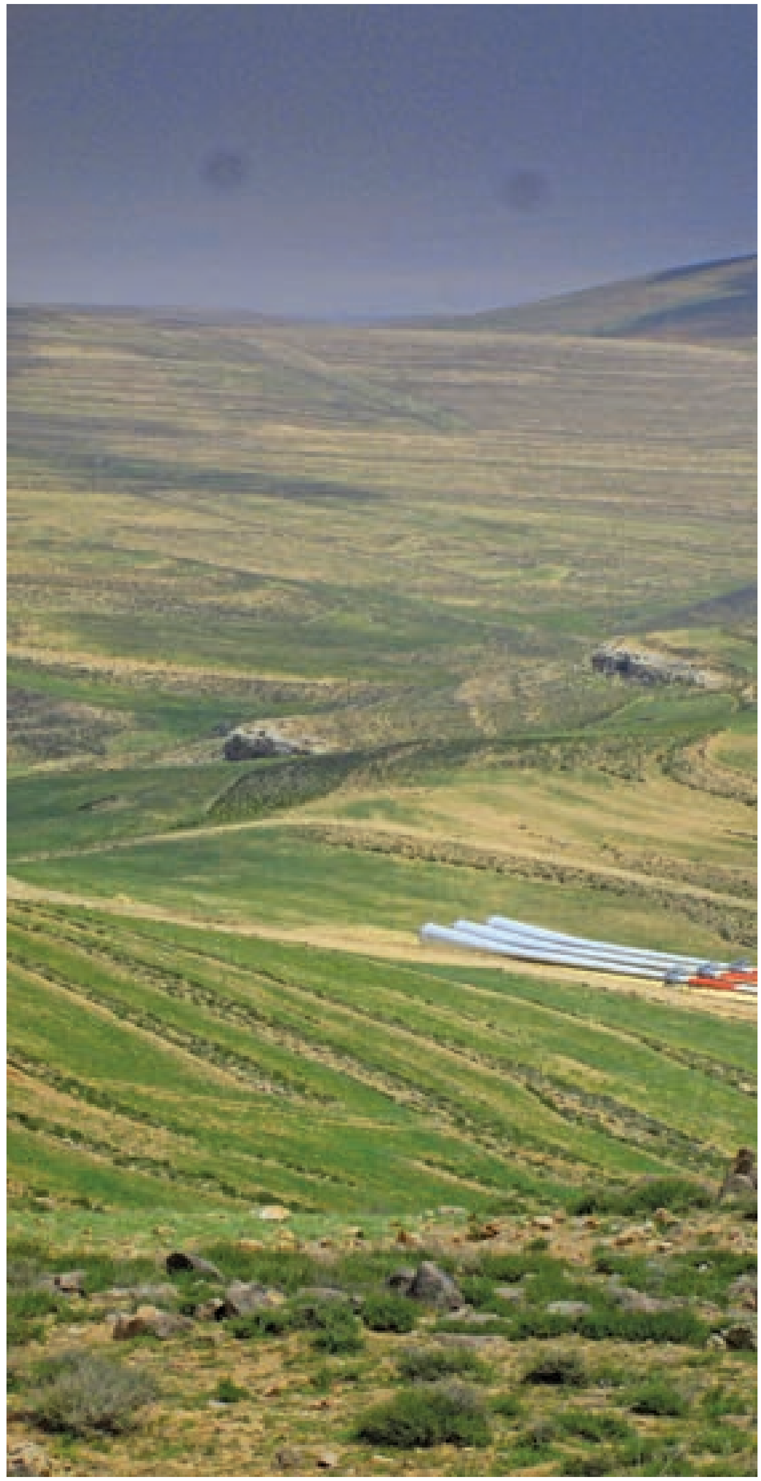
TABLE E3. OVERALL COLLISION RISK PER SPECIES AND FACTORS INFLUENCING COLLISION RISK AT DIFFERENT DISTANCES FROM RIFT VALLEY RIDGE (AUTUMN SEASON)

The autumn model is less complex than the spring model (see Table E1). For all MSBs the model predicted that half or more of the records of birds passing over the TRWPP sites would be at collision risk height, indicating a moderate to high collision risk level irrespective of the distance from the Rift Valley ridge. Within these results, the highest risk in autumn for all species was close to (i.e., < 1 km) the ridge.

The results indicated a moderate level of collision risk at <1 km from the Rift Valley ridge when air temperature is > 18.5°C, with approximately half of records predicting birds flying at collision risk height. This effect was not evident beyond 1 km from the ridge.

During the autumn migration period, the collision risk level was high for all MSBs in the early morning and evening but only at a distance of > 1 km from the Rift Valley ridge. This contrasts with the spring migration period when high collision risk in the early morning and evening was evident only close to the ridges.

The autumn model indicated a high collision risk level for a varied group of MSBs (white stork, short-toed snake-eagle, Egyptian vulture, western marsh-harrier, pallid harrier, and Eurasian sparrowhawk) when migration was associated with tailwinds but only at distances > 1 km away from the Rift Valley ridge.


Turbine blades during construction phase of wind power project

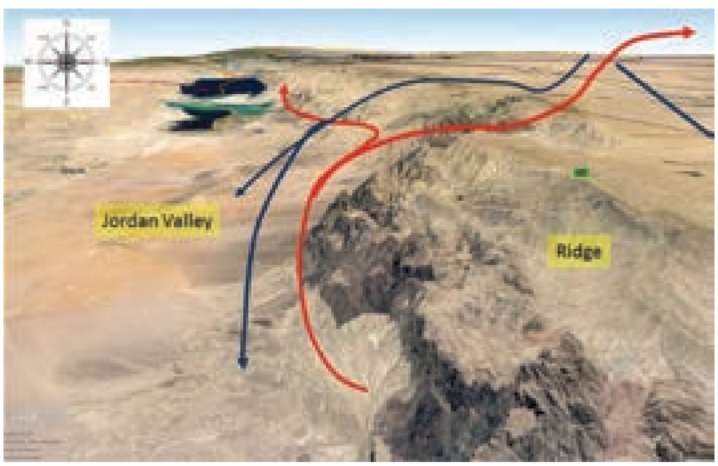
CONCLUSIONS

- In general, there is an increased risk of collision and thus more fatalities expected during autumn migration for the MSB species considered.
- The presence of the Rift Valley ridge in the landscape appears to affect the heights of the MSBs flying over the TRWPP area. This effect appears to be different in spring than in autumn. These local movements could be explained according to general movements in spring and autumn (see Figure E1):

- In spring, field observations suggest that MSBs travelling south–north mainly follow the same south–north route with some deviations to the east. Birds following the latter deviation pass through the TRWPP area: they come from low altitudes after crossing near or through the Red Sea and have to "climb" the Rift before heading north.
- In autumn, migration is more scattered over the area. The ridge appears to have less effect on the flying height of MSBs, as they are heading north–south and "descending" almost all the time. Yet, the same effect as in spring exists for the MSBs that fly over the TRWPP area—they come from the northeast and have to gain height to pass over high mountains in the Tafila area before following the Rift Valley ridge to head south (see middle blue arrow in Figure E1).

- Certain weather conditions appear to affect the flying height of some MSB populations passing over the TRWPP sites. This effect differs between spring and autumn.
- The possible impacts of topography (landscape) and weather conditions need to be considered when designing mitigation and adaptive management strategies, e.g., when establishing the shutdown periods of the turbines and the data collection in the postconstruction monitoring. This may be particularly relevant where turbines are located closer to the Rift Valley ridge. Yet, more data (on landscape features, flight trajectories) will be needed to refine mitigation—this would be based on project-level postconstruction monitoring.

FIGURE E1. GENERAL FLIGHT TRAJECTORIES OF MSBs DURING SPRING (RED ARROWS) AND AUTUMN (BLUE ARROWS)



- The finding that MSBs fly at collision risk height during the early part of the day may also be a consequence of birds roosting at or close to WPP sites (e.g., steppe eagles have been recorded perched on pylons of high-voltage power lines during the autumn migration). Monitoring and mitigation planning, in particular the distribution of postconstruction monitoring effort, would therefore benefit from a greater understanding of the locations of actual and potential roosting sites for those species identified as potentially at risk.

Annex F. Standardized Bird Survey

This annex describes the standardized vantage-point (VP) bird survey methodology developed to ensure that flight activity data collected at TRWPP sites during the spring 2015 surveys were suitable for predicting bird mortality rates using a CRM. It was designed as a cost-effective, efficient method for obtaining reasonably unbiased data, representative of the migration period and providing a viable alternative to "continuous," day-long migration surveys. The methods are based on good practice in VP survey protocols, tailored specifically to capture flight activity data for MSBs at TRWPP sites.

VP surveys refer to timed and repeated observational monitoring sessions from predefined locations strategically positioned in relation to each other so that as much as possible of the airspace over a WPP site can be monitored effectively and efficiently for bird flight activity.

This annex covers the process of selecting VPs, the process of designing a stratified survey visit protocol to ensure that the results are representative of flight activity through the migration period and through the day, and key aspects of the field survey protocol. The annex covers only a recommended approach for VP surveys. Other survey methods, in particular those to quantify breeding bird populations, are not covered.

SELECTING VANTAGE POINTS

Ideally, VP locations should initially be identified within a geographical information system (GIS) using a digital elevation model (DEM) of the site, the proposed turbine layout, and tools to assess the visible airspace (*viewshed*) from prospective VPs. Ideally, VPs should be selected so that together they provide a view of all wind farm turbine locations buffered to 500 m, with the viewing arc from each VP not exceeding 180 degrees and the viewing distance not exceeding 2 km. Including a 500 m buffer around each turbine reduces the potential that birds that use the flight activity area only occasionally will be missed. Using GIS viewshed tools allows the visible airspace at rotor height from each VP to be mapped and VP locations to be optimally positioned to detect birds flying at collision risk height at all turbine locations with a minimum of viewing overlap (for an example, see Figure F1).

VPs and their associated viewsheds identified within the GIS need to be verified in the field before the survey starts. This is done to check that small-scale topographic features and/or human-created obstacles absent from the DEM are not obscuring the view. If the view is obscured, then it may be feasible to move the VP a short distance so that the view is no longer obstructed and the viewshed remains relatively unchanged.

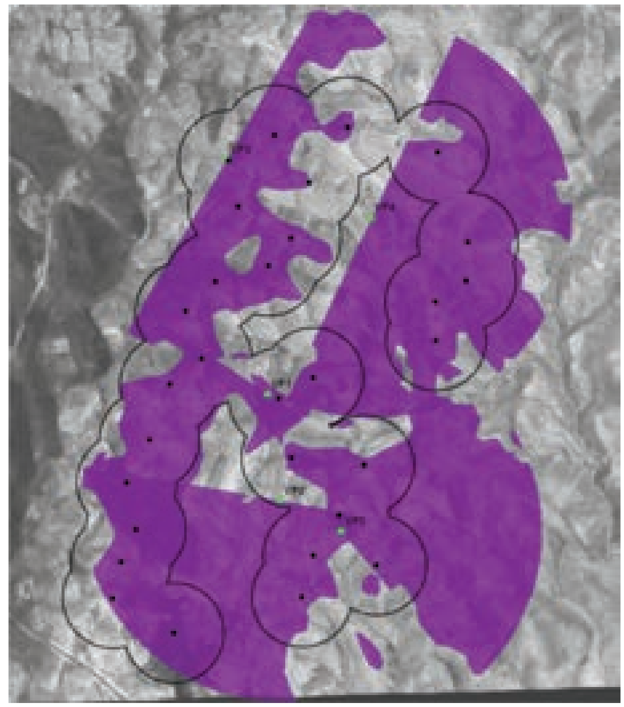
DEMs were not available for TRWPP sites so VPs were carefully selected using maps overlaid with turbine locations and validated during initial field visits to ensure that collectively VPs had an optimal view of proposed development area and had a clear view of all turbine locations.

STRATIFYING EFFORT THROUGH THE MIGRATION SEASON AND THROUGH THE DAY

Stratifying the survey effort helps to ensure that flight activity data are representative of the overall migration period. The suggested approach is to split the survey effort into two strata for each migration season; "low activity periods" preceding and following the peak migration and a "high activity period," that covers the main migration period. For the spring migration in the TRWPP study area, the following periods are suggested:

- **High-activity period:** 22 March to 15 May. This is an eight-week period when the watch effort covers 15 percent of daylight time (equivalent to 18 hours per VP per week).
- **Low-activity period:** 1 March to 21 March, and then 16 May to 31 May. These two periods total five weeks during which the watch effort is half that of the high-activity period, comprising 7.5 percent of daylight time (equivalent to 9 hours per VP per week).

FIGURE F1. EXAMPLE OF VP SELECTION DEM, TURBINE LAYOUT AND GIS TOOLS, ILLUSTRATING THE VISIBLE AREAS FROM EACH VP



The total allotted hours for low-activity periods and for the high-activity period are further stratified into different periods within a day with an equal number assigned to each of the following periods:

- Early morning (sunrise–10:00)
- Late morning (10:00–13:00, approximately solar noon)
- Early afternoon (13:00–16:00)
- Late afternoon (16:00–sunset)

The same approach is taken for the autumn migration, with the recommended high-activity period between September 16 and October 15, and low-activity periods between September 1 and 15 and October 16 and November 30. As in spring, the allotted hours within these activity periods are spread equally across the four periods in the day given above. For an example of a stratified approach for the spring migration showing ideal distribution of survey hours at each VP per week, see Table F1.

Since this survey was carried out, it has been recognized that migration peak activity for certain MSB species occurs in February (very early spring). Although February was not surveyed in 2015, there were multiple surveys that were conducted in February in previous years (2013–2014). This information was incorporated into the common database (see Annex D) and trends analysis (see Annex E), which were used to support the findings of the CRM.

TABLE F1. EXAMPLE OF A STRATIFIED APPROACH FOR THE SPRING MIGRATION SHOWING IDEAL DISTRIBUTION OF SURVEY HOURS AT EACH VP PER WEEK

DAYTIME STRATA	LOW ACTIVITY			HIGH ACTIVITY								LOW ACTIVITY	
	1–21 MARCH			22 MAR–15 MAY								16–31 MAY	
	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9	WK10	WK11	WK12	WK13
Early morning	2.3	2.3	2.3	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	2.3	2.3
Late morning	2.3	2.3	2.3	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	2.3	2.3
Early afternoon	2.3	2.3	2.3	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	2.3	2.3
Late afternoon	2.3	2.3	2.3	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	2.3	2.3
Totals	9	9	9	18	18	18	18	18	18	18	18	9	9
	27			144								18	
	189												

FIELD TECHNIQUES

To help ensure that the flight activity data collected is consistent, has minimal bias, and is suitable for CRM, the following field work guidelines were recommended:

- Surveyors should position themselves inconspicuously to minimize their effects on bird movements. This often precludes the use of hill summits for VP observations.
- If permitted by the land owner, surveyors should mark the exact location of each VP on the ground (i.e., a pile of stones or a marked cane) to ensure consistency in observer position, and take the coordinates of VPs using a global positioning system (GPS) device as accurately as possible.
- Watches should be by a single surveyor under conditions of good visibility (> 2 km).
- Weather conditions (i.e., wind direction and strength, cloud cover, precipitation, and visibility) should be recorded at the start of the watch and at every subsequent hour. Ideally observations should be made in a range of wind conditions. This is particularly important in the case of soaring birds, for which wind direction and strength is likely to affect migration behavior and flight routes.
- Each continuous watch session should last a maximum of three hours but can be suspended and then resumed to take account of changes in visibility (e.g., fluctuations in the cloud base) or short rest breaks. Experience from field trials shows that the performance of most observers declines after three hours, and some may prefer to conduct shorter watches. A gap of at least half an hour between watches is advisable to reduce fatigue. A shorter gap might be used if the watch is shorter than three hours.
- Using a combination of naked eye and binoculars, surveyors should constantly scan a predefined arc of up to 180° from each VP until a target species is detected in flight. Larger arcs cannot be scanned efficiently.

Annex G. CEA for Birds Results: Step 1 – Species Population List

TABLE G1. STEP 1 RESULTS—SPECIES POPULATION LIST

SPECIES POPULATION CATEGORY	SPECIES NAME	SPECIES SCIENTIFIC NAME	REASON INCLUDED
Category 1: Migratory Soaring Bird (MSB) populations	Common crane	*Grus grus*	Recorded at TRWPP during bird surveys
	Black stork	*Ciconia nigra*	Recorded at TRWPP during bird surveys
	White stork	*Ciconia ciconia*	Recorded at TRWPP during bird surveys
	Osprey	*Pandion haliaetus*	Recorded at TRWPP during bird surveys
	European honey-buzzard	*Pernis apivorus*	Recorded at TRWPP during bird surveys
	Egyptian vulture	*Neophron percnopterus*	Recorded at TRWPP during bird surveys
	Short-toed snake-eagle	*Circaetus gallicus*	Recorded at TRWPP during bird surveys
	Lesser spotted eagle	*Clanga pomarina*	Recorded at TRWPP during bird surveys
	Steppe eagle	*Aquila nipalensis*	Recorded at TRWPP during bird surveys
	Eastern imperial eagle	*Aquila heliaca*	Recorded at TRWPP during bird surveys
	Booted eagle	*Hieraaetus pennatus*	Recorded at TRWPP during bird surveys
	Western marsh-harrier	*Circus aeruginosus*	Recorded at TRWPP during bird surveys
	Hen harrier	*Circus cyaneus*	Recorded at TRWPP during bird surveys
	Pallid harrier	*Circus macrourus*	Recorded at TRWPP during bird surveys
	Montagu's harrier	*Circus pygargus*	Recorded at TRWPP during bird surveys
	Levant sparrowhawk	*Accipiter brevipes*	Recorded at TRWPP during bird surveys
	Eurasian sparrowhawk	*Accipiter nisus*	Recorded at TRWPP during bird surveys
	Black kite	*Milvus migrans*	Recorded at TRWPP during bird surveys
	Steppe buzzard	*Buteo buteo vulpinus*	Recorded at TRWPP during bird surveys
	Lesser kestrel	*Falco naumanni*	Recorded at TRWPP during bird surveys
	Common kestrel	*Falco tinnunculus*	Recorded at TRWPP during bird surveys
	Red-footed falcon	*Falco vespertinus*	Recorded at TRWPP during bird surveys
	Eurasian hobby	*Falco subbuteo*	Recorded at TRWPP during bird surveys
	Lanner falcon	*Falco biarmicus*	Recorded at TRWPP during bird surveys
Category 2: Resident and summer breeding raptor populations	Short-toed snake-eagle	*Circaetus gallicus*	Recorded at TRWPP during bird surveys
	Griffon vulture	*Gyps fulvus*	Recorded at TRWPP during bird surveys
	Golden eagle	*Aquila chrysaetos*	Recorded at TRWPP during bird surveys
	Verreaux's eagle	*Aquila verreauxii*	Recorded at TRWPP during bird surveys
	Bonelli's eagle	*Aquila fasciata*	Recorded at TRWPP during bird surveys

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TABLE G1. STEP 1 RESULTS—SPECIES POPULATION LIST *(continued)*

SPECIES POPULATION CATEGORY	SPECIES NAME	SPECIES SCIENTIFIC NAME	REASON INCLUDED
	Long-legged buzzard	*Buteo rufinus*	Recorded at TRWPP during bird surveys
	Lesser kestrel	*Falco naumanni*	Recorded at TRWPP during bird surveys
	Common kestrel	*Falco tinnunculus*	Recorded at TRWPP during bird surveys
	Sooty falcon	*Falco concolor*	Listed as population occurring at Dana IBA
	Barbary falcon	*Falco pelegrinoides*	Recorded at TRWPP during bird surveys
Category 3: Other migrants and wintering populations	Common quail	*Coturnix coturnix*	Recorded at TRWPP during bird surveys
	European nightjar	*Caprimulgus europaeus*	Recorded at TRWPP during bird surveys
	Alpine swift	*Tachymarptis melba*	Recorded at TRWPP during bird surveys
	Little swift	*Apus affinis*	Recorded at TRWPP during bird surveys
	Pallid swift	*Apus pallidus*	Recorded at TRWPP during bird surveys
	Common swift	*Apus apus*	Recorded at TRWPP during bird surveys
	Common cuckoo	*Cuculus canorus*	Recorded at TRWPP during bird surveys
	Corncrake	*Crex crex*	Recorded at TRWPP during bird surveys
	Glossy ibis	*Plegadis falcinellus*	Recorded at TRWPP during bird surveys
	Eurasian bittern	*Botaurus stellaris*	Recorded at TRWPP during bird surveys
	Common hoopoe	*Upupa epops*	Recorded at TRWPP during bird surveys
	European bee-eater	*Merops apiaster*	Recorded at TRWPP during bird surveys
	European roller	*Coracias garrulus*	Recorded at TRWPP during bird surveys
	Eurasian wryneck	*Jynx torquilla*	Recorded at TRWPP during bird surveys
	Merlin	*Falco columbarius*	Recorded at TRWPP during bird surveys
	Red-backed shrike	*Lanius collurio*	Recorded at TRWPP during bird surveys
	Woodchat shrike	*Lanius senator*	Recorded at TRWPP during bird surveys
	Masked shrike	*Lanius nubicus*	Recorded at TRWPP during bird surveys
	Eurasian golden oriole	*Oriolus oriolus*	Recorded at TRWPP during bird surveys
	Sand martin	*Riparia riparia*	Recorded at TRWPP during bird surveys
	Eurasian crag-martin	*Hirundo rupestris*	Recorded at TRWPP during bird surveys
	Barn swallow	*Hirundo rustica*	Recorded at TRWPP during bird surveys
	Red-rumped swallow	*Hirundo daurica*	Recorded at TRWPP during bird surveys
	Northern house-martin	*Delichon urbicum*	Recorded at TRWPP during bird surveys
	Calandra lark	*Melanocorypha calandra*	Recorded at TRWPP during bird surveys
	Bimaculated lark	*Melanocorypha bimaculata*	Recorded at TRWPP during bird surveys
	Greater short-toed lark	*Calandrella brachydactyla*	Recorded at TRWPP during bird surveys
	Wood lark	*Lullula arborea*	Abour wind farm report; listed as occurring in project area
	Eurasian skylark	*Alauda arvensis*	Recorded at TRWPP during bird surveys
	Upcher's warbler	*Hippolais languida*	Listed as population occurring at Dana IBA
	Willow warbler	*Phylloscopus trochilus*	Recorded at TRWPP during bird surveys
	Common chiffchaff	*Phylloscopus collybita*	Recorded at TRWPP during bird surveys
	Common chiffchaff (wintering)	*Phylloscopus collybita*	Recorded at TRWPP during bird surveys

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TABLE G1. STEP 1 RESULTS—SPECIES POPULATION LIST (*continued*)

SPECIES POPULATION CATEGORY	SPECIES NAME	SPECIES SCIENTIFIC NAME	REASON INCLUDED
	Wood warbler	*Phylloscopus sibilatrix*	Recorded at TRWPP during bird surveys
	Blackcap	*Sylvia atricapilla*	Recorded at TRWPP during bird surveys
	Garden warbler	*Sylvia borin*	Abour wind farm report; listed as occurring in project area
	Common whitethroat	*Sylvia communis*	Recorded at TRWPP during bird surveys
	Lesser whitethroat	*Sylvia curruca*	Recorded at TRWPP during bird surveys
	Common starling	*Sturnus vulgaris*	Recorded at TRWPP during bird surveys
	Eurasian blackbird	*Turdus merula*	Recorded at TRWPP during bird surveys
	Song thrush	*Turdus philomelos*	Recorded at TRWPP during bird surveys
	European robin	*Erithacus rubecula*	Abour wind farm report; listed as occurring in project area
	Bluethroat	*Luscinia svecica*	Abour wind farm report listed as occurring in project area
	Bluethroat (wintering)	*Luscinia svecica*	Abour wind farm report listed as occurring in project area
	Black redstart	*Phoenicurus ochruros*	Recorded at TRWPP during bird surveys
	Black redstart (wintering)	*Phoenicurus ochruros*	Recorded at TRWPP during bird surveys
	Common redstart	*Phoenicurus phoenicurus*	Recorded at TRWPP during bird surveys
	Whinchat	*Saxicola rubetra*	Recorded at TRWPP during bird surveys
	Common stonechat	*Saxicola torquatus*	Recorded at TRWPP during bird surveys
	Common stonechat (wintering)	*Saxicola torquatus*	Recorded at TRWPP during bird surveys
	Northern wheatear	*Oenanthe oenanthe*	Recorded at TRWPP during bird surveys
	Finsch's wheatear	*Oenanthe finschii*	Recorded at TRWPP during bird surveys
	Black-eared wheatear	*Oenanthe hispanica*	Recorded at TRWPP during bird surveys
	Pied wheatear	*Oenanthe pleschanka*	Recorded at TRWPP during bird surveys
	Isabelline wheatear	*Oenanthe isabellina*	Recorded at TRWPP during bird surveys
	Rufous-tailed rock-thrush	*Monticola saxatilis*	Recorded at TRWPP during bird surveys
	Blue rock-thrush	*Monticola solitarius*	Recorded at TRWPP during bird surveys
	Spotted flycatcher	*Muscicapa striata*	Abour wind farm report; listed as occurring in project area
	Spanish sparrow	*Passer hispaniolensis*	Recorded at TRWPP during bird surveys
	Dead sea sparrow	*Passer moabiticus*	Listed as population occurring at Dana IBA
	Pale rock sparrow	*Petronia brachydactyla*	Recorded at TRWPP during bird surveys
	White wagtail	*Motacilla alba*	Recorded at TRWPP during bird surveys
	White wagtail (wintering)	*Motacilla alba*	Recorded at TRWPP during bird surveys
	Yellow wagtail	*Motacilla flava*	Recorded at TRWPP during bird surveys
	Tawny pipit	*Anthus campestris*	Recorded at TRWPP during bird surveys
	Tree pipit	*Anthus trivialis*	Recorded at TRWPP during bird surveys
	Red-throated pipit	*Anthus cervinus*	Recorded at TRWPP during bird surveys
	Eurasian chaffinch	*Fringilla coelebs*	Recorded at TRWPP during bird surveys

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TABLE G1. STEP 1 RESULTS—SPECIES POPULATION LIST *(continued)*

SPECIES POPULATION CATEGORY	SPECIES NAME	SPECIES SCIENTIFIC NAME	REASON INCLUDED
	European serin	*Serinus serinus*	Recorded at TRWPP during bird surveys
	European greenfinch	*Carduelis chloris*	Abour wind farm report; listed as occurring in project area
	European goldfinch	*Carduelis carduelis*	Recorded at TRWPP during bird surveys
	Eurasian linnet	*Carduelis cannabina*	Recorded at TRWPP during bird surveys
	Corn bunting	*Miliaria calandra*	Recorded at TRWPP during bird surveys
	Ortolan bunting	*Emberiza hortulana*	Recorded at TRWPP during bird surveys
Category 4: Other residents and summer breeding populations	Chukar	*Alectoris chukar*	Recorded at TRWPP during bird surveys
	Sand partridge	*Ammoperdix heyi*	Recorded at TRWPP during bird surveys
	Rock dove	*Columba livia*	Recorded at TRWPP during bird surveys
	Feral pigeon	*Columba livia domestica*	Recorded at TRWPP during bird surveys
	Eurasian collared dove	*Streptopelia decaocto*	Recorded at TRWPP during bird surveys
	Laughing dove	*Spilopelia senegalensis*	Recorded at TRWPP during bird surveys
	Spotted sandgrouse	*Pterocles senegallus*	Listed as population occurring at Dana IBA
	Crowned sandgrouse	*Pterocles coronatus*	Listed as population occurring at Dana IBA
	Alpine swift	*Tachymarptis melba*	Recorded at TRWPP during bird surveys
	Eurasian thick-knee	*Burhinus oedicnemus*	Recorded at TRWPP during bird surveys
	Cream-colored courser	*Cursorius cursor*	Recorded at TRWPP during bird surveys
	Little owl	*Athene noctua*	Recorded at TRWPP during bird surveys
	Hume's owl	*Strix butleri*	Listed as population occurring at Dana IBA
	Pharaoh eagle-owl	*Bubo ascalaphus*	Listed as population occurring at Dana IBA
	Woodchat shrike	*Lanius senator*	Recorded at TRWPP during bird surveys
	Masked shrike	*Lanius nubicus*	Recorded at TRWPP during bird surveys
	Brown-necked raven	*Corvus ruficollis*	Recorded at TRWPP during bird surveys
	Common raven	*Corvus corax*	Recorded at TRWPP during bird surveys
	Pale crag-martin	*Hirundo obsoleta*	Recorded at TRWPP during bird surveys
	Greater hoopoe-lark	*Alaemon alaudipes*	Listed as population occurring at Dana IBA
	Bar-tailed lark	*Ammomanes cinctura*	Listed as population occurring at Dana IBA
	Desert lark	*Ammomanes deserti*	Recorded at TRWPP during bird surveys
	Dunn's lark	*Eremalauda dunni*	Listed as population occurring at Dana IBA
	Crested lark	*Galerida cristata*	Recorded at TRWPP during bird surveys
	Wood lark	*Lullula arborea*	Recorded breeding in Dana IBA (expert review)
	Temminck's lark	*Eremophila bilopha*	Recorded at TRWPP during bird surveys
	Streaked scrub-warbler	*Scotocerca inquieta*	Recorded at TRWPP during bird surveys
	Graceful prinia	*Prinia gracilis*	Abour wind farm report; listed as occurring in project area
	White-spectacled bulbul	*Pycnonotus xanthopygos*	Abour wind farm report; listed as occurring in project area
	Orphean warbler	*Sylvia hortensis*	Abour wind farm report; listed as occurring in project area

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TABLE G1. STEP 1 RESULTS—SPECIES POPULATION LIST (*continued*)

SPECIES POPULATION CATEGORY	SPECIES NAME	SPECIES SCIENTIFIC NAME	REASON INCLUDED
	Arabian warbler	*Sylvia leucomelaena*	Listed as population occurring at Dana IBA
	Sardinian warbler	*Sylvia melanocephala*	Listed as population occurring at Dana IBA
	Spectacled warbler	*Sylvia conspicillata*	Recorded at TRWPP during bird surveys
	Arabian babbler	*Turdoides squamiceps*	Listed as population occurring at Dana IBA
	Tristram's starling	*Onychognathus tristramii*	Listed as population occurring at Dana IBA
	Eurasian blackbird	*Turdus merula*	Recorded breeding in Dana IBA (expert review)
	White-tailed wheatear	*Oenanthe leucopyga*	Listed as population occurring at Dana IBA
	Hooded wheatear	*Oenanthe monacha*	Listed as population occurring at Dana IBA
	Mourning wheatear	*Oenanthe lugens*	Recorded at TRWPP during bird surveys
	Black-eared wheatear	*Oenanthe hispanica*	Recorded at TRWPP during bird surveys
	Desert wheatear	*Oenanthe deserti*	Recorded at TRWPP during bird surveys
	Isabelline wheatear	*Oenanthe isabellina*	Recorded at TRWPP during bird surveys
	Blue rock-thrush	*Monticola solitarius*	Recorded at TRWPP during bird surveys
	Blackstart	*Cercomela melanura*	Recorded at TRWPP during bird surveys
	Palestine sunbird	*Nectarinia osea*	Recorded at TRWPP during bird surveys
	House sparrow	*Passer domesticus*	Recorded at TRWPP during bird surveys
	Spanish sparrow	*Passer hispaniolensis*	Recorded at TRWPP during bird surveys
	Dead sea sparrow	*Passer moabiticus*	Recommended for inclusion by expert review
	Rock sparrow	*Petronia petronia*	Recorded at TRWPP during bird surveys
	Pale rock sparrow	*Petronia brachydactyla*	Recorded at TRWPP during bird surveys
	Tawny pipit	*Anthus campestris*	Recorded at TRWPP during bird surveys
	Long-billed pipit	*Anthus similis*	Recorded at TRWPP during bird surveys
	Syrian Serin	*Serinus syriacus*	Listed as population occurring at Dana IBA
	European greenfinch	*Carduelis chloris*	Abour wind farm report; listed as occurring in project area
	European goldfinch	*Carduelis carduelis*	Recorded at TRWPP during bird surveys
	Eurasian linnet	*Carduelis cannabina*	Recorded at TRWPP during bird surveys
	Desert finch	*Rhodopechys obsoletus*	Recorded at TRWPP during bird surveys
	Trumpeter finch	*Bucanetes githagineus*	Recorded at TRWPP during bird surveys
	Pale rosefinch	*Carpodacus synoicus*	Listed as population occurring at Dana IBA
	Corn bunting	*Miliaria calandra*	Recorded at TRWPP during bird surveys
	Ortolan bunting	*Emberiza hortulana*	Recorded at TRWPP during bird surveys
	Cretzschmar's bunting	*Emberiza caesia*	Listed as population occurring at Dana IBA
	Striolated bunting	*Emberiza striolata*	Listed as population occurring at Dana IBA

TABLE G2. STEP 1—SPECIES POPULATIONS SCOPED "OUT" OF CEA STEP

SPECIES NAME	SPECIES SCIENTIFIC NAME	SCREENING – REASON SPECIES POPULATION EXCLUDED FROM STEP 2
Eurasian spoonbill	*Platalea leucorodia*	Recognized as a vagrant in Jordan (including Andrews, 1996)
Oriental honey-buzzard	*Pernis ptilorhynchus*	Rare and vagrant (principle migratory is not Rift Valley/Rea Sea flyway)
Cinereous vulture	*Aegypius monachus*	Recognized as a vagrant in Jordan (including Andrews, 1996)
Lappet-faced vulture	*Torgos tracheliotos*	Recognized as a vagrant in Jordan (including Andrews, 1996)
Greater spotted eagle	*Clanga clanga*	Recognized as a vagrant in Jordan (including Andrews, 1996)
White-tailed sea-eagle	*Haliaeetus albicilla*	No evidence that population recorded or likely to be recorded at TRWPP
Eleonora's falcon	*Falco eleonorae*	Vagrant (principle migratory is not Rift Valley/Rea Sea flyway)
Saker falcon	*Falco cherrug*	Very scarce migrant (principle migratory is not Rift Valley/Rea Sea flyway)
Peregrine falcon	*Falco peregrinus*	Very scarce migrant
Bearded vulture	*Gypaetus barbatus*	Former breeding in Dana IBA (last recorded in 1966; Andrews, 1996)
Garganey	*Spatula querquedula*	No evidence that population recorded or likely to be recorded at TRWPP
European turtle-dove	*Streptopelia turtur*	No evidence that population recorded at TRWPP
Great white pelican	*Pelecanus onocrotalus*	No evidence that population recorded or likely to be recorded at TRWPP
Lesser grey shrike	*Lanius minor*	No evidence that population recorded at TRWPP
Orphean warbler	*Sylvia hortensis*	No evidence that population recorded at TRWPP
Rueppell's warbler	*Sylvia rueppelli*	No evidence that population recorded at TRWPP
Kurdish wheatear	*Oenanthe xanthoprymna*	Recognized as a vagrant in Jordan (including Andrews, 1996)
Brambling	*Fringilla montifringilla*	No evidence that population recorded at TRWPP
Cretzschmar's bunting	*Emberiza caesia*	No evidence that population recorded at TRWPP
Little swift	*Apus affinis*	Does not breed in the TRWPP Study Area (expert review)
Pallid swift	*Apus pallidus*	Does not breed in the TRWPP Study Area (expert review)
Common barn-owl	*Tyto alba*	Only breeds in north of Jordan; no evidence that population recorded at TRWPP
Tawny owl	*Strix aluco*	Only breeds in north of Jordan; no evidence that population recorded at TRWPP
Fan-tailed raven	*Corvus rhipidurus*	No evidence that population recorded at TRWPP
Cetti's warbler	*Cettia cetti*	No evidence that population recorded at TRWPP

Annex H. CEA For Birds Results: Step 2 – Species Sensitivity Results

MSB "broad front" migrant populations were categorized for *Relative Importance* according to criteria below except for Common and Lesser Kestrel. These species were assumed to have both migratory and resident populations present at the TRWPP sites. It was not possible to separate out migrants from resident populations. As a result, a precautionary approach was taken. All recorded birds for each species were assumed to be migrants in Category 1 and assessed in the same way as all other non-broad front MSB populations by comparing seasonal maximum estimate from TRWPP sites with the seasonal maximum given for the flyway. This precautionary approach resulted in higher *Relative Importance* score than if the species were dealt with as MSB "broad front" species.

Dana Biosphere Reserve

TABLE H1. CATEGORY 1, MIGRATORY SOARING BIRD POPULATIONS—RELATIVE IMPORTANCE, VULNERABILITY AND SENSITIVITY SCORING

SPECIES NAME	SPECIES SCIENTIFIC NAME	RELATIVE IMPORTANCE SCORING				VULNERABILITY SCORING				ASSIGN SPECIES SENSITIVITY
		HIGHEST SEASONAL COUNTS FOR TRWPP	RIFT VALLEY/ RED SEA FLYWAY POPULATION	ESTIMATED SHARE OF FLYWAY POPULATION PASSING THROUGH TRWPP (%)	RELATIVE IMPORTANCE SCORE	IUCN GLOBAL RED LIST CATEGORY	CMS RAPTORS MOU CATEGORY 2 RATING	SPECIES VULNERABILITY INDEX (SVI)	VULNERABILITY SCORE	SENSITIVITY PER SPECIES POPULATION
Common crane	*Grus grus*	3,493	60,000	5.8	Moderate	LC		10	Moderate	Medium
Black stork	*Ciconia nigra*	930	8,300	11.2	High	LC		10	Moderate	High
White stork	*Ciconia ciconia*	516	338,000	0.2	Negligible	LC		10	Moderate	Negligible
Osprey	*Pandion haliaetus*	9	130	6.9	Low*	LC	yes	7	Low	Low
European honey-buzzard	*Pernis apivorus*	12,099	850,000	1.4	Low	LC		7	Low	Low
Egyptian vulture	*Neophron percnopterus*	67	1,200	5.6	Moderate	EN		10	High	High
Booted eagle	*Hieraaetus pennatus*	32	2,000	1.6	Low	LC	yes	9	High	Medium
Short-toed snake-eagle	*Circaetus gallicus*	459	12,100	3.8	Low	LC	yes	7	Moderate	Low
Lesser spotted eagle	*Clanga pomarina*	727	142,000	0.5	Negligible	LC	yes	9	High	Low
Eastern imperial eagle	*Aquila heliaca*	214	556	38.5	High	VU		9	High	High
Steppe eagle	*Aquila nipalensis*	297	76,600	0.4	Negligible	EN	yes	9	High	Low
Western marsh-harrier	*Circus aeruginosus*	92	1,600	6.0	Low*	LC		8	Low	Low
Hen harrier	*Circus cyaneus*	227	40	567.5	Moderate*	LC	yes	8	Moderate	High
Pallid harrier	*Circus macrourus*	89	165	53.9	Low*	NT		8	Moderate	High
Montagu's harrier	*Circus pygargus*	92	252	36.5	Low*	LC		8	Low	Medium
Levant sparrow-hawk	*Accipiter brevipes*	3,746	60,400	6.2	High	LC	yes	6	Low	Medium
Eurasian spar-rowhawk	*Accipiter nisus*	153	4,000	3.8	Low*	LC		6	Negligible	Negligible
Black kite	*Milvus migrans*	550,044	36,700	1.5	Low	LC	yes	8	Moderate	Low
Steppe buzzard	*Buteo buteo vulpinus*	4,452	205,000	5.9	Moderate	LC		7	Low	Low
Lesser kestrel	*Falco naubmanni*	942	500	188.4	High	LC		6	Negligible	Low
Common kestrel	*Falco tinnunculus*	883,872	450	196.4	High	LC	yes	6	Low	Medium
Red-footed falcon	*Falco vespertinus*	38	11,400	0.3	Negligible*	NT		6	Low	Negligible
Eurasian hobby	*Falco subbuteo*	10	190	5.3	Low*	LC		6	Negligible	Negligible
Lanner falcon	*Falco biarmicus*	11	4	275	Moderate*	LC	yes	6	Low	Low

* MSB "broad-front" migrant. RI score treats flyway estimate as indicative of a typical seasonal maximum for many locations within the flyway and compares this with seasonal maximum at TRWPP. If RI score below or approximately 100% = low, if RI score above 100% = medium. (Section 3.3.1. for details.)

TABLE H2. CATEGORY 2, RESIDENT AND SUMMER BREEDING RAPTOR POPULATIONS—RELATIVE IMPORTANCE, VULNERABILITY AND SENSITIVITY SCORING

		RELATIVE IMPORTANCE SCORING			VULNERABILITY SCORING			ASSIGN SPECIES SENSITIVITY
SPECIES NAME	SPECIES SCIENTIFIC NAME	APPROXIMATE MAXIMUM SHARE OF NATIONAL POPULATION USING TRWPP AREA (%)	BIOME RESTRICTED SPECIES IN DANA IBA	RELATIVE IMPORTANCE SCORE	IUCN REGIONAL RED LIST CATEGORY	SPECIES VULNERABILITY INDEX (SVI)	VULNERABILITY SCORE	SENSITIVITY PER SPECIES POPULATION
Short-toed snake-eagle	*Circaetus gallicus*	>10	no	High	VU	7	Moderate	High
Griffon vulture	*Gyps fulvus*	>10	no	High	EN	10	High	High
Golden eagle	*Aquila chrysaetos*	>10	no	High	EN	9	High	High
Verreaux's eagle	*Aquila verreauxii*	>10	no	High	EN	10	High	High
Bonelli's eagle	*Aquila fasciata*	>10	no	High	LC	9	Moderate	High
Long-legged buzzard	*Buteo rufinus*	>1 and ≤5	no	Low	LC	7	Low	Low
Lesser kestrel	*Falco naumanni*	>10	no	High	NT	6	Low	Medium
Common kestrel	*Falco tinnunculus*	≤1	no	Negligible	LC	6	Negligible	Negligible
Sooty falcon	*Falco concolor*	>10	no	High	VU	6	Low	Medium
Barbary falcon	*Falco pelegrinoides*	>10	no	High	VU	6	Low	Medium

TABLE H3. CATEGORY 3, OTHER MIGRANTS AND/OR WINTERING POPULATIONS—RELATIVE IMPORTANCE, VULNERABILITY AND SENSITIVITY SCORING

SPECIES NAME	SCIENTIFIC NAME	RELATIVE IMPORTANCE SCORING		VULNERABILITY SCORING		ASSIGN SPECIES SENSITIVITY
		BIRDLIFE BREEDING DISTRIBUTION SIZE (KM2)	RELATIVE IMPORTANCE SCORE	IUCN GLOBAL RED LIST CATEGORY	VULNERABILITY SCORE	SENSITIVITY PER SPECIES POPULATION
Common quail	*Coturnix coturnix*	16,200,000	Negligible	LC	Negligible	Negligible
European nightjar	*Caprimulgus europaeus*	6,550,000	Low	LC	Negligible	Negligible
Alpine swift	*Tachymarptis melba*	7,350,000	Low	LC	Negligible	Negligible
Little swift	*Apus affinis*	22,200,000	Negligible	LC	Negligible	Negligible
Pallid swift	*Apus pallidus*	1,720,000	Low	LC	Negligible	Negligible
Common swift	*Apus apus*	24,800,000	Negligible	LC	Negligible	Negligible
Common cuckoo	*Cuculus canorus*	12,000,000	Negligible	LC	Negligible	Negligible
Glossy ibis	*Plegadis falcinellus*	19,400,000	Negligible	LC	Negligible	Negligible
Eurasian bittern	*Botaurus stellaris*	8,150,000	Low	LC	Negligible	Negligible
Corncrake	*Crex crex*	3,980,000	Low	LC	Negligible	Negligible
Common hoopoe	*Upupa epops*	28,400,000	Negligible	LC	Negligible	Negligible
European bee-eater	*Merops apiaster*	11,000,000	Negligible	LC	Negligible	Negligible
European roller	*Coracias garrulus*	11,400,000	Negligible	NT	Low	Negligible
Eurasian wryneck	*Jynx torquilla*	12,700,000	Negligible	LC	Negligible	Negligible
Merlin	*Falco columbarius*	23,100,000	Negligible	LC	Negligible	Negligible
Red-backed shrike	*Lanius collurio*	5,360,000	Low	LC	Negligible	Negligible
Woodchat shrike	*Lanius senator*	2,580,000	Low	LC	Negligible	Negligible
Masked shrike	*Lanius nubicus*	353,000	Moderate	LC	Negligible	Negligible
Eurasian golden oriole	*Oriolus oriolus*	10,500,000	Negligible	LC	Negligible	Negligible
Sand martin	*Riparia riparia*	28,900,000	Negligible	LC	Negligible	Negligible
Eurasian crag-martin	*Hirundo rupestris*	9,090,000	Low	LC	Negligible	Negligible
Barn swallow	*Hirundo rustica*	43,400,000	Negligible	LC	Negligible	Negligible
Red-rumped swallow	*Hirundo daurica*	19,100,000	Negligible	LC	Negligible	Negligible
Northern house-martin	*Delichon urbicum*	16,200,000	Negligible	LC	Negligible	Negligible
Calandra lark	*Melanocorypha calandra*	5,630,000	Low	LC	Negligible	Negligible
Bimaculated lark	*Melanocorypha bimaculata*	2,580,000	Low	LC	Negligible	Negligible
Greater short-toed lark	*Calandrella brachydactyla*	8,080,000	Low	LC	Negligible	Negligible

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TABLE H3. CATEGORY 3, OTHER MIGRANTS AND/OR WINTERING POPULATIONS—RELATIVE IMPORTANCE, VULNERABILITY AND SENSITIVITY SCORING *(continued)*

SPECIES NAME	SCIENTIFIC NAME	RELATIVE IMPORTANCE SCORING		VULNERABILITY SCORING		ASSIGN SPECIES SENSITIVITY
		BIRDLIFE BREEDING DISTRIBUTION SIZE (KM2)	RELATIVE IMPORTANCE SCORE	IUCN GLOBAL RED LIST CATEGORY	VULNERABILITY SCORE	SENSITIVITY PER SPECIES POPULATION
Wood lark	*Lullula arborea*	7,110,000	Low	LC	Negligible	Negligible
Eurasian skylark	*Alauda arvensis*	33,000,000	Negligible	LC	Negligible	Negligible
Upcher's warbler	*Hippolais languida*	2,600,000	Low	LC	Negligible	Negligible
Willow warbler	*Phylloscopus trochilus*	15,800,000	Negligible	LC	Negligible	Negligible
Common chiffchaff	*Phylloscopus collybita*	17,000,000	Negligible	LC	Negligible	Negligible
Common chiffchaff (wintering)	*Phylloscopus collybita*	17,000,000	Negligible	LC	Negligible	Negligible
Wood warbler	*Phylloscopus sibilatrix*	4,060,000	Low	LC	Negligible	Negligible
Blackcap	*Sylvia atricapilla*	6,860,000	Low	LC	Negligible	Negligible
Garden warbler	*Sylvia borin*	9,650,000	Low	LC	Negligible	Negligible
Common white-throat	*Sylvia communis*	14,100,000	Negligible	LC	Negligible	Negligible
Lesser whitethroat	*Sylvia curruca*	16,700,000	Negligible	LC	Negligible	Negligible
Common starling	*Sturnus vulgaris*	17,200,000	Negligible	LC	Negligible	Negligible
Eurasian blackbird	*Turdus merula*	13,900,000	Negligible	LC	Negligible	Negligible
Song thrush	*Turdus philomelos*	13,700,000	Negligible	LC	Negligible	Negligible
European robin	*Erithacus rubecula*	10,200,000	Negligible	LC	Negligible	Negligible
Bluethroat	*Luscinia svecica*	12,900,000	Negligible	LC	Negligible	Negligible
Bluethroat (wintering)	*Luscinia svecica*	12,900,000	Negligible	LC	Negligible	Negligible
Black redstart	*Phoenicurus ochruros*	13,600,000	Negligible	LC	Negligible	Negligible
Black redstart (wintering)	*Phoenicurus ochruros*	13,600,000	Negligible	LC	Negligible	Negligible
Common redstart	*Phoenicurus phoenicurus*	5,280,000	Low	LC	Negligible	Negligible
Whinchat	*Saxicola rubetra*	5,330,000	Low	LC	Negligible	Negligible
Common stonechat	*Saxicola torquatus*	19,500,000	Negligible	LC	Negligible	Negligible
Common stonechat (wintering)	*Saxicola torquatus*	19,500,000	Negligible	LC	Negligible	Negligible
Northern wheatear	*Oenanthe oenanthe*	10,200,000	Negligible	LC	Negligible	Negligible

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TABLE H3. CATEGORY 3, OTHER MIGRANTS AND/OR WINTERING POPULATIONS—RELATIVE IMPORTANCE, VULNERABILITY AND SENSITIVITY SCORING (*continued*)

		RELATIVE IMPORTANCE SCORING		VULNERABILITY SCORING		ASSIGN SPECIES SENSITIVITY
SPECIES NAME	**SCIENTIFIC NAME**	**BIRDLIFE BREEDING DISTRIBUTION SIZE (KM2)**	**RELATIVE IMPORTANCE SCORE**	**IUCN GLOBAL RED LIST CATEGORY**	**VULNERABILITY SCORE**	**SENSITIVITY PER SPECIES POPULATION**
Finsch's wheatear	*Oenanthe finschii*	1,160,000	Low	LC	Negligible	Negligible
Black-eared wheat-ear	*Oenanthe hispanica*	3,530,000	Low	LC	Negligible	Negligible
Pied wheatear	*Oenanthe pleschanka*	3,380,000	Low	LC	Negligible	Negligible
Isabelline wheatear	*Oenanthe isabellina*	11,700,000	Negligible	LC	Negligible	Negligible
Rufus-tailed rock-thrush	*Monticola saxatilis*	3,130,000	Low	LC	Negligible	Negligible
Blue rock-thrush	*Monticola solitarius*	9,790,000	Low	LC	Negligible	Negligible
Spotted flycatcher	*Muscicapa striata*	11,800,000	Negligible	LC	Negligible	Negligible
Spanish sparrow	*Passer hispaniolensis*	5,010,000	Low	LC	Negligible	Negligible
Dead sea sparrow	*Passer moabiticus*	188,000	Medium	LC	Negligible	Negligible
Pale rock sparrow	*Petronia brachydactyla*	282,000	Medium	LC	Negligible	Negligible
Yellow wagtail	*Motacilla flava*	28,400,000	Negligible	LC	Negligible	Negligible
White wagtail	*Motacilla alba*	39,500,000	Negligible	LC	Negligible	Negligible
White wagtail (win-tering)	*Motacilla alba*	39,500,000	Negligible	LC	Negligible	Negligible
Tawny pipit	*Anthus campestris*	8,450,000	Low	LC	Negligible	Negligible
Tree pipit	*Anthus trivialis*	12,300,000	Negligible	LC	Negligible	Negligible
Red-throated pipit	*Anthus cervinus*	3,790,000	Low	LC	Negligible	Negligible
Eurasian chaffinch	*Fringilla coelebs*	13,400,000	Negligible	LC	Negligible	Negligible
European serin	*Serinus serinus*	2,420,000	Low	LC	Negligible	Negligible
European greenfinch	*Carduelis chloris*	9,710,000	Low	LC	Negligible	Negligible
European goldfinch	*Carduelis carduelis*	9,920,000	Low	LC	Negligible	Negligible
Eurasian linnet	*Carduelis cannabina*	10,900,000	Negligible	LC	Negligible	Negligible
Corn bunting	*Miliaria calandra*	1,680,000	Low	LC	Negligible	Negligible
Ortolan bunting	*Emberiza hortulana*	627,000	Moderate	LC	Negligible	Negligible

TABLE H4. CATEGORY 4, OTHER RESIDENT AND SUMMER BREEDING POPULATIONS – RELATIVE IMPORTANCE, VULNERABILITY AND SENSITIVITY SCORING

SPECIES NAME	SCIENTIFIC NAME	RELATIVE IMPORTANCE SCORING			VULNERABILITY SCORING		ASSIGN SPECIES SENSITIVITY
		APPROXIMATE MAXIMUM SHARE OF NATIONAL POPULATION USING TRWPP AREA (%)	BIOME RESTRICTED SPECIES IN DANA IBA	RELATIVE IMPORTANCE SCORE	IUCN REGIONAL RED LIST CATEGORY	VULNERABILITY SCORE	SENSITIVITY PER SPECIES POPULATION
Chukar	*Alectoris chukar*	>10	no	High	LC	Negligible	Low
Sand partridge	*Ammoperdix heyi*	>1 and ≤ 5	yes	Medium	LC	Negligible	Negligible
Eurasian thick-knee	*Burhinus oedicnemus*	≤ 1	no	Negligible	LC	Negligible	Negligible
Cream-colored courser	*Cursorius cursor*	≤ 1	no	Negligible	LC	Negligible	Negligible
Spotted sandgrouse	*Pterocles senegallus*	>5 and ≤10	no	Medium	LC	Negligible	Negligible
Crowned sandgrouse	*Pterocles coronatus*	>5 and ≤10	no	Medium	LC	Negligible	Negligible
Feral pigeon	*Columba livia domestica*	≤ 1	no	Negligible	LC	Negligible	Negligible
Rock dove	*Columba livia*	≤ 1	no	Negligible	LC	Negligible	Negligible
Eurasian collared dove	*Streptopelia decaocto*	≤ 1	no	Negligible	LC	Negligible	Negligible
Laughing dove	*Spilopelia senegalensis*	≤ 1	no	Negligible	LC	Negligible	Negligible
Pharaoh eagle-owl	*Bubo ascalaphus*	>5 and ≤10	yes	High	LC	Negligible	Low
Hume's owl	*Strix butleri*	>10	yes	High	LC	Negligible	Low
Little owl	*Athene noctua*	≤ 1	no	Negligible	LC	Negligible	Negligible
Alpine swift	*Tachymarptis melba*	≤ 1	no	Negligible	LC	Negligible	Negligible
Woodchat shrike	*Lanius senator*	≤ 1	no	Negligible	LC	Negligible	Negligible
Masked shrike	*Lanius nubicus*	≤ 1	no	Negligible	LC	Negligible	Negligible
Brown-necked raven	*Corvus ruficollis*	≤ 1	yes	Low	LC	Negligible	Negligible
Common raven	*Corvus corax*	>10	no	High	LC	Negligible	Low
Greater hoopoe-lark	*Alaemon alaudipes*	≤ 1	no	Negligible	LC	Negligible	Negligible

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TABLE H4. CATEGORY 4, OTHER RESIDENT AND SUMMER BREEDING POPULATIONS – RELATIVE IMPORTANCE, VULNERABILITY AND SENSITIVITY SCORING *(continued)*

		RELATIVE IMPORTANCE SCORING			VULNERABILITY SCORING		ASSIGN SPECIES SENSITIVITY
SPECIES NAME	SCIENTIFIC NAME	APPROXIMATE MAXIMUM SHARE OF NATIONAL POPULATION USING TRWPP AREA (%)	BIOME RESTRICTED SPECIES IN DANA IBA	RELATIVE IMPORTANCE SCORE	IUCN REGIONAL RED LIST CATEGORY	VULNERABILITY SCORE	SENSITIVITY PER SPECIES POPULATION
Desert lark	*Ammomanes deserti*	≤ 1	yes	Low	LC	Negligible	Negligible
Bar-tailed lark	*Ammomanes cinctura*	≤ 1	yes	Low	LC	Negligible	Negligible
Wood lark	*Lullula arborea*	>10	no	High	LC	Negligible	Low
Crested lark	*Galerida cristata*	≤ 1	no	Negligible	LC	Negligible	Negligible
Temminck's lark	*Eremophila bilopha*	≤ 1	yes	Low	LC	Negligible	Negligible
Dunn's lark	*Eremalauda dunni*	≤ 1	no	Negligible	LC	Negligible	Negligible
White-spectacled bulbul	*Pycnonotus xanthopygos*	≤ 1	no	Negligible	LC	Negligible	Negligible
Pale crag-martin	*Hirundo obsoleta*	≤ 1	no	Negligible	LC	Negligible	Negligible
Streaked scrub-warbler	*Scotocerca inquieta*	≤ 1	yes	Low	LC	Negligible	Negligible
Graceful prinia	*Prinia gracilis*	≤ 1	no	Negligible	LC	Negligible	Negligible
Arabian babbler	*Turdoides squamiceps*	>10	yes	High	LC	Negligible	Low
Orphean warbler	*Sylvia hortensis*	>1 and ≤ 5	no	Low	LC	Negligible	Negligible
Arabian warbler	*Sylvia leucomelaena*	>10	no	High	LC	Negligible	Low
Spectacled warbler	*Sylvia conspicillata*	>1 and ≤ 5	no	Low	LC	Negligible	Negligible
Sardinian warbler	*Sylvia melanocephala*	≤ 1	yes	Low	LC	Negligible	Negligible
Tristram's starling	*Onychognathus tristramii*	>10	no	High	LC	Negligible	Low
Eurasian blackbird	*Turdus merula*	≤ 1	no	Negligible	LC	Negligible	Negligible

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TABLE H4. CATEGORY 4, OTHER RESIDENT AND SUMMER BREEDING POPULATIONS – RELATIVE IMPORTANCE, VULNERABILITY AND SENSITIVITY SCORING *(continued)*

		RELATIVE IMPORTANCE SCORING			VULNERABILITY SCORING		ASSIGN SPECIES SENSITIVITY
SPECIES NAME	SCIENTIFIC NAME	APPROXIMATE MAXIMUM SHARE OF NATIONAL POPULATION USING TRWPP AREA (%)	BIOME RESTRICTED SPECIES IN DANA IBA	RELATIVE IMPORTANCE SCORE	IUCN REGIONAL RED LIST CATEGORY	VULNERABILITY SCORE	SENSITIVITY PER SPECIES POPULATION
Blue rock-thrush	*Monticola solitarius*	≤ 1	no	Negligible	LC	Negligible	Negligible
Isabelline wheatear	*Oenanthe isabellina*	≤ 1	no	Negligible	LC	Negligible	Negligible
Hooded wheatear	*Oenanthe monacha*	≤ 1	no	Negligible	LC	Negligible	Negligible
Desert wheatear	*Oenanthe deserti*	≤ 1	no	Negligible	LC	Negligible	Negligible
Black-eared wheatear	*Oenanthe hispanica*	≤ 1	yes	Low	LC	Negligible	Negligible
Blackstart	*Cercomela melanura*	≤ 1	yes	Low	LC	Negligible	Negligible
White-tailed wheatear	*Oenanthe leucopyga*	≤ 1	no	Negligible	LC	Negligible	Negligible
Mourning wheatear	*Oenanthe lugens*	≤ 1	yes	Low	LC	Negligible	Negligible
Palestine sunbird	*Nectarinia osea*	≤ 1	no	Negligible	LC	Negligible	Negligible
House sparrow	*Passer domesticus*	≤ 1	no	Negligible	LC	Negligible	Negligible
Spanish sparrow	*Passer hispaniolensis*	≤ 1	no	Negligible	LC	Negligible	Negligible
Dead sea sparrow	*Passer moabiticus*	≤ 1	no	Negligible	LC	Negligible	Negligible
Pale rock sparrow	*Petronia brachydactyla*	>10	no	High	LC	Negligible	Low
Rock sparrow	*Petronia petronia*	≤ 1	no	Negligible	LC	Negligible	Negligible
Tawny pipit	*Anthus campestris*	>5 and ≤10	no	Moderate	LC	Negligible	Negligible
Long-billed pipit	*Anthus similis*	≤ 1	no	Negligible	LC	Negligible	Negligible
Trumpeter finch	*Bucanetes githagineus*	≤ 1	yes	Low	LC	Negligible	Negligible
Pale rosefinch	*Carpodacus synoicus*	≤ 1	no	Negligible	LC	Negligible	Negligible

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TABLE H4. CATEGORY 4, OTHER RESIDENT AND SUMMER BREEDING POPULATIONS – RELATIVE IMPORTANCE, VULNERABILITY AND SENSITIVITY SCORING (*continued*)

SPECIES NAME	SCIENTIFIC NAME	RELATIVE IMPORTANCE SCORING			VULNERABILITY SCORING		ASSIGN SPECIES SENSITIVITY
		APPROXIMATE MAXIMUM SHARE OF NATIONAL POPULATION USING TRWPP AREA (%)	BIOME RESTRICTED SPECIES IN DANA IBA	RELATIVE IMPORTANCE SCORE	IUCN REGIONAL RED LIST CATEGORY	VULNERABILITY SCORE	SENSITIVITY PER SPECIES POPULATION
European greenfinch	*Carduelis chloris*	≤ 1	no	Negligible	LC	Negligible	Negligible
Desert finch	*Rhodopechys obsoletus*	≤ 1	no	Negligible	LC	Negligible	Negligible
Eurasian linnet	*Carduelis cannabina*	≤ 1	no	Negligible	LC	Negligible	Negligible
European goldfinch	*Carduelis carduelis*	>10	no	High	EN	High	High
Syrian Serin	*Serinus syriacus*	>10	yes	High	EN	High	High
Corn bunting	*Miliaria calandra*	≤ 1	no	Negligible	LC	Negligible	Negligible
Ortolan bunting	*Emberiza hortulana*	>1 and ≤ 5	no	Low	NT	Low	Low
Cretzschmar's bunting	*Emberiza caesia*	≤ 1	no	Negligible	LC	Negligible	Negligible
Striolated bunting	*Emberiza striolata*	≤ 1	yes	Low	LC	Negligible	Negligible

Annex I. Calculating Likelihood of Effect for Migratory Soaring Birds and for Resident and Summer Breeding Raptors

INTRODUCTION

This annex describes the principal method used in step 3 of the CEA for birds (Section 3.4) to assess the cumulative likelihood of effect (LoE) of TRWPPs on migratory soaring birds (MSBs) (category 1 species populations) and resident and summer breeding raptors (category 2 species populations). Collision with turbine blades is assumed to be the only potentially significant adverse effect for both migrating and resident raptor populations within each WPP site. The method therefore provides **species-specific estimates of the annual likelihood of collision per individual bird for all the WPP sites included in this CEA study,** which are then used to rank the LoE between species. The annual likelihood of collision per individual is derived from (i) the predicted annual estimates of collision fatalities calculated using the "Band" Collision Risk Model (CRM);[63] (ii) the annual number of individuals passing through (MSBs), or using (breeding raptors) WPP sites; and (iii) an assumed estimate of the number of individual birds involved. The data used to conduct the analyses come from flight activity surveys conducted during the spring and autumn migration periods at WPP sites in the study area as part of the preconstruction baseline surveys. The output from this method provides a relative measure by which raptor populations can be ranked according to a level of effect. This measure is used as the principal evidence for determining priority birds within these two species population groups.

CATEGORY 1: MSB POPULATIONS – LOE

The principal LoE metric for MSBs is an estimate of the annual likelihood (in percent) of collision per individual passing through WPP sites with any of the TRWPP turbines. It has three components:

i. **Cumulative Collision Risk Estimate**: These are species-specific annual estimates (spring and autumn migration periods), using CRM results from preconstruction baseline studies at each WPP, of the predicted number of fatalities if all five wind farms were operational. To obtain this figure estimates from individual WPPs were combined. Where more than one CRM estimate was available for a specific WPP, an average of those estimates was used. All CRM analyses were reviewed by Natural Research Projects Ltd to ensure that they were correctly conducted at each WPP. As a consequence, some CRM results were omitted from the LoE analysis. Results from the following WPPs were used: Tafila, spring and autumn 2013; LAMSA, autumn 2014 and spring 2015; KOSPO, spring 2015; Fujeij, spring 2014; and Abour Energy, spring 2015.

ii. **Estimated Number of Birds Flying Through TRWPP Study Area Annually**: These are species-specific annual estimates (spring and autumn migration periods) of the number of birds flying through the WPP sites using the results from the preconstruction baseline flight activity surveys. Estimates were derived from the number of flights recorded, corrected to account for the proportion of time during the spring and autumn migration periods when surveys were not taking place.

[63] For details on the "Band" CRM method for estimating annual collision fatality estimates, see Section 2.3.3.

iii. **Number of Individuals:** It is possible that MSBs recorded at WPPs during a spring and an autumn migration period (i.e., annually) are all different individuals. However, it is likely that some individuals may pass through more than one of the wind farms within the TRWPP area during the course of a year (e.g., either passing through more than one WPP site during the same migration or passing through a site again on the return migration). In an attempt to account for this in the LoE estimate, it is assumed that on average each individual passes through two individual wind farm areas in a year. For example, if there were 1,000 birds of a particular species recorded passing through the wind farms annually, it is assumed this would equate to 500 individuals.

The *annual likelihood (per individual) of colliding with TRWPP turbines*, expressed as a percentage, was calculated for MSB populations using the method indicated in Table I1.

TABLE I1. ANNUAL LIKELIHOOD OF COLLIDING WITH TRWPP TURBINES – LOE METHOD FOR MSB POPULATIONS (CATEGORY 1)

	METRIC A	METRIC B	METRIC C	
SPECIES	ESTIMATED NO. OF BIRDS FLYING THROUGH WPP SITES DURING SIX MIGRATION MONTHS, THREE IN SPRING, THREE IN AUTUMN	ASSUME EACH BIRD FLIES THROUGH ONLY TWO WIND FARMS; THEREFORE DIVIDE METRIC A BY 2	CUMULATIVE CRM ESTIMATE OF THE PREDICTED ANNUAL NUMBER OF FATALITIES BASED ON SURVEY DATA FOR SIX MIGRATION MONTHS (THREE IN SPRING, THREE IN AUTUMN)	ANNUAL LIKELIHOOD PER INDIVIDUAL OF COLLIDING WITH TRWPP TURBINES METRIC C DIVIDED BY METRIC B X 100 (%)
e.g., *Egyptian vulture*	181	90.5	0.071	0.08

The annual probability of an individual colliding with TRWPP turbines for each species population was assigned to one of four categories: Negligible (< 0.05 percent), Low (> 0.05 and ≤ 0.1 percent), Medium (> 0.1 and ≤ 1 percent) and High (> 1 percent). Category divisions were informed by the distribution of values across all MSB and breeding raptor species in step 3 (Figure I1).

The reliability of the collision risk estimate depends on how representative the sample flight activity data is of the flight activity during the lifetime of the wind farm. It also depends on the accuracy of the assumptions used in the model, most notably the proportion of occasions that a bird faced with collision avoids the turbines (collision avoidance rate).[64] For these reasons there will be uncertainty surrounding a single value for a collision risk estimate. Furthermore, the model is unable to generate realistic confidence limits around the collision risk estimate. Recognizing this, each estimate was compared with the broader trends analysis (see Annex E). Where the trends analysis indicated that the *annual probability of an individual of colliding with TRWPP turbines* may be higher than the calculated CRM results suggested, the LoE was increased by one category level (e.g., from negligible to low) as a precautionary measure. Finally, the LoE category determined by the CRMs and the trends analysis was reviewed by the ERP together with ornithologists on the CEA team, to identify any relevant factors not otherwise captured (see Section 3.4.1).

[64] For more details, see Madders and Whitfield (2006).

CATEGORY 2: RESIDENT AND SUMMER BREEDING RAPTOR POPULATIONS – LOE

As for MSBs, the LoE for resident and summer breeding raptors is the annual likelihood (in percent) per individual using a WPP site of collision with any of the TRWPP area turbines. It is calculated using the following components:

i. **Cumulative Collision Risk Estimate:** This estimate uses species-specific CRM results from preconstruction baseline studies at the five WPP sites as derived from the Band model. The CRM estimates for each species are combined to obtain the predicted annual number of fatalities if all five wind farms were operational. These estimates are calculated for the six-month period during which survey data were collected (i.e., spring and autumn migration periods). To correct these estimates, this initial CRM estimate was multiplied by two (2 x 6 months) for year-round residents, corresponding to exposure to collision risk for 12 months and by 1.5 for summer breeding raptors, corresponding to exposure to collision risk for approximately 9 months of the year.

ii. **Assumed Number of Resident and/or Summer Breeding Individuals Sharing Collision Risk:** As with MSBs, the estimate of collision risk to an individual resident or summer breeding raptor requires information on the number of individuals exposed to the risk. Unlike MSBs, which tend to transit through WPP sites, it is likely that both resident and summer breeding raptor individuals will be exposed to a collision risk on multiple occasions a year (i.e., an individual may fly within the TRWPP area many times a year). No survey information is available to track individuals; therefore, an estimate of the number of individuals exposed to the risk of collision is based on the number of individuals likely to be present within species-specific foraging ranges of the WPP sites. This is an approximate and precautionary estimate of the number of breeding adults and young birds likely to use WPPs for foraging and other activities, and is guided by breeding survey information and expert opinion provided by the ERP.

The *annual likelihood (per individual) of colliding with TRWPP turbines*, expressed as a percentage, was calculated for resident and summer breeding raptor populations using the method indicated in Table I2.

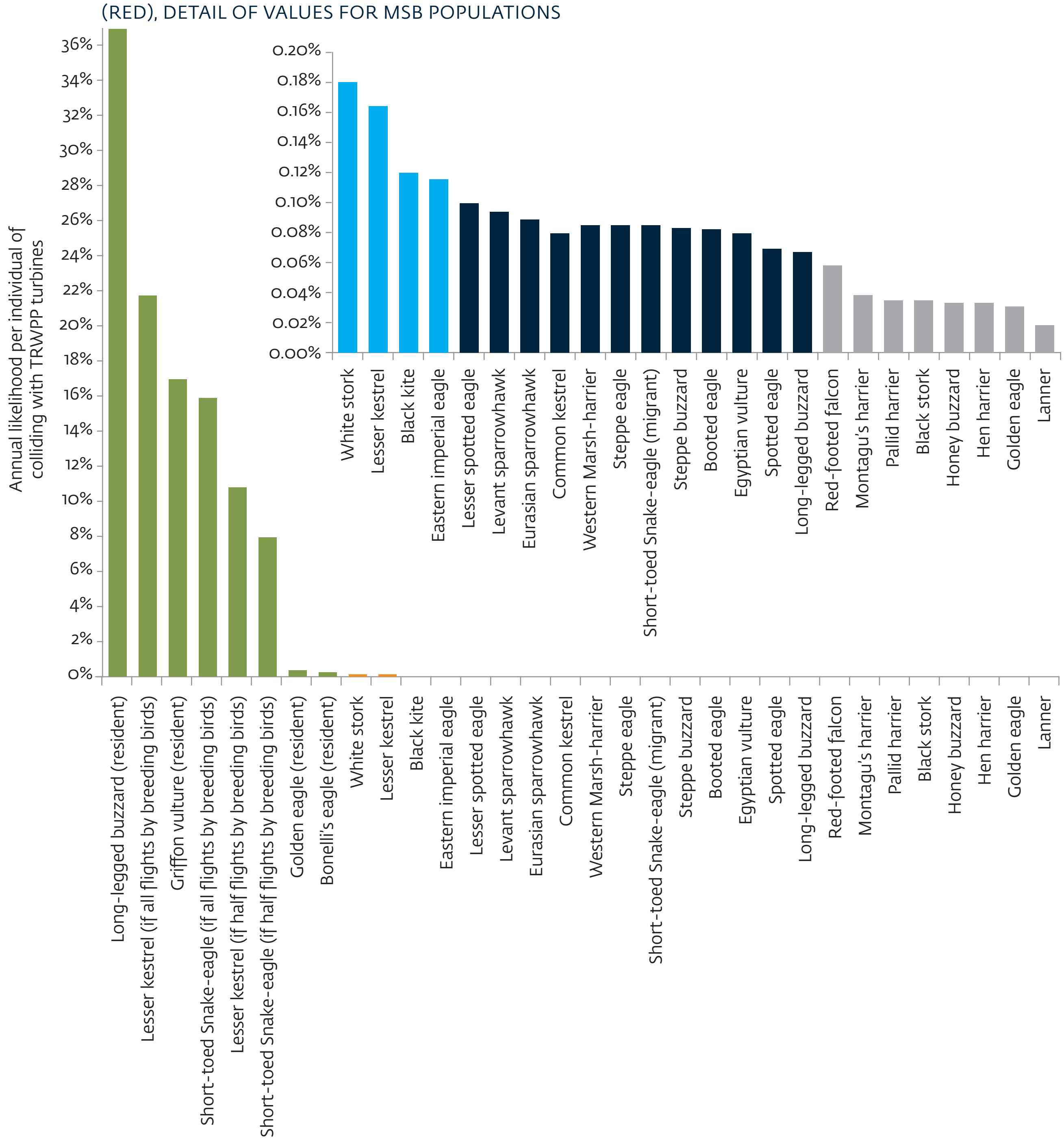
TABLE I2. ANNUAL LIKELIHOOD OF COLLIDING WITH TRWPP TURBINES – LOE METHOD FOR RESIDENT AND SUMMER BREEDING RAPTORS (CATEGORY 2)

	METRIC A	METRIC B	METRIC C	ANNUAL LIKELIHOOD PER INDIVIDUAL OF COLLIDING WITH TRWPP TURBINES (%)
SPECIES	ASSUMED NO. OF RESIDENT INDIVIDUALS SHARING COLLISION RISK	CUMULATIVE CRM ESTIMATE OF THE PREDICTED NUMBER OF FATALITIES BASED ON SURVEY DATA FROM SIX MIGRATION MONTHS	MODIFIED CUMULATIVE CRM VALUE—TO ACCOUNT FOR COLLISIONS OF RESIDENT AND SUMMER BREEDERS THAT OCCUR OUTSIDE THE SIX-MONTH SURVEY PERIOD: EITHER 1.5 OR 2 TIMES THE VALUE OF METRIC B[a]	METRIC C/ METRIC A X 100
e.g., Griffon vulture	30	2.542	5.084	16.9

a. For year-round residents, the annual risk is assumed to be twice the estimated risk value for the combined migration seasons (six months). For summer residents and/or breeders, the annual risk is assumed to be 1.5 times the estimated risk value for the combined migration seasons. Average flight activity and flying height outside the migration seasons are assumed to be the same during the migration season.

The annual likelihood of an individual colliding with TRWPP turbines for each species population was assigned to categories (negligible, low, medium, and high) based on the range values in Figure I1. As with MSBs, the trends analysis and a review by the ERP were used to adjust the LoE category rating where appropriate (see Section 3.4.1).

FIGURE I1. ANNUAL LIKELIHOOD (%) PER INDIVIDUAL OF COLLISION WITH TWRPP TURBINES, DISTRIBUTION OF VALUES AND ASSIGNED CATEGORIES: NEGLIGIBLE (BLUE), LOW (GREEN), MODERATE (YELLOW), HIGH (RED), DETAIL OF VALUES FOR MSB POPULATIONS



Annex J. CEA for Birds Results: Step 3 – Likelihood of Effect and Final Risk Rating

TABLE J1. CATEGORY 1, MIGRATORY SOARING BIRD POPULATIONS—LIKELIHOOD OF EFFECT AND FINAL RISK RATING

SPECIES NAME	SPECIES SCIENTIFIC NAME	SENSITIVITY SCORE FROM STEP 2	LIKELIHOOD OF EFFECT (LOE)						ASSIGNED RISK RATING FOR EACH SPECIES POPULATION
			METRIC A ESTIMATED NO. OF RECORDS OF INDIVIDUAL BIRDS AT FIVE WPP SITES PER YEAR (SPRING AND AUTUMN MIGRATIONS[a]	METRIC B ESTIMATED NO. OF INDIVIDUALS AT RISK (DERIVED FROM METRIC A)[b]	METRIC C NO. OF PREDICTED FATALITIES PER YEAR (SPRING AND AUTUMN MIGRATIONS) AT TRWPP[c]	ANNUAL LIKELIHOOD OF COLLISION AT TRWPP PER INDIVIDUAL (%) METRIC C/ METRIC B X 100	LOE PRE-ADJUSTMENT SCORE BASED ON ANNUAL LIKELIHOOD OF COLLISION AT TRWPP PER INDIVIDUAL	ADJUSTMENT OF LOE SCORE BASED ON TRENDS ANALYSIS AND/ OR EXPERT REVIEW (NO. OF LEVELS BY WHICH LOE ADJUSTED)	
Common crane[d]	*Grus grus*	Medium					Negligible	0	Negligible
Black stork	*Ciconia nigra*	High	787	393	0.13	0.03	Negligible	0	Minor
Osprey[d]	*Pandion haliaetus*	Low					Low	0	Minor
European honey-buzzard	*Pernis apivorus*	Low	65,753	32,877	10.59	0.03	Negligible	0	Negligible
Egyptian vulture	*Neophron percnopterus*	High	181	90	0.07	0.08	Low	0	Moderate
Short-toed snake-eagle	*Circaetus gallicus*	Low	2,023	1,011	0.85	0.08	Low	+1	Minor
Lesser spotted eagle	*Clanga pomarina*	Low	260	130	0.13	0.10	Low	0	Minor
Steppe eagle	*Aquila nipalensis*	Low	2,302	1,151	0.97	0.08	Low	+2	Moderate
Eastern imperial eagle	*Aquila heliaca*	High	191	96	0.11	0.12	Medium	0	Major
Booted eagle	*Hieraaetus pennatus*	Medium	170	85	0.05	0.06	Low	+1	Moderate
Western marsh-harrier	*Circus aeruginosus*	Low	247	123	0.10	0.08	Low	0	Minor
Hen harrier	*Circus cyaneus*	Medium	67	33	0.00	0.01	Negligible	0	Minor
Pallid harrier	*Circus macrourus*	Low	341	170	0.06	0.03	Negligible	0	Minor
Montagu's harrier	*Circus pygargus*	Low	169	84	0.03	0.04	Negligible	0	Negligible
Levant sparrowhawk	*Accipiter brevipes*	Medium	14,060	7,030	6.60	0.09	Low	0	Minor
Black kite	*Milvus migrans*	Low	2,602	1,301	1.54	0.12	Medium	0	Minor
Steppe buzzard	*Buteo buteo vulpinus*	Low	72,108	36,054	29.84	0.08	Low	0	Minor
Lesser kestrel	*Falco naumanni*	Low	5,326	2,663	4.34	0.16	Medium	0	Minor
Common kestrel	*Falco tinnunculus*	Medium	978	489	1.68	0.08	Low	0	Minor
Lanner falcon	*Falco biarmicus*	Low	23	12	0.00	0.02	Negligible	0	Negligible

Note: Priority bird VECs outlined in red.

[a] This is an estimate of the total number of individual birds recorded passing through the five WPP sites per year (spring and autumn migrations), corrected for periods during the migration periods when no surveys occurred. The figure does not account for the possibility that the same individuals were recorded at more than one WPP or that the same individuals are recorded in both spring and autumn migrations.

[b] Some individuals may pass through more than one WWP site as they pass through the TRWPP area and/or the same individual may pass over the TRWPP area twice in the same year—once during the spring migration and then again in the autumn. For the purpose of assessing the LoE, it was assumed that on average the same individual was recorded twice during the course of a year at the TRWPP sites. Therefore, the estimate of the total number of individual bird records (Metric A) was halved to estimate the number of individual birds at risk.

[c] Total number of predicted fatalities per year (based on spring plus autumn migration monitoring) at all WPP sites calculated by averaging the annual CRM fatality estimate for each WWP site and then summing the resulting five WPP site CRM estimates.

[d] No collision risk model estimates—LoE per individual determined by the ERP.

TABLE J2. CATEGORY 2, RESIDENT AND SUMMER BREEDING RAPTOR POPULATIONS—LIKELIHOOD OF EFFECT AND FINAL RISK RATING

			LIKELIHOOD OF EFFECT (LOE)							
SPECIES NAME	SPECIES SCIENTIFIC NAME	SENSITIVITY SCORE FROM STEP 2	METRIC A ESTIMATED NO. OF INDIVIDUALS USING TRWPP SITES (ESTIMATE BASED ON EXPERT OPINION)[a]	METRIC B NO. OF PREDICTED FATALITIES PER YEAR BASED ON MONITORING DURING SPRING AND AUTUMN MIGRATION (FROM COLLISION RISK MODEL)[b]	METRIC C ADJUSTMENT FACTOR FOR METRIC B TO ACCOUNT FOR EXTENDED PRESENCE OF RESIDENT AND SUMMER POPULATIONS	METRIC D ADJUSTED NO. OF PREDICTED FATALITIES PER YEAR USING METRIC B X METRIC C	ANNUAL LIKELIHOOD OF COLLISION AT TRWPP PER INDIVIDUAL METRIC D/ METRIC A X 100 (%)	LOE PRE-ADJUSTMENT SCORE, BASED ON ANNUAL LIKELIHOOD OF COLLISION AT TRWPP PER INDIVIDUAL	ADJUSTMENT OF LOE SCORE BASED ON TRENDS ANALYSIS AND/ OR EXPERT REVIEW (NO. OF LEVELS BY WHICH LOE WAS ADJUSTED)	ASSIGNED RISK RATING FOR EACH SPECIES POPULATION
Short-toed snake-eagle	*Circaetus gallicus*	High	8	0.847	1.5	1.27	15.89	High	+1	Major
Griffon vulture	*Gyps fulvus*	High	30	2.542	2	5.08	16.95	High	0	Major
Golden eagle	*Aquila chrysaetos*	High	8	0.016	2	0.03	0.41	Medium	0	Major
Verreaux's eagle[d]	*Aquila verreauxii*	High						Low	0	Moderate
Bonelli's eagle	*Aquila fasciata*	High	8	0.014	2	0.03	0.34	Medium	0	Major
Long-legged buzzard	*Buteo rufinus*	Low	8	1.477	2	2.95	36.92	High	0	Moderate
Lesser kestrel	*Falco naumanni*	Medium	30	4.340	1.5	6.51	21.70	High	0	Major
Sooty falcon[d]	*Falco concolor*	Medium						Low	0	Minor
Barbary falcon[d]	*Falco pelegrinoides*	Medium						Low	0	Minor

Note: Priority bird VECs outlined in red.

[a] Unlike in MSB populations, the number of individual resident and summer breeding raptors at risk of collision cannot be estimated from the number of birds transiting through TRWPP sites because resident and/or summer breeding raptor populations may repeatedly visit WPP sites for foraging and other activities. To know the actual number of individuals of these populations would require that birds be individually identifiable, which they are not. Therefore the number of individuals of each category 2 species was an estimate of the number of breeding adult, immature, and juvenile birds considered likely to be using the wind farm areas for foraging and other activities, on the basis of expert knowledge of the number of pairs likely to be breeding in the area.

[b] Total number of predicted fatalities per year (based on spring plus autumn migration monitoring) at all WPP sites calculated by averaging the annual CRM fatality estimate for each WWP site and then summing the resulting estimates for the five WPP sites.

[c] All collision risk estimates are based on monitoring that took place only during the spring and autumn migration periods. To estimate the predicted number of fatalities for resident or summer breeding populations, the collision risk estimates were adjusted to take account of the extended period that these populations were potentially exposed to collision risk from TRWPP turbines. For summer breeding populations, the sum of the spring and autumn collision risk was multiplied by 1.5 to account for risk during the summer period. For resident populations, the figure for the six months of spring and autumn collision risk was multiplied by 2 to account for risk during the six months outside the migration period.

[d] No collision risk model estimates—LoE per individual determined by the ERP.

CATEGORY 3, OTHER MIGRANTS AND/OR WINTERING BIRD POPULATIONS—LOE AND FINAL RISK RATING

All species populations in this category were scoped out in step 2.

TABLE J3. CATEGORY 4, OTHER RESIDENT AND SUMMER BREEDING POPULATIONS—LIKELIHOOD OF EFFECT AND FINAL RISK RATING

SPECIES NAME	SPECIES SCIENTIFIC NAME	SENSITIVITY SCORE FROM STEP 2	LIKELIHOOD OF EFFECT (LOE) (ANNUAL LIKELIHOOD PER INDIVIDUAL OF COLLISION; BASED ON EXPERT REVIEW)	ASSIGNED RISK RATING FOR EACH SPECIES POPULATION
Chukar	*Alectoris chukar*	Low	Negligible	Negligible
Hume's owl	*Strix butleri*	Low	Negligible	Negligible
Pharaoh eagle-owl	*Bubo ascalaphus*	Low	Low	Minor
Common raven	*Corvus corax*	Low	Moderate	Minor
Wood lark	*Lullula arborea*	Low	Negligible	Negligible
Arabian warbler	*Sylvia leucomelaena*	Low	Negligible	Negligible
Arabian babbler	*Turdoides squamiceps*	Low	Negligible	Negligible
Tristram's starling	*Onychognathus tristramii*	Low	Low	Minor
Pale rock sparrow	*Petronia brachydactyla*	Low	Low	Minor
Syrian Serin	*Serinus syriacus*	High	Low	Moderate
European goldfinch	*Carduelis carduelis*	High	Low	Moderate
Ortolan bunting	*Emberiza hortulana*	Low	Low	Minor

Note: Priority bird VECs outlined in red.

Annex K. Threshold Setting: Determining Estimates of Fatalities from External Stressors and Defining Thresholds for Priority Bird Populations

This annex describes the process used in step 4 of the CEA Framework for birds (see Section 3.5) to estimate the annual number of bird fatalities[65] resulting from the effects of external stressors. This estimate was used to help assess whether each of the priority bird populations is likely to be viable in the long term. It was also used in the process of determining an appropriate threshold for each priority bird population.

In the CEA, external stressors are human-derived non-TRWPP effects; for example, illegal killing, power line electrocution, and taking of live birds from the wild. Quantitative information on the number of individuals affected by these external stressors is geographically patchy and/or largely nonexistent for both Jordan and the Rift Valley/Red Sea flyway. As a consequence, the CEA relied on expert opinion from the ERP to estimate annual losses from external stressors.

OBTAINING ANNUAL FATALITY ESTIMATES FOR EXTERNAL STRESSORS FROM THE ERP

The ERP was provided with a table that included for each priority bird population the annual fatality rate from the PBR[66] analysis, the cumulative annual fatality rate for all TRWPPs, and blank cells to provide estimates of annual fatalities from three component external stressors and the combined effect of all external stressors. Component external stressors were those considered by the ERP to be most relevant to priority bird populations (see the example in Table K1).

TABLE K1. EXTRACT FROM TABLE OF INFORMATION USED TO DETERMINE ANNUAL LOSSES DUE TO EXTERNAL STRESSORS AND TO DETERMINE THRESHOLDS FOR PRIORITY BIRDS

SPECIES	PBR RESULT (FATALITIES PER YEAR)	TRWPP COLLISION RISK (FATALITIES PER YEAR)	EXTERNAL STRESSOR COMPONENT (FATALITIES PER YEAR)			CUMULATIVE EFFECT OF EXTERNAL STRESSORS (FATALITIES PER YEAR)	EXPERT OPINION ON THRESHOLD (ZERO FATALITIES OR PVA NEEDED)
			POWER LINE ELECTROCUTION AND/OR COLLISION	ILLEGAL KILLING	COLLECTION OF LIVE BIRDS OF PREY		
e.g., Egyptian vulture	5.2	0.07	≥ 1 to < 5	≥ 1 to < 5	≥ 1 to < 5	≥ 1 and < 5	Zero fatality

[65] In the context of external stressors, the term *fatalities* includes the capture and keeping of live birds.
[66] **Potential Biological Removal** analysis is a simple, robust, and precautionary test developed for situations in which information on species population biology is limited (see Wade, 1998; Neil and Lebreton, 2005; Dillingham and 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.

CATEGORIES USED TO ESTIMATE FATALITY RATES

For each external stressor component, the ERP was asked to collectively agree and assign, to one of four categories, the annual number of fatalities estimated to be likely within the relevant UoA[67] population (see Table K2). The ERP was also asked to estimate cumulative fatalities from all external stressors without specifically referring to the component scores. This cumulative fatality estimate was included as an informal check to see if perceptions of overall loss were being over- or underestimated by using only the component results.

TABLE K2. CATEGORIES FOR ANNUAL NUMBER OF FATALITIES

NUMBER OF FATALITIES PER YEAR
≥ 10
≥ 5 and < 10
≥1 and < 5
< 1

Where the cumulative fatality category agreed with the minimum number of fatalities from the component stressors, the cumulative effects category was used to inform threshold setting. This is the case in the example in Table K1, where the minimum number of losses estimated for the component stressors is 1 + 1 + 1 = 3, which is within the range assigned to the cumulative number of losses (≥ 1 but < 5 per year). Where this was not the case, ornithologists on the CEA team reviewed the external stressor estimates with the ERP to better understand the reasons for the discrepancy and, where necessary, revised the appropriate category rating.

DEFINING THRESHOLDS FOR EXTERNAL STRESSORS USING THE ERP

For each priority VEC, the ERP was asked to use the *cumulative effect of external stressors* category score plus the annual TRWPP collision rate to estimate the combined number of annual fatalities. The ERP was also asked to factor into the assessment any species-specific external stressors not accounted for by the three principal external stressor components. The ERP compared this assessment against the annual number of fatalities given by the PBR analysis to inform the final decision on a threshold target. A *zero fatality threshold target* was automatically assigned if the cumulative fatalities from the three principal external stressors plus the TRWPP estimate exceeded the PBR. In addition, the ERP recommended a *zero fatality threshold target* if the *cumulative effect of external stressors* category score plus the annual TRWPP collision rate was sufficiently close to the PBR that, taking account of any additional species-specific external stressors or other uncertainties, no WPP-related mortality was possible without a likely adverse effect on the long-term viability of the population.

If the assessment of annual fatalities was likely to be below the PBR level, even after any additional species-specific uncertainties were accounted for, the ERP had the option to recommend a more complex PVA. This was used to assess future population trends under different wind farm and external stressor mortality scenarios to determine whether a *zero fatality* or *annual fatality threshold* was most appropriate and to inform the setting of any *annual fatality threshold targets*.

[67] For category 1 priority birds, the UoA population is the Rift Valley/Red Sea flyway population. For resident and summer breeding priority birds, the UoA is the national population estimate.

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