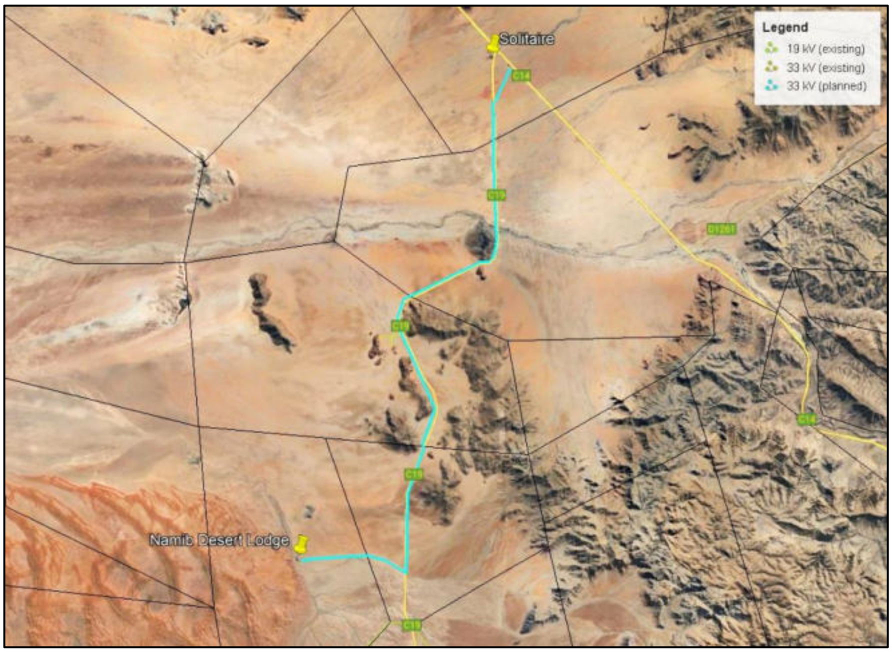
Environmental Impact Assessment for the Naukluft Electricity 33 kV power line, Solitaire to Namib Desert Lodge, Karas Region, Namibia

Avifauna baseline/scoping and assessment



Prepared by:

African Conservation Services cc

Prepared for:

Green Earth Environmental Consultants

12 April 2024

Name of project	**Environmental Impact Assessment for the Naukluft Electricity 33 kV power line, Solitaire to Namib Desert Lodge, Karas Region, Namibia** **Avifauna baseline/scoping and assessment**
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Executive summary

Background

Naukluft Electricity Investments Pty Ltd intends to expand its 33 kV overhead power line network by constructing a new 33 kV distribution line 36 km long, to link Namib Desert Lodge with its existing 33 kV line at Solitaire, in the Hardap Region of Central Namibia. The new line will be running parallel to the existing 19 kV distribution line currently servicing customers in the area.

Green Earth Environmental Consultants have been appointed by NEI to attend to and complete an Environmental Impact Assessment (EIA) and Environmental Management Plan (EMP) in order to obtain an Environmental Clearance Certificate (ECC) for the construction of the new overhead power line. The proposed power line presents a potential risk to birds, including collisions and electrocutions. The present avifauna baseline/scoping and assessment for the new 33 kV power line therefore forms part of the above EIA.

Power line structure

For the new 33 kV power line, a horizontal line post compact delta (HLPCD) structure will be used. The single wooden monopole is 9.2 m high above ground level and the average ruling span between poles is 120 m. The line will be strung with three "rabbit" conductors, suspended 800 mm one above the other but in staggered "delta" (offset) configuration, each resting on an insulator. The intermediate poles do not have stay wires. Each of the above pole structures is earthed by means of a galvanised wire running vertically from the ground to the top of the pole. It is standard practice to provide an "air space safety gap", whereby the earth wire on each pole stops 300 mm below the lowest conductor phase, in order to reduce the electrocution risk.

Potential sensitivities: habitat

According to the avifauna baseline and scoping of sites and species, the study area is potentially sensitive in terms of birds and their habitats.

The area lies in the Namib Desert, in close proximity to the nearest formally protected area, the extensive Namib Naukluft Park, which is also recognised as an Important Bird Area and Key Biodiversity Area. As part of the park, the Namib Sand Sea is a proclaimed World Heritage Site. The area also falls within the Greater Sossusvlei-Namib Landscape, a landscape-level conservation initiative (https://www.landscapes namibia.org/sossusvlei-namib/). The greater area also includes several smaller private nature reserves, including the Gondwana Namib Park.

The area falls within the Namib Plains Landscape. Major topographical features of the greater study area include the extensive dune fields of the Namib Sand Sea; the Naukluft mountains, part of the high-rising escarpment that marks the western edge of the interior highlands of Namibia; and ephemeral rivers. The area falls into the Nama Karoo Biome, and the vegetation type is classed as Nama Karoo, a desert/dwarf shrub transition.

The avifauna habitats in the study area include:

- Sandy plains with sparse grass
- Rocky hills/mountains
- Ephemeral drainage lines/watercourses and riverine habitats associated with the Tsondab River catchment
- Extensive dune fields, including sand dunes and ancient, fossilised dunes.

Potential sensitivities: birds

A relatively moderate-high bird species richness has been recorded in the study area and surrounds, with a total of 207 species, or 31% of the 676 species currently recorded in Namibia. The area is well atlased.

The checklist includes 14 species (7% of the total) that are threatened in Namibia (and comprising 20% of the 71 species on the Namibian Red Data List); nine of the 14 species are also Globally Threatened; one species that is a full Namibian endemic (with 100% of the population in this country), and five other species that are near-endemic to Namibia (with at least 90% of the populations occurring within the country); one large terrestrial bird species and four raptors with migrant status.

Risk assessment and mitigation efforts are directed towards priority species, namely those that have a high biological significance, i.e. primarily Red Data species (including those with migrant status) and/or endemic or near-endemic species.

Fifty-three potential priority species were initially identified as being at risk in terms of the proposed project. A total of 21 priority bird species was then short-listed, based on the likelihood of their occurrence in the study area. Although the focus of the impact assessment is on the short-listed species, the full priority list also needs to be taken into account due to the high species numbers and the difficulty in predicting those likely to be impacted. The emphasis should be on groups of birds likely to be at risk, rather than on individual species; and the precautionary principle should prevail.

Details of priority species

The details of the 21 short-listed priority species and their sensitivities are as follows:

Red Data species and migrant raptors (4)

- Lappet-faced Vulture (Endangered, also Globally Endangered; scavenging raptor, congregatory; resident, with extensive movements in non-breeding birds; power line-prone; local abundance high)
- White-backed Vulture (Critically Endangered, also Globally Critically Endangered; scavenging raptor, congregatory; resident, with large-scale movements, especially in juveniles; power line-prone; local abundance high)
- Ludwig's Bustard (Endangered, Globally Endangered; southern African near-endemic [40% of population in Namibia]; large terrestrial bird; local movements, nomadic [sometimes in large groups of up to 100 birds in the Namib], partial migrant; highly collision-prone; local abundance high)
- Martial Eagle (Endangered, also Globally Endangered; raptor, resident; power line-prone; local abundance medium-high)

Species near-endemic to Namibia (1)

- Rüppell's Korhaan (near-endemic to Namibia; sedentary/nomadic; power line-prone; local abundance high)

Other non-Red Data raptor species that are power line-prone (11)

- Black-chested Snake Eagle (resident, nomadic; local abundance high)
- Southern Pale Chanting Goshawk (southern African near-endemic [30% of population in Namibia]; resident; sedentary, with local movements; electrocution-prone; local abundance high)
- Greater Kestrel (resident; local abundance high)
- Rock Kestrel (resident; local abundance high)

- Lanner Falcon (resident + migratory populations; local abundance high)
- Pygmy Falcon (resident, uses nests of Sociable Weavers; local abundance high)
- Augur Buzzard (resident, nomadic; local abundance medium-high)
- Jackal Buzzard (southern African near-endemic [<5% of population in Namibia]; mostly sedentary; local abundance medium-high)
- Spotted Eagle-Owl (resident; local abundance medium-high)
- Red-necked Falcon (resident, nomadic; local abundance medium-high)
- Pearl-spotted Owlet (resident; local abundance medium-high)

Other (larger) terrestrial bird species that are power line-prone (5)

- Namaqua Sandgrouse (southern African near-endemic [45% of population in Namibia]; resident, nomadic, partial migrant; local abundance high)
- Double-banded Sandgrouse (southern African near-endemic [35% of population in Namibia]; resident, nomadic, (partial) migrant; local abundance high)
- Helmeted Guineafowl (local abundance high)
- Common Scimitarbill (local abundance high)
- Rosy-faced Lovebird (southern African near-endemic [80% of population in Namibia]; local abundance high)

Other (mostly non-priority) species with the potential to cause impacts on infrastructure

Several other (mostly non-priority) bird species have the potential to impact on power line structures through their perching, nesting and other activities, which may impact on the power supply. All breed readily on artificial structures, including (distribution) power line infrastructure, especially in view of the scarcity of suitable tall trees in the environment.

Examples include:

- Pied Crow (local abundance high; potential to increase in numbers, attracted by human activity/ novel resources)
- Cape Crow (local abundance medium-high)
- Sociable Weaver (local abundance high, likely to be seasonal)

Summary of priority bird species

The above total of 21 short-listed priority bird species include the following groups:

- 4 Red Data species (1 Critically Endangered, 3 Endangered; 3 species also Globally Endangered; 1 species partial migrant)
- 1 species near-endemic to Namibia

The above species also fall into the following groups:

- 14 raptor species (3 Red Data; 11 other non-Red Data priority raptor species)
- 7 large terrestrial bird species (one Red Data; one Namibian near-endemic; 5 other terrestrial species)

In addition: 3 other (non-priority) species with the potential to cause impacts on infrastructure (not included in the above totals)

Potential impacts

Potential impacts from the development may be summarised as follows:

- Physical/human disturbance of birds, including noise andlight disturbance
  - Rated as LOW-VERY LOW, and INSIGNIFICANT post-mitigation
- Direct and indirect modification/loss/destruction of bird habitat
  - Rated as LOW, and VERY LOW post-mitigation
- Bird collisions with power line infrastructure
  - Rated as MEDIUM-HIGH, and MEDIUM-LOW post-mitigation
- Bird electrocutions on power line infrastructure
  - Rated as MEDIUM, and LOW post-mitigation
- Attraction of birds to novel habitats through the artificial provision of scarce resources
  - Rated as MEDIUM; no mitigation recommended, but adaptive management is required.

Cumulative impacts are an important consideration.

Mitigation and monitoring

Mitigation measures are aimed at avoiding, minimising or rehabilitating negative impacts or enhancing potential benefits. As the main potential impacts identified are bird collisions and electrocutions on power line structures, it is believed that these risks can be reduced by appropriate mitigation.

Recommended measures include the marking of more sensitive sections of power line with bird flight diverters to increase visibility, at identified sites and according to a specified design. Standard mitigations against electrocution are also recommended, including the insulation of live components.

Recommendations are made to reduce the impacts of physical disturbance to birds, and the destruction/modification of bird habitats, as well as road mortality and poaching of birds during the construction of the power lines.

Detailed monitoring initiatives are recommended that should be conducted by the proponent, with the support of landowners/managers and other partners.

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Abbreviations, acronyms and glossary of terms

AEWA	African-Eurasian Migratory Waterbird Agreement	
BFD	Bird Flight Diverter	
CBD	Convention on Biological Diversity	
CMS	Convention on Migratory Species	
DEA	Department of Environment Affairs	
ECB	Electricity Control Board	
ECC	Environmental Clearance Certificate	
EIA	Environmental Impact Assessment	
EIS	Environmental Information Service	
EMA	Environmental Management Act	
EMP	Environmental Management Plan	
Endemic	Occurring within a restricted range	
Endemic status categories		
	E = endemic, NE = near-endemic, sA = southern Africa, Nam = Namibia	
HLPCD	horizontal line post compact delta (distribution line structure)	
IBA	Important Bird Area	
IUCN	International Union for the Conservation of Nature	
IUCN Red List Categories		
	LC	Least Concern
	NT	Near Threatened
	VU	Vulnerable
	EN	Endangered
	CR	Critically Endangered
	EW	Extinct in the Wild
	EX	Extinct
	G	Global status
kV	kilovolt	
MEFT	Ministry of Environment, Forestry and Tourism	
NAD	Namibian Avifaunal Database	
NEI	Naukluft Electricity Investments Pty Ltd	
NNF	Namibia Nature Foundation	
OPGW	Optical ground wire (earth wire): a type of cable used in overhead power lines, combining the functions of communications and grounding/earthing	
ORM	Operating and reporting manual (ECB)	
Pentad	A 5-minute x 5-minute coordinate grid super-imposed over the continent for spatial reference; nine pentads make up one Quarter Degree Square	
Power line interaction categories		
	C = collision, D = disturbance, E = electrocution, H = habitat destruction, N = potential to disrupt the power supply through nesting and other activities	
QDS	quarter degree square	
Residency	R = resident, N = nomadic, M = migrant, V = vagrant; Ra = rare	
SABAP	Southern African Bird Atlas Project (SABAP1 & SABAP2)	
S/S	Substation	
SWER	Single Wire Earth Return (distribution line structure)	

Expertise and declaration of independence

Dr Ann Scott and Mike Scott of African Conservation Services cc are independent consultants subcontracted by Green Earth Environmental Consultants. We are registered Ordinary Member Practitioners and Environmental Manager with the Environmental Assessment Practitioners Association of Namibia (EAPAN; https://eapan.org/) and uphold its Code of Conduct. We have no business, financial, personal or other interest in the activity, application or appeal in respect of which we were appointed, other than fair remuneration for work performed in connection with the activity, application or appeal. There are no circumstances that compromise our objectivity as a specialist in performing such work.

Name of specialist: African Conservation Services cc

Representatives:

Dr HA Scott RM Scott

Date: 12 April 2024

1 Background

1.1 Introduction

Naukluft Electricity Investments Pty Ltd (NEI) intends to expand its 33 kV overhead power line network, by constructing a new 33 kV distribution line 36 km long, to link Namib Desert Lodge with its existing 33 kV line at Solitaire, in the Hardap Region of Central Namibia (Figure 1). The new line will be running parallel to the existing 19 kV distribution line currently servicing customers in the area (Figure 2).

Green Earth Environmental Consultants have been appointed by NEI to attend to and complete an Environmental Impact Assessment (EIA) and Environmental Management Plan (EMP) in order to obtain an Environmental Clearance Certificate (ECC) for the construction of a new 33 kV, horizontal line post compact delta (HLPCD; or staggered delta formation) overhead line from the Solitaire Substation to Namib Desert Lodge, as per the requirements of the Environmental Management Act (No 7 of 2007) and the Environmental Impact Assessment Regulations (GN 30 in GG 4878 of 6 February 2012; Anon. 2012).

The purpose of the EIA is to consider social, ecological, legal and institutional issues related to the intended use of the land, guided by the principles and stipulations of the Namibian Environmental Assessment Policy (1995) and Namibia's Environmental Management Act (2007), to determine the desirability of the proposed activities on the suggested area and to develop an Environmental Management Plan (EMP) to mitigate and manage environmental issues identified in the process.

The proposed power line presents a potential risk to birds, including collisions and electrocutions. Several potentially sensitive, collision-prone bird species in the area could be impacted in this way, including Ludwig's Bustard, Rüppell's Korhaan and Lappet-faced Vulture.

The present avifauna baseline/scoping and assessment for the new 33 kV power line therefore forms part of the above EIA.

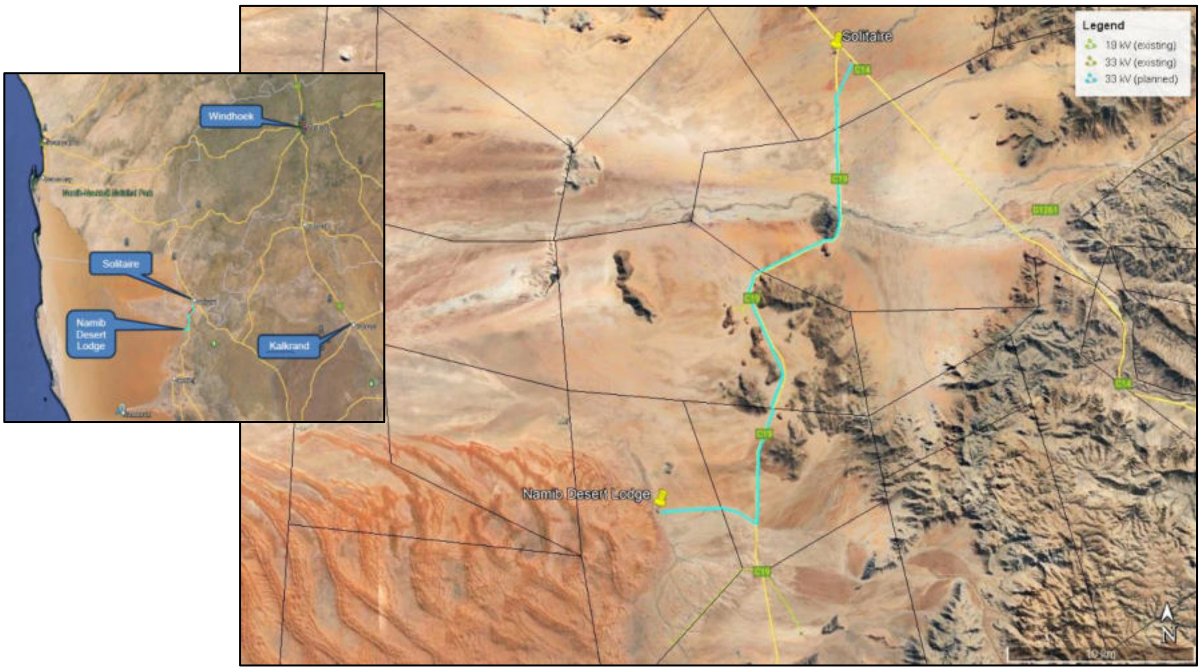


Figure 1. Locality map (inset; BID 2024) and project area map (based on a Google Earth map).

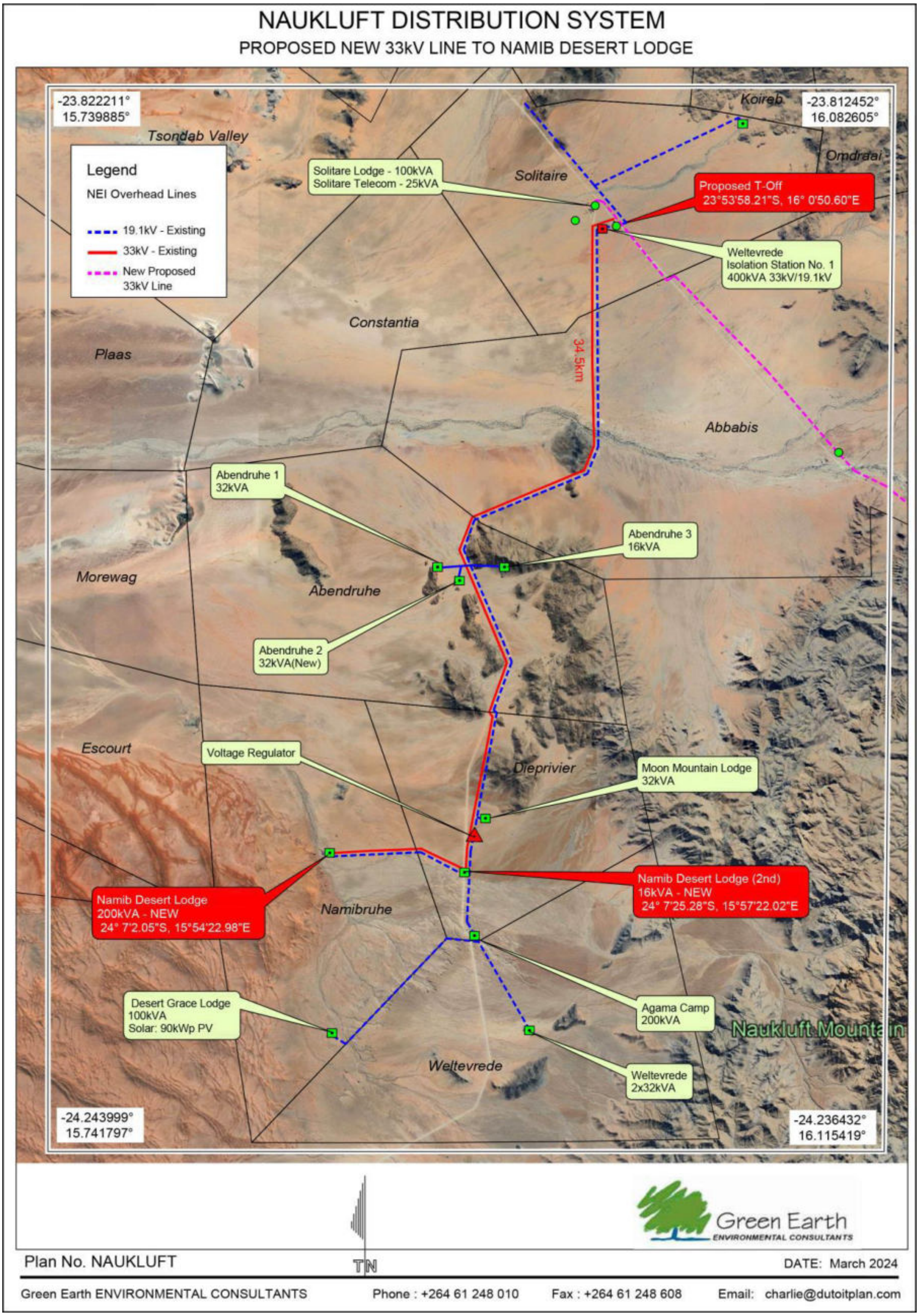


Figure 2. The Naukluft electricity distribution system, showing existing distribution power lines (19 kV and 33 kV), and proposed new 33 kV line from Solitaire to Namib Desert Lodge (Green Earth Environmental Consultants 2024).

1.2 Technical details of the proposed power line and existing distribution power lines in the area

Technical details of the proposed new 33 kV distribution line are described below (Figure 3, 5, 6).

As the new 33 kV line will be running in parallel with the existing 19 kV line, 12 m apart and thus with the potential for cumulative impacts, the structure of the 19 kV line is also included (Figure 4).

Power line structures

33 kV HLPCD

The intermediate power line structure for the new 33 kV power line, that will be used on the straight sections, will be a standard horizontal line post compact delta (HLPCD), with single wooden monopoles 11 m high planted at 1.8 m, i.e. assuming 9.2 m high above ground level (Figure 3).

The average ruling span between poles is 120 m, with shorter spans to compensate for the terrain and bend points.

The line will be strung with three "rabbit" conductors (consisting of stranded steel surrounded by aluminium) in a horizontal line post compact delta (HLPCD) configuration: the conductors are suspended, 800 mm one above the other but in staggered "delta" (offset) configuration, each resting on an insulator mounted on the side of the pole (Figure 3).

The intermediate poles do not have stay wires.

The strain pole structure at bend points includes live "jumpers" to convey the power around the bend, and stay wires (Figure 3).

19 kV SWER

The structure of the (existing) 19 kV Single Earth Wire Return (SWER) overhead distribution power line comprises a single "magpie" conductor on one pole top insulator (Figure 4). The conductor is thin and has low visibility.

The single wooden pole is also 11 m planted at 1.8m, i.e. assumed 9.2 m above ground level (the same height as the 33 kV pole). The ruling span is larger than for the 33 kV structure, i.e. 240 m, which also contributes to the low visibility of the SWER power line.

Earthing (grounding)

Each of the above pole structures is earthed by means of a galvanised wire running vertically from the ground to the top of the pole (Figure 3). It is standard practice to provide an "air space safety gap", whereby the earth wire on each pole stops 300 mm below the lowest conductor phase. The gap should be wide enough to avoid being permanently active, but close enough to allow lightning strikes to bridge it. This procedure is known as "gapping", and is a means to ensure that the pole is not permanently earthed, to avoid the electrocution of larger birds sitting on top of the pole.

Road crossings

When the power line crosses a road, there will be a 5.6 m conductor clearance from the ground and 30 m (pending the road reserve width) road clearance from the centre of the road. The wooden poles each side of the road crossing will be fitted with steel A-frames to allow for additional conductor ground clearance (Figure 3). With the proposed alignment, three crossings of the C19 road are envisaged (Figure 2).

The A-frame pole is also earthed by means of a vertical cable mounted on the pole; the earth should be gapped, as above. The structure may have stay wires, which should also be insulated/gapped by means of an insulator.

Line route and servitude

The proposed line route (Figure 1 & 2) has been determined through consultations between NEI, the affected landlords and the clients to be serviced by the line.

It has been decided to keep the existing 19 kV SWER distribution line and the new 33 kV line together and to let them run in parallel. The distance between the two lines will be 12 m.

It is assumed that a 22 m wide servitude will be registered/cleared beneath the new power line (the NamPower standard for 33 kV).

Step-down/transformer structures

The customer supply / offtake points from the existing 33 kV line to the 19 kV SWER distribution lines at the Solitaire Isolating Station are shown in Figure 5 & 6.

Step-down/transformer structures are used at the substation to step down the current before distribution, and are mounted on either a wooden pole with a steel A-frame, or other configurations including a wooden H-pole. Note the live jumpers (also referred to as "droppers"), conveying the power between the transformer and conductors.

The structures also serve to isolate specific sections of the power line, e.g. during maintenance or outages.

The step-down structures are similar for the 33 kV and 19 kV lines. Both live jumpers and droppers should be insulated, to prevent electrocutions.

Timeline and operation

The construction timeline / period for the line would be around 4 months and it is the intention of the proponent to have it completed before the peak tourist season starts, in winter 2024.

The extension of the reticulation network will be registered with the Electricity Control Board (ECB) under the routine ORM (operating and reporting manual) and license up-date.

Existing power lines in the area

Existing distribution power line routes in the area are shown in Figure 1 & 2. These include:

- 33 kV Klein Aub-Rietoog-Solitaire
- 19 kV SWER lines from Solitaire to Namib Desert Lodge and other offtake points

The ongoing construction of power lines of varying heights and structures in the area is likely to have a cumulative impact in terms of avifauna, particularly where this infrastructure is concentrated around substations and supply points.

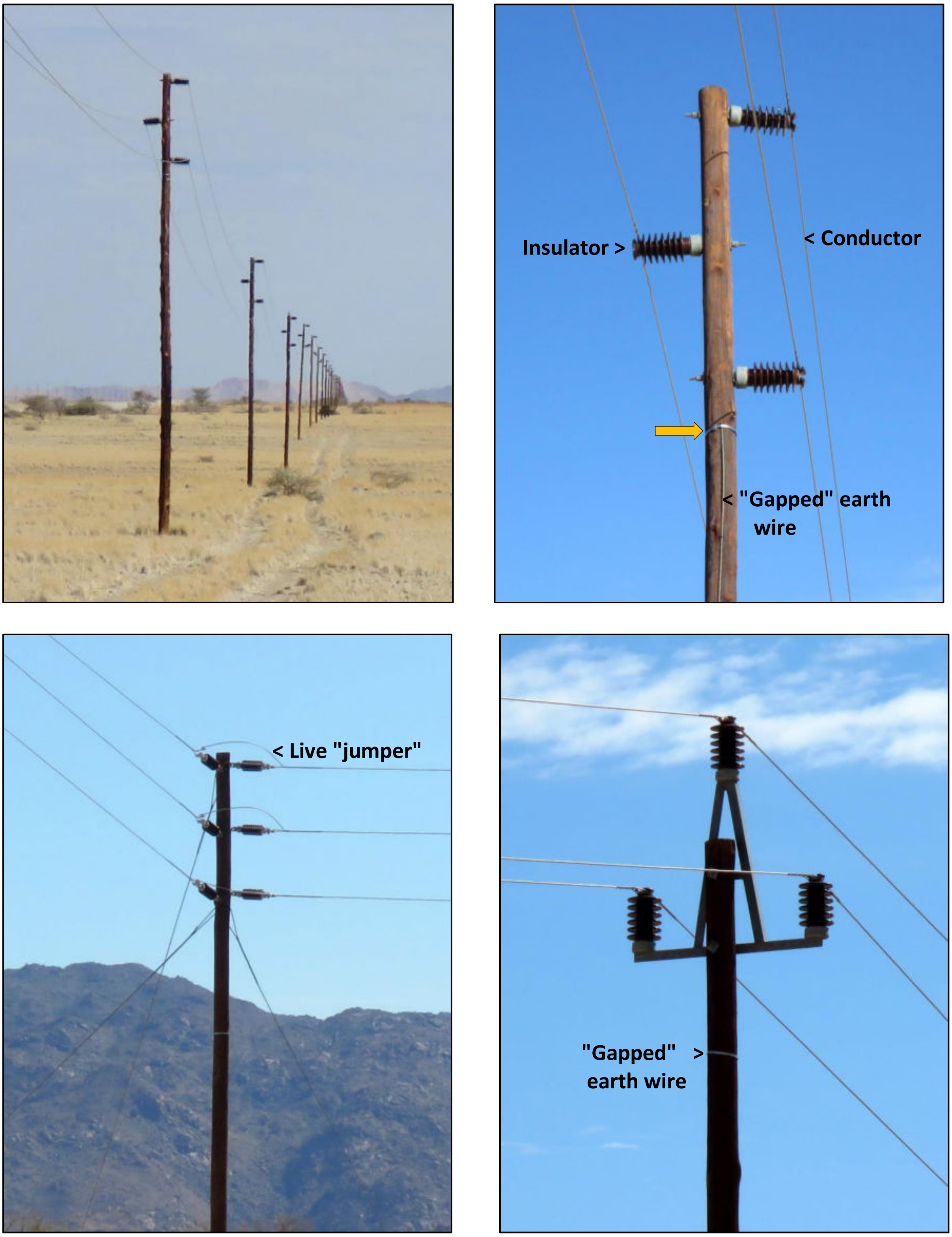


Figure 3 a-d. Example of the intermediate HLPCD structure on the existing 33 kV distribution line in the study area (top left), showing structure of the wooden 33 kV horizontal line post compact delta (HLPCD) pole that has been "gapped" (top right; arrow shows upper limit of the earth wire); example of a strain structure at a bend point (bottom left); note the live "jumpers", which ensure the continuation of the power supply across the pole; and example of a steel A-frame strain structure, used for extra height and support at a road crossing (bottom right), also with "gapped" earth wire.

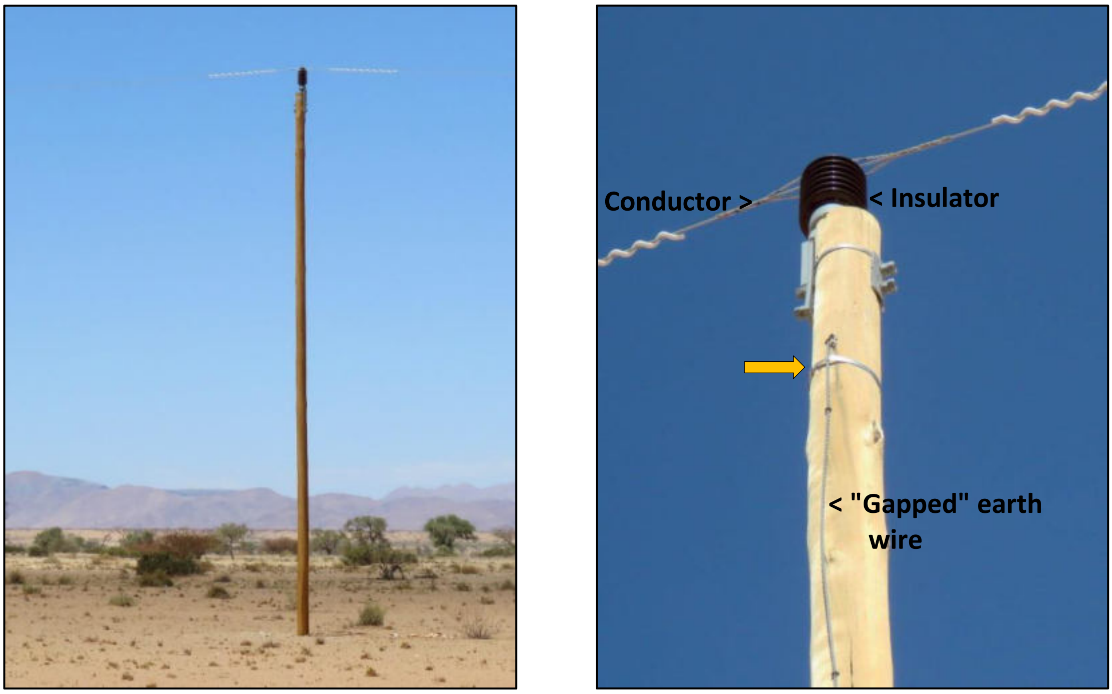
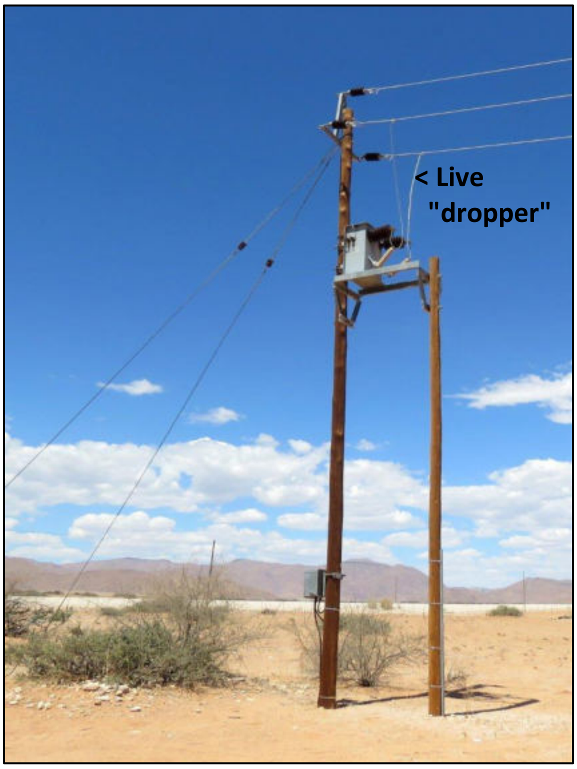


Figure 4 a-b. Example of the intermediate SWER structure on the existing 19 kV distribution line in the study area, showing a wooden pole fitted with "vibration dampers" (left); note the relatively low visibility of the thin conductor. The structure of the wooden SWER pole, that has been "gapped", is shown right (arrow indicates the upper limit of the earth wire).

Figure 5. Customer supply / offtake points for the existing 33 kV power line at the Solitaire Isolating Station.



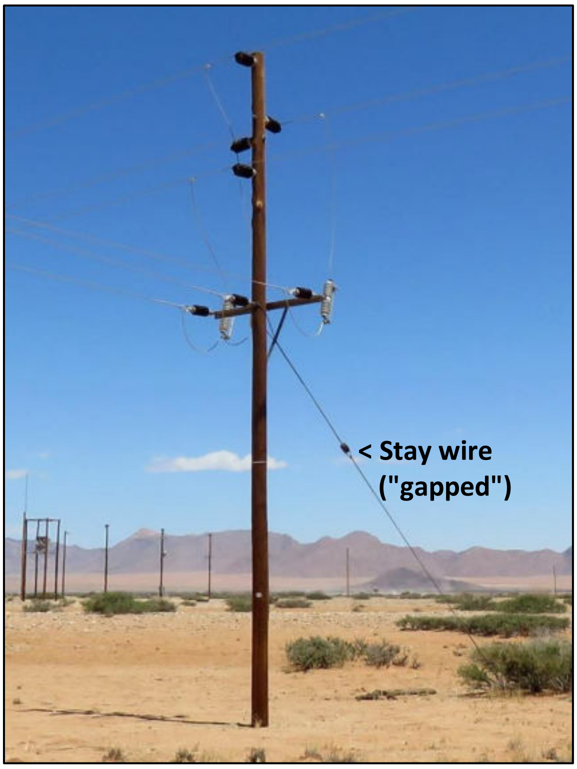


Figure 6 a-b. Examples of typical step-down/transformer installations for the existing 33 kV power line at the customer supply/offtake point at the Solitaire Isolating Station; note the live "dropper", and the stay wires "gapped" by means of an insulator.

1.3 Investigation of alternatives

Best practice environmental assessment methodology calls for consideration and assessment of alternatives to a proposed project. During the assessment, alternatives will consider optimisation and the use of eco-friendly solutions to reduce potential impacts.

- Different **power supply options** / alternatives have been investigated (i.e. solar photovoltaic [PV] power / wind power / "no-go" option / etc.), but the proposed line is the only feasible option to increase the capacity on the reticulation and to provide Gondwana (Namib Desert Lodge) with a dedicated 200 kVA three phase supply. The installed solar PV capacity at Namib Desert Lodge as well as installed PV on the NEI reticulation has reached maximum capacity.
- Alternative **route options**
  The primary mitigation at the design stage is the choice of route options and alternatives for a power line; if possible, areas where impacts on birds are likely to take place (sensitive habitats/sites) should be avoided as far as possible. No alternative route options are being assessed at present.
- The option of eventually **removing the 19 kV line** is being considered, although this is not an immediate option.
- **Burying** of the power line in sensitive sections is not considered technically or financially feasible.
- No alternative **pole structures** are proposed.

1.4 Terms of reference

1.4.1 Aim and approach

The aim of the avifauna study is to establish the extent to which the proposed new 33 kV distribution power line will impact on the avifauna in the study area, especially threatened, endemic or other biologically significant (priority) species.

The scope of the study is the proposed new 33 kV line from the Solitaire Isolation Station at Solitaire to the Namib Desert Lodge (35 km).

The study will compile a baseline of avifauna habitats and species and their sensitivities. It will identify and assess potential impacts of the proposed power line on the avifauna and recommend mitigation measures and a monitoring programme in order to minimise any negative impacts. Additional, cumulative impacts will also be considered.

1.4.2 Baseline/scoping

The baseline/scoping study will take the form of a desk-top assessment of the bird habitats and their likely avifauna and their sensitivity in terms of the proposed development. This will be supplemented by a site visit to the area, including to representative sections of the servitude/ route of the new power line. Any proposed alternatives will also be considered and assessed. Representative sections of existing power lines in the area (in particular, distribution lines) will be checked for any signs of avifauna incidents.

The best available data sources (both published and unpublished literature, including other EIA studies) will be used to establish the baseline conditions. Landowners/managers will be consulted for input on the occurrence of likely power line-prone bird species, and any past collision/electrocution incidents, also making use of any other local knowledge (e.g. bird atlas data, local birders who are familiar with the study area), if available.

Gaps in baseline data will be identified if applicable, and an indication of the confidence levels will be provided.

The study site will be characterised in terms of:

- the avifauna habitats present, and their sensitivities
- an inclusive list of bird species likely to occur there
- sensitivities of the bird species and the identification of priority species, based on criteria such as conservation status, endemism, residency, recorded breeding sites (in particular of vultures and other raptors), abundance etc.
- known and potential sensitivities of the bird species to power line interactions
- any obvious, highly sensitive, "no-go" areas to be avoided by the development from the outset.

1.4.3 Impact assessment

The study will determine the impact on the avifauna and its habitats of the various changes that may be caused by the construction, operation and decommissioning of the new 33 kV power line on the ecosystems in question including, but not limited to, disturbance and loss of avifauna habitat; poaching and road mortalities; and bird mortalities due to collisions or electrocutions on power lines and associated infrastructure.

The impacts will be assessed according to standard procedures. An indication of confidence in the prediction will be provided.

Possible cumulative impacts will be identified in relation to the other existing power lines in the area, as well as to other activities currently taking place in the environment.

1.4.4 Recommendations for mitigation and monitoring

Recommendations for the mitigation of impacts on avifauna and its habitats will be provided together with a Monitoring Plan, for inclusion in the Environmental Management Plan (EMP).

In terms of any proposed alternatives, the most suitable options will be recommended.

As the route for the new 33 kV line follows the same route of the existing 19 kV line from the Solitaire Isolation Station to the Namib Desert Lodge, any mitigation recommendations made for the new line could also be considered for the existing 19 kV line.

2 Approach and methodology

2.1 General approach

Avifaunal input to the EIA was requested in the form of a baseline/scoping and impact assessment study to provide an understanding of the potential risks to birds with the proposed development and to serve as a basis for the recommendations of mitigation for such risks and the monitoring programme for the Environmental Management Plan (EMP).

The study includes a baseline scoping of the project area some 185 km south-west of Windhoek at Solitaire, in the Hardap Region of Central Namibia (Figure 1 & 2). A desk-top study was supported by a site visit on 11-13 March 2024.

Two sources of bird distribution data were used (Brooks *et al*. 2022). The primary data, for the first Southern African Bird Atlas Project (SABAP1; Harrison *et al*. 1997), were gathered during 1987-1992. This information is available on the comprehensive Namibian Avifaunal Database (NAD; www.biodiversity. org.na; NAD 2024), which includes all available information on birds in Namibia including SABAP1 data, nest record cards, wetland bird counts, Raptor Road Counts for Namibia and museum specimens, as well as on the Environmental Information Service (EIS; www.the-eis.com; EIS 2024). SABAP1 data are recorded on a quarter degree square (QDS) basis and are extremely comprehensive, although the information dates back to 1992.

A follow-up Southern African Bird Atlas Project (SABAP2) was initiated in South Africa in 2007 and in Namibia in 2012 (http://sabap2.adu.org.za). This information comprises more recent distribution data on a finer scale (in units termed pentads, or 5-minute x 5-minute coordinates; nine pentads make up one quarter degree square [QDS]). Although the distribution data are at a finer scale, the data collected to date for Namibia are still patchy and not yet as extensive as those for SABAP1. Although some pentads in the study area are well atlased, it is still advisable to use a combination of SABAP1 and SABAP2 data, as well as any other available data.

The bird checklist for the present study (Appendix 1) is based on both SABAP1 data for four QDSs: 2315DD, 2316CC, 2415BB, 2416AA (Figure 7), and available SABAP2 data for five (well-atlased) pentads: 2359_1600, 2355_1605, 2400_1555, 2405_1550, 2410_1550, which fall within the above QDSs. For the above SABAP1 and SABAP2 sources, as well as for observations made in the field (mainly March 2024), presence/absence of species is indicated as a measure of local abundance (Appendix 1).

Other sources of information include the Environmental Information Service (see above), and the updated Atlas of Namibia (Mendelsohn *et al*. 2002, Atlas of Namibia Team 2022; https:// atlasofnamibia.online/); the Red Data Book for Birds in Namibia (Simmons *et al*. 2015), other published sources (e.g. Hockey *et al*. 2005), the global International Union for the Conservation of Nature (IUCN) Red Data list for birds (www.iucnredlist.org; IUCN 2024); discussions with local landowners/landlords and other birders; and both the authors' 35+ years of experience of working together on and observing birds in southern Africa, including in Namibia. The above sources were used to compile one combined checklist for the study area.

Recent EIA studies in the greater area that pertain to the present study area include a scoping report for the new Gondwana Namib Desert Lodge and power line (Cooper 2017).

Potential sensitivities of the avifaunal environment were assessed according to standard criteria, i.e. in the context of protected area status; major topographical features and vegetation habitats; and wetland habitats including ephemeral rivers and associated drainage lines, and borrow-pits (EIS 2024). Avifaunal habitats that are limited in the present context were identified, in particular aquatic habitats.

Potential sensitivities of the bird species were assessed in terms of criteria identified for "priority species" that include bird species diversity (according to recorded distribution data, see above); the most recent Red Data status, both on a national scale (Simmons *et al*. 2015; and an update by Brown *et al*. 2017) and global scale (IUCN 2024; see above); uniqueness or endemism/near-endemism to Namibia (i.e. having ≥90% of their global population in this country) (Simmons *et al*. 2015; Brown *et al*. 2017); residency/migrant status (for Red Data species); an indication of abundance, based on presence/absence for the above sources; any recorded breeding in the area (focusing on Red Data and endemic species, as well as identified priority species); known sensitivity to collisions with overhead structures; and other ecological aspects. The NamPower/Namibia Nature Foundation (NNF) Strategic Partnership database (EIS 2024) was also consulted for relevant power line incidents on record in the greater study area.

During the field trip for the present study (March 2024), the servitude for the new power line was investigated. Existing power lines in the study area were also checked extensively on foot or by vehicle for any signs of bird collisions or electrocutions, namely for 25.4 km for the 19 kV line (and proposed servitude for the new 33 kV line); and 11.3 km for the existing 33 kV line.

The methodology for the assessment of impacts is outlined in Section 5.1.

Gaps in baseline data were identified where applicable, and an indication of the confidence levels is provided. Recommendations were made for future work in terms of the EIA process.

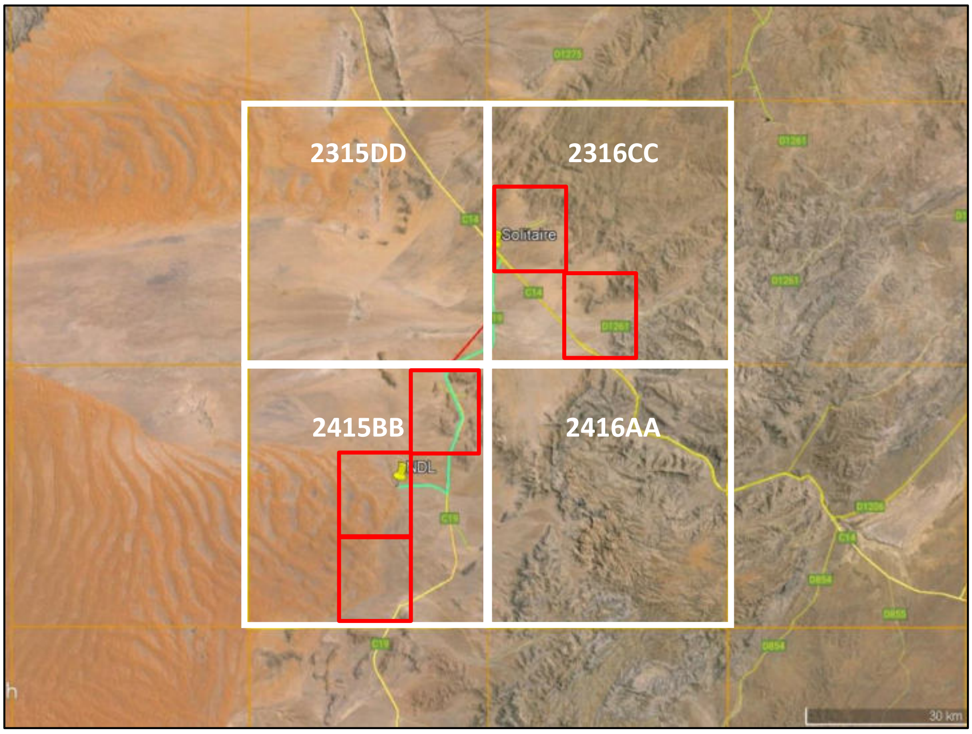


Figure 7. Four quarter degree squares (QDSs; 2315DD, 2316CC, 2415BB and 2416AA; white blocks; NAD 2024, EIS 2024) and five pentads (red blocks, SABAP2; see Appendix 1) on which available bird atlas data for the checklist for the study area is based (based on a Google Earth map).

2.2 Limitations and assumptions

Limitations

- A major limitation to the assessment and mitigation of potential impacts from power line structures is the difficulty in obtaining confirmed records of bird flight paths. The present investigation was limited in particular by the dry conditions during the site visit, with very little rainfall for the current season. The avifaunal diversity in general is likely to increase under wetter conditions, including in the ephemeral drainage lines and river habitats, such as the Tsondab River, and in the mountainous habitats. These limitations were addressed, in part, by incorporating long term bird atlas data in the assessment.
- A further limitation is the lack of representative long-term data on power line incidents in Namibia. Available data from the NamPower/NNF Strategic Partnership (EIS 2024) were consulted in this respect; however, no data are available for dedicated surveys of power lines in the study area, including of the 19 kV SWER structure.

Assumptions

- Combined SABAP1 and SABAP2 and other data used in this report provide a representative indication of the bird species likely to occur in the study area throughout the seasonal and inter-annual cycles.

In all the above respects, however, the precautionary principle should apply.

3 Legislation and international conservation agreements

The Avifauna Impact Assessment is conducted in accordance with, and ensuring compliance with, the following legal requirements, agreements, and best practice standards and guidelines (Table 1).

Table 1: Legislation, conservation agreements, best practice standards and guidelines for the avifauna impact assessment.

3.1 Namibian environmental legislation	
Namibian Constitution, 1990	Environmental conservation is entrenched in the Namibian Constitution (1990, Article 95, Promotion of the Welfare of the People), in terms of which the State shall actively promote and maintain the welfare of the people by adopting, *inter alia,* policies aimed at the following: (l) maintenance of ecosystems, essential ecological processes and biological diversity of Namibia and utilization of living natural resources on a sustainable basis for the benefit of all Namibians, both present and future … The above description would include the promotion of sustainable energy developments.
Namibian Environmental Management Act, 2007 (Act no. 7 of 2007)	The Environmental Impact Assessment (EIA) process in Namibia is governed and controlled by the Environmental Management Act (EMA), 2007 and the EIA Regulations 30 of 2012 (Anon. 2012), which are administered by the office of the Environmental Commissioner through the Department of Environment Affairs (DEA) of the Ministry of Environment, Forestry and Tourism (MEFT). The above Act requires the full consideration of biodiversity (including birds), habitat and landscape parameters, values and criteria as part of the environmental assessment processes. The present avifauna scoping and assessment study forms part of the above process. Under this legislation, activities that may not be undertaken without an Environmental Clearance Certificate (ECC) to include energy generation, transmission and storage activities. An ECC application will therefore be submitted to the competent authority, in Namibia being the Ministry of Mines and Energy (MME) and Ministry of Environment, Forestry and Tourism (MEFT), to make a Record of Decision (RoD) with regard to the proposed project.
Namibian Nature Conservation Ordinance of 1975	The study area does not fall within an officially protected area proclaimed under the above Nature Conservation Ordinance of 1975. The nearest officially protected area is the extensive Namib Naukluft Park, which lies in close proximity to the west, south and east of the study area (Figure 8). The conservation of terrestrial birds in Namibia is governed by the Nature Conservation Ordinance of 1975. It is envisaged that the above Ordinance will eventually be replaced by the (draft) Parks and Wildlife Management Bill (2005). The list of Specially Protected Birds according to this Bill is based on the Namibian Red Data Book (Simmons *et al.* 2015), and the Namibian Red

	Data categories in the latter document are used in the present report, together with those of a recent update (Brown *et al.* 2017).
3.2 International conservation agreements	
Convention on Biological Diversity (CBD) Post-2020 Biodiversity Framework	Namibia is a signatory to the international Convention on Biological Diversity (CBD). The CBD is the overarching multilateral environmental agreement for biodiversity, with 196 Parties comprising nearly all the world's countries (Bennun *et al.* 2021). The CBD's post-2020 global biodiversity framework will build on the Strategic Plan for Biodiversity 2011–2020 and sets out an ambitious plan to implement broad-based action to bring about a transformation in society's relationship with biodiversity and to ensure that, by 2050, the shared vision of living in harmony with nature is fulfilled.
United Nations Sustainable Development Goals (SDGs)	Seventeen United Nations Sustainable Development Goals (SDGs) were adopted by all UN Member States in 2015, as part of the 2030 Agenda for Sustainable Development, which set out a 15-year plan to achieve the Goals (Bennun *et al.* 2021). Namibia has been a member state of the United Nations since 1990. SDGs relevant to energy and biodiversity include: • GOAL 7: Affordable and Clean Energy - Ensure access to affordable, reliable, sustainable and modern energy • GOAL 13: Climate Action - Take urgent action to combat climate change and its impacts • GOAL 15: Life on Land - Sustainably manage forests, combat desertification, halt and reverse land degradation, halt biodiversity loss
United Nations Framework Convention on Climate Change (UNFCCC)	Since 1995, Namibia has been a signatory to the United Nations Framework Convention on Climate Change (UNFCCC), as a Non-Annex I party (NAI). As party to the convention, Namibia is obliged to prepare and submit National Communications (NCs) and in addition Biennial Updated Reports (BURs) (http://www.met.gov.na/services/national-communications-and-biennial-update-reports/238/). The adoption of the Paris Climate Change Agreement (2015; under the above convention) has also brought home the need for low-carbon development based on environmentally-friendly technologies.
Convention on the Conservation of Migratory Species of Wild Animals (CMS)	The Convention on the Conservation of Migratory Species of Wild Animals (CMS 2011) is an intergovernmental treaty with global remit (Bennun *et al.* 2021). A number of relevant agreements and memorandums under the CMS umbrella include the Agreement on the Conservation of African-Eurasian Migratory Birds (AEWA) and the Memorandum of Understanding on the Conservation of Migratory Birds of Prey in Africa and Eurasia (Raptors MOU). Namibia is classed as a range state for AEWA but, although guided by its principles, is not yet a contracting party to this international agreement.
Important Bird and Biodiversity Areas (IBAs)	The BirdLife International Important Bird and Biodiversity Area (IBA) Programme aims to identify, monitor and protect a global network of IBAs for the conservation of the world's birds and other wildlife (Barnes 1998; Simmons *et al.* 1998; Simmons *et al.* 2001; Kolberg 2015; Marnewick *et al.* 2015). These areas were initially known as Important Bird Areas.

<table>
<tr><td></td><td>IBAs are thus sites of international significance for the conservation of birds at the Global, Regional (Continental) or Sub-regional (southern African) level, selected according to a set of four criteria based on globally threatened species, restricted-range species, biome-restricted species and congregations (Kolberg 2015). However, not all IBAs receive official protection.
Namibia has 19 IBAs. The nearest IBA to the study site (in close proximity) is:
• The Namib-Naukluft Park IBA (NA010; Simmons et al. 1998, 2001); a Global IBA under criteria A1, A2 (s045, s046), A3 (A11, A12), A4i; area 4,976,800 ha.</td></tr>
<tr><td>Key Biodiversity Areas (KBAs)</td><td>Key Biodiversity Areas (KBAs) are defined as sites contributing significantly to the global persistence of biodiversity, in terrestrial, freshwater and marine ecosystems. The KBA Standard establishes a consultative, science-based, globally agreed process for KBA identification (KBA Standards and Appeals Committee 2020; www.keybiodiversityareas.org). KBAs within the greater study area include:
• Namib-Naukluft Park: this site in Namibia qualifies as a KBA of international significance.</td></tr>
<tr><td colspan="2">3.3 Best practice standards and guidelines for birds and energy</td></tr>
<tr><td>World Bank Environmental and Social Framework (World Bank 2016)
The World Bank Environmental, Health, and Safety (EHS) Guidelines (World Bank 2007b)</td><td>The World Bank Environmental and Social Framework (ESF) sets out the World Bank's commitment to sustainable development, through a Bank Policy and a set of Environmental and Social Standards (ESS) that are designed to support Borrowers' projects, with the aim of ending extreme poverty and promoting shared prosperity.
The ESF includes the Environmental and Social Standards (ESSs), which set out the requirements that apply to Borrowers. These include:
• ESS1 Assessment and Management of Environmental and Social Risks and Impacts
• ESS6 Biodiversity Conservation and Sustainable Management of Living Natural Resources
The World Bank Environmental, Health, and Safety (EHS) Guidelines (World Bank 2007b) are technical reference documents with general and industry-specific examples of Good International Industry Practice (GIIP).
The above guidelines are endorsed by the International Finance Corporation (IFC) Performance Standards on Environmental and Social Sustainability (https://www.ifc.org; IFC 2012b) and by the Equator Principles (July 2020), a global financial industry benchmark for determining, assessing and managing environmental and social risk in projects (www.equator-principles.com).</td></tr>
<tr><td>International Finance Corporation Performance Standards on Environmental and Social Sustaina-bility (IFC 2012b)</td><td>The IFC Sustainability Framework articulates the Corporation's strategic commitment to sustainable development, and is an integral part of IFC's approach to risk management. Eight Performance Standards establish standards that the client is to meet throughout the life of an investment by IFC. These include:
• Performance Standard 1 (PS1): Assessment and Management of Environmental and Social Risks and Impacts.
• Performance Standard 6 (PS6): Biodiversity Conservation and Sustainable Management of Living Natural Resources. For the purposes of</td></tr>
</table>

	implementation of this Performance Standard, habitats are divided into modified, natural, and critical (the most sensitive).
World Bank Environmental, Health, and Safety Guidelines for Electric Power Transmission and Distribution (World Bank 2007a)	The World Bank EHS Guidelines for Electric Power Transmission and Distribution (World Bank 2007a) include information relevant to power transmission (including environmental issues) between a generation facility and a substation located within an electricity grid, in addition to power distribution from a substation to consumers located in residential, commercial, and industrial areas. The above guidelines recommend prevention and control measures to minimise avian collisions and electrocutions, including: • Aligning transmission corridors to avoid Critical Habitats (IFC 2012b; World Bank 2016; see above); • Considering the installation of underground transmission and distribution lines in sensitive areas (e.g. critical natural habitats); • Installing visibility enhancement objects such as marker balls, bird deterrents, or diverters; • Maintaining 1.5 m spacing between energised components and grounded hardware or, where spacing is not feasible, covering energised parts and hardware; and • Retrofitting existing transmission or distribution systems by installing elevated perches, insulating jumper loops, placing obstructive perch deterrents (e.g. insulated "V's"), changing the location of conductors, and/or using raptor hoods.
Best practice guide – Environmental Principles for Mining in Namibia (Environmental Compliance Consultancy 2019)	Phase 4: Mining and processing operations. Case study by NamPower/ Namibia Nature Foundation: Best practice for monitoring of powerlines and energy producing structures on mines (pp 22-25). The above case study aims at showcasing generic procedures and guidelines for the monitoring of electricity generation and supply structures and their interactions with wildlife in Namibia.

4 Potential sensitivities

4.1 Avifaunal environment

The study area lies in the Namib Desert, some 185 km south-west of Windhoek at Solitaire, in the Hardap Region of Central Namibia (Figure 1 & 2).

4.1.1 Protected area status

The study area lies in close proximity to the nearest formally protected area, the Namib Naukluft Park (Figure 8). The size of this large conservation area is 4,976,800 ha. As part of the park, the Namib Sand Sea is a proclaimed World Heritage Site. The area also falls within the Greater Sossusvlei-Namib Landscape, a landscape-level conservation initiative (https://www.landscapes namibia.org/sossusvlei-namib/). The greater area also includes several smaller private nature reserves, including the Gondwana Namib Park.

The Namib Naukluft Park has a high bird species richness, and is also classed as an Important Bird and Biodiversity Area (IBA), and a Key Biodiversity Area (KBA; see above). The Important Bird and Biodiversity Area (IBA; initially known as Important Bird Area) Programme has been established by BirdLife International, through which it aims to identify, monitor and protect a global network of IBAs for the conservation of the world's birds and other wildlife (Barnes 1998; Simmons *et al*. 1998, 2001; Kolberg 2015; Marnewick *et al*. 2015; www.birdlife.org.za/conservation/important-bird-areas). IBAs are thus sites of international significance for the conservation of birds at the Global, Regional (Continental) or Sub-regional (southern African) level, selected according to a set of four criteria based on globally threatened species, restricted-range species, biome-restricted species and congregations (Kolberg 2015); however, not all IBAs receive official protection. IBAs are home to a large number of bird species and individuals, with regular movements among such habitats.

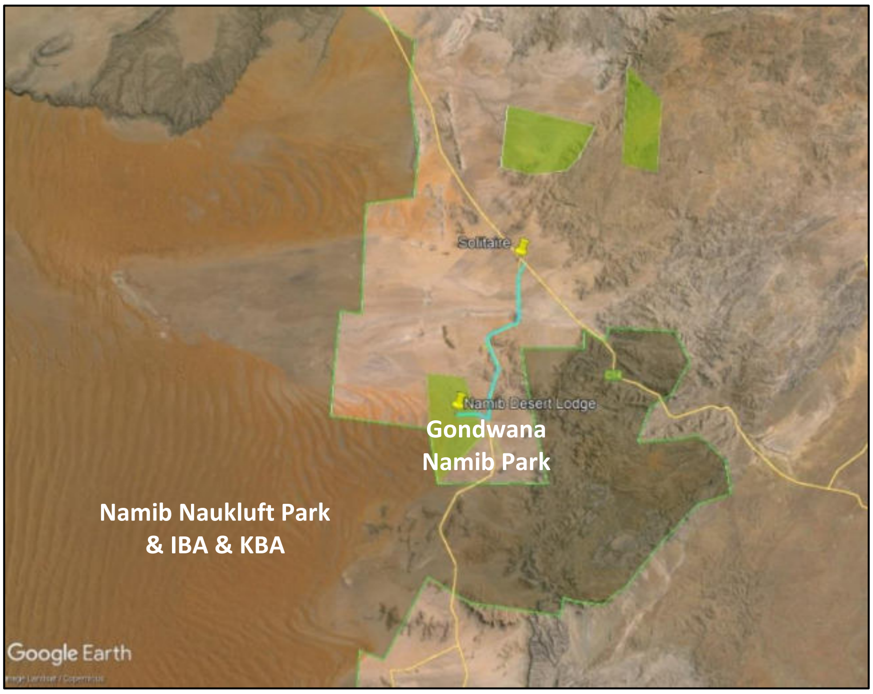


Figure 8. Protected areas, Important Bird Areas (IBAs) and Key Biodiversity Areas (KBAs) in relation to the study area (brown = formally protected areas; green = private nature reserves; EIS 2024, based on a Google Earth map).

Namibia has 19 IBAs (Simmons *et al*. 2001). The Namib-Naukluft Park IBA (NA010) is classified as a Global IBA under criteria A1, A2 (s045, s046), A3 (A11, A12), A4i. The park is rich in raptors, including Secretarybird, White-backed Vulture, Lappet-faced Vulture, Martial Eagle, Rock Kestrel and Greater Kestrel. In the east, the Naukluft mountains hold breeding Verreaux's Eagle and Black Stork. Characteristic species more typical of northern Namibia around the Naukluft mountains include Monteiro's Hornbill and Rüppell's Parrot. Typical desert-dune and gravel-plain species include Ludwig's Bustard and Rüppell's Korhaan. The coastline holds its own suite of waterbirds.

The Namib Naukluft Park also qualifies as a Key Biodiversity Area (KBA) of international significance (the Namib-Naukluft Park KBA). KBAs are defined as sites contributing significantly to the global persistence of biodiversity, in terrestrial, freshwater and marine ecosystems. The KBA Standard establishes a consultative, science-based, globally agreed process for KBA identification (KBA Standards and Appeals Committee 2020; Key Biodiversity Areas Partnership 2024; www.keybiodiversityareas.org.

The conservation status of the study area is thus regarded as relatively high.

4.1.2 Climate

The average annual rainfall for the greater study area is relatively low, namely 50-150 mm, falling mainly during January-March (Mendelsohn *et al*. 2002; Atlas of Namibia Team 2022).

Average annual temperatures are 18-20°C (range 22-26°C, but reaching 40°C and over).

The dominant wind direction is from the south, with average wind speeds of around 15-20 km per hour.

4.1.3 Major topographical features and vegetation habitats

The study area lies within the Namib Plains Landscape (Atlas of Namibia Team 2022). The broad topography consists of Namib Plains with sand-drifts and prominent inselbergs, largely of mid-palaeozoic age (i.e. ~540-250 million years old). The altitude is around 1,000 metres above sea level (masl) on the plains.
In the east lie the extensive dune fields of the Namib Sand Sea (Figure 9), mostly falling within the Namib Naukluft Park, IBA and KBA.
To the east, the Naukluft mountains (reaching 2,000 masl) are part of the high-rising escarpment that marks the western edge of the interior highlands of Namibia (Figure 9; Simmons *et al*. 2001). The escarpment provides a transition between the coastal plain and the central, inland plateau (Mendelsohn *et al*. 2002). It is widely agreed that the Namibian deserts and escarpment are evolutionary nodes holding many endemic taxa (Simmons *et al*. 2001).
To the north-east of the study area lies the Rehoboth Plateau and, beyond the mountains, the flat habitats of the Nama-Karoo Basin plateau. The extensive, active sand dune fields of the Namib Dunes (the "Namib Sand Sea"), lie to the west.

Several large ephemeral rivers are found in the greater area, all running from east to west (Figure 9). The Tsondab passes through the centre of the study area and is the main drainage. The river flows only after good rains, but the water does not reach the sea; it filters into the ground or collects in and evaporates from the large Tsondabvlei Pan. A smaller tributary, the Diep River, is found in the Gondwana Desert Park. To the south, the Tsauchab River follows the same pattern, flowing west into Sossusvlei, while the Kuiseb River lies in the north. Surface water is limited, in the form of scattered farm dams and waterholes in the greater area.

The study area falls within the Nama Karoo Biome (Mendelsohn *et al*. 2002; Atlas of Namibia Team 2022). The vegetation type is classed as Nama Karoo, a desert/dwarf shrub transition. Dominant species include *Rhigozum trichotomum* three-thorn rhigozum, *Euphorbia gregaria* Karas euphorbia, *Zygophyllum decumbens* twin-leaf, spekbos and *Aloe dichotoma* quiver tree, kokerboom. Tree cover is <0.1% (2-5 m high); shrub cover is <0.1% (1-2 m high); dwarf shrub cover is 0.1-1% (,0.5 m high); and grass cover is 0.1% (<0.5 m high). Grass cover is present only after good rains, then decreases. The vegetation in the ephemeral watercourses (such as Tsondab River) is denser, with larger trees (e.g. *Acacia tortilla* umbrella thorn, *Ficus* sp. wild fig). Large, old, deep-rooted *Acacia* (*Vachellia*) *erioloba* camel-thorn trees are found in the watercourses and closer to the mountains.

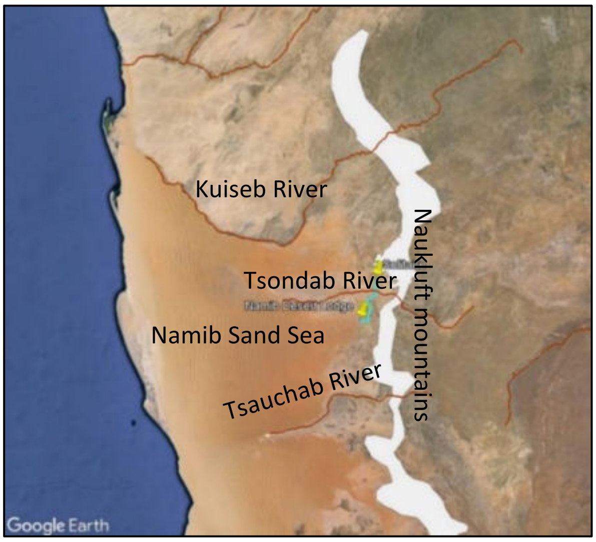


Figure 9. Major topographical features of the greater study area include the extensive dune fields of the Namib Sand Sea; the Naukluft mountains, part of the high-rising escarpment (white shading) that marks the western edge of the interior highlands of Namibia; and ephemeral rivers (indicated in brown; EIS 2024, based on a Google Earth map).

4.1.4 Habitats in the study area and surrounds, in relation to birds

The predominant land uses in the greater study area are conservation and nature-based tourism, with some (limited) small-stock farming. The landscape is largely unmodified.

The avifauna habitats in the study area are shown in Figure 10-12 and include:

- Sandy plains with sparse grass, favoured by large terrestrial birds such as bustards and korhaans, as well as raptors
- Rocky hills/mountains, also attractive to raptors, providing opportunities for foraging/nesting/flight
- Ephemeral drainage lines/watercourses and riverine habitats associated with the Tsondab River catchment occasionally hold surface water, and have denser, taller vegetation and a higher animal biodiversity, used by a greater number of bird species; drainage lines are an important habitat for bustards and korhaans. A large borrow pit near the Tsondab River is reported to have water during good rains, but cannot hold it for long; waterbirds have not been observed here (K Schulze Neuhoff pers. comm. 2024); it is assumed that the same would apply to other borrow pits in the area.
- Extensive dune fields, including sand dunes and the ancient, fossilised dunes at Namib Desert Lodge with cliffs that provide nesting habitats for raptors and other birds**.**

Figure 10 a-e. Sandy plain habitats with sparse grass in March 2024 (also showing good grass cover after rains in October 2021, bottom right). These habitats are favoured by large terrestrial birds such as bustards and korhaans, as well as raptors.

Figure 11 a-f. Rocky hills and mountains in the study area. These habitats are attractive to raptors, providing opportunities for foraging, nesting and flight.

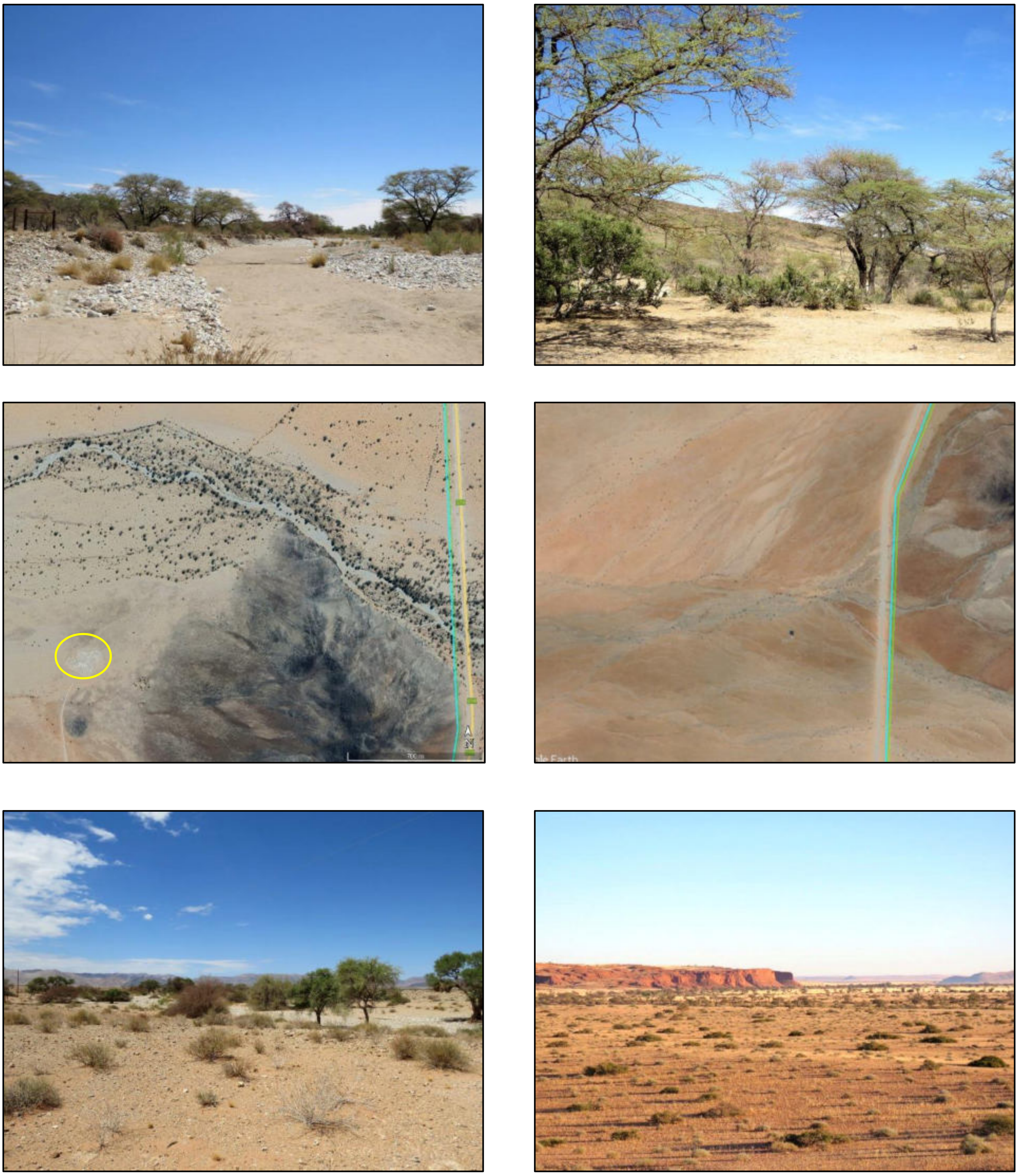


Figure 12 a-e. Ephemeral drainage lines/watercourses and riverine habitats associated with the Tsondab River catchment occasionally hold surface water, and have denser, taller vegetation and a higher animal biodiversity, used by a greater number of bird species; a large borrow pit near the Tsondab River (centre left; yellow ring) may hold water after rain, but not for long; typical drainage line patterns (centre right).

Figure 12 f. Extensive dune fields include the ancient, fossilised dunes at Namib Desert Lodge, with cliffs that provide nesting habitats for raptors and other birds (bottom right).

4.2 Sensitivities in terms of bird species

Sensitivities of the bird species in the study area are discussed below, according to relevant criteria.

Note that risk assessment and mitigation efforts are directed towards priority species, namely those species that have a high biological significance, i.e. primarily Red Data species (including those with migrant status) and/or endemic or near-endemic species.

4.2.1 Bird species richness

A total of 208 bird species has been recorded for the study area (SABAP1 and SABAP2 data, and other sources: see above; Appendix 1). The area is well atlased, and the list is considered representative of the species likely to occur in the area.

The above total represents 31% of the 676 species currently recorded in Namibia (Brown *et al*. 2017), a richness that is classed as relatively moderate-high (5-6 on a scale of 8: Figure 13; Atlas of Namibia Team; EIS 2024), and noteworthy for such an arid environment.

The site visit for the present study took place during a prolonged dry spell (March 2024) with high temperatures (≥40˚), and the bird species richness then observed was fairly low. The combined data in Appendix 1 are thus considered the best reflection of bird diversity over the longer term.

Some of the bird species observed in the study area are shown in Figure 14 & 15.

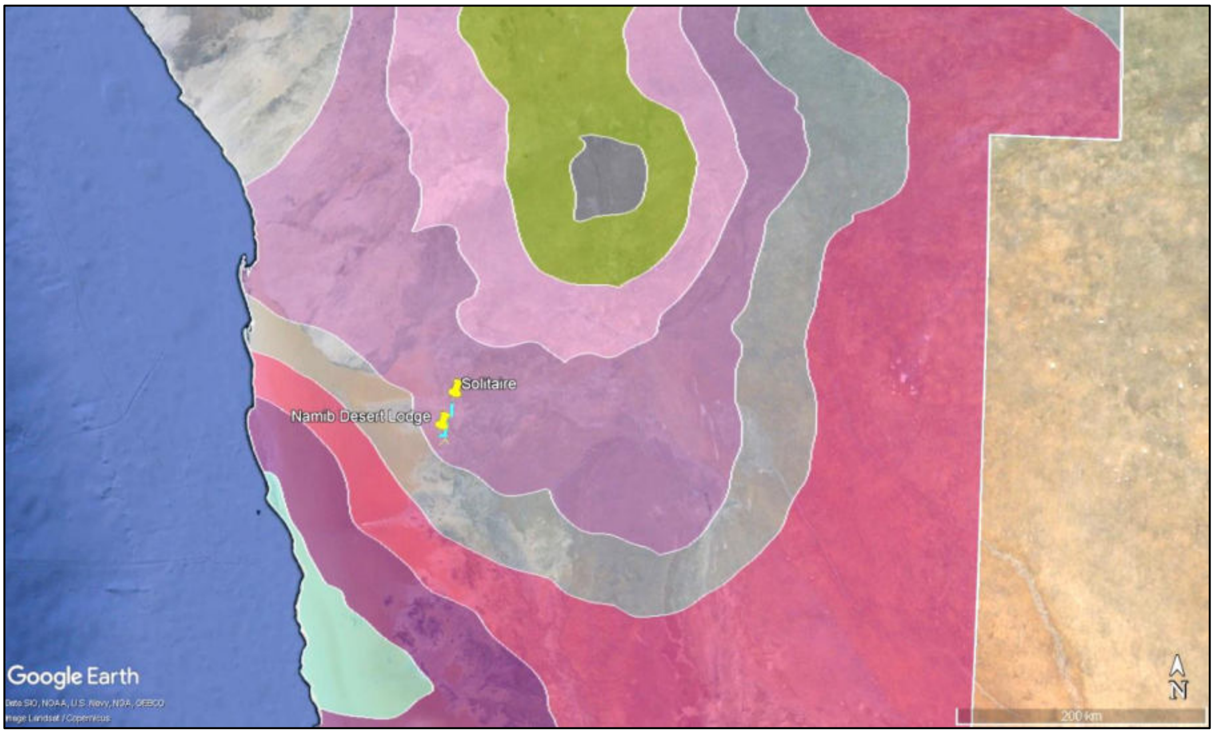


Figure 13. Bird species richness in the study area is regarded as relatively moderate-high (5-6 on a scale of 8) (Atlas of Namibia Team 2020; based on a Google Earth map, EIS 2024).

Figure 14 a-f. Examples of some of the large terrestrial bird species observed in the study area: Lappet-faced Vulture (top; photo top right Greg Laverty [https://ebird.org]); Ludwig's Bustard (centre; October 2021: note the good grass cover); Rüppell's Korhaan (bottom left; January 2021); Namaqua Sandgrouse (bottom right; March 2024).

Figure 15 a-d. Examples of some of the raptors observed in the study area: Pale Chanting Goshawk (top; September 2020 and centre; March 2024), with juvenile (centre right), all on 19 kV SWER power line; Greater Kestrel (bottom left) on 33 kV HLPCD line, and Rock Kestrel in the same area (bottom right; March 2024).

4.2.2 Red Data status

The following Red Data categories apply to the present study, as defined in the Red Data Book for Namibia and aligned with IUCN Red List categories (Simmons *et al*. 2015):

- **Critically Endangered**: a species with at least a 50% chance of going extinct in 10 years
- **Endangered**: a species with at least a 20% chance of going extinct in 20 years
- **Vulnerable**: a species with at least a 10% chance of going extinct in 100 years
- **Near Threatened**: a species that does not quite meet the criteria for inclusion into any of the above categories, but which is likely to enter the Vulnerable category in the near future

The remaining species fall into the following categories: Least Concern (the majority of species); Data Deficient; and Rare or Peripheral.

The checklist for the study area (Appendix 1) includes 14 species (7%) that are threatened in Namibia (Brown *et al*. 2017). This represents 20% of the 71 species that are on the Namibian Red Data List. Nine of these species are also Globally Threatened (IUCN 2024).

For the study area, these 14 Red-listed species include two that are Critically Endangered, seven that are Endangered, one that is Vulnerable and four that are Near Threatened; and comprise ten raptors, three large terrestrial species, and one wetland-associated species.

The 14 Red-listed species are as follows:

- White-backed Vulture (Critically Endangered, also Globally Critically Endangered)
- Cape Vulture (Critically Endangered, also Globally Vulnerable; now rare in Namibia)

- Ludwig's Bustard (Endangered, also Globally Endangered)
- Lappet-faced Vulture (Endangered, also Globally Endangered)
- Martial Eagle (Endangered, also Globally Endangered)
- Black Harrier (Endangered, also Globally Endangered)
- Tawny Eagle (Endangered, also Globally Vulnerable)
- Booted Eagle (Endangered)
- Black Stork (Endangered)

- Secretarybird (Vulnerable, also Globally Endangered)

- Kori Bustard (Near Threatened, also Globally Near Threatened)
- Verreaux's Eagle (Near Threatened)
- Peregrine Falcon (Near Threatened)
- Marabou Stork (Near Threatened)

A number of the above species have small population numbers in Namibia, and may be in decline, already under threat.

It should be noted that large birds that collide with power lines, such as vultures and other raptors, bustards and flamingos, have been identified as one of four major groups of birds classed as threatened in Namibia (Simmons *et al*. 2015). The Namib Desert is an epi-centre for the Lappet-faced Vulture in this country (also see Section 4.2.7 below for satellite tracking data).

4.2.3 Endemism

The Naukluft mountains are part of the high-rising escarpment that marks the western edge of the interior highlands of Namibia. A high level of endemism is associated with this formation, which includes a suite of endemic and near-endemic birds that have individual ranges exceeding 50,000 km² (Simmons *et al*. 2001).

The checklist for the study area includes one species that is a full Namibian endemic (with 100% of the population in this country); and at least five other species that are near-endemic to Namibia, with at least 90% of the populations occurring within the country (Appendix 1). The above checklist also includes a number of species that are endemic or near-endemic to southern Africa; however, the focus in this study is on those species that are near-endemic to Namibia, which the country has a special responsibility to conserve.

Endemism or having a limited distribution renders populations more vulnerable to threats.

The Namibian full-endemic species is:

- Dune Lark

The five recorded Namibian near-endemic species are as follows:

- Rüppell's Korhaan
- Monteiro's Hornbill
- Herero Chat
- Rockrunner
- White-tailed Shrike

The recorded level of endemism in the study area is considered relatively moderate (rank 3 on a scale of 5; Figure 16).

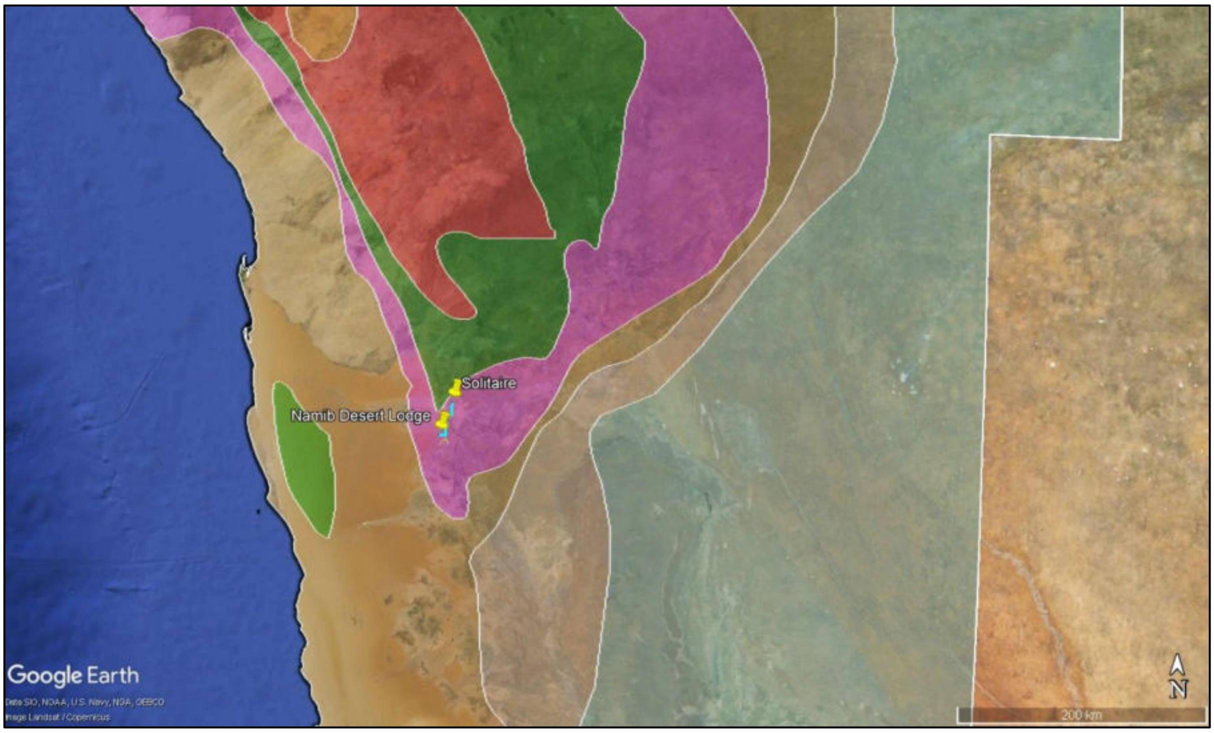


Figure 16. Bird species endemism in the study area is regarded as relatively moderate (rank 3 on a scale of 5; Atlas of Namibia Team 2020; based on a Google Earth map, EIS 2024).

4.2.4 Migrant status (Red Data species) and nomadism

The checklist includes one large terrestrial bird species and four raptors with migrant status, two Red-listed (Appendix 1; see above), namely:

- Ludwig's Buistard (partial migrant; Endangered, also Globally Endangered)
- Booted Eagle (Palearctic migrant; Endangered)
- Common Buzzard (Palearctic migrant)
- Black Kite (Palearctic migrant)
- Yellow-billed Kite (intra-African migrant)

Several other (Red Data) species are nomadic or make extensive movements, including the vulture species and the bustards. Other (non-Red data) migrant species also occur, including Lanner Falcon (with both resident and migratory populations); and Namaqua Sandgrouse and Double-banded Sandgrouse (migrant/partial migrant).

Nomadic/migrant habits result in high mobility and consequently increase the risk of impacts such as collisions on overhead structures. It should be emphasised that both short-distance and longer bird movements are possible. This is particularly true under the changing conditions associated with the desert habitat. For much of the time, and even for years on end, there are very few birds in ephemeral river systems, and their importance as a bird habitat could then easily be under-estimated. During and after times of good rains and occasional flooding, the habitats are transformed. Extensive nomadic movements take place and birdlife increases accordingly, and this is reflected in the SABAP data over the longer term. The largest numbers of birds are potentially found in the area between October and April, when summer migrant species may be present, and especially after good rains.

Large groups of up to to 80 Ludwig’s Bustards were observed on farm Solitaire in June 1986, and around 100 in June 1987 on farm Gorrasis (part of NamibRand Nature Reserve, south of Solitaire; Bridgeford 1988). Both sightings were on grassy plains, where the bustards were feeding opportunistically following the emergence of locusts in hopper stage.

4.2.5 Breeding birds

Limited evidence of actively breeding birds was obtained during the site visit for the present study (March 2024), owing to the very dry conditions.

Large, active Sociable Weaver nests were recorded from time to time in the large, old, deep-rooted *Acacia* (*Vachellia*) *erioloba* camel-thorn trees in some of the watercourses and closer to the mountains (Figure 17). This bird species has the potential to nest on any suitable nesting structures, such as the proposed 33 kV HLPCD power line poles and associated structures, with the potential to cause outages during wet weather.

Nesting habitats for raptors and other species are also present on the cliffs of the petrified dune system at Namib Desert Lodge (Figure 17).

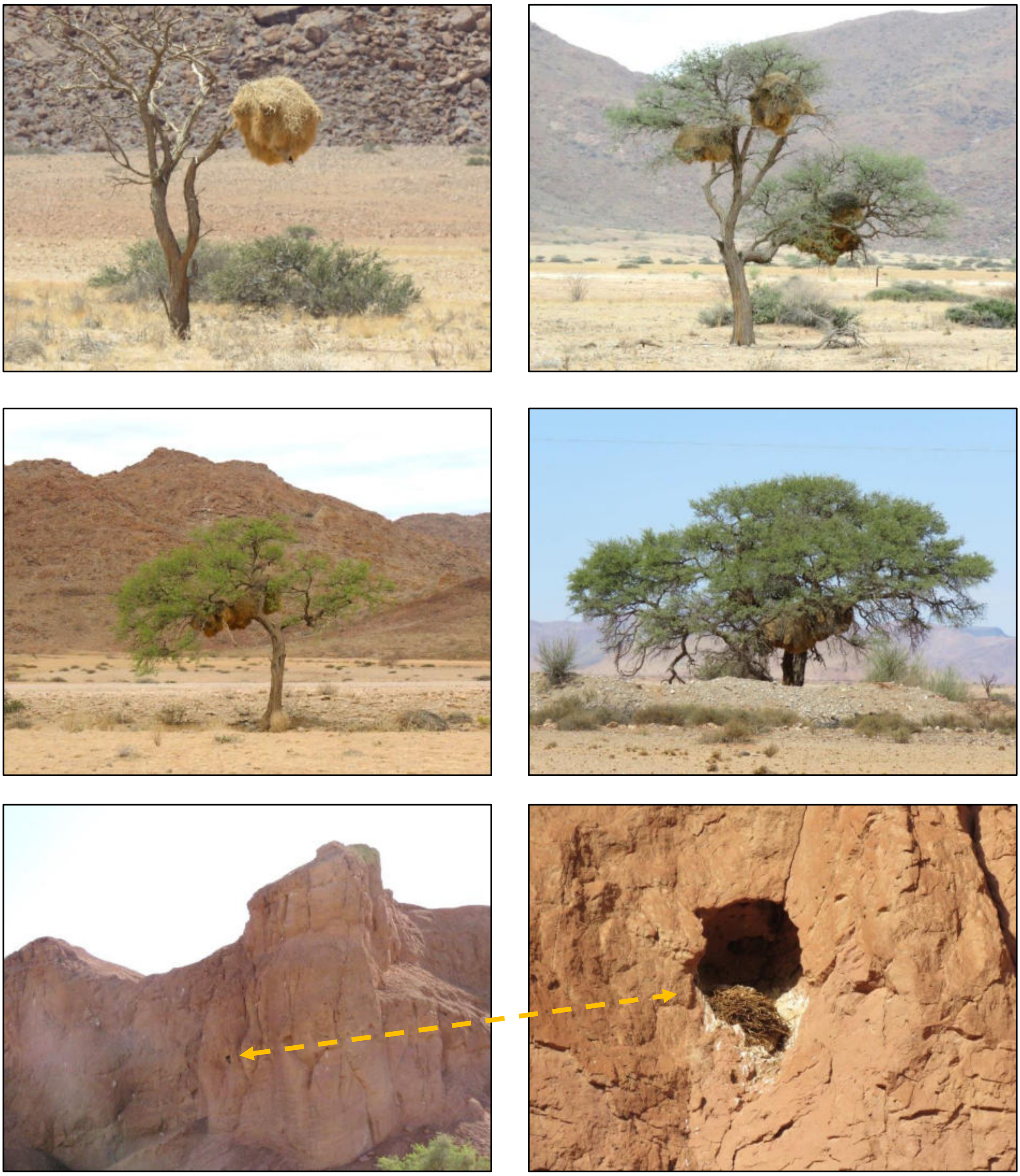


Figure 17 a-d. Examples of large, active Sociable Weaver nests in the large, old, deep-rooted *Acacia* (*Vachellia*) *erioloba* camel-thorn trees in some of the watercourses and closer to the mountains.

Figure 17 e-f. Nesting habitats for raptors and other species on the cliffs of the petrified dune system at Namib Desert Lodge.

4.2.6 Sensitivity to power line interactions

Bird species may be sensitive, in varying degrees, to power line impacts such as collision, electrocution and/or disturbance and habitat destruction. The incidence of Red Data power line-sensitive bird species per QDS (i.e. 4-7 species per QDS [excluding species that cause nesting impacts]; based in SABAP1 data) in the greater study area is shown in Figure 18. The sensitivity in the southern part of the study area is slightly higher than in the northern part.

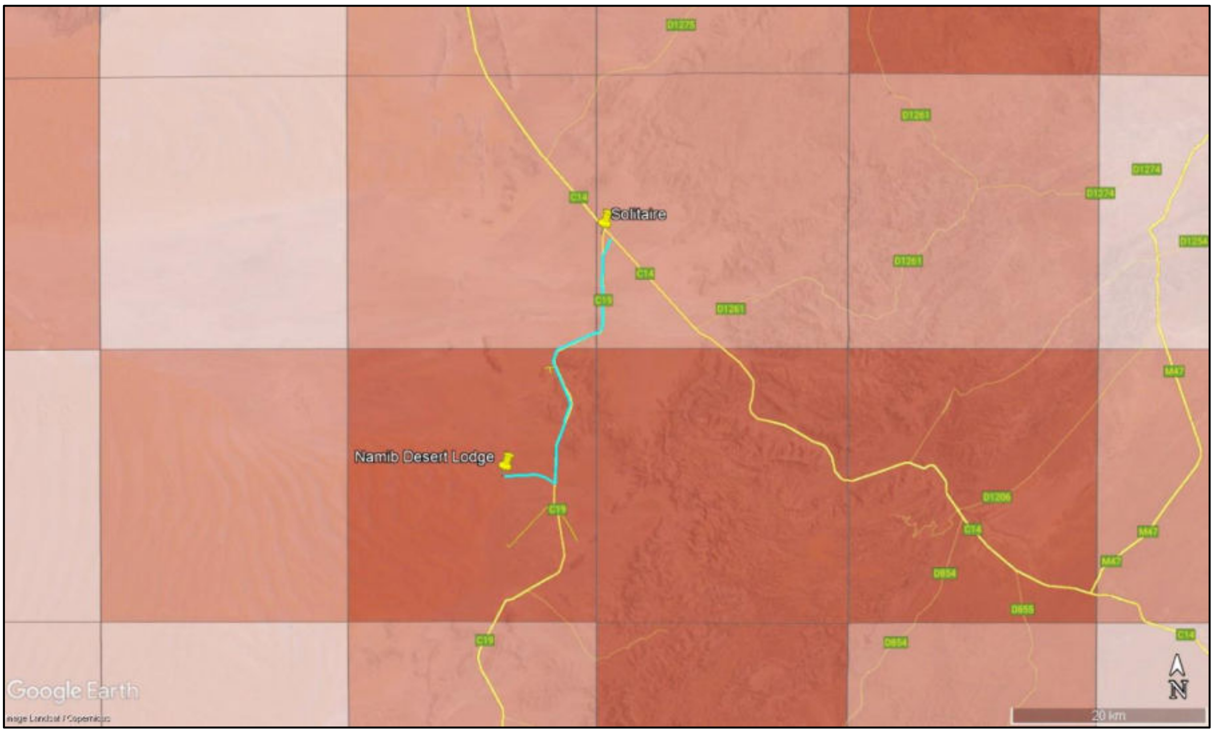


Figure 18. Relative occurrence of power line-sensitive Red Data bird species in the greater study area (based on SABAP1 data; 4-7 spp per QDS; range of sensitivity from low [light] to high [dark]; EIS 2024).

Examples of power line-sensitive species in the study area

Examples of the distribution of some of the power line-sensitive species in the study area are shown below (Figure 19-24), based on more recent SABAP2 data.

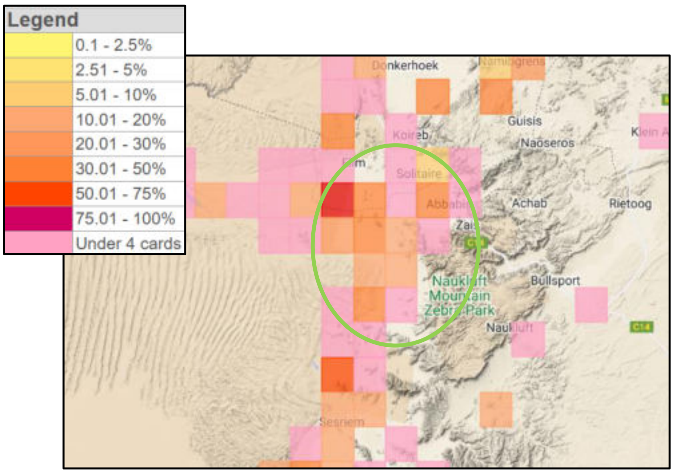


Figure 19. Reporting rates for Ludwig's Bustard in the greater study area (SABAP2 2024).

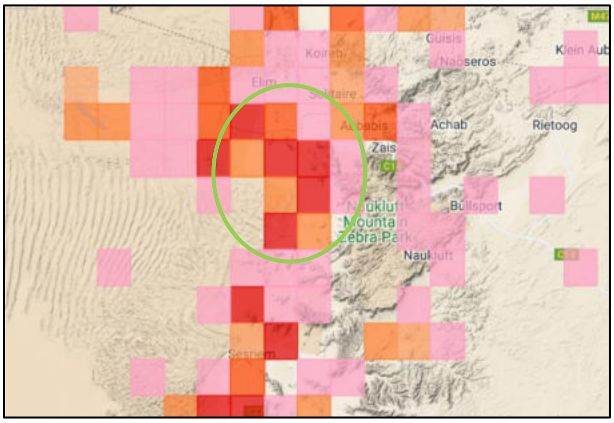


Figure 20. Reporting rates for Rüppell's Korhaan in the greater study area (SABAP2 2024).

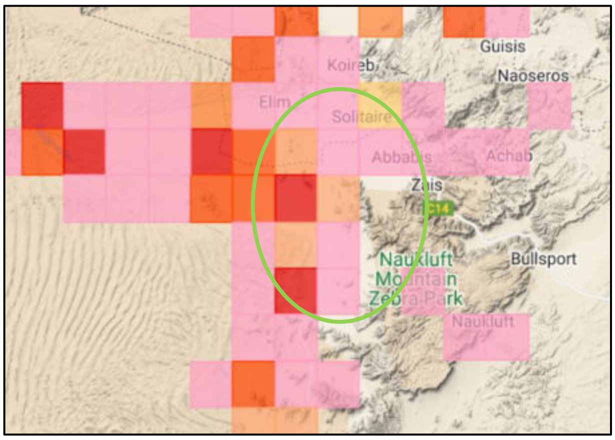


Figure 21. Reporting rates for Lappet-faced Vulture in the greater study area (SABAP2 2024).

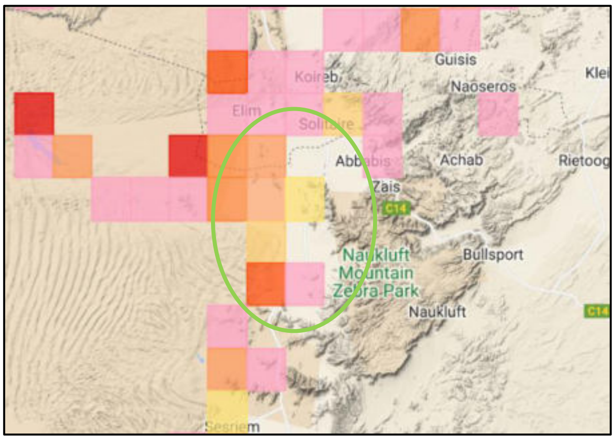


Figure 22. Reporting rates for White-backed Vulture in the greater study area (SABAP2 2024).

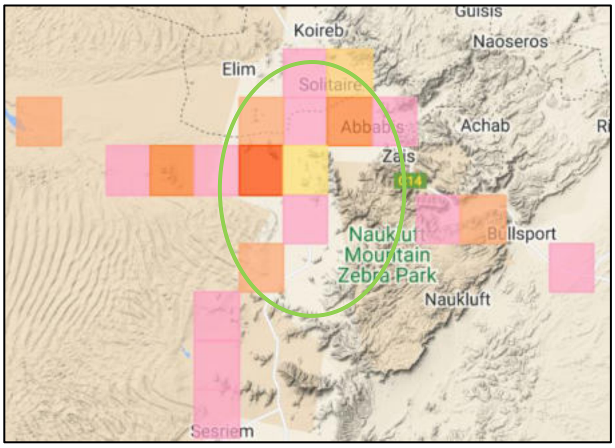


Figure 23. Reporting rates for Martial Eagle in the greater study area (SABAP2 2024).

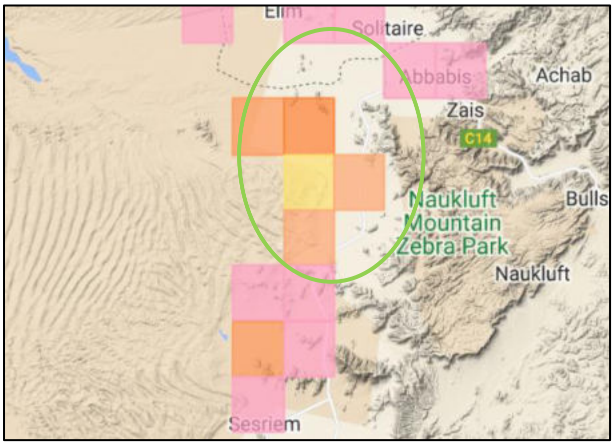


Figure 24. Reporting rates for Secretarybird in the greater study area (SABAP2 2024).

Power line incidents on record for Namibia

The NamPower/Namibia Nature Foundation Strategic Partnership (http://www.nnf.org.na/project/nampowernnf-partnership/13/5/5.html) has documented wildlife and power line incidents from 2009 to the end of 2020, involving some 847 animals, mostly birds and mostly collisions, but also electrocutions (EIS 2024). Due to the difficulty of obtaining records in bush-encroached areas (especially in the northern and north-eastern parts of the country, including in the study area), low reporting rates and the high scavenging rates in general, it is likely that the incidents observed are an under-estimate.

Most of the incidents throughout the country have involved flamingos (39%) and bustards/korhaans (27%; Figure 25 & 26). A further 11% have involved raptors, mainly vultures as well as eagles, snake-eagles and owls; and 11% have involved other waterbirds. Most of the incidents involving Lappet-faced Vulture and White-backed Vulture (33 individuals) have comprised electrocution on low-voltage distribution structures; however, collisions are an ongoing concern. No power line survey data are available for the study area; however, a local landowner has commented that they have never found any incidents when travelling along the existing 33 kV line (K Schulze Neuhoff pers. comm. 2024).
High mobility of bird species, e.g. among ephemeral resources, may render them prone to power line interactions. Bustards are susceptible to collisions due to their nomadic habits, a large body size with low manoeuvrability, and a visual "blind spot" when flying forwards (Martin & Shaw 2010, Martin 2011). This proneness to collision has also been demonstrated in vultures, storks, snake-eagles and other groups.

A comparative power line survey of around 100 km on a 33 kV HLPCD structure in the greater study area (Aroab-Koës distribution line, 2013) resulted in six incidents (0.06 incidents/km), including four bustards and one flamingo collision, and one vulture electrocution (Figure 27; NamPower/NNF Strategic Partnership database, EIS 2024).

Power line surveys for the present area

Power line surveys were carried out during the present study, as follows:

- 25.4 km of existing 19 kV SWER line (also the proposed route of the new 33 kV line)
- 11.3 km of the existing 33 kV HLPCD line.

Indications of four possible past incidents on the 19 kV line were as follows (Figure 28):

- Ring-necked (Cape Turtle) Dove (24.03115S 15.69494E; likely collision incident)
- Three separate, old feathers of Ludwig's Bustard/Ruppell's Korhaan (24.013983S 15.958565E and 24.959113S 15.959113E; suspected/possible incidents)

This results in a mean of 0.16 incidents/km for the 19 kV and 0 incidents/km for the 33 kV line. Incidents are likely to be underestimated, due to the suspected high scavenging activity in the area, and the harsh environmental conditions.

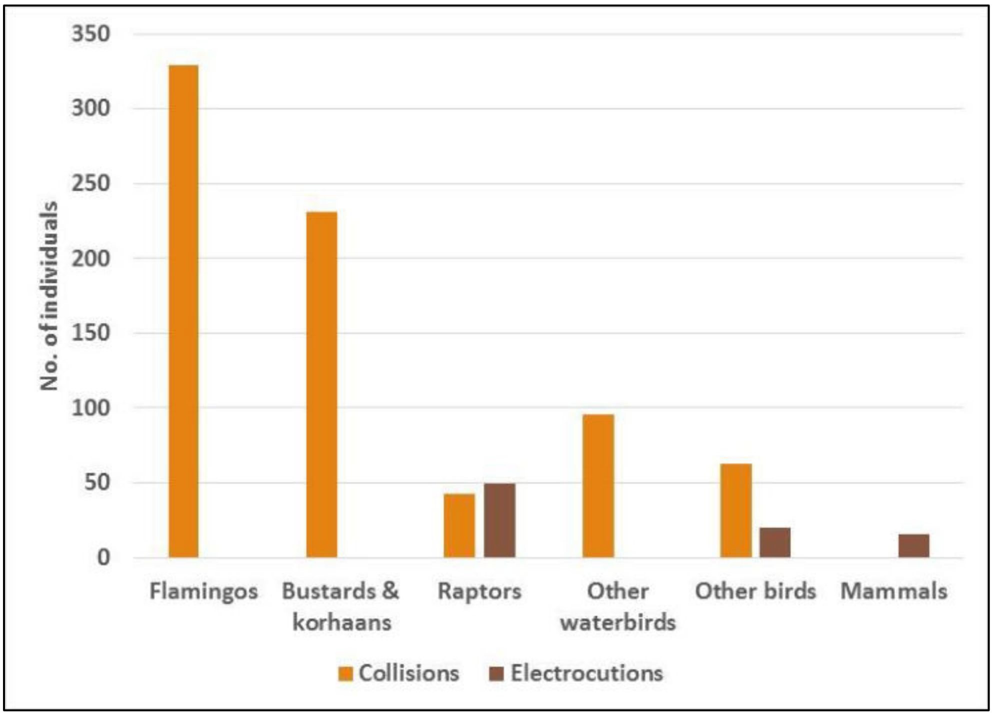


Figure 25. Numbers of birds and other wildlife involved in power line collision/electrocution incidents in Namibia, 2009-2020 (n = 847 individuals; NamPower/NNF Strategic Partnership data; EIS 2024).

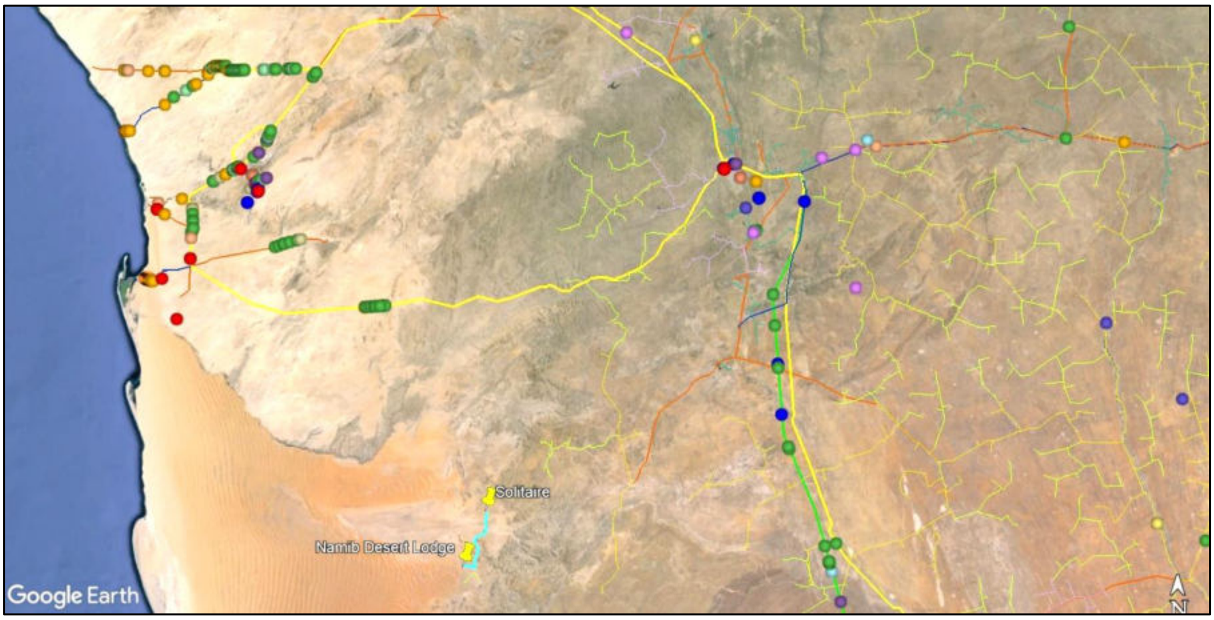


Figure 26. Power line incidents on record for the greater study area in Central Namibia, 2009-2020 (n = 732 individuals; NamPower/NNF Strategic Partnership data; EIS 2024; green = bustards/korhaans, dark blue = raptors; purple = vultures, pink = flamingos, red = other waterbirds).

Figure 27 a-c. Examples of recorded power line incidents on a 33 kV structure in the greater study area (Aroab-Koës, 2013): Lappet-faced Vulture electrocution (left and top right); Kori Bustard (juvenile) collision (bottom right).

Figure 28 a-d. (Likely) collision of Ring-necked (Cape Turtle) Dove recorded in the study area in March 2024 (top left); and potential/suspected collisions of three bustards/korhaans, indicated by weathered single feathers.

4.2.7 Potential flight paths/flyways

Vultures

Lappet-faced Vultures have been satellite tracked in Namibia by Vultures Namibia and the Ministry of Environment, Forestry and Tourism (MEFT) since 2018 (see Kolberg 2023, and preceding issues of *Lanioturdus*; www.movebank.org). The results for 34 tracked individuals to date indicate considerable movement over the greater study area, although flying activity is higher in the west, and lower over the Naukluft mountains in the east (Figure 29).

Potential local flight paths for Ludwig's Bustard between observed distribution localities are shown in Figure 30 (K Stürm pers. comm. 2024). No tracking data are available for the species.

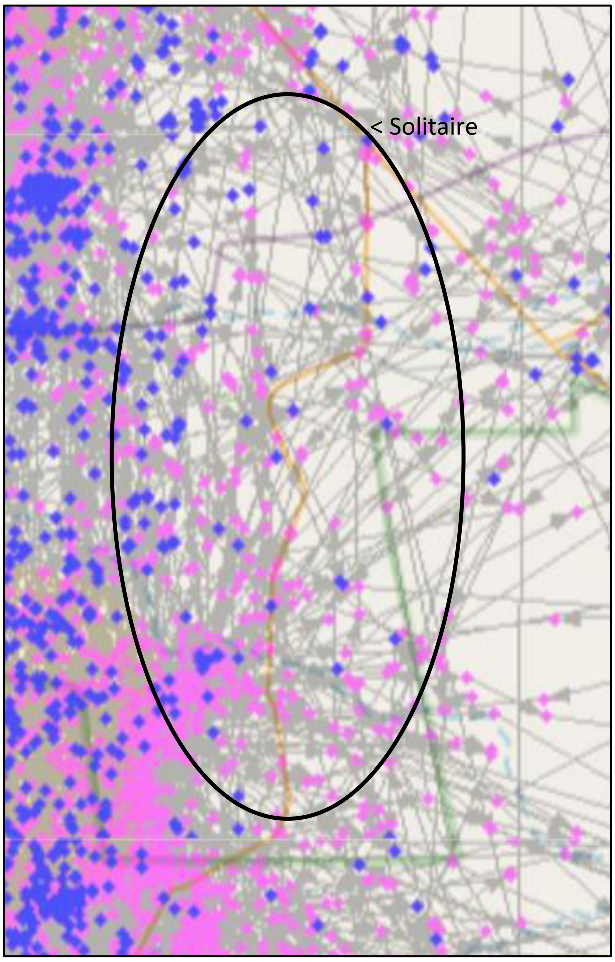


Figure 29. The results for 34 satellite-tracked Lappet-faced Vulture individuals to date indicate considerable movement over the greater study area (www.movebank.org; Kolberg 2023, and preceding issues of *Lanioturdus*).

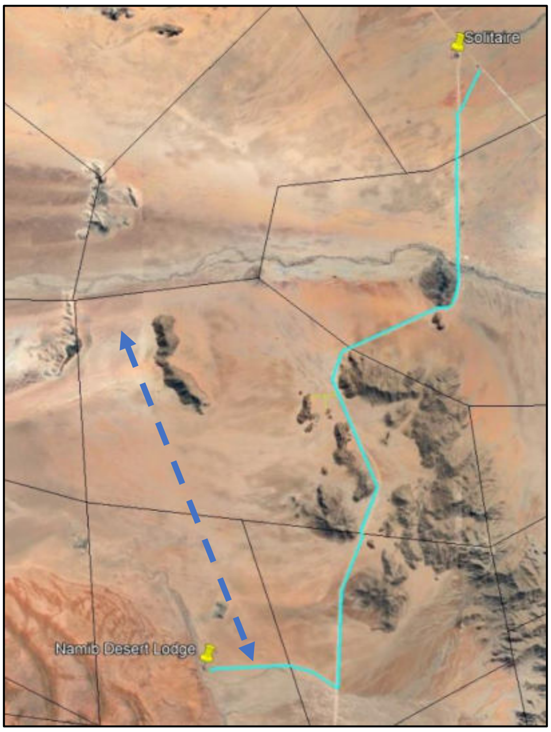


Figure 30. Potential local flight paths for Ludwig's Bustard between observed distribution localities (blue arrow; K Stürm pers. comm. 2024).

4.3 Bird species at risk

4.3.1 Introduction: identification of priority species

As mentioned above, risk assessment and mitigation efforts are directed towards priority species, namely those that have a high biological significance, i.e. primarily Red Data species (including any with migrant status) and/or endemic or near-endemic species.

Of the 208 bird species on the checklist (Appendix 1), 53 potential priority species were initially identified as being at risk in terms of the proposed project (Table 2 below).

Due to the above high numbers of species potentially at risk in the study area, a total of 21 priority bird species was then short-listed (Table 3), as a focal group considered at higher risk to potential impacts resulting from the proposed project. This short-listing takes into account the probability of the species occurring in the study area and surrounds (using an index of local abundance, on a scale of very low-high), and hence their vulnerability to impacts in the area.

Although the focus of the impact assessment is on the above short-listed species, the full priority list still needs to be taken into account, due to the relatively high species numbers and the difficulty in predicting those likely to be impacted, especially those with very small, marginal populations. The emphasis for assessment should be on groups of birds likely to be at risk, rather than on individual species; and the precautionary principle should prevail. Note that only selected (e.g. Red Data and raptor) migrant species are listed; other migrant species also occur in the area.

Groups of birds at risk

The above short-listed species fall into the following groups.

Raptors (including eagles and vultures) play a key ecological role in ecosystems, being predators at the top of food webs. Vultures and some of the other raptor species tend to be congregatory. As a group, raptors are prone to power line interactions, including collision, electrocution (both direct and by "streamers" of excrement) and disturbance/habitat modification. They are long-lived and relatively slow to reproduce and to replace themselves, and are already impacted by poisoning, habitat loss and energy supply interactions. At least 32 raptor species have been recorded in the greater study area.

Large terrestrial bird species, including larger (cursorial/striding) species such as bustards and korhaans, as well as medium-sized hornbills, sandgrouse and spurfowl/francolins are also collision-prone.

Migrant species (both terrestrial and aquatic; included under the above groups) are at higher risk to impacts, due to their mobility. Some migrant species tend to be congregatory.

Smaller **near-endemic species**, with specific habitat requirements and therefore a restricted distribution, are also subject to habitat destruction and disturbance impacts.

Waterbirds are particularly susceptible to collisions due to their habit of flying at night or under conditions of poor light, often in groups and at speed; however, the incidence of waterbirds is low in the present environment.

A final group of (non-priority) bird species has the potential to **impact on infrastructure**, by their perching, nesting and/or other activities, e.g. Sociable Weaver, Pied Crow.

Table 2. Potential priority bird species at risk from the proposed 33 kV Naukluft Electricity distribution power line

(also see Appendix 1 for scientific names of bird species)

53 species

KEY:

RDB = Red Data/conservation status (Brown *et al*. 2017) CE = Critically Endangered, EN = Endangered, VU = Vulnerable, NT = Near Threatened, LC = Least Concern; G = global status; rare = now rare in Namibia

END = Endemism: (Brown *et al*. 2017): E = full endemic (100% of population in Namibia); NE = near-endemic (≥90% of population in Namibia); Nam = Namibia

RES = Residency (for Red Data species): Res = resident, Nom = nomadic, Mig = (Red Data) species that have migrant status, Pal = Palearctic-breeding, intra-Afr mig = intra-African migrant, mov = local/seasonal movements

Codes: R = raptor; T = large terrestrial bird

SABAP1 NAD: Southern African Bird Atlas Project 1 and other data, available on Namibian Avifaunal Database (NAD; www.biodiversity.org.na; 4 QDSs)

SABAP1 EIS: Southern African Bird Atlas Project 1 data that was published as Harrison *et al.* (1997), available on EIS 2024 (www.the-eis.com; 4 QDSs)

SABAP2: Southern African Bird Atlas Project 2 data, available on http://sabap2.adu.org.za; 5 pentads)

Pers obs: personal observations (including March 2024)

Local abundance: based on SABAP1 & SABAP2 data and personal observations (scale H = high; M = moderate; L = low; VL = very low/improbable)

Priority species potentially at higher risk from the project are highlighted

Common group	Common species	Sensitivity	SABAP1		SABAP2					Pers obs	Local abundance
					Solitaire	Ababis	NNL	NDL	DG		
			NBD	EIS	2350_1600	2355_1605	2400_1555	2405_1550	2410_1550		
A. Red Data species and migrant raptors (17)											
Vulture	**White-backed**	R, CR, G CR	√	√	2022	2020	2023	2023	2023		H
Vulture	**Lappet-faced**	R, EN, G EN	√	√	2019	2020	2023	2023	2024		H
Bustard	**Ludwig's**	T, EN, G EN, part mig	√	√	2021	2019	2023	2023	2023	(2021)	H
Eagle	**Martial**	R, EN, G EN	√	√	2022	2015	2021		2023		M-H
Eagle	Booted	R, EN, Pal mig		√	2022	2022			2019		L-M
Secretarybird	Secretarybird	R, VU, G EN	√	√		2019		2017	2022		L-M
Eagle	Verreaux's	R, NT	√	√		2019	2020				L
Falcon	Peregrine	R, NT							2019		L
Kite	Black	R, Pal mig	√				2021				L
Vulture	Cape	R, CR, G VU (now rare in Nam)	√						2019		VL
Harrier	Black	R, EN, G EN	√	√							VL
Eagle	Tawny	R, EN, G VU	√	√							VL
Stork	Black	A, EN	√	√		2013					VL
Bustard	Kori	T, NT, G NT	√	√							VL
Stork	Marabou	NT		√							VL
Buzzard	Common (Steppe)	R, Pal mig		√							VL
Kite	Yellow-billed	R, intra-Afr mig	√						2018		VL

Common group	Common species	Sensitivity	SABAP1		SABAP2					Pers obs	Local abundance
					Solitaire	Ababis	NNL	NDL	DG		
			NBD	EIS	2350_1600	2355_1605	2400_1555	2405_1550	2410_1550		
B. Namibian endemic/ near-endemic species (6)											
Korhaan	**Rüppell's**	T; NamNE	√	√	2022	2023	2024	2023	2023	2024	H
Lark	Dune	NamE						2023	2021		M
Chat	Herero	NamNE	√	√			2023				L
Rockrunner		NamNE	√	√			2019				L
Shrike	White-tailed	NamNE	√	√		2023					L
Hornbill	Monteiro's	NamNE	√	√							VL
C. Other power line-prone raptors (19)											
Eagle	**Black-chested Snake**	R	√	√	2022	2023	2022	2020	2024		H
Goshawk	**Pale Chanting**	R; sA NE	√	√	2023	2023	2022	2023	2023	2024	H
Kestrel	**Greater**	R	√	√	2021	2021	2022	2022	2023	2024	H
Kestrel	**Rock**	R		√	2022	2022	2023	2023	2023	2024	H
Falcon	**Lanner**	R; res + mig populations	√	√	2022	2019	2023	2022	2023		H
Falcon	**Pygmy**	R	√	√	2022	2020	2023	2023	2022		H
Buzzard	**Augur**	R	√	√	2018		2023	2014			M-H
Buzzard	**Jackal**	R; sA NE	√	√			2023		2019		M-H
Eagle-Owl	**Spotted**	R	√	√		2020	2022	2023	2019		M-H
Falcon	**Red-necked**	R	√					2019	2024		M-H
Owlet	**Pearl-spotted**	R	√	√		2023	2021	2015	2018		M-H
Goshawk	Gabar	R		√				2019	2019		M
Hawk-eagle	African	R		√	2016	2013	2020	2020	2019		M
Kite	Black-winged	R	√	√				2013	2022		M

Common group	Common species	Sensitivity	SABAP1		SABAP2					Pers obs	Local abundance
					Solitaire	Ababis	NNL	NDL	DG		
			NBD	EIS	2350_1600	2355_1605	2400_1555	2405_1550	2410_1550		
Owl	Western Barn	R	√	√	2012	2019	2022	2022	2020		M
Owl	Southern White-faced Scops	R		√				2020	2014		L
Eagle-Owl	Verreaux's	R						2022			L
Owl	African Scops	R	√								VL
Shikra		R	√								VL
D. Other power line-sensitive species (11)											
Sandgrouse	**Namaqua**	T; partial mig; sA NE; nom	√	√	2019	2019	2023	2023	2023	2024	H
Sandgrouse	**Double-banded**	T; partial mig; sA NE; nom	√	√	2017	2023	2023	2017	2020		H
Guineafowl	**Helmeted**	T	√	√	2018	2023	2023	2023		2024	H
Scimitarbill	**Common**	T	√	√	2021	2023	2023	2023	2023		H
Lovebird	**Rosy-faced**	T; sA NE	√	√	2022	2023		2023	2023		H
Hornbill	African Grey	T	√	√		2017			2019		M
Hornbill	Southern Yellow-billed	T	√	√	2015			2017		2024	M
Korhaan	Northern Black	T		√	2010	2020			2018		M
Quail	Common	T					2022	2022	2022		M
Korhaan	Karoo	T	√	√			2018		2012		L
Spurfowl	Red-billed	T		√	2012			2019			L
E. Species that could impact on power line infrastructure due to nesting and other activities											
Crow	**Pied**	Nesting	√	√	2023	2020	2023	2023	2024	2024	H
Crow	**Cape**	Nesting	√	√	2023		2022	2023	2023		M-H
Weaver	**Sociable**	Nesting	√	√	2023	2023	2023	2023	2024	2024	H

Table 3. Short-listed priority bird species that are regarded as potentially at risk from the proposed 33 kV Naukluft Electricity distribution power line

(also see Appendix 1 for scientific names of bird species)

21 species

KEY:

RDB = Red Data/conservation status (Brown *et al*. 2017) CE = Critically Endangered, EN = Endangered, VU = Vulnerable, NT = Near Threatened, LC = Least Concern; G = global status; rare = now rare in Namibia

END = Endemism: (Brown *et al*. 2017): E = full endemic (100% of population in Namibia); NE = near-endemic (≥90% of population in Namibia); Nam = Namibia

RES = Residency (for Red Data species): Res = resident, Nom = nomadic, Mig = (Red Data) species that have migrant status, Pal = Palearctic-breeding, intra-Afr mig = intra-African migrant, mov = local/seasonal movements

Codes: R = raptor; T = large terrestrial bird

SABAP1 NAD: Southern African Bird Atlas Project 1 and other data, available on Namibian Avifaunal Database (NAD; www.biodiversity.org.na; 4 QDSs)

SABAP1 EIS: Southern African Bird Atlas Project 1 data that was published as Harrison *et al.* (1997), available on EIS 2024 (www.the-eis.com; 4 QDSs)

SABAP2: Southern African Bird Atlas Project 2 data, available on http://sabap2.adu.org.za; 5 pentads)

Pers obs: personal observations (including March 2024)

Local abundance: based on SABAP1 & SABAP2 data and personal observations (scale H = high; M = moderate; L = low; VL = very low/improbable)

Potential impact (for main priority species): D = disturbance; H = habitat modification/destruction; C = collisions on power line infrastructure; E = electrocutions on power line infrastructure; N = impacts caused by creation of novel habitats (for perching, nesting etc.); "power line-prone" indicates a susceptibility to the above impacts associated with the construction of power lines

Probability of impact (also taking into account local abundance; impacts on power line as well as associated transformer structures): H = high; M = moderate; L = low; VL = very low/improbable

Common group	Common species	Sensitivity	SABAP1		SABAP2					Pers obs	Local abun-dance	Potential impact (and probability)
					Solitaire	Ababis	NNL	NDL	DG			
			NBD	EIS	2350_1600	2355_1605	2400_1555	2405_1550	2410_1550			
A. Red Data species and migrant raptors (4)												
Vulture	Lappet-faced	R, EN, G EN	√	√	2019	2020	2023	2023	2024		H	C E D H (H)
Vulture	White-backed	R, CR, G CR	√	√	2022	2020	2023	2023	2023		H	C E D H (H)
Bustard	Ludwig's	T, EN, G EN, part mig	√	√	2021	2019	2023	2023	2023	(2021)	H	C D (H)
Eagle	Martial	R, EN, G EN	√	√	2022	2015	2021		2023		M-H	C E D (M)
B. Namibian endemic/near-endemic species (1)												
Korhaan	Rüppell's	T; NamNE	√	√	2022	2023	2024	2023	2023	2024	H	C D (H)
C. Other power line-prone raptors (11)												
Eagle	Black-chested Snake	R	√	√	2022	2023	2022	2020	2024		H	C E D H (H)
Goshawk	Pale Chanting	R; sA NE	√	√	2023	2023	2022	2023	2023	2024	H	C E D H (M-L)
Kestrel	Greater	R	√	√	2021	2021	2022	2022	2023	2024	H	
Kestrel	Rock	R		√	2022	2022	2023	2023	2023	2024	H	
Falcon	Lanner	R; res + mig populations	√	√	2022	2019	2023	2022	2023		H	
Falcon	Pygmy	R	√	√	2022	2020	2023	2023	2022		H	
Buzzard	Augur	R	√	√	2018		2023	2014			M-H	
Buzzard	Jackal	R; sA NE	√	√			2023		2019		M-H	
Eagle-Owl	Spotted	R	√	√		2020	2022	2023	2019		M-H	
Falcon	Red-necked	R	√					2019	2024		M-H	
Owlet	Pearl-spotted	R	√	√		2023	2021	2015	2018		M-H	

Common group	Common species	Sensitivity	SABAP1		SABAP2					Pers obs	Local abun-dance	Potential impact (and probability)
					Solitaire	Ababis	NNL	NDL	DG			
			NBD	EIS	2350_1600	2355_1605	2400_1555	2405_1550	2410_1550			
D. Other power line-sensitive species (5)												
Sandgrouse	Namaqua	sA NE; Partial mig; nom	√	√	2019	2019	2023	2023	2023	2024	H	C, D (H)
Sandgrouse	Double-banded	sA NE; Partial mig; nom	√	√	2017	2023	2023	2017	2020		H	C, D (H)
Guineafowl	Helmeted		√	√	2018	2023	2023	2023		2024	H	C, E (H)
Scimitarbill	Common		√	√	2021	2023	2023	2023	2023		H	C, E (M)
Lovebird	Rosy-faced	sA NE	√	√	2022	2023		2023	2023		H	C (M)
E. Species to impact on power line infrastructure due to nesting and other activities												
Crow	Pied	Nesting	√	√	2023	2020	2023	2023	2024	2024	H	N (H)
Crow	Cape	Nesting	√	√	2023		2022	2023	2023		M-H	N (M-H)
Weaver	Sociable	Nesting	√	√	2023	2023	2023	2023	2024	2024	H	N (H)

4.3.2 Details of priority bird species

Due to the high species richness of the study area, 53 potential priority bird species (Table 2) have been short-listed to a total of 21 priority species (Table 3), as a focal group identified as being at higher risk to potential impacts resulting from the proposed project. As mentioned above, this short-listing takes into account the probability of the species occurring in the study area and surrounds (using an index of local abundance), and hence their vulnerability to impacts in the area.

Although the focus of the impact assessment is on the short-listed species, the full priority list still needs to be taken into account (see above; Table 2).

Priority species observed during the site visit, under very dry conditions, in March 2024 are shown in Figure 31 below.

The total of 21 short-listed priority species falls into the following groups:

Red Data species and migrant raptors (4)

- **Lappet-faced Vulture** (Endangered, also Globally Endangered; scavenging raptor, congregatory; resident, with extensive movements in non-breeding birds; power line-prone; local abundance high)
- **White-backed Vulture** (Critically Endangered, also Globally Critically Endangered; scavenging raptor, congregatory; resident, with large-scale movements, especially in juveniles; power line-prone; local abundance high)
- **Ludwig's Bustard** (Endangered, Globally Endangered; southern African near-endemic [40% of population in Namibia]; large terrestrial bird; local movements, nomadic [sometimes in large groups of up to 100 birds in the Namib], partial migrant; highly collision-prone; local abundance high)
- **Martial Eagle** (Endangered, also Globally Endangered; raptor, resident; power line-prone; local abundance medium-high)

Species near-endemic to Namibia (1)

- **Rüppell's Korhaan** (near-endemic to Namibia; sedentary/nomadic; power line-prone; local abundance high)

Other non-Red Data raptor species that are power line-prone (11)

- **Black-chested Snake Eagle** (resident, nomadic; local abundance high)
- **Southern Pale Chanting Goshawk** (southern African near-endemic [30% of population in Namibia]; resident; sedentary, with local movements; electrocution-prone; local abundance high)
- **Greater Kestrel** (resident; local abundance high)
- **Rock Kestrel** (resident; local abundance high)
- **Lanner Falcon** (resident + migratory populations; local abundance high)
- **Pygmy Falcon** (resident, uses nests of Sociable Weavers; local abundance high)
- **Augur Buzzard** (resident, nomadic; local abundance medium-high)
- **Jackal Buzzard** (southern African near-endemic [<5% of population in Namibia]; mostly sedentary; local abundance medium-high)
- **Spotted Eagle-Owl** (resident; local abundance medium-high)

- **Red-necked Falcon** (resident, nomadic; local abundance medium-high)
- **Pearl-spotted Owlet** (resident; local abundance medium-high)

Other (larger) terrestrial bird species that are power line-prone (5)

- **Namaqua Sandgrouse** (southern African near-endemic [45% of population in Namibia]; resident, nomadic, partial migrant; local abundance high)
- **Double-banded Sandgrouse** (southern African near-endemic [35% of population in Namibia]; resident, nomadic, (partial) migrant; local abundance high)
- **Helmeted Guineafowl** (local abundance high)
- **Common Scimitarbill** (local abundance high)
- **Rosy-faced Lovebird** (southern African near-endemic [80% of population in Namibia]; local abundance high)

Other (mostly non-priority) species with the potential to cause impacts on infrastructure

Several other (mostly non-priority) bird species have the potential to impact on power line structures through their perching, nesting and other activities, which may impact on the power supply. All breed readily on artificial structures including (distribution) power line poles, especially in view of the scarcity of suitable tall trees in the environment.

Examples include:

- **Pied Crow** (local abundance high; potential to increase in numbers, attracted by human activity/ novel resources)
- **Cape Crow** (local abundance medium-high)
- **Sociable Weaver** (local abundance high, likely to be seasonal)

Summary of priority bird species

The above total of 21 short-listed priority bird species include the following groups:

- 4 Red Data species (1 Critically Endangered, 3 Endangered; 3 species also Globally Endangered; 1 species partial migrant)
- 1 species near-endemic to Namibia

The above species also fall into the following groups:

- 14 raptor species (3 Red Data; 11 other non-Red Data priority raptor species)
- 7 large terrestrial bird species (one Red Data; one Namibian near-endemic; 5 other terrestrial species)

In addition: 3 other (non-priority) species with the potential to cause impacts on infrastructure (not included in the above totals)

All the above 21 priority bird species are potentially at risk to impacts on power line structures, including collisions, physical disturbance and habitat destruction/modification during the construction, and electrocution (including by streamers of excrement). These impacts are assessed in Section 5 below.

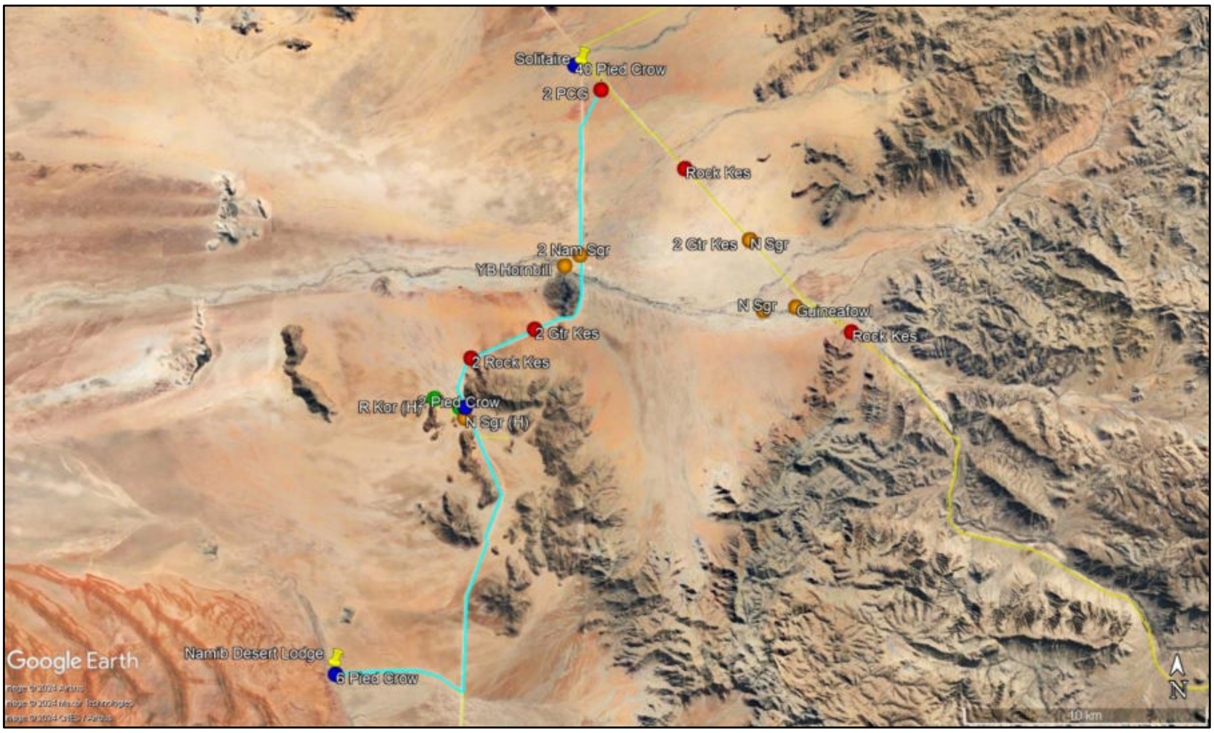


Figure 31. Priority species observed during the site visit, under very dry conditions, in March 2024 (red = raptors; green = korhaans; orange = sandgrouse; blue = crows).

5 Impact description and assessment, and recommendations for mitigation

5.1 Introduction

Details of the 21 priority bird species that could become affected by the impacts for the proposed 33 kV power line are included in Table 2 & 3 (and Section 4.3) above.

The above priority species are potentially at risk to the following impacts:

- Physical/human disturbance of birds
- Direct and indirect modification/loss/destruction of bird habitat
- Bird collisions with power line infrastructure
- Bird electrocutions on power line infrastructure
- Attraction of birds to novel habitats through the artificial provision of scarce resources

The above impacts are described and assessed below, and mitigation and management measures are recommended.

Note that, due to certain uncertainties regarding the specifics of local distribution and flight paths, the precautionary principle should apply.

The impact assessment is provided in Section 5.2 and summarised in Section 5.3 below. Alternatives are assessed in Section 5.4. Cumulative impacts are discussed in Section 5.5. Recommended monitoring protocols are described in Section 6.

Note on power line impacts

Electricity transmission and distribution grids are expanding rapidly worldwide, with significant recorded negative impacts on biodiversity and, in particular, on birds; however, some information gaps on impacts still need to be addressed (Bernardino *et al.* 2018).

The impacts of power line structures on avifauna and recommended mitigation measures are well documented, both globally and for the southern African subregion (e.g. Bevanger 1994, 1998; Lehman *et al.* 2007; Jenkins *et al.* 2010; Prinsen *et al.* 2011; Scottish Natural Heritage 2016; Simmons *et al.* 2015; Bernardino *et al.* 2018; Shaw *et al.* 2018; Bernardino *et al.* 2019; D'Amico *et al.* 2019; Gális, Ševčík 2019; Shaw *et al.* 2021, Silva *et al.* 2022). Of the potential impacts identified, bird collisions are one of the major concerns.

Impact assessment methodology

The impact assessment is based on the methodology of SLR Environmental Consulting (Namibia) (Pty) Ltd (SLR; 2023), following standard practice for determining impact consequence (combining intensity, extent, and duration) and impact significance (the overall rating of the impact).

Approach to mitigation

The recommended mitigation/management measures are based on the mitigation hierarchy (Bennun *et al.* 2021; see below), and are the responsibility of the proponent and contractors.

A key, underlying requirement is ongoing awareness and communication amongst relevant landowners/managers, and ongoing monitoring and periodic assessment of results, as part of an adaptive management approach.

Note that end-of-life/decommissioning management and mitigation follow the same principles as the construction phase, and are therefore not included in the project phases below.

According to international best practice, a hierarchical approach to mitigation is recommended, comprising four steps in sequence (Bennun *et al.* 2021). Implementing this hierarchy is an iterative (rather than a linear) process, that involves ongoing monitoring, incorporating the feedback into adaptive management where necessary. Avoidance and minimisation measures prevent or reduce impacts, whereas restoration and offset measures attempt to remedy impacts that have already taken place.

The mitigation hierarchy can be applied throughout a project's life cycle, from early planning and design, through to construction, operations and eventual decommissioning and repowering.

The mitigation hierarchy comprises the following steps:

- **Avoidance** is based on measures to anticipate and prevent the creation of impacts. Biodiversity risks need to be identified early in the project planning stages. Effective avoidance can occur through site selection (to ensure projects are not located in areas of high risk), project design (to locate infrastructure and select designs that avoid impacts) and scheduling (to ensure the timing of project activities is favourable for biodiversity).
- **Minimisation** refers to measures taken to reduce the duration, intensity and/or extent of impacts that cannot be completely avoided, as far as is practically feasible. Potential minimisation measures can be identified during early planning, and when developing design alternatives to be considered. Measures to minimise impacts can be applied throughout the project cycle.
  Minimisation actions fall into three broad categories:
  - **Physical controls:** adapting the physical design of project infrastructure to reduce potential impacts such as reducing habitat fragmentation through the installation of culverts or installing bird flight diverters on power lines.
  - **Operational controls:** measures taken to manage and regulate the actions of people, including project staff and contractors, such as restricting access to sensitive sites within the project area.
  - **Abatement controls:** steps taken to reduce levels of pollutants (e.g. light, noise, gases or liquids) that could have negative biodiversity impacts.
- **Restoration** refers to measures that aim to repair specific biodiversity features or ecosystem services damaged by project impacts that could not be completely avoided or minimised. Restoration is typically undertaken either during construction, or towards the end of a project as part of decommissioning and/or repowering.
- **Offsets** are measures to compensate for significant adverse residual impacts that cannot be avoided, minimised or restored. Offsets involve positive conservation interventions to generate biodiversity gains either through **avoided loss** (addressing threats to prevent predicted biodiversity loss) or **restoration** (for example, improving the quality of degraded habitat). Offsets can be complex and expensive to implement. Fortunately, most projects can usually avoid the need for offsets through careful siting and effective minimisation measures that reduce residual impacts to negligible levels.

5.2 Impact description and assessment, and recommendations for mitigation

5.2.1 Physical/human disturbance of birds, including road mortalities and poaching

Description of impact

Physical/human disturbance can impact potentially on birds during both the construction and operational phases, thereby affecting the presence and/or foraging and breeding success of key species (Jenkins *et al.* 2017). During the construction phase, vehicle and human activity on the site is at a peak, with high levels of disturbance. There is a potential for road mortalities, and for poaching of birds (including chicks) and eggs. Once operational, the amount of disturbance should decrease. Construction noise is not considered to cause long-term impacts since it is temporary, and daily construction activities will be limited to daytime hours.

Results of impact

The results of disturbance may be indirect or direct, and are likely to be cumulative. These could include:

- Potential impacts of noise caused by construction activities on foraging or breeding birds
- Displacement of birds from areas suitable for them before development, either temporarily or permanently; possible barrier effects to normal movements
- A reduction in bird breeding success due to displacement (including of any territorial bird species)
- Unnatural mortalities or injuries of birds (adults and chicks), caused by road collisions or poaching
- Indirectly, mortalities of adults could also lead to the mortalities of dependent chicks

Bird species potentially affected

Priority bird species in the study area may potentially be impacted by disturbance as a result of the construction of the new power line. These species include:

- **Ludwig's Bustard** (Endangered, Globally Endangered; partial migrant); nomadic; readily displaced by disturbance.
- **Rüppell's Korhaan** (near-endemic to Namibia); breeding suspected in the area; disturbance could enhance opportunities for predation of adults, chicks and eggs; sedentary and may be displaced.
- **Lappet-faced Vulture** (Endangered, Globally Endangered); breeding recorded in greater area; disturbance could cause displacement.
- **Martial Eagle** (Endangered, Globally Endangered); sedentary; disturbance could cause displacement.
- Other raptors, e.g. Black-chested Snake Eagle; Rock Kestrel and Greater Kestrel; Pale Chanting Goshawk; Peregrine Falcon; disturbance could create stress/displacement for this territorial group.

Impact analysis: Physical/human disturbance of birds, including road mortalities and poaching

Disturbance is known to impact on bird species in different ways, resulting in displacement that may be either temporary or permanent.

The **intensity** of the impact is medium during construction and very low during operation. The **duration** is short term, mainly during construction. The **extent** is the whole site (power line servitude) and its nearby surroundings. The **consequence** is low. The impact is **probable.** The **significance** is **LOW-VERY LOW** (reduced to **INSIGNIFICANT** with mitigation).

The impact is partially reversible. The degree to which **impact may cause irreplaceable loss of resources** is very low. The degree to which the **impact can be avoided** is medium. The degree to which the **impact can be mitigated** is medium: disturbance can be kept to the minimum, through awareness, abatement and operation controls; and avoiding any breeding birds. The **potential for cumulative impacts** is unlikely.

Impact assessment

Table 4. Physical/human disturbance of birds, including road mortalities and poaching		
Phases: Mainly construction (also operation)		
Criteria	Without Mitigation	With Mitigation
Intensity	– Medium during construction; very low during operation	– Low-very low
Duration	– Short term; mainly during construction	– Very short term
Extent	– Whole site/servitude	– Whole site/ servitude
Consequence	– Low	– Very low
Probability	– Probable	– Possible
Significance	– LOW-VERY LOW	– INSIGNIFICANT
Interpretation of significance	– Low: These adverse impacts are unlikely to have a real influence on the decision; (limited) mitigation is likely to be required – Very low: these adverse impacts will not have an influence on the decision – Insignificant: inconsequential	
Degree to which impact can be reversed	– Partially reversible	
Degree to which impact may cause irreplaceable loss of resources	– Very low	
Degree to which impact can be avoided	– Medium	
Degree to which impact can be mitigated	– Medium	
Potential for cumulative impacts	– Unlikely	

Mitigation and management recommendations: Physical/human disturbance of birds, including road mortalities and poaching

Construction phase

Much of the noise and other disturbance associated with construction is unavoidable. Impacts can, however, be kept to a minimum through responsible construction practices.

Avoidance:

- Before construction starts, the proposed power line route should be inspected for any signs of bird breeding/nesting activity. Disturbance of nesting/chick-rearing birds should be avoided (breeding season for Rüppell's Korhaan is mainly February-May; for raptors, mainly spring).

Minimisation:

- Abatement controls to reduce noise disturbance created during construction.
- Operational controls to manage and regulate contractor activity, such as:
  - A speed limit should be strictly enforced.
  - The construction activity should be restricted to the actual construction site and no unnecessary movement of vehicles or people should be allowed outside the construction zone. All vehicles should be fitted with silencers.
  - Exclusion fencing should be erected around identified sensitive areas, if required (e.g. pre-identified active nesting sites).
  - Anti-poaching measures should be strictly enforced, with zero tolerance, and this should be emphasised during induction to contractors; offenders should be prosecuted.
- Ongoing awareness should be promoted about the value of biodiversity and the negative impacts of disturbance, especially to breeding birds, and of poaching and road mortality.

Operation

- Disturbance levels should be kept to a minimum during operation.

5.2.2 Direct and indirect modification/loss/destruction of bird habitat

Description of impact

Any removal or disturbance/modification of natural vegetation will result in a change to the habitat available to the birds in the area, potentially impacting on their ability to breed, forage and roost in the vicinity. The sparsely vegetated drainage lines in the study area are sensitive for bustards and korhaans, and vulnerable to habitat destruction resulting from development. The Tsondab River habitats are particularly sensitive, and the large trees are an important resource for birds in terms of nesting, roosting and other activities, including for larger raptors.

Results of impact

The results of habitat destruction/modification may be indirect or direct, and could include:

- Displacement of birds from areas suitable for them before development, either temporarily or permanently; barrier effects to normal movements/activities
- A reduction in bird breeding success due to displacement (including of territorial bird species)
- Permanent modification/destruction of sensitive habitats, already subject to cumulative impacts

Habitat modification/loss/destruction is known to impact on bird species in different ways, resulting in displacement that may be either temporary or permanent.

Bird species that may be affected

Priority bird species in the study area that may potentially be impacted by habitat modification/ loss/destruction as a result of the construction of the new power line include the following terrestrial species:

- **Ludwig's Bustard** (Endangered, Globally Endangered; partial migrant); nomadic; dependent on (limited) ephemeral grassy habitats, resulting from good rainfall, and on drainage lines.
- **Rüppell's Korhaan** (near-endemic to Namibia); subject to cumulative impacts including habitat loss; sedentary; dependent on drainage lines.
- **Raptors**, e.g. **Lappet-Faced Vulture**, **Martial Eagle**; and Black-chested Snake Eagle; Rock Kestrel and Greater Kestrel; Pale Chanting Goshawk; Peregrine Falcon; loss of habitat could reduce breeding and feeding opportunities and result in stress/displacement for this territorial group.

Impact analysis: Direct and indirect modification/loss/destruction of bird habitat

Habitat modification/loss/destruction is known to impact on bird species in different ways, resulting in displacement that may be either temporary or permanent.

The **intensity** of the impact is low during construction. The **duration** is medium term. The **extent** is the site (servitude) for the power line. The **consequence** is low for the power line. The impact is **probable**. The **significance** is **MEDIUM**, reduced to **LOW** with mitigation.

The impact is partially **reversible**. The degree to which **impact may cause irreplaceable loss of resources** is very low. The degree to which the **impact can be avoided** is medium. The degree to which the **impact can be mitigated** is partially reversible. The **potential for cumulative impacts** is unlikely.

Table 5. Direct and indirect modification/loss/destruction of bird habitat		
Phases: Mainly construction		
Criteria	Without Mitigation	With Mitigation
Intensity	– Low	– Low
Duration	– Medium term	– Short term
Extent	– Whole site (servitude)	– Whole site (servitude)
Consequence	– Low	– Low
Probability	– Probable	– Possible
Significance	– LOW	– VERY LOW
Interpretation of significance	– Low: These adverse impacts are unlikely to have a real influence on the decision; (limited) mitigation is likely to be required – Very low: these adverse impacts will not have an influence on the decision	
Degree to which impact can be reversed	– Partially reversible	
Degree to which impact may cause irreplaceable loss of resources	– Very low	
Degree to which impact can be avoided	– Medium	
Degree to which impact can be mitigated	– Medium	
Potential for cumulative impacts	– Unlikely	

Mitigation and management recommendations: Direct and indirect modification/loss/destruction of bird habitat

Avoidance and minimisation:

- Where possible, the unnecessary destruction of habitat or degradation of the environment should be avoided, with special attention to water courses and drainage lines.
- The Tsondab River habitats are particularly sensitive, especially with regard to the destruction of taller trees and shrubs.

Construction phase

Restoration and rehabilitation:

- Repair of degradation or damage to biodiversity features and ecosystem services from project-related impacts that cannot be completely avoided and/or minimised, should this be necessary.

Minimisation:

- Abatement controls to reduce emissions and pollutants (erosion, dust, waste) created during construction.
- Operational controls to manage and regulate contractor activity, such as exclusion fencing around sensitive areas (e.g. pre-identified active nest sites), designated machinery and lay-down areas, minimisation of vegetation loss and disturbance to soil.
- Ongoing awareness should be promoted about the value of biodiversity and the negative impacts of habitat destruction.

5.2.3 Bird collisions on power line infrastructure

Description of impact

Birds may be injured or killed by colliding with power line infrastructure, including cables and poles, stay wires and transformer/step-down structures.

A collision occurs when a bird in mid-flight does not see the overhead cables or structures (including conductors) until it is too late to take evasive action. These impacts could take place on any sections of the power line, but are more likely in areas where the line crosses flight paths/corridors or flyways, such as water courses/drainage lines or ridges. Collisions may also take place on stay wires (which are usually present on strain poles/bend points), for instance when a bird is flushed from its position on the ground, and on other associated structures. Collisions may take place even during the construction phase, once the conductors have been strung although not yet energised, but occur mainly during the operational phase. Environmental conditions, including topography, vegetation and climatic factors (e.g. strong [including east, in the local situation] winds, dust, rain, fog), may strongly affect both exposure to collision risk, and susceptibility to collision (Jenkins *et al.* 2010).

Recent research has highlighted the fact that the most susceptible groups to collision mortality on power lines are large, long-lived and slow-reproducing birds, often habitat specialists with hazardous behavioural traits (especially flight height and flocking flight), with high spatial exposure to collision risk with power lines, and with unfavourable conservation status (Jenkins *et al.* 2010; Bernardino *et al.* 2018 and authors cited therein; D'Amico *et al.* 2019). The collision risk is believed to be increased by factors that include a large wingspan and low manoeuvrability, nomadic/migrant habits, flying in groups, flying in low light, territorial or courtship behaviour (e.g. raptors), juvenile inexperience and predation. Predominantly, the above collision-prone group comprises large terrestrial, as well as wetland species (Jenkins *et al.* 2010). Gregarious species (such as vultures) are generally thought to be more vulnerable than species with solitary habits (Bernardino *et al.* 2018).

A further contributory factor to bird collisions is the occurrence of a visual "blind spot" when flying forwards, which has been demonstrated in some groups of birds, including bustards and korhaans, vultures, snake-eagles and storks (Martin & Shaw 2010; Martin 2011); while searching for food on the ground, or observing conspecifics, these birds thus fail to see overhead structures such as power lines in their path, especially cables.

Collisions may occur when birds cross power lines in their local, daily movements between breeding/ nesting or roosting sites, and foraging areas (or between foraging areas); often such regular flights may take place at dawn and/or dusk (Bernardino *et al.* 2018). High mobility and nomadism, especially in habitats with ephemeral resources, may render bird species prone to power line interactions. In the present study, groups such as bustards are particularly susceptible to collisions due to their nomadic habits (sometimes in groups of up to 100 birds in the Namib [Bridgeford 1988]).

The collision risk is likely to be higher where more than one power line structure runs in parallel, with a potential cumulative impact resulting from several cables of differing heights across the bird flight path.

The bird collision impact on power line infrastructure is well documented in Namibia and elsewhere in the world (see Section 5.1 above), and a cause for conservation concern; generally, individuals are affected, rather than entire populations.

A further collision risk that applies to the present study is the configuration and close proximity of adjacent power lines (of different structures) in the same area. The proposed 33 kV line will run in parallel with the existing 19 kV line; the two lines are of the same height (i.e. 9.2 m above ground level), but with the poles at different span lengths. Although this would help to increase visibility, in effect the two lines together would also increase the size of the physical barrier and hence the collision risk. The risk is increased by the presence of the thinner, less visible conductor of the 19 kV structure; fortunately, no optical ground wires (OPGW) are present on the horizontal plane, as they are vertically placed on the poles of both structures.

The marking of wires is currently regarded as the most widespread and recommended measure for reducing bird collisions on power line infrastructure (Barrientos 2011, 2012; Bernardino *et al.* 2019; Shaw *et al*. 2021; Silva *et al*. 2022). However, there is still much uncertainty about the explanations for the effectiveness of this practice. Overall, wire-marking has been shown to reduce bird collisions with power lines by half (Bernardino *et al.* 2019); and by 51% for all large birds, testing two types of markers in South Africa: bird flappers (Viper Live Bird Flapper) and static bird flight diverters (SWANFLIGHT Diverters – although in the latter case, this was 92% effective for Blue Cranes, but with no effect for bustards [Shaw *et al.* 2021]). Mitigation effectiveness has been shown to be as high as 94% during the testing three types of markers (Fire-Fly Bird Diverter, RIBE Bird Flight Diverter and SWANFLIGHT Diverter) on 77 km of 22 kV and 110 kV power lines in Slovakia (Gális, Ševčík 2019). However, such mitigation does not work as well for all bird species, including bustards (Shaw *et al*. 2021).

Overall, the reactions of birds at greater distances and reduced number of bird fatalities under marked lines are considered to indicate that all the latter tested diverters have a positive effect on reducing the number of avian collisions with power lines.

Mitigation marking of power lines is carried out by power utilities in Namibia as standard practice under EIA regulations and recommendations.

Results of impact

The results of collisions may be indirect or direct, and could include:

- As a direct impact, collisions could potentially result in bird injuries and/or mortalities.
- Indirect impacts are also possible, e.g. loss of adults to chicks.

Bird species that may be affected

Most of the 21 priority species in the present study are prone to collisions on power line infrastructure. These include:

- Lappet-faced Vulture (Endangered, Globally Endangered; resident, juvenile movements)
- White-backed Vulture (Endangered, Globally Endangered; resident, juvenile movements)
- Ludwig's Bustard (Endangered, Globally Endangered; partial migrant, nomadic)
- Martial Eagle (Endangered, Globally Endangered; resident)
- Rüppell's Korhaan (Namibian near-endemic; sedentary)
- 11 other raptor species, including Black-chested Snake-eagle, Pale Chanting Goshawk, Greater Kestrel, Rock Kestrel, Lanner Falcon

- Other larger terrestrial species, including Namaqua Sandgrouse and Double-banded Sandgrouse (partial migrant; nomadic)

Bustards are likely to visit the area after good rains, and to move along drainage lines in search of food and shelter, while also using the open spaces. Korhaans are resident, and use the same drainage lines, including as nursery areas. Both the above groups are prone to power line collisions, including on stay wires.

A precautionary approach, based on ongoing monitoring and adaptive management, is therefore recommended.

Impact analysis: collisions with power line infrastructure

Bird collisions with power line infrastructure may impact on bird species in different ways, resulting in injury or mortality of birds. Few monitoring data are available for movements of priority bird species in the area, apart from for Lappet-faced Vultures; and some areas used by Ludwig's Bustard have been identified. Some live priority species were recorded in the proposed power line servitude in 2024.

The **intensity** of the collision impact is high. The **duration** is long term/life of the project; the death of a bird is permanent. The **extent** is the whole site and possibly beyond. The **consequence** is medium. Based on available evidence, it is **probable** that there will be a collision impact.

The **significance** is **MEDIUM-HIGH**, reduced to **MEDIUM-LOW** with mitigation. Mortalities may be relatively higher for bustards and korhaans, and lower for raptors. These mortality impacts are very important considerations and must have an influence on the decision. Substantial mitigation will be required.

The **impact can be reversed** at the end of the project by the removal of such structures; however, death of a bird is irreversible. The degree to which **impact may cause irreplaceable loss of resources** is medium: individuals may be affected, rather than populations. The degree to which the **impact can be avoided** is medium. The degree to which the **impact can be mitigated** is medium: mitigation is feasible and may reduce the impact significance rating. The **potential for cumulative impacts** is likely.

Impact assessment

Table 6. Bird collisions with power line infrastructure		
Phases: Operational		
Criteria	Without Mitigation	With Mitigation
Intensity	High	Medium
Duration	Long term: life of the project Permanent: death of bird	Long term
Extent	Whole site and possibly beyond	Whole site
Consequence	Medium-high	Medium
Probability	Probable	Possible
Significance	MEDIUM-HIGH	MEDIUM-LOW
Interpretation of significance	– High: These adverse impacts are considered to be very important considerations and must have an influence on the decision. Substantional mitigation will be required. – Medium: These adverse impacts may be important but are not likely to be key decision-making factors; mitigation will be required	

	– Low: These adverse impacts are unlikely to have a real influence on the decision; (limited) mitigation is likely to be required
Degree to which impact can be reversed	Fully reversible at the end of the project: impact can be reversed by the removal of power line structures Death of a bird is irreversible
Degree to which impact may cause irreplaceable loss of resources	Medium
Degree to which impact can be avoided	Medium
Degree to which impact can be mitigated	Medium: mitigation is feasible and may reduce the impact significance rating
Potential for cumulative impacts	Likely

Mitigation and management recommendations: Bird collisions with power line infrastructure

Project design phase

Avoidance & minimisation:

- No sections of the power line are identified as "no-go" areas, to be avoided at all costs; however, some sections are regarded as being more sensitive to collision impacts (see below).

Construction phase

Avoidance & minimisation:

- To address the collision risk on the proposed 33 kV distribution line, the marking of the more sensitive sections of the line to increase visibility is recommended, with the minimum for each section as follows (A-B and C-D; Table 7; also see Figure 32 below for marking sections).
- Ideally, the burial of any sensitive sections underground would be preferable, if technically and economically feasible.
- Should monitoring results indicate a need, further sections of the line should be (retro-)marked, using an adaptive management approach. In particular, these include the sections on the Namib Naukluft Lodge property, and on Moon Mountain.

Table 7. Recommended (minimum) sections of power line to be marked (see Figure 32 for map)

Marking section	Distance (km)	Coordinates: start	Coordinates: end
A-B	**2.4 km**	23.960254S 16.006713E	23.981557S 16.005908E
C-D	**5.2 km**	24.122929S 15.957871E	24.116151S 15.908621E
TOTAL	**7.6 km**		

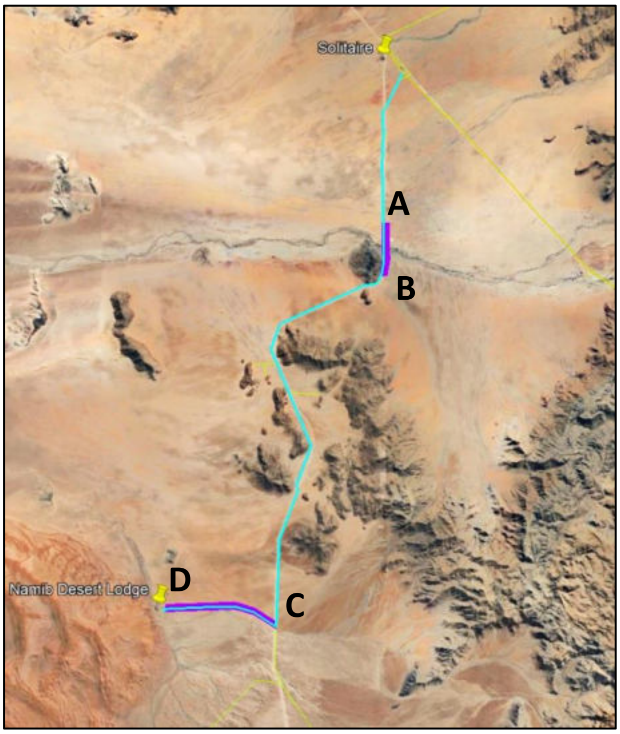


Figure 32. Two sections of the proposed 33 kV power line recommended for fitting with marking devices (purple; A-B and C-D), as a mitigation for bird collisions (see Table 7 for GPS coordinates; based on a Google Earth image).

- The top horizontal conductor should be marked, for the full length of each span.
  - Examples of appropriate marking devices (Figure 33) include the following, both made in South Africa: RAPTOR-CLAMP Diverter (also known as the Viper Live Bird Flapper ["Viper"]); and the BIRD-FLIGHT Diverter (BFD) could also be considered, with at least 4-5 of the latter devices on each span and alternating with the Vipers.
- The marking distance between devices on each line should be 10 m; the colours should be offset where possible (e.g. black and white/yellow).
- At this stage, no nocturnally visible marking is recommended, but it should become mandatory should monitoring results indicate the necessity (e.g. repeat collisions of any nocturnal fliers such as owls on power lines), using an adaptive management approach.
- The need for retro-fitting any mitigation for collisions on stay wires (e.g. marking with vibration dampers or other markers) should also be based on monitoring results, using an adaptive management approach.

Operational phase

Minimisation:

- The need for reporting power line incidents should be stressed. Set up a reporting channel, and clarify monitoring and reporting procedures to all partners (see Section 6 below).
- Should monitoring results indicate a need, further sections of the line should be (retro-)marked, using an adaptive management approach.

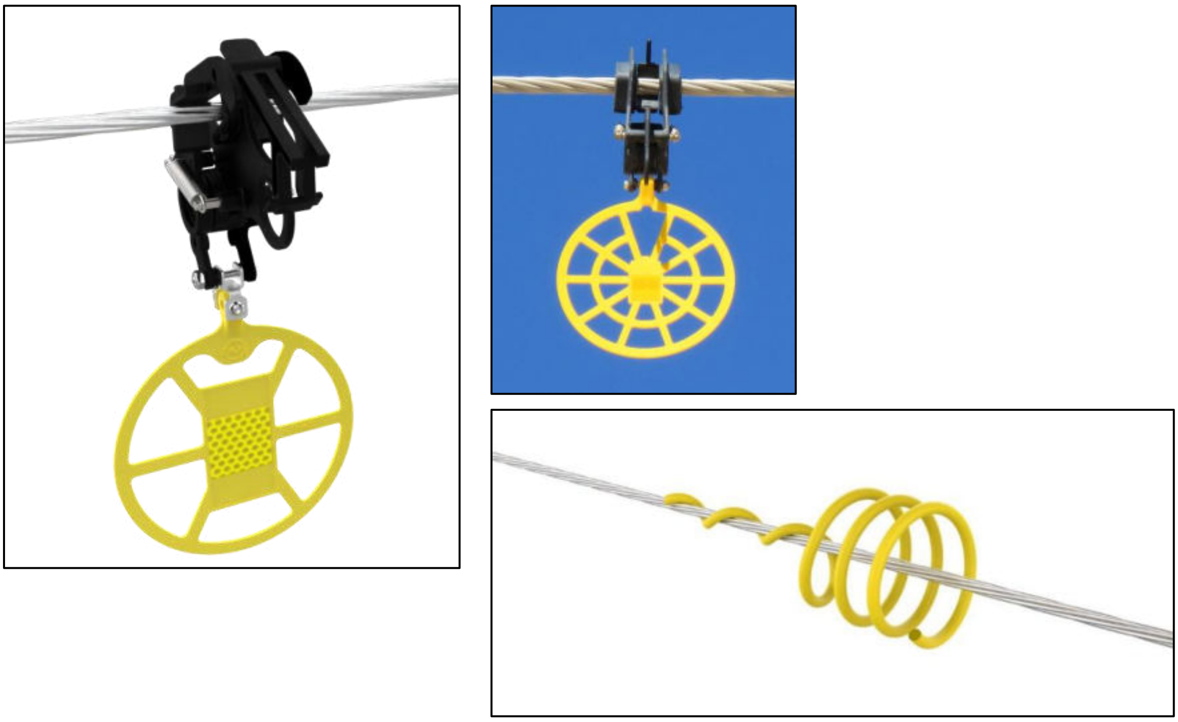


Figure 33. Examples of appropriate power line marking devices, used as a mitigation for bird collisions: a. RAPTOR-CLAMP Diverter (or Viper Live Bird Flapper ["Viper"] left and top right); and BIRD-FLIGHT Diverter (BFD; bottom right).

5.2.4 Bird electrocutions on power line infrastructure

Description of impact

An electrocution occurs when a large bird is perched or attempts to perch on an electrical structure and causes an electrical short circuit by physically bridging the air gap between live components and/or live and earthed components.

An electrocution could also be caused should a large bird perch on top of a tower and send down a "streamer" of excrement that could hit a conductor, thereby bridging the gap between an earthed and a live component.

Electrocution impacts may potentially take place on the main/suspension pole structures, as well as other associated structures (including strain poles, and step-down / transformer structures).

The use of power line pole structures as perches by raptors and other larger birds in the area is possible, given the lack of large trees (see Figure 15, Section 4.2 above). This could attract birds to potentially unsafe sections of the structures; also see Section 5.2.5 below: attraction of birds to novel habitats through the artificial provision of scarce resources

On the proposed monopole structure, a suitable perching space is available. The size of the clearances is 800 mm between conductors. Should a larger bird perch or attempt to perch on a pole, an electrocution risk would apply, in view of the relative size of the wingspan (for instance 2.8 m in the case of a Lappet-faced Vulture and 2.2 m in the case of White-backed Vulture).

In the case of present structure, to which an earth wire is fitted vertically along the pole, the risk of electrocution is increased unless an air space safety gap is provided at the top of the pole (see mitigation measures below). The risk is also greater if the structure or bird is wet or damp (e.g. from precipitation, or bathing), or when groups of birds (such as vultures) interact.

The electrocution risk is likely to be higher on step-down/transformer structures, where clearances between live components are smaller.

Result of impact

The results of electrocutions may be indirect or direct, and could include:

- As a direct impact, collisions could potentially result in
  - Bird injuries and/or mortalities
  - Outages/disruptions to the power supply
- Indirect impacts are also possible, e.g. loss of adults to chicks.

Bird species that may be affected

Priority species in the study area that are prone to electrocution on power line infrastructure (i.e. by direct contact, or by streamers) include (mainly) perching raptors, e.g.:

- Lappet-faced Vulture (Endangered, Globally Endangered; resident, juvenile movements)
- White-backed Vulture (Endangered, Globally Endangered; resident, juvenile movements)
- Martial Eagle (Endangered, Globally Endangered; resident)
- 11 other (non-Red data) raptor species, including Black-chested Snake-eagle, Pale Chanting Goshawk, Greater Kestrel, Rock Kestrel, Lanner Falcon

Non-priority species:

- Pied Crow, Cape Crow
- Other larger terrestrial species, including hornbills, scimitarbills, lovebirds; Helmeted Guineafowl

Impact analysis: Bird electrocutions on power line infrastructure

Bird electrocutions on power line infrastructure impact on bird species in negative ways.

The **intensity** of the impact is low. The **duration** is long term-permanent. The **extent** is the low: whole site and its nearby surroundings (site-specific). The **consequence** is medium. The **probability** is probable. The **significance** is **MEDIUM**, reduced to **LOW** with mitigation.

The **impact** is fully reversible (but death of a bird is irreversible). The degree to which **impact may cause irreplaceable loss of resources** is low. The degree to which the **impact can be avoided** is medium. The degree to which the **impact can be mitigated** is medium. The **potential for cumulative impacts** is possible.

Impact assessment

Table 8. Bird electrocutions on power line infrastructure		
Phases: Operational		
Criteria	Without Mitigation	With Mitigation
Intensity	Low	Very low
Duration	Long term: life of the project Permanent: death of bird	Long term
Extent	Low	Low
Consequence	Medium	Low
Probability	Probable	Conceivable
Significance	MEDIUM	LOW
Interpretation of significance	– Medium: These adverse impacts may be important but are not likely to be key decision-making factors; mitigation will be required	

	– Low: These adverse impacts are unlikely to have a real influence on the decision; (limited) mitigation is likely to be required
Degree to which impact can be reversed	Fully reversible at end of the project: impact can be reversed by the removal of such structures Death of a bird is irreversible
Degree to which impact may cause irreplaceable loss of resources	Low
Degree to which impact can be avoided	Medium
Degree to which impact can be mitigated	Medium: mitigation is feasible and may reduce the impact significance rating
Potential for cumulative impacts	Possible

Mitigation and management recommendations: bird electrocutions on power line infrastructure

The mitigation measures below are standard procedure for most distribution power line structures, but are mentioned for the sake of completeness.

Construction phase

Minimisation:

- A standard mitigation for electrocutions on wooden power line poles is to "gap" the earth wire near the top of the pole, i.e. the earth wire on each power line pole should stop at least 300 mm below the lowest phase to provide an air space safety gap, in order to reduce the electrocution risk (Figure 34; also see Section 1.2, and Figure 3 above for further details).
- Transformer/switchgear structures should be designed in such a way that they are not attractive as bird perches/nesting sites; selected /all live components should be insulated (e.g. using PVC piping or LDPE pipe; Figure 35).
- On strain structures where "jumper" wires are used, at least the centre jumper (but preferably all three jumpers) should be insulated, using PVC piping or LPDE pipe. Jumpers should be offset where possible, to reduce the clearance between these wires.
- The stay wires should also be "gapped" by the use of an insulator.

Operational phase

Minimisation:

- The need for reporting power line incidents should be stressed, and reporting procedures clarified.
- Any sections that subsequently still prove to be problematic in terms of electrocutions should be retro-mitigated, by way of adaptive management.
- Should electrocutions prove to be problematic on a specific structure, a steel perching bar for birds is proposed as a mitigation for electrocutions (Figure 36). This horizontal bar should be >500 mm long, and fitted onto the top of each pole, 220 mm above the pole top or any related structure.

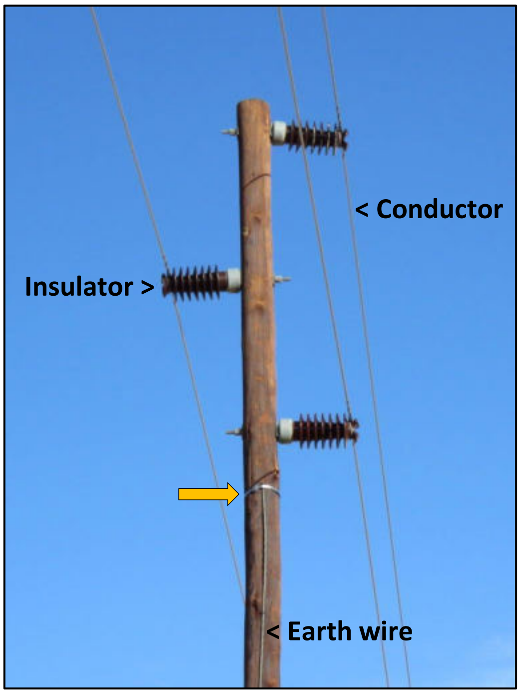


Figure 34. Example of "gapping" of a pole earth wire to provide an air space safety gap, in order to reduce the electrocution risk; the arrow indicates the upper limit of the earth wire.

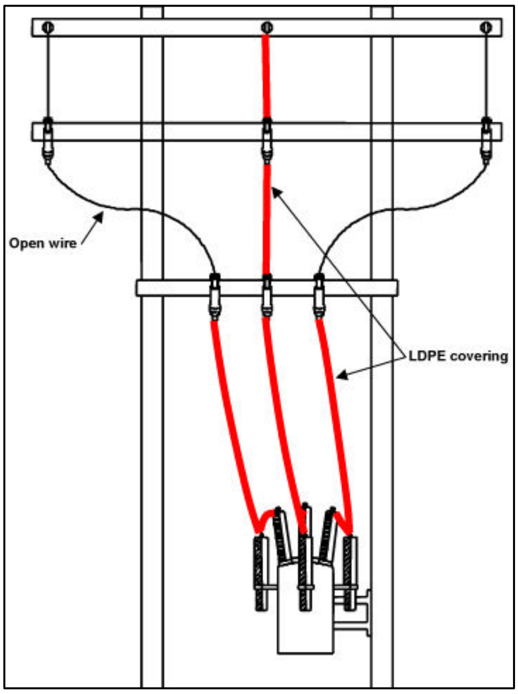


Figure 35. Example of use of Low Density Polyethylene (LDPE) pipe on jumpers to insulate selected live components of transformers and switch gears.

Figure 36. Example of a Brown Snake Eagle making use of a perching structure fitted to a 66 kV steel monopole.

5.2.5 Attraction of birds to novel habitats through the artificial provision of scarce resources

Description of impact

The construction of power lines and related infrastructure has the potential to attract bird species to novel habitats, by providing perching, nesting or foraging sites. This could result in negative impacts on birds (see Section 5.2.4 above). The effects of this impact would be more marked in a relatively treeless environment such as the present study area.

The provision of artificial habitats/resources such as power line poles, transformers and other structures could also result in negative impacts on the power supply (i.e. flash-overs) caused by bird activities. Distribution lines (such as the proposed 33 kV line) are more at risk to such impacts, given the smaller clearances. Crow nests on power line structures may contain pieces of wire, which could cause outages. Pied Crow has been recorded in the overall study area in relatively high numbers (e.g. ≥40 birds at Solitaire); Cape Crow also occurs.

Crows are attracted to food sources in areas with human activity and may similarly be attracted to new food sources, e.g. food waste associated with construction workers. Numbers of Pied Crow may easily increase in this way.

Sociable Weavers nest readily on power line infrastructure, including the 33 kV HLPCD. These nesting activities are known to cause disruptions to the power supply in Namibia, especially during the rainy season. Pygmy Falcon (the smallest diurnal raptor in the region) uses the nests of Sociable Weavers for breeding and roosting. This species could easily be overlooked in operations to remove large Sociable Weaver nests from power line structures.

Bird species that may be affected

Priority bird species in the study area that may potentially be impacted by the attraction to novel (artificial) habitats and resources include:

- **Raptors** may perch/hunt from or attempt to nest on power line infrastructure, which could result in electrocution (see Section 5.2.4 above)

Non-priority species may also be attracted to power line infrastructure, including for nesting purposes, e.g.:

- Pied Crow
- Cape Crow
- Sociable Weaver

Impact analysis: Attraction of birds to novel habitats through the artificial provision of scarce resources

The attraction of birds to novel habitats through the artificial provision of scarce resources may impact on bird species in different ways that may be potentially positive or negative, with direct and indirect impacts. The impact is related to other impacts (e.g. electrocution, collisions; see above).

The **intensity** of the impact is low-medium. The **duration** is long term. The **extent** is the whole site. The **consequence** is medium. The impact is **probable**. The **significance** is **MEDIUM**; no mitigation is proposed, but adaptive management.

The **impact can be reversed** at end of project by the removal of such artificial structures/resources. The degree to which **impact may cause irreplaceable loss of resources** is low; some negative impacts may result on infrastructure (negative for developer). The degree to which the **impact can be avoided** is medium. The degree to which the **impact can be mitigated** is medium: the impact can be mitigated through adaptive management. The **potential for cumulative impacts** is possible.

Impact assessment

Table 9. Attraction of birds to novel habitats through the provision of artificial habitats and resources		
Phases: Construction and operation		
Criteria	Without Mitigation	With Mitigation
Intensity	Low-medium	No mitigation proposed; adaptive management is recommended, based on monitoring results
Duration	Long term (life of the project)	
Extent	Whole site	
Consequence	Medium	
Probability	Probable	
Significance	MEDIUM	
Interpretation of significance	– Medium: These adverse impacts on both birds and the power supply may be important but are not likely to be key decision-making factors; mitigation will be required	
Degree to which impact can be reversed	Impact can be reversed at end of project by the removal of such structures	
Degree to which impact may cause irreplaceable loss of resources	Low; some negative impacts on infrastructure (negative for developer)	
Degree to which impact can be avoided	Medium	
Degree to which impact can be mitigated	Medium: impact can be mitigated through adaptive management	
Potential for cumulative impacts	Possible	

Mitigation and management recommendations: Attraction of birds to novel habitats through the artificial provision of scarce resources

Construction phase

Avoidance:

- Ensure strict and effective waste management (including of food) during construction activities, to discourage an unnatural increase in scavenging species such as Pied Crow.
- Avoid creating new habitats with open water, e.g. accumulations of storm water or pipe leakages/open water/run-off, that may attract birds.

Operational phase

Minimisation:

- Monitoring is essential to identify (potential) problem areas (see Section 6 below); any movement of hitherto unrecorded species onto power line infrastructure should be monitored; and any resulting negative impacts (e.g. electrocutions or power outages), should be addressed accordingly.
- Bird nesting activities on power line infrastructure should be discouraged early in the cycle, before any eggs are laid; the Ministry of Environment, Forestry and Tourism (MEFT) should be contacted for specific guidelines for dealing with such problems.
- Should any nesting or other activity by crows or Sociable Weavers on power supply structures cause disruptions of the power supply, consult with the MEFT for appropriate measures to discourage and manage such activities, e.g. by removing nests at a stage when this is acceptable.

- During operations to remove large Sociable Weaver nests from power line structures, special care should be taken not to destroy any active Pygmy Falcon nests within these structures (breeding season August-March, mainly October-November).

Also see above (Section 5.2.4) for mitigation recommendations for electrocution.

5.3 Summary of impact assessment

Potential impacts from the development may be summarised as follows:

- Physical/human disturbance of birds, including noise andlight disturbance
  - Rated as LOW-VERY LOW, and INSIGNIFICANT post-mitigation
- Direct and indirect modification/loss/destruction of bird habitat
  - Rated as LOW, and VERY LOW post-mitigation
- Bird collisions with power line infrastructure
  - Rated as MEDIUM-HIGH, and MEDIUM-LOW post-mitigation
- Bird electrocutions on power line infrastructure
  - Rated as MEDIUM, and LOW post-mitigation
- Attraction of birds to novel habitats through the artificial provision of scarce resources
  - Rated as MEDIUM; no mitigation recommended, but adaptive management

5.4 Assessment of alternatives

Best practice environmental assessment methodology calls for consideration and assessment of alternatives to a proposed project.

- Alternative **route options**
  No alternative route options were assessed during the present study; however, should any new alternative route options be proposed, they would also need to be assessed (particularly in sensitive habitats).
- The option of eventually **removing the 19 kV line** is being considered. Should this be decided upon, it would help reduce the cumulative impacts of collision and electrocution of birds (see below).

5.5 Cumulative impacts

Cumulative impacts are defined as those impacts that result from the successive, incremental and/or combined effects of existing, planned and/or reasonably anticipated future human activities in combination with project development impacts (Bennun *et al*. 2021). They may arise from multiple projects in one sector (such as several power lines) and/or due through pressures from many sectors and sources (sometimes referred to as "aggregated" or "in-combination" impacts).

Together with existing threats both in the area and in other areas used by the bird species, the impacts identified above have the potential to act cumulatively, e.g. on avian food sources, feeding and roosting, movements, breeding and survival. The above impacts are more likely to be felt by nomadic species, rather than resident birds that could become accustomed to such disturbance.

Cumulative impacts can be highly significant for sensitive species and ecosystem services, but are often overlooked (Bennun *et al*. 2021). Although recorded mortalities may be in low numbers, the cumulative impacts of such negative interactions over the entire lifespan of the development are an important consideration. Sensitive species that are already under threat, including Red Data and endemic species, raptors, waterbirds and other migrants/nomadic species are at particular risk to such cumulative effects.

The clustering of existing infrastructure in the area, including the road network, power lines and communication masts, as well as associated human presence and noise, would increase the cumulative effect of any impacts associated with the present development.

As the new 33 kV line will be running in parallel with the existing 19 kV line, with a 12 m space between the two lines, there is a potential for cumulative impacts.

The effective application of the recommended mitigation measures is considered essential. However, ongoing monitoring is also required in order to identify the effectiveness of mitigation, and any need for additional intervention.

It should be noted that sections of a number of power lines in the greater area have already been marked as mitigation for bird collisions (including for bustard collisions) by power utilities during construction. The acceptance of these mitigation recommendations is an indication of the sensitivity of the bird species in the area and a confirmation of the potential for power line collisions.

6 Recommendations for monitoring

The following monitoring initiatives should be conducted by the proponent, in collaboration with and with the support of landowners/landlords, and any other relevant partners. If required, the avifauna specialist can be contacted for assistance with monitoring procedures.

- The new 33 kV power line should be monitored according to existing protocols for power line surveys (see ECC 2019). The power line surveys should include the new 33 kV line as well as the existing 19 kV line, for possible cumulative impacts. The surveys should include the step-down/ transformer structures. Ideally, regular dedicated monitoring patrols should be carried out once a month for at least the first year after construction, and thereafter at least once per quarter.
- Both mortalities and live birds should be monitored; these would include any new species that appear to be attracted to the area. If there is a need, camera traps could be used to document the occurrence of sensitive species, such as terrestrial birds and/or raptors.
- The need for reporting any incidents should be stressed, and reporting procedures should be clarified. All bird mortalities should be recorded on a standardised form, with the GPS coordinates (or pole number, if present) and structure involved and other details, and photographs of the carcass (including head and beak), structure and point of impact if possible.
- Monitoring results should be reviewed on a quarterly basis, or more frequently if required, to direct further adaptive management.
- Monitor the effectiveness of mitigation measures; should repeat collision or electrocution incidents involving raptors/vultures, bustards, korhaans or any other group of birds, occur, consider the retro-fitting of further mitigation; replace mitigation devices as and when necessary.

7 Conclusion

According to the avifauna baseline and scoping of sites and species, the study area is potentially sensitive in terms of birds and their habitats.

A relatively moderate-high bird species richness has been recorded in the study area and surrounds, with a total of 207 species, or 31% of the 676 species currently recorded in Namibia. The area is well atlased.

The checklist includes 14 species (7% of the total) that are threatened in Namibia (and comprising 20% of the 71 species on the Namibian Red Data List); nine of the 14 species are also Globally Threatened; one species that is a full Namibian endemic (with 100% of the population in this country), and five other species that are near-endemic to Namibia (with at least 90% of the populations occurring within the country); one large terrestrial bird species and four raptors with migrant status.

Risk assessment and mitigation efforts are directed towards priority species, namely those that have a high biological significance, i.e. primarily Red Data species (including those with migrant status) and/or endemic or near-endemic species.

Fifty-three potential priority species were initially identified as being at risk in terms of the proposed project. A total of 21 priority bird species was then short-listed, based on the likelihood of their occurrence in the study area. Although the focus of the impact assessment is on the short-listed species, the full priority list also needs to be taken into account due to the high species numbers and the difficulty in predicting those likely to be impacted. The emphasis should be on groups of birds likely to be at risk, rather than on individual species; and the precautionary principle should prevail.

Potential impacts from the development may be summarised as follows:

- Physical/human disturbance of birds, including noise andlight disturbance
  - Rated as LOW-VERY LOW, and INSIGNIFICANT post-mitigation
- Direct and indirect modification/loss/destruction of bird habitat
  - Rated as LOW, and VERY LOW post-mitigation
- Bird collisions with power line infrastructure
  - Rated as MEDIUM-HIGH, and MEDIUM-LOW post-mitigation
- Bird electrocutions on power line infrastructure
  - Rated as MEDIUM, and LOW post-mitigation
- Attraction of birds to novel habitats through the artificial provision of scarce resources
  - Rated as MEDIUM; no mitigation recommended, but adaptive management

Cumulative impacts are an important consideration.

Mitigation measures are recommended for the Environmental and Social Monitoring Plan, aimed at avoiding, minimising or rehabilitating negative impacts or enhancing potential benefits and using an adaptive approach. It is considered that the effective application of the above mitigation should help reduce the impacts of the proposed development.

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Appendix 1: Checklist of bird species recorded in the Naukluft Electricity Investments study area, Solitaire, Hardap Region (March 2024)

*Scientific and common names according to Southern African Bird Atlas Project 2 (http://sabap2.adu.org.za); also see Roberts Bird Guide 2016 (Chittenden *et al.* 2016)

208 species

KEY:

RDB = Red Data/conservation status (Brown *et al*. 2017) CE = Critically Endangered, EN = Endangered, VU = Vulnerable, NT = Near Threatened, LC = Least Concern; G = global status; rare = now rare in Namibia

END = Endemism: (Brown *et al*. 2017): E = full endemic (100% of population in Namibia); NE = near-endemic (≥90% of population in Namibia); Nam = Namibia; sAfr = southern African

RES = Residency (for Red Data species): Res = resident, Nom = nomadic, Mig = (Red Data) species that have migrant status, Pal = Palearctic-breeding, intra-Afr mig = intra-African migrant, mov = local/seasonal movements

Codes: A = aquatic; R = raptor; T = large terrestrial bird

SABAP1 NAD: Southern African Bird Atlas Project 1 and other data (available on Namibian Avifaunal Database [NAD]; www.biodiversity.org.na; QDSs 2315DD, 2316CC, 2415BB, 2416AA)

SABAP1 EIS: Southern African Bird Atlas Project 1 data that was published as Harrison *et al.* (1997) (available on EIS 2024, www.the-eis.com; 4 QDSs, as above)

SABAP2: Southern African Bird Atlas Project 2 data (available on http://sabap2.adu.org.za; 5 pentads 2350_1600, 2355_1605, 2400_1555, 2405_1550, 2410_1550)

Pers obs: personal observations (including March 2024, and Oct 2019 and Oct 2022)

Priority species potentially at risk from the project are highlighted

Common group	**Common species**	**Genus**	**Species**	**Sensitivity**	**NBD 159**	**EIS**	**Solitaire 90**	**Ababis 98**	**NNL 94**	**NDL 119**	**DG 100**	**Pers obs 2024**
					4 QDSs	**4 QDSs**	**2350_1600**	**2355_1605**	**2400_1555**	**2405_1550**	**2410_1550**	
Barbet	Acacia Pied	*Tricholaema*	*leucomelas*		√	√	2023	2023	2023	2023	2023	√
Batis	Pririt	*Batis*	*pririt*		√	√	2019	2020	2019	2023	2023	
Bee-eater	European	*Merops*	*apiaster*		√			2023				
Bee-eater	Swallow-tailed	*Merops*	*hirundineus*		√	√	2019			2022		
Bittern	Little	*Ixobrychus*	*minutus*		√							
Bokmakierie	Bokmakierie	*Telophorus*	*zeylonus*		√	√	2013		2023	2016	2022	√
Brubru		*Nilaus*	*afer*		√	√	2019	2023		2023	2020	√
Bulbul	African Red-eyed	*Pycnonotus*	*nigricans*		√	√	2023	2023	2023	2023	2023	√
Bunting	Cape	*Emberiza*	*capensis*		√	√				2016		
Bunting	Cinnamon-breasted	*Emberiza*	*tahapsi*		√	√						
Bunting	Golden-breasted	*Emberiza*	*flaviventris*		√	√						
Bunting	Lark-like	*Emberiza*	*impetuani*		√	√	2022	2023	2023	2023	2023	√
Bustard	**Kori**	*Ardeotis*	*kori*	T, NT, G NT	√	√						
Bustard	**Ludwig's**	*Neotis*	*ludwigii*	T, EN, G EN, part mig	√	√	2021	2019	2023	2023	2023	
Buttonquail	Common	*Turnix*	*sylvaticus*						2022		2022	
Buzzard	**Augur**	*Buteo*	*augur*	R	√	√	2018		2023	2014		
Buzzard	**Common (Steppe)**	*Buteo*	*buteo*	R, Pal mig		√						
Buzzard	**Jackal**	*Buteo*	*rufofuscus*	R	√	√			2023		2019	
Canary	Black-headed	*Serinus*	*alario*		√	√						
Canary	Black-throated	*Crithagra*	*atrogularis*			√	2013	2020	2021	2023		

Common group	Common species	Genus	Species	Sensitivity	NBD 159	EIS	Solitaire 90	Ababis 98	NNL 94	NDL 119	DG 100	Pers obs 2024
					4 QDSs	4 QDSs	2350_1600	2355_1605	2400_1555	2405_1550	2410_1550	
Canary	White-throated	*Crithagra*	*albogularis*			√	2019	2023	2023	2023	2021	
Canary	Yellow	*Crithagra*	*flaviventris*			√	2021	2021		2023	2023	
Chat	Ant-eating	*Myrmecocichla*	*formicivora*			√	2016					
Chat	Familiar	*Oenanthe*	*familiaris*		√	√	2023	2023	2023	2023	2024	√
Chat	**Herero**	*Namibornis*	*herero*	NamNE	√	√			2023			
Chat	Karoo	*Emarginata*	*schlegelii*		√	√	2022	2022	2022	2023	2023	
Chat	Tractrac	*Emarginata*	*tractrac*		√	√		2022	2021	2018		
Cisticola	Desert	*Cisticola*	*aridulus*				2022			2014	2022	
Cisticola	Grey-backed	*Cisticola*	*subruficapilla*		√							
Cormorant	Reed	*Microcarbo*	*africanus*		√	√						
Cormorant	White-breasted	*Phalacrocorax*	*lucidus*			√						
Courser	Burchell's	*Cursorius*	*rufus*		√	√		2019	2019			
Courser	Double-banded	*Rhinoptilus*	*africanus*			√			2021	2022	2019	
Courser	Temminck's	*Cursorius*	*temminckii*		√			2022				
Crombec	Long-billed	*Sylvietta*	*rufescens*		√	√		2017	2023	2023	2023	
Crow	***Cape***	*Corvus*	*capensis*	Nesting	√	√	2023		2022	2023	2023	
Crow	***Pied***	*Corvus*	*albus*	Nesting	√	√	2023	2020	2023	2023	2024	√
Cuckoo	Black	*Cuculus*	*clamosus*		√	√						
Cuckoo	Diederik	*Chrysococcyx*	*caprius*		√	√	2016	2020		2022	2018	√
Cuckoo	Great Spotted	*Clamator*	*glandularius*		√	√						
Cuckoo	Klaas's	*Chrysococcyx*	*klaas*		√	√						
Dove	Ring-necked (Cape Turtle)	*Streptopelia*	*capicola*		√	√	2022	2023	2023	2023	2024	√
Dove	Laughing	*Spilopelia*	*senegalensis*		√	√	2022	2023	2023	2023	2023	√

Common group	Common species	Genus	Species	Sensitivity	NBD 159	EIS	Solitaire 90	Ababis 98	NNL 94	NDL 119	DG 100	Pers obs 2024
					4 QDSs	4 QDSs	2350_1600	2355_1605	2400_1555	2405_1550	2410_1550	
Dove	Namaqua	*Oena*	*capensis*		√	√	2022	2023	2023	2023	2022	√
Dove	Rock (Feral Pigeon)	*Columba*	*livia*		√	√						
Drongo	Fork-tailed	*Dicrurus*	*adsimilis*		√	√	2019	2023	2023	2023	2023	√
Duck	African Black	*Anas*	*sparsa*		√							
Eagle	**Black-chested Snake**	*Circaetus*	*pectoralis*	R	√	√	2022	2023	2022	2020	2024	
Eagle	**Booted**	*Hieraaetus*	*pennatus*	R, EN, Pal mig			2022	2022			2019	
Eagle	**Martial**	*Polemaetus*	*bellicosus*	R, EN, G EN	√	√	2022	2015	2021		2023	
Eagle	**Tawny**	*Aquila*	*rapax*	R, EN, G VU	√	√						
Eagle	**Verreaux's**	*Aquila*	*verreauxii*	R, NT	√	√		2019	2020			
Eagle-Owl	**Spotted**	*Bubo*	*africanus*	R	√	√		2020	2022	2023	2019	
Eagle-Owl	**Verreaux's**	*Bubo*	*lacteus*	R						2022		
Egret	Western Cattle	*Bubulcus*	*ibis*		√	√						
Eremomela	Karoo	*Eremomela*	*gregaris*		√	√						
Eremomela	Yellow-bellied	*Eremomela*	*icteropygialis*		√	√	2022	2023	2023	2023	2019	
Falcon	**Lanner**	*Falco*	*biarmicus*	R	√	√	2022	2019	2023	2022	2023	
Falcon	**Peregrine**	*Falco*	*peregrinus*	R, NT							2019	
Falcon	**Pygmy**	*Polihierax*	*semitorquatus*	R	√	√	2022	2020	2023	2023	2022	
Falcon	**Red-necked**	*Falco*	*chicquera*	R, nom	√					2019	2024	
Finch	Red-headed	*Amadina*	*erythrocephala*		√	√	2023	2022	2023	2023	2023	
Fiscal	Southern	*Lanius*	*collaris*		√	√	2022	2023	2023	2023	2023	
Flycatcher	African Paradise	*Terpsiphone*	*viridis*		√	√						
Flycatcher	Chat	*Melaenornis*	*infuscatus*			√	2023	2023	2023	2023	2024	√

Common group	Common species	Genus	Species	Sensitivity	NBD 159	EIS	Solitaire 90	Ababis 98	NNL 94	NDL 119	DG 100	Pers obs 2024
					4 QDSs	4 QDSs	2350_1600	2355_1605	2400_1555	2405_1550	2410_1550	
Flycatcher	Marico	*Melaenornis*	*mariquensis*			√	2023	2020	2019	2023	2023	√
Flycatcher	Spotted	*Muscicapa*	*striata*		√	√						
Go-away-bird	Grey	*Crinifer*	*concolor*		√	√	2021	2023		2021		√
Goose	Egyptian	*Alopochen*	*aegyptiaca*		√	√				2016		
Goshawk	**Gabar**	*Micronisus*	*gabar*	R		√				2019	2019	
Goshawk	**Pale Chanting**	*Melierax*	*canorus*	R	√	√	2023	2023	2022	2023	2023	√
Guineafowl	Helmeted	*Numida*	*meleagris*		√	√	2018	2023	2023	2023		√
Hamerkop		*Scopus*	*umbretta*		√	√						
Harrier	**Black**	*Circus*	*maurus*	R, EN, G EN	√	√						
Hawk-eagle	**African**	*Aquila*	*spilogaster*	R		√	2016	2013	2020	2020	2019	
Heron	Grey	*Ardea*	*cinerea*		√	√						
Honeyguide	Lesser	*Indicator*	*minor*		√	√						
Hoopoe	African	*Upupa*	*africana*		√	√		2023	2021	2023	2023	√
Hornbill	African Grey	*Lophoceros*	*nasutus*		√	√		2017			2019	
Hornbill	**Monteiro's**	*Tockus*	*monteiri*	NamNE	√	√						
Hornbill	Southern Yellow-billed	*Tockus*	*leucomelas*		√	√	2015			2017		√
Kestrel	**Greater**	*Falco*	*rupicoloides*	R	√	√	2021	2021	2022	2022	2023	√
Kestrel	**Rock**	*Falco*	*rupicolus*	R		√	2022	2022	2023	2023	2023	√
Kite	**Black**	*Milvus*	*migrans*	R, Pal mig	√				2021			
Kite	**Black-winged**	*Elanus*	*caeruleus*	R	√	√				2013	2022	
Kite	**Yellow-billed**	*Milvus*	*aegyptius*	R, intra-Afr mig	√						2018	
Korhaan	**Karoo**	*Eupodotis*	*vigorsii*	T	√	√			2018		2012	

Common group	Common species	Genus	Species	Sensitivity	NBD 159	EIS	Solitaire 90	Ababis 98	NNL 94	NDL 119	DG 100	Pers obs 2024
					4 QDSs	4 QDSs	2350_1600	2355_1605	2400_1555	2405_1550	2410_1550	
Korhaan	**Northern Black**	*Afrotis*	*afraoides*	T		√	2010	2020			2018	
Korhaan	**Rüppell's**	*Eupodotis*	*rueppelii*	T, NamNE	√	√	2022	2023	2024	2023	2023	√
Lapwing	Blacksmith	*Vanellus*	*armatus*		√	√						
Lapwing	Crowned	*Vanellus*	*coronatus*		√	√	2021	2022		2022	2021	
Lark	**Dune**	*Calendulauda*	*erythrochlamys*	T, NamE						2023	2021	
Lark	Cape Clapper	*Mirafra*	*apiata*			√						
Lark	Eastern Clapper	*Mirafra*	*fasciolata*		√							
Lark	Fawn-colored	*Calendulauda*	*africanoides*			√	2018			2013		
Lark	Karoo	*Calendulauda*	*albescens*			√						
Lark	Karoo Long-billed	*Certhilauda*	*subcoronata*		√	√	2023		2022			
Lark	Monotonous	*Mirafra*	*passerina*				2022			2023		
Lark	Red-capped	*Calandrella*	*cinerea*							2014		
Lark	Rufous-naped	*Mirafra*	*africana*						2022			
Lark	Sabota	*Calendulauda*	*sabota*			√	2023	2022	2023	2020	2019	
Lark	Spike-heeled	*Chersomanes*	*albofasciata*		√	√	2023		2022	2022	2023	
Lark	Stark's	*Spizocorys*	*starki*		√	√	2023	2018	2023	2022	2019	√
Lovebird	Rosy-faced	*Agapornis*	*roseicollis*		√	√	2022	2023		2023	2023	
Martin	Brown-throated	*Riparia*	*paludicola*		√							
Martin	Rock	*Ptyonoprogne*	*fuligula*		√	√	2022	2023	2023	2023	2022	
Martin	Sand	*Riparia*	*riparia*		√	√						
Mousebird	Red-faced	*Urocolius*	*indicus*		√	√	2016			2019		
Mousebird	White-backed	*Colius*	*colius*		√	√	2018		2022	2023	2021	
Nightjar	European	*Caprimulgus*	*europaeus*							2022		

Common group	Common species	Genus	Species	Sensitivity	NBD 159	EIS	Solitaire 90	Ababis 98	NNL 94	NDL 119	DG 100	Pers obs 2024
					4 QDSs	4 QDSs	2350_1600	2355_1605	2400_1555	2405_1550	2410_1550	
Nightjar	Freckled	*Caprimulgus*	*tristigma*		√	√					2021	
Nightjar	Rufous-cheeked	*Caprimulgus*	*rufigena*		√	√		2023				
Oriole	Eurasian Golden	*Oriolus*	*oriolus*		√	√			2019			
Ostrich	Common	*Struthio*	*camelus*		√	√	2016		2023	2023	2023	
Owl	**African Scops**	*Otus*	*senegalensis*	R	√							
Owl	**Southern White-faced Scops**	*Ptilopsis*	*granti*	R		√				2020	2014	
Owl	**Western Barn**	*Tyto*	*alba*	R	√	√	2012	2019	2022	2022	2020	
Owlet	**Pearl-spotted**	*Glaucidium*	*perlatum*	R	√	√		2023	2021	2015	2018	
Peafowl	Indian	*Pavo*	*cristatus*				2013					
Pigeon	Speckled (Rock Dove)	*Columba*	*guinea*		√	√	2023	2023	2023	2023	2024	√
Pipit	Long-billed	*Anthus*	*similis*		√	√						
Pipit	Nicholson's	*Anthus*	*nicholsoni*					2017				
Plover	Common Ringed	*Charadrius*	*hiaticula*		√	√						
Plover	Three-banded	*Charadrius*	*tricollaris*		√	√		2013				
Prinia	Black-chested	*Prinia*	*flavicans*		√	√	2023	2023	2022	2023	2024	
Pytilia	Green-winged	*Pytilia*	*melba*		√	√				2015		
Quail	Common	*Coturnix*	*coturnix*						2022	2022	2022	
Quelea	Red-billed	*Quelea*	*quelea*		√	√	2022	2022	2022	2012		
Rockrunner		*Achaetops*	*pycnopygius*	NamNE	√	√			2019			
Roller	Lilac-breasted	*Coracias*	*caudatus*			√				2022		
Roller	Purple	*Coracias*	*naevius*			√				2022		

Common group	Common species	Genus	Species	Sensitivity	NBD 159	EIS	Solitaire 90	Ababis 98	NNL 94	NDL 119	DG 100	Pers obs 2024
					4 QDSs	4 QDSs	2350_1600	2355_1605	2400_1555	2405_1550	2410_1550	
Sandgrouse	**Double-banded**	*Pterocles*	*bicinctus*	T	√	√	2017	2023	2023	2017	2020	
Sandgrouse	**Namaqua**	*Pterocles*	*namaqua*	T	√	√	2019	2019	2023	2023	2023	√
Sandpiper	Common	*Actitis*	*hypoleucos*		√							
Sandpiper	Wood	*Tringa*	*glareola*		√	√						
Scimitarbill	Common	*Rhinopomastus*	*cyanomelas*		√	√	2021	2023	2023	2023	2023	
Scrub Robin	Kalahari	*Cercotrichas*	*paena*			√	2022	2017		2022	2021	
Scrub Robin	Karoo	*Cercotrichas*	*coryphoeus*			√						
Secretarybird	**Secretarybird**	*Sagittarius*	*serpentarius*	R, VU, G EN	√	√		2019		2017	2022	
Shikra		*Accipiter*	*badiuis*	R	√							
Shrike	Crimson-breasted	*Laniarius*	*atrococcineus*		√	√		2017		2023	2023	
Shrike	Lesser Grey	*Lanius*	*minor*		√	√		2022	2022		2019	
Shrike	Red-backed	*Lanius*	*collurio*		√	√			2019	2023	2019	
Shrike	**White-tailed**	*Lanioturdus*	*torquatus*	T, NamNE	√	√		2023				
Sparrow	Cape	*Passer*	*melanurus*		√	√	2023	2023	2023	2023	2023	√
Sparrow	Great	*Passer*	*motitensis*		√	√	2023			2014	2019	
Sparrow	House	*Passer*	*domesticus*		√	√	2023			2023	2023	√
Sparrow	Southern Grey-headed	*Passer*	*diffusus*		√	√	2021	2023		2022	2013	
Sparrow-Lark	Black-eared	*Eremopterix*	*australis*						2022			
Sparrow-Lark	Chestnut-backed	*Eremopterix*	*leucotis*								2021	
Sparrow-Lark	Grey-backed	*Eremopterix*	*verticalis*		√	√	2022	2022	2023	2023	2023	
Sparrow-Weaver	White-browed	*Plocepasser*	*mahali*		√	√	2022	2022	2023	2022		

Common group	Common species	Genus	Species	Sensitivity	NBD 159	EIS	Solitaire 90	Ababis 98	NNL 94	NDL 119	DG 100	Pers obs 2024
					4 QDSs	4 QDSs	2350_1600	2355_1605	2400_1555	2405_1550	2410_1550	
Spurfowl	Red-billed	*Pternistis*	*adspersus*			√	2012			2019		
Starling	Burchell's	*Lamprotornis*	*australis*							2015		
Starling	Cape	*Lamprotornis*	*nitens*		√	√	2023	2022	2021	2022	2023	√
Starling	Pale-winged	*Onychognathus*	*nabouroup*		√	√	2023	2024	2023	2023	2023	√
Starling	Violet-backed	*Cinnyricinclus*	*leucogaster*		√	√		2020		2015	2020	
Starling	Wattled	*Creatophora*	*cinerea*		√	√	2022	2022	2022		2021	
Stork	**Black**	*Ciconia*	*nigra*	A, EN	√	√		2013				
Stork	**Marabou**	*Leptoptilos*	*crumenifera*			√						
Sunbird	Dusky	*Cinnyris*	*fuscus*			√	2019	2022	2023	2023	2023	
Sunbird	Marico	*Cinnyris*	*mariquensis*				2016			2022		
Sunbird	Scarlet-chested	*Chalcomitra*	*senegalensis*			√				2023	2023	
Swallow	Barn	*Hirundo*	*rustica*		√	√	2019	2019	2019	2020	2019	
Swallow	Greater Striped	*Cecropis*	*cucullata*		√	√	2015	2013		2013	2018	
Swallow	South African Cliff	*Pterochelidon*	*spilodera*		√							
Swift	African Palm	*Cypsiurus*	*parvus*				2013	2020	2022	2022		
Swift	Alpine	*Tachymarptis*	*melba*		√	√	2021			2021		
Swift	Bradfield's	*Apus*	*bradfieldi*		√	√	2022		2021	2023	2023	
Swift	Common	*Apus*	*apus*		√	√			2021	2013		
Swift	Little	*Apus*	*affinis*				2022	2022	2022	2018		
Swift	White-rumped	*Apus*	*caffer*		√	√	2017	2021	2022			
Tchagra	Brown-crowned	*Tchagra*	*australis*		√		2015					
Thick-knee	Spotted	*Burhinus*	*capensis*		√	√		2020	2022			
Thrush	Groundscraper	*Turdus*	*litsitsirupa*			√		2023				

Common group	**Common species**	**Genus**	**Species**	**Sensitivity**	**NBD 159**	**EIS**	**Solitaire 90**	**Ababis 98**	**NNL 94**	**NDL 119**	**DG 100**	**Pers obs 2024**
					4 QDSs	**4 QDSs**	**2350_1600**	**2355_1605**	**2400_1555**	**2405_1550**	**2410_1550**	
Thrush	Olive	*Turdus*	*olivaceus*			√						
Thrush	Short-toed Rock	*Monticola*	*brevipes*		√	√	2023	2022	2022	2023	2022	
Tit	Ashy	*Melaniparus*	*cinerascens*		√	√	2012	2020	2023	2023	2024	
Tit	Cape Penduline	*Anthoscopus*	*caroli*		√	√						
Vulture	**Cape**	*Gyps*	*coprotheres*	R, CR, G VU (now rare in Namibia)	√						2019	
Vulture	**Lappet-faced**	*Torgos*	*tracheliotos*	R, EN, G EN	√	√	2019	2020	2023	2023	2024	
Vulture	**White-backed**	*Gyps*	*africanus*	R, CR, G CR	√	√	2022	2020	2023	2023	2023	
Wagtail	Cape	*Motacilla*	*capensis*		√	√	2019	2018				
Wagtail	Western Yellow	*Motacilla*	*flava*		√	√						
Warbler	Chestnut-vented	*Curruca*	*subcoerulea*		√	√	2023	2023	2022	2023	2023	
Warbler	Cinnamon-breasted	*Euryptila*	*subcinnamomea*		√							
Warbler	Common (African) Reed	*Acrocephalus*	*baeticatus*		√	√				2020		
Warbler	Garden	*Sylvia*	*borin*		√	√						
Warbler	Icterine	*Hippolais*	*icterina*				2012					
Warbler	Layard's	*Curruca*	*layardi*		√	√			2023			
Warbler	Rufous-eared	*Malcorus*	*pectoralis*		√	√	2023		2022	2023	2019	
Warbler	Willow	*Phylloscopus*	*trochilus*		√	√				2013		
Waxbill	Black-faced	*Brunhilda*	*erythronotos*		√	√		2017				
Waxbill	Common	*Estrilda*	*astrild*		√	√						
Waxbill	Violet-eared	*Granatina*	*granatina*			√		2019		2019		

Common group	Common species	Genus	Species	Sensitivity	NBD 159	EIS	Solitaire 90	Ababis 98	NNL 94	NDL 119	DG 100	Pers obs 2024
					4 QDSs	4 QDSs	2350_1600	2355_1605	2400_1555	2405_1550	2410_1550	
Weaver	Chestnut	*Ploceus*	*rubiginosus*		√	√		2022	2022			
Weaver	Lesser Masked	*Ploceus*	*intermedius*							2021		
Weaver	Scaly-feathered	*Sporopipes*	*squamifrons*		√	√	2022	2022	2022	2023	2023	√
Weaver	***Sociable***	*Philetairus*	*socius*	Nesting	√	√	2023	2023	2023	2023	2024	√
Weaver	Southern Masked	*Ploceus*	*velatus*		√	√	2023	2022	2022	2023	2019	√
Wheatear	Capped	*Oenanthe*	*pileata*		√	√	2022	2023	2022	2022	2022	
Wheatear	Mountain	*Myrmecocichla*	*monticola*		√	√	2023	2023	2024	2023	2024	√
White-eye	Orange River	*Zosterops*	*pallidus*		√	√						
Whydah	Long-tailed Paradise	*Vidua*	*paradisaea*		√	√						
Whydah	Pin-tailed	*Vidua*	*macroura*		√							
Whydah	Shaft-tailed	*Vidua*	*regia*		√	√				2015		
Woodpecker	Cardinal	*Dendropicos*	*fuscescens*		√	√		2022		2020	2021	
Woodpecker	Golden-tailed	*Campethera*	*abingoni*		√	√		2019		2018		