Appendix G.7

AVIFAUNA IMPACT ASSESSMENT

Avifauna Pre-construction Monitoring Assessment for the Proposed Verkykerskop WEF Cluster: Normandien WEF

Prepared by:

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Report Name	**Avifauna Pre-construction Monitoring Assessment for the Proposed Verkykerskop WEF Cluster: Normandien WEF**
Submitted to	**Normandien Wind Power (Pty) Ltd**
Lead Specialist (Fieldwork and Report Writing)	**Tyron Clark**
	Tyron Clark (Pr. Sci. Nat. 121338) has more than decade's worth of experience conducting biodiversity assessments in a number of African countries, affording him good experience in variety of development types, particularly avifaunal assessments. He attained his MSC in Zoological science from the University of the Witwatersrand. His research interests centre on biogeography and ecological niche modelling. Tyron has also completed courses in wetland delineation and management hosted by the University of the Free State.
Reviewer	**Dr Ryno Kemp**
	Dr Ryno Kemp is Pr Sci Nat registered (117462/17) in Zoological Science. Ryno is a qualified Avifauna specialist with over three years of experience, three years of experience in conservation and more than eight years of scientific research experience across South Africa.
Reviewer	**Andrew Husted**
	Andrew Husted is Pr Sci Nat registered (400213/11) in the following fields of practice: Ecological Science, Environmental Science and Aquatic Science. Andrew is an Aquatic, Wetland and Biodiversity Specialist with more than 16 years' experience in the environmental consulting field.
Fieldwork	Core: Lloyd Mhlongu (Phd candidate), Susan Abell (MSc), Tyron Clark (MSc). Contributors: Dr. Ryno Kemp, Andre van Tonder (MSc), Cheri Clark, Ernest Porter, Geoff Lockwood, Samantha Bradley.
Declaration	The Biodiversity Company and its associates operate as independent consultants under the auspice of the South African Council for Natural Scientific Professions. We declare that we have no affiliation with or vested financial interests in the proponent. We have no conflicting interests in the undertaking of this activity and have no interests in secondary developments resulting from the authorisation of this project. We have no vested interest in the project, other than to provide a professional service within the constraints of the project (timing, time and budget) based on the principals of science.

Rock Kestrel (*Falco rupicolus*)

DECLARATION

I, Tyron Clark, declare that:

- I act as the independent specialist in this application;
- I have performed the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing any decision to be taken with respect to the application by the competent authority; and the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- All the particulars furnished by me in this form are true and correct; and
- I realise that a false declaration is an offence in terms of Regulation 71 and is punishable in terms of Section 24F of the Act.

Tyron Clark (Pr. Sci. Nat. 121338)

Avifaunal Lead (Meraki Consulting Pty Ltd)

For: The Biodiversity Company

June 2025

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1. Introduction

This report presents the baseline avifaunal findings and anticipated impacts associated with the proposed Kromhof Wind Power (Pty) Ltd Wind Energy Facility (WEF), herein referred to as Kromhof WEF (or the Project), in the Eastern Free State. The results and assertions are based an intensive two-year monitoring program informed by several supplementary investigations. These included nest and roost investigations, aerial drone surveys, sophisticated habitat modelling and robust tracking data on key species.

The Kromhof WEF forms part of the Verkykerskop WEF Cluster (VWC). The VWC (Figure 1-1) is situated in the Thabo Mofutsanyane District Municipality and Phumelela Local Municipality, near the town of Harrismith, in the Free State Province of South Africa near Verkykerskop, South Africa. The VWC consists of three separate WEF applications, each with their own 132 kV Grid Connections (subject to a separate Basic Assessment Process), within an area spanning approximately 19506 ha in extent. The individual WEFs include Groothoek (6170 ha, up to 300 MW), Kromhof (7269 ha, up to 300 MW) and Normandien (6067 ha, up to 300 MW). The location of the Kromhof WEF is shown in Figure 1-2. The project triggers three species-specific best practice guidelines as published by BirdLife South Africa for (1) Cape Vulture as the VWC is within 50 km of seven roosts one of which is a breeding colony (Pfeiffer and Ralston-Paton, 2021), (2) Verreaux's Eagle, the VWC is within 10 km of at least three nests of which none were active (Ralston-Paton and Murgatroyd, 2021) and (3) Black Harrier as the grasslands in the VWC are utilised as non-breeding foraging grounds (Simmons et al. 2020). Collectively, these guidelines impose, *inter-alia*, two years' worth of intensive pre-construction monitoring (including 72 hours of vantage point surveying by two observers per year).

The monitoring was carefully designed to collect data in a way that would allow for compliance with all relevant global and national legislation as well as best practice standards. This includes the national best practice standards specifically with regards to birds and wind energy (Jenkins et al. 2015), the various species-specific guidelines as well as global best practice as outlined in the International Finance Corporation (IFC) Performance Standard 6 (IFC, 2019), Equator Principles (EP4, 2020) Multi-species Action Plan to conserve African-Eurasian Vultures (Botha et al. 2017; Pritchard, 2020). For reference purposes, the Area of Influence or "AOI", as referred to in this study, was defined so as to include all potential Cape Vulture roost sites within a 50 km radius of the project area and was refined to follow natural or man-made boundaries such as roads or escarpments. The term "region" refers to all areas within the greater Phumelela Local Municipality.

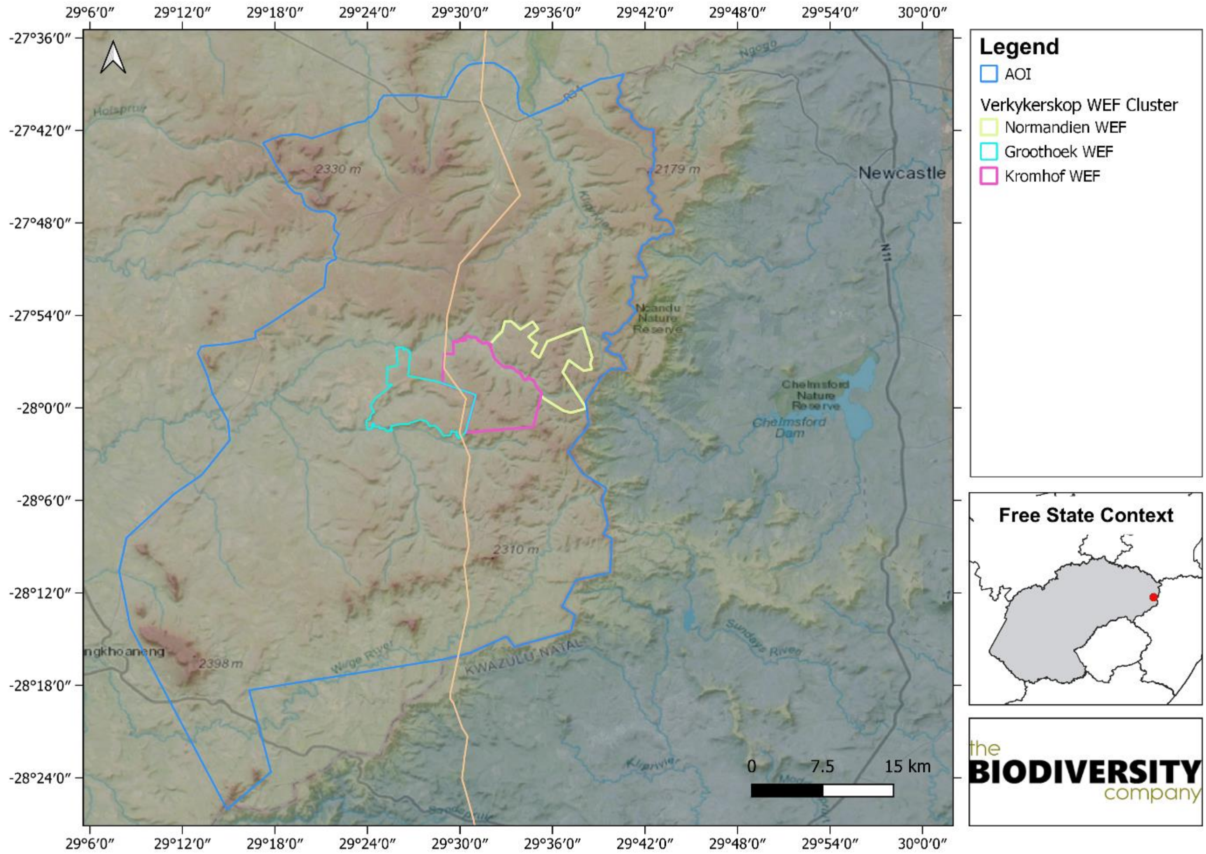

Figure 1-1 Overview of the location of Verkykerskop WEF Cluster

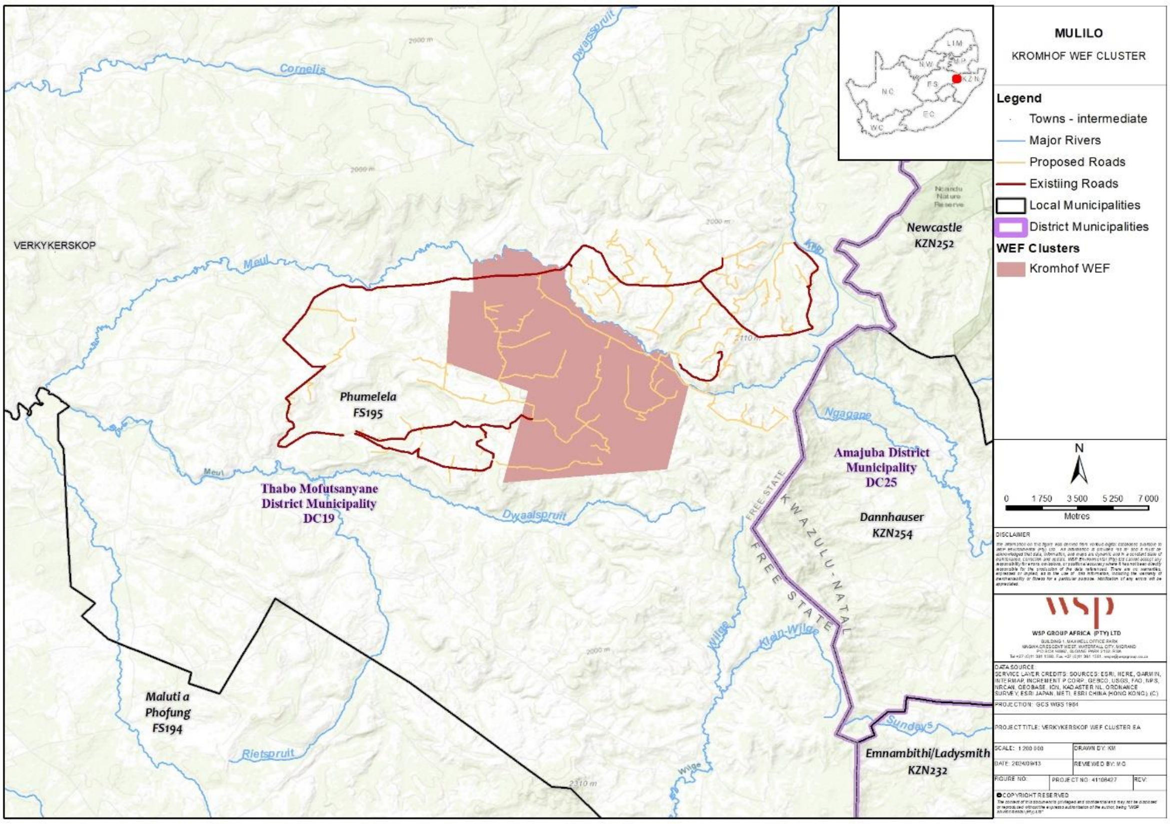

Figure 1-2 Location of the Kromhof WEF (WSP, 2025)

1.1 Project Description

The Kromhof Wind Power Project is divided into two separate applications. The first being the WEF itself (up to 320 MW) which is subject to the full Scoping and EIA (S&EIA), The second is the Grid Connection (132 KV) which is subject to a separate Basic Assessment (BA) process. As such only the WEF will be considered for the purposes of this assessment (although the cumulative impacts of the WEF have been considered with the WEF).

The WEF is situated in the west of the cluster and spans an area of 5721 ha. It covers 11 farm portions namely Leiden No. 2, Myn-Burg No. 3, Naauw Kloof No. 4, Krom Hof No. 530, Puntje No. 1240, Aanfield No. 253, Aanfield No. 253, Ox Hoek No. 98, Ox Hoek No. 98, Ox Hoek No. 98 and Ox Hoek No. 98, Markgraaff's Rest No. 478. At present, the Kromhof WEF is planned to comprise:

- A total of up to 36 wind turbines with a rotor diameter of 200 m, a hub height of 150 m and a total height of 250 m. The hard standing area is < 0.8 ha per turbine;
- A reticulation network of 33kV cabling to connect the wind turbines to the onsite collector substations, to be laid underground where practical;
- A 132kV onsite collector substation (<2 ha);
- Concrete batching plant (1 ha);
- Construction camp and site office (4 ha);
- Materials laydown area (8 ha);
- Internal roads (8 m width);
- O&M building (<1 ha); and
- An 800MWH Battery Energy Storage System or BESS (7 ha).

1.2 Legislative Setting

The legislation, policies and guidelines listed below are applicable to the current project with regard to avifauna. The list below, although extensive, is not exhaustive and other legislation, policies and guidelines may apply in addition to those listed below (Table 1-1).

Table 1-1 A list of key legislative requirements relevant to these studies in the Free State

Region	Legislation
International	Convention on Biological Diversity (CBD, 1993)
	The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES 1973)
	African-Eurasian Waterbird Agreement (AEWA)
	Memorandum of Understanding on the Conservation of Migratory Birds of Prey in Africa and Eurasia.
	The Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention, 1979)
National	Constitution of the Republic of South Africa (Act No. 108 of 2006)
	The National Environmental Management Act (NEMA) (Act No. 107 of 1998)
	The National Environmental Management Act (NEMA) (Act No. 107 of 1998) Section 24, No 42946 (January 2020)
	The National Environmental Management Act (NEMA) (Act No. 107 of 1998) Section 24, No 43110 (March 2020)
	The National Environmental Management Protected Areas Act (Act No. 57 of 2003)
	The National Environmental Management Biodiversity Act (Act No. 10 of 2004)
	The National Environmental Management: Waste Act, 2008 (Act 59 of 2008);
	The Environment Conservation Act (Act No. 73 of 1989) and associated EIA Regulations
	National Protected Areas Expansion Strategy (NPAES)

	Environmental Conservation Act (Act No. 73 of 1983)
	Natural Scientific Professions Act (Act No. 27 of 2003)
	National Biodiversity Framework (NBF, 2009)
	National Spatial Biodiversity Assessment (NSBA)
	National Heritage Resources Act, 1999 (Act 25 of 1999)
	Alien and Invasive Species Regulations, 2014
	South Africa's National Biodiversity Strategy and Action Plan (NBSAP)
	Conservation of Agricultural Resources Act, 1983 (Act 43 of 1983)
	White Paper on Biodiversity
	Government Gazette 8 August 2024, No. 51022. Cape Vultures. Protocol for Specialist Assessment and Minimum Report Content Requirements for Environmental Impacts on Cape Vultures by Onshore Generation Facilities Where the Electricity Output is 20 Megawatts or More.
	Government Gazette. Vol. 705, 18 March, No. 4517, NEMA, 2004 (Act No. 10 of 2004). Publication of the Multi-species Biodiversity Management Plan for Vultures in South Africa for Implementation in Terms of Section 43 of the National Environmental Management Act, 2004 (Act No. 10 of 2004); Assignment of Responsibilities to the national Vulture Task Force and the Repeal of the Biodiversity Management Plan for the Bearded Vulture.
	South African National Biodiversity Institute (SANBI). 2020. Species Environmental Assessment Guideline. Guidelines for the implementation of the Terrestrial Fauna and Terrestrial Flora Species Protocols for environmental impact assessments in South Africa. South African National Biodiversity Institute, Pretoria. Version 1.2020.
	Procedures for the Assessment and Minimum Criteria for Reporting on Identified Environmental Themes in terms of Sections 24(5)(a) and (h) and 44 of the National Environmental Management Act, 1998
Provincial	Free State Nature Conservation Ordinance 8 of 1969

1.3 Assumptions and Limitations

The following limitations should be noted for the assessment:

- Access was only arranged for survey work within the VWC;
- Flight paths were visually assessed and manually drawn onto topographical field maps for later digitisation. There are inherent human limitations associated with accurately translating visual observations into mapped flight paths. Efforts were made to identify landmarks in different cardinal directions of known distance from the Vantage Points. Flight path maps were made with concentric radial buffers of different distances from the VP to assist in georeferencing;
- Flight corridors were manually delineated in an attempt to best intersect with the available data in a way that is both intuitive and biologically meaningful. This included flight paths, the flight path density intersection model (kernel density estimation), species occurrence density model (kernel density estimation), Vulpro (2025) flight data (point cloud), Martial Eagle core use areas (kernel density estimation). It is, however, acknowledged that although the resultant flight corridor shapefile represents the best fit to these various datasets it does not fit them absolutely and should not be considered a static end result, nor should it be considered entirely comprehensive. It is also important to note that the above-mentioned models use a relative scale which limits their contextualisation relative to other parts of South Africa. Flights of priority species are dynamic and vary both spatially and temporally. As such these risk estimation areas may just as easily under-represent risk as they may over predict it;
- An update was published by BirdLifeSA (in the form of an Ebook and updated checklist) on the conservation status of the birds of South Africa, Lesotho and Eswatini. This update came after the completion of the draft report. An effort has, however, been made to ensure that all conservation statuses as presented in this report and the appendices reflect these new red-list classifications. However, as data analysis was completed prior to the publication of the red-list the 10 recently added species are acknowledged but excluded from the initial set of priority species shortlisted for detailed assessment in this report. These species include African Darter, Black-crowned Night Heron, Black-winged Kite, Cape Shoveler, Great Egret, Hamerkop, Knob-billed Duck, Red-billed Teal, Southern Pochard and White-backed Duck.

- With regards to the Martial Eagle tracking, it is acknowledged by EWT that the methods behind the calculation of flight height could be refined by improving GPS calibration and through the use more precise digital elevation models;
- Although the Cape Vulture tracking data provides a reliable representation of vulture movement patterns and has been collected from several birds over multiple years, Vulpro (2025) highlight the following;
    - "…*inherent limitations of GPS technology—such as signal loss, positioning errors, and variations in logging intervals—may result in certain birds being overrepresented or underrepresented in the dataset. This data is provided exclusively to support environmental assessments and planning processes and is intended to complement, not replace, fieldwork and on-site evaluations*".
    - "*It includes data obtained using various GPS tracking devices, each with different logging intervals and study regimes*."
    - "*Vulpro's GPS tracking data for the Eastern Free State is less comprehensive than in other parts of South Africa and may not fully reflect the species' activity in this region*."

2. Methodology

The preconstruction avifaunal monitoring involved two parts. The first being the standard (originally planned) two-year Cape Vulture compliant monitoring program which consisted of twelve surveys (S1-12) over a two-year period (six per year) allowing each season to be represented three times. The second being the addition of two more surveys (S13 and 14) conducted in Summer and Autumn respectively which was commissioned to detect changes in vulture flight activity following the implementation of Kromhof WEF's carcass management initiative in early 2025. The two-year monitoring program was designed to comply with all relevant global and national legislation and best practice standards. In addition to the species-specific guidelines for Cape Vulture, Verreaux's Eagle and Black Harrier, this includes the International Finance Corporation (IFC) Performance Standard 6 (IFC, 2019) Equator Principles (EP4, 2020) and Jenkins et al. (2015).

2.1 Desktop Assessment

The following resources were consulted during the desktop assessment and for the compilation of the expected species list:

- A Utilization Distribution for the Global Population of Cape Vultures (*Gyps coprotheres*) to guide wind energy development (Cervantes et al. 2022).
- Important Bird and Biodiversity Areas (https://www.birdlife.org.za/iba-directory);
- Key Biodiversity Areas (https://www.keybiodiversityareas.org).
- Birds and wind energy best practice guidelines (Jenkins et al. 2015);
- Cape Vulture and wind farms best practice guidelines (Pfeiffer and Ralston-Paton, 2021);
- Chittenden et al. (2016), Roberts Birds of Guide (2nd Edition.). The primary source for species identification, geographic range, life history information and birding routes in the AOI;
- Procedures for the Assessment and Minimum Criteria for Reporting on Identified Environmental Themes in terms of Sections 24(5)(a) and (h) and 44 of the National Environmental Management Act, 1998.
- Sinclair and Ryan (2010), Birds of Africa. Secondary source for identification;
- South African Bird Atlas Project (SABAP 2, https://sabap2.birdmap.africa/). Full protocol atlassing data from nine pentads that cover the VWC was used to construct the expected

species list. These included 2755_2920, 2800_2920, 2755_2925, 2800_2925, 2750_2930, 2755_2930, 2800_2930, 2750_2935, 2755_2935;

- South African National Biodiversity Institute (SANBI). 2020. Species Environmental Assessment Guideline. Guidelines for the implementation of the Terrestrial Fauna Protocols for environmental impact assessments in South Africa;
- South African National Biodiversity Institute, Pretoria. Version 1.2020; and
- Lee et al. (2025). The 2025 Red Data Book of Birds of South Africa, Lesotho and Eswatini. Johannesburg, South Africa: BirdLife South Africa. Used for conservation status, nomenclature and taxonomical ordering;
- The National Web-Based Environmental Screening Tool DEA website (2025);
- Verreaux's Eagle and wind farms best practice guidelines (Ralston-Paton and Murgatroyd, 2021);

2.2 Fieldwork

Fieldwork was conducted in line with the birds and wind energy best practice standards (Jenkins et al. 2015) as well as the species-specific guidelines for Cape Vulture (Pfeiffer and Ralston-Paton, 2018; Government Gazette No. 51022 of 08 August 2024), Verreaux's Eagle (Ralston-Paton and Murgatroyd, 2021) and Black Harrier (Simmons et al. 2020). All data was logged on BirdLasser to standardise entries among observers and streamline data processing.

Sampling was conducted within an AOI spanning an area (281494 ha) from Memel in the north to Harrismith and Van Reenen in the south and from Verkykerskop in the west to the Great Escarpment in the east. However, the standardised, formal sampling (vantage points, walked transects, driven transects) was restricted to within the 17958 ha WEF Complex and specifically with regards to Kromhof WEF this involved an area of 7269 ha. The sampling point codes by WEF are given in Table 2-1. Sampling within the remainder of the AOI was limited to incidental observations of priority species and focal point surveys (primarily roost and nest investigations).

Table 2-1 Standardised sampling points by type within the Verkykerskop WEF Cluster

Sampling Type	Groothoek				Kromhof					Normandien						Control			
Vantage Points (VP)	1	2	3	4	5	9	10	11	12	9	13	14	15	16	17	6	7	8	18
Walked Transects (WT)	1	2	3	4	5	9	10	11	12	13	14	15	16	17	-	6	7	8	18
Driven Transects (DT)	1	2	3	-	4	6	7	8	-	9	10	-	-	-	-	5	11	-	-

Sampling was always conducted by at least three observers at a time. Two observers were assigned to a vantage point while the third (floater) observer was tasked with conducting either walked transects, driven transects or focal points at the same time. Observer tasks were rotated to avoid fatigue. Aside from the eight-day scoping investigation, the pre-construction monitoring effort involved 14 surveys (12 for the standard pre-construction program and 2 additional surveys to monitor the effects of carcass management efforts) typically 20-23 days each (broken in to two 10 to 12-day legs), spanning a period from June 2022 – March 2025.

Sampling was designed to account for both seasonal and (to some degree) annual variation in order to facilitate the detection of the best possible spectrum of migratory avifauna, including both Intra-African and Palearctic migrants and observe changes in vulture attendance. Fortuitously, the survey coincided with two contrasting climatic patterns namely the dry (El Niño 2023/2024) and wet (La Niña 2024/2025) periods which assists in capturing variation in Cape Vulture and other priority species attendance. A map of the various sampling points and transects is given in Figure 2-2.

Fieldwork was conducted primarily by Lloyd Mhlongu (PhD candidate), Susan Abell (MSc) and Tyron Clark (MSc). Additional contributors included Andre Van Tonder (MSc), Cheri Clark, Ernest Porter, Dr.

Gareth Tate, Geoff Lockwood and Dr Ryno Kemp and. The following people also provided useful data and / or insights based on their experience in the area, Albert Froneman (AfriAvian), Carina Pienaar (BirdlifeSA) and Dr. Robin Colyn (AfriAvian). Details on the specific sampling protocol followed are discussed in greater detail below.

- Pre-scoping:
  - Remotely Piloted Aircraft System (RPAS) survey of threatened bird nests near the eastern Drakensberg Escarpment Part 1: Verkykerskop and Potter's Hill: 23-27 May 2022. EWT (2022), responsible contact Matt Pretorius;
- Scoping:
  - Scoping: 8 days, 18-25 July 2022;
- Standard pre-construction monitoring surveys (Years1 and 2):
  - Survey 1: 20 days, 3-12 August and 15-25 August 2022, winter;
  - Survey 2: 20 days, 16-25 November and 28 November-07 December 2022;
  - Survey 3: 23 days, 1-10 February, 13-22 February and 15-17 March 2023;
  - Survey 4: 23 days, 11-20 April, 2-11 May and 17-19 May 2023;
  - Survey 5: 23 days, 3-12 July, 17-26 July and 4-6 August 2023;
  - Survey 6: 22 days 31July-8 Aug, 11-20 September and 26-28 September 2023;
  - Survey 7, Year 2: Leg 1 (20-29 November 2023), Leg 2 (5-16 December 2023);
  - Survey 8, Year 2: Leg 1 (19 February -1 March 2024), Leg 2 (6-15 March 2024);
  - Survey 9 Year 2 Leg 1 (4 April -15 April 2024), Leg 2 (16-21 May 2024), Leg 3 (3-9 June);
  - Survey 10 Year 2 Leg 1 (18 – 27 June 2024), Leg 2a (22 June -2 August 2024);
  - Survey 11 Year 2: Leg1 (21-30 August), Leg 2 (3 -14 September 2024); and
  - Survey 12 Leg1 (2-11 October 2024), Leg 2 (14-25 October 2024).
- Supplementary Investigations:
  - Survey 13 Leg1 (14-27 January 2025), Leg 2 (2-9 February 2025), Carcass Management;
  - Survey 14 Leg1 (17-28 February 2025), Leg 2 (3-12 March 2025), Carcass Management;
  - Cape Vulture Roost Investigation Survey 1: 11-14 June 2023 Dr Ryno Kemp
  - Cape Vulture Roost Investigation Survey 2: 12-14 October 2023 Tyron Clark; and
  - Martial Eagle Investigation: 12-14 October 2023 Tyron Clark.
  - Detailed habitat modelling exercise for selected threatened species including, *inter alia*, Species 23, refined using in-field data: April 2025 (AfriAvian).

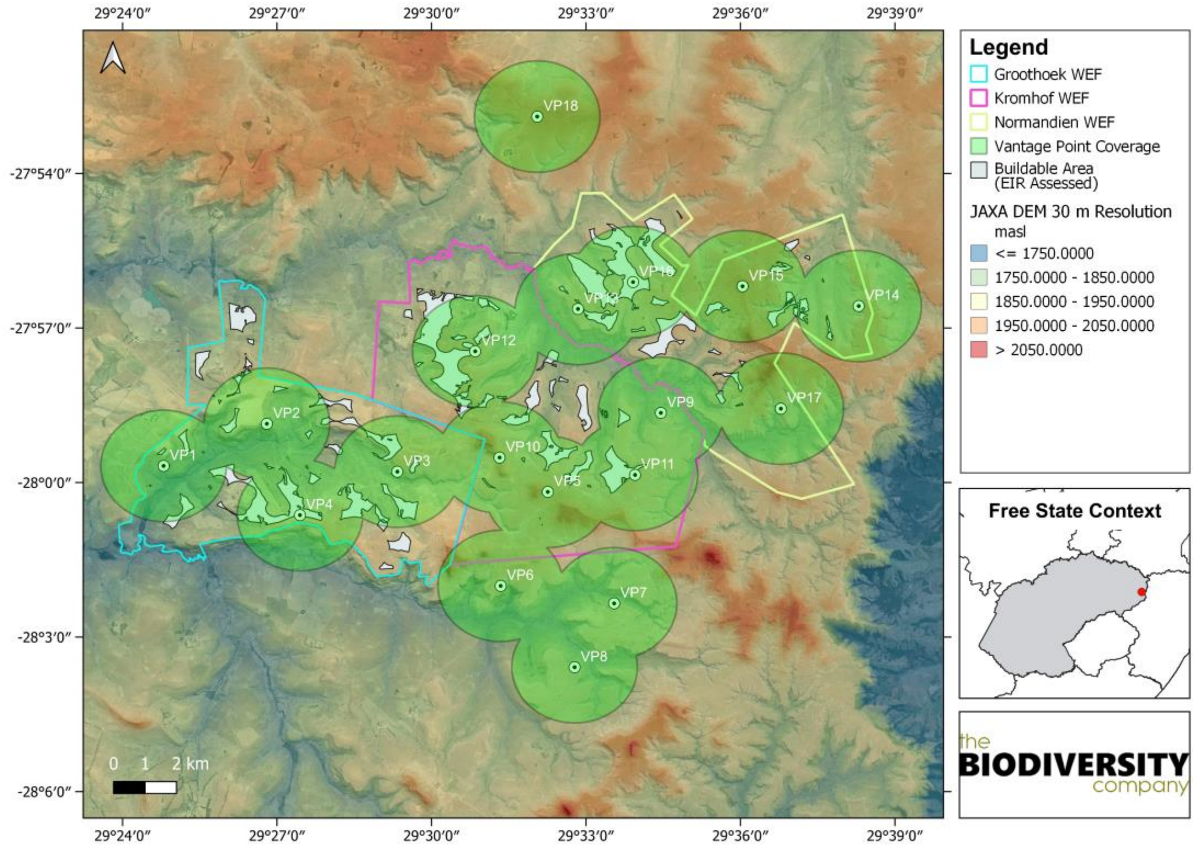

Figure 2-1 ***Spatial depiction of vantage point coverage (VP coverage of EIR Assessed Buildable Area = 76% over entire Verkykerskop WEF Cluster)***

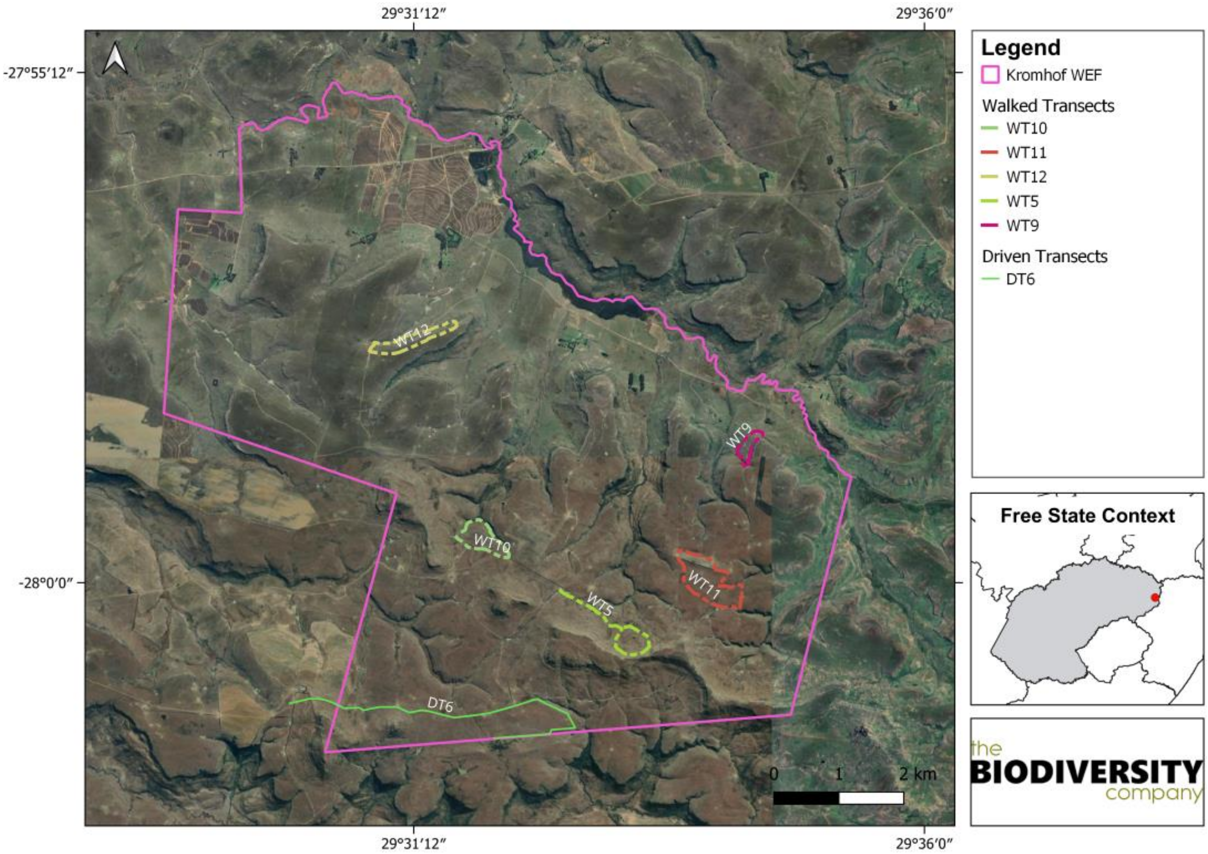

Figure 2-2 ***Location of walked and driven transects in relation to the vantage points***

2.2.1 Vantage Point Surveys

Five of the 18 Verkykerskop WEF Complex (VWC) vantage points were sampled in the Kromhof WEF (Table 2-1), VPs 5, 9, 10, 11 and 12. Another four vantage points were sample outside of the Kromhof WEF (and VWC) namely VPs 6, 7, 8 and 18. The Kromhof WEF was sampled six times per year totalling twelve visits over the two-year period. In accordance with the species-specific best practice guidelines for Cape Vulture, each vantage point was sampled by two observers for 72 hours per year, equating to 144 hours per VP over the two-year period. As part of the Kromhof WEF carcass management imitative, two additional surveys were conducted after the completion of the originally planned 12 surveys, namely S13 (Early Summer 2025) and S14 (Late Summer / Early Autumn 2025) to test its efficacy. In summary, a total of 720 hours were spent vantage point surveying Kromhof WEF from S1-12 by two observers (1440 person hours) and an extra 120 hours (240 person hours) were spent surveying the WEF during the additional S13 and 14 surveys totalling 840 hours (1680 person hours) for the Kromhof WEF and 672 hours (1344) for the Control area.

The position of the vantage points within the Kromhof WEF is shown in Figure 2-1. Each VP was carefully selected using a combination of digital elevation models and GIS processing to ensure > 75% coverage of the Verkykerskop WEF Cluster's EIR assessed buildable area. This was done in accordance with best practice requirements (Jenkins et al. 2015). This calculation assumes a maximum 2 km radial detection limit on each VP. Information recorded during vantage point surveys included, *inter alia*, climatic conditions, wind speed, wind direction, visibility, species, counts, activity (perched, flying, on grounds, on water), flight direction, flight height, flight duration and flight path (mapped visually on Google Earth).

Figure 2-3 Views from each vantage point

2.2.2 Walked Transects

Five walked transects were surveyed in the Kromhof WEF (WTs 5, 9. 10, 11, 12) and four outside of it which served as controls (WTs 6, 7, 8 and 18). Average walked transect lengths for the WEF and control were 2.64 km and 2.6 km respectively. The total walked distance covered in the WEF over the standard two-year period (S1-12) was 158.41 km with the additional S13-14 carcass management surveys from Year 3 bringing the total to 184.81 km. Total distance sampled along control transects was 125.17 km for the standard S1-12 monitoring and 146.03 km in total including the S13-14 surveys. The aim of the transects was to gather data on the diversity and relative abundance of birds on site, particularly with regard to smaller passerines that are not always adequately represented in the vantage point surveys, which are better suited to recording flights of larger species.

Table 2-2 ***Distances of walked transects comparing the site and control as well as the standard Year 1-2 surveys (S1-12) and additional carcass management surveys (S13-14).***

Metric	Kromhof						Control				
	WT5	WT9	WT10	WT11	WT12	Total	WT6	WT7	WT8	WT18	Total
Distance (km)	2.788	1.613	2.128	3.622	3.05	13.20	3.24	2.64	2.49	2.06	10.43
Samples (n) Y1-2 (S1-12)	12	12	12	12	12	60	12	12	12	12	48
Total Distance (km) Y1-2	33.46	19.36	25.54	43.46	36.60	158.41	38.92	31.70	29.89	24.66	125.17
Samples (n) Y3 (S13-14)	2	2	2	2	2	10	2	2	2	2	8
Total Distance (km) Y3	5.58	3.23	4.26	7.24	6.10	26.40	6.49	5.28	4.98	4.11	20.86
Total Distance (km) All	39.03	22.58	29.79	50.71	42.70	184.81	45.40	36.99	34.87	28.77	146.03

2.2.3 Driven Transects

Four driven transects were surveyed in the Kromhof WEF (DTs 4, 6, 7, 8) and two outside of it which served as controls (DTs 5 and 11). Average driven transect lengths for the WEF and control were 5.9 km and 11 km respectively. The total driven transect distance covered in the WEF over the standard two-year period (S1-12) was 283.7 km with the additional S13-14 carcass management surveys from Year 3 bringing the total to 331.02 km. Total distance sampled along control transects was 263.4 km for the standard S1-12 monitoring and 307.3 km in total including the S13-14 surveys. The variables recorded were the same as for walked transects. However, the primary objective of the driven transects was to cover ground in search of large-bodied, wide-ranging mobile species, such as cranes, bustards, korhaans, storks, eagles and vultures that are less easily encountered during the much shorter and more rigid walked transects.

Table 2-3 ***Distances of driven transects comparing the site and control as well as the standard Year 1-2 surveys (S1-12) and additional carcass management surveys (S13-14).***

Metric	Kromhof					Control		
	DT4	DT7	DT8	DT6	Total	DT5	DT11	Total
Distance (km)	6.284	5.088	6.189	6.083	23.64	4.66	17.29	21.95
Samples (n) Y1-2 (S1-12)	12	12	12	12	48	12	12	24
Total Distance (km) Y1-2	75.41	61.06	74.27	73.00	283.73	55.91	207.52	263.42
Samples (n) Y3 (S13-14)	2	2	2	2	8	2	2	4
Total Distance (km) Y3	12.57	10.18	12.38	12.17	47.29	9.32	34.59	43.90
Total Distance (km) All	87.98	71.23	86.65	85.16	331.02	65.23	242.10	307.33

2.2.4 Focal Point Surveys

Several focal points were sampled during the survey (Figure 2-4). Avifaunal abundance is hardly ever evenly distributed throughout a project area. Instead, birds tend to congregate in hotspots centred around prominent landscape features with higher primary productivity and moisture levels, such as a pan, lake, dam, wetland or rocky outcrop. Sampling involved an adapted form of point count sampling for a more extended (yet fixed duration) at the same time of day during each site visit. The observer utilised either a spotting scope or binoculars to maximise detection and identification. Breeding areas for red-listed species or other key areas likely to support/attract significant congregations of local and migratory species were prioritised for the focal surveys. Efforts were made to visit the various focal points at the appropriate time of day to maximise observation. For example, vulture roosts were surveyed after 14:00 or before 09:00 (when most vultures are on the roost).

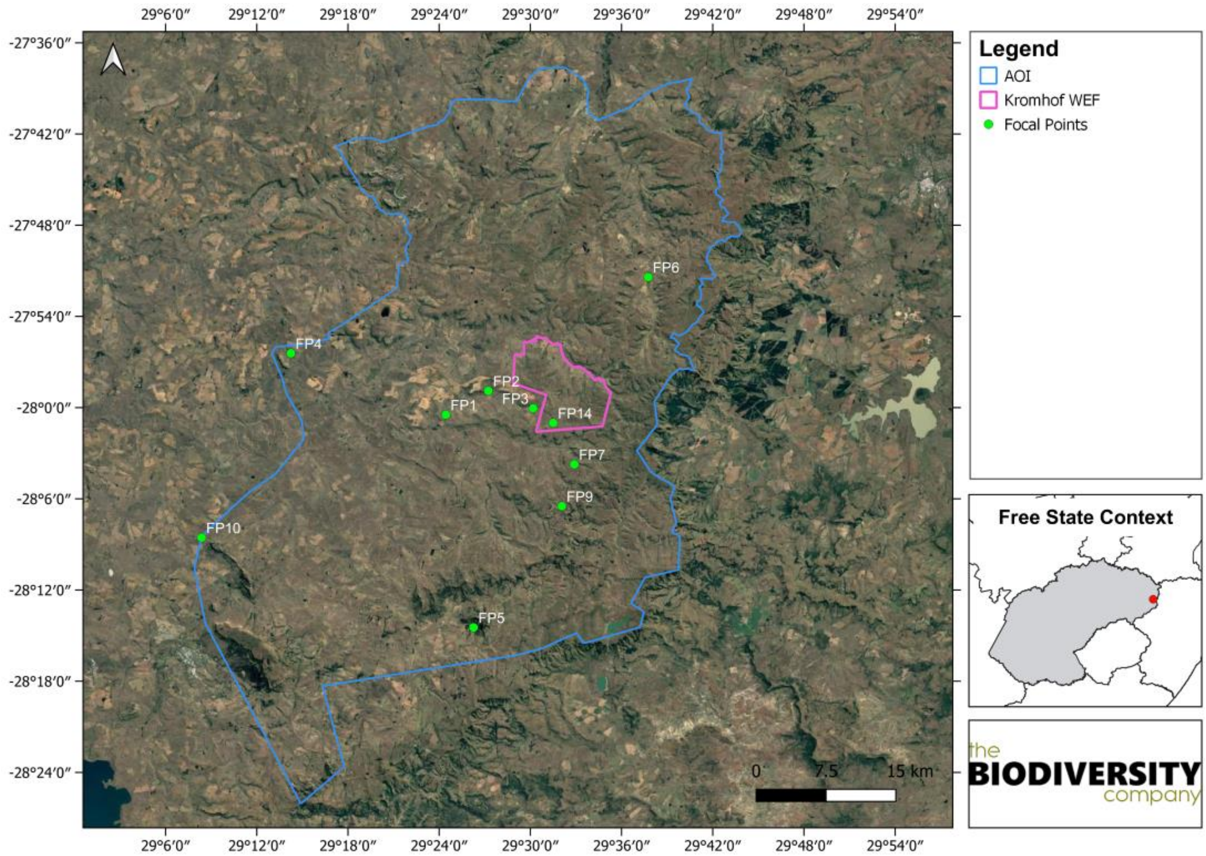

Figure 2-4 ***Spatial arrangement of key focal points in the AOI***

2.2.5 Incidental Searches

Diurnal incidental searches are also included to supplement the species inventory with cryptic and illusive species that may not have been detected within the rigid point count protocol. This involved opportunistic sampling of species between vantage points, transects and focal points.

2.2.6 Cape Vulture

2.2.6.1 Tracking

Cape Vulture tracking data was supplied courtesy of Vulpro to supplement the pre-construction monitoring data and assist in refining project planning and risk assessment. The dataset which includes the movement patterns of 16 birds, collected over multiple years as part of ongoing research by the organisation. The full Vulpro (2025) report is supplied in Appendix 2 of this report. The following disclaimer regarding the use of this data is issued by Vulpro: "*The GPS vulture tracking data and auxiliary vulture information provided are the property of Vulpro. Any analysis, interpretation, or conclusions drawn from this data are solely the responsibility of the independent avifaunal specialist. Vulpro does not endorse, validate, or assume liability for any findings, recommendations, decisions, or actions arising from such analysis. Vulpro reserves the right to review, comment on, or dispute any interpretations or conclusions derived from its data, in line with relevant environmental legislation, public participation processes, and its conservation principles*."

2.2.6.2 Roost Investigation

Initial planning (conducted before scoping) involved utilising digital elevation data and satellite imagery to identify potential roost sites for Cape Vulture within a 50 km radius of the project area (defined as the Verkykerskop WEF cluster). During scoping and the course of the first pre-construction monitoring trip, these sites were briefly visited to verify signs of vulture use. Three roost sites were identified. Contact was then made with Dr. Gareth Tate from the Endangered Wildlife Trust (together with Kromhof WEF) to establish the extent of knowledge regarding the three roosts identified within the Area of Influence (AOI). Efforts were also made to organise permission from landowners to access the roost sites. Valuable insights were also obtained from landowners Rick Dillon and Graham Hobbs.

Fieldwork was conducted over two separate trips. It was decided that the first trip should take place in May-August (preferably June) to coincide with peak egg-laying and nest attendance. The first visit was conducted from 11-14 June 2023 by Dr Ryno Kemp (The Biodiversity Company) and involved a visit to all three roosts. Tyron Clark (Meraki Consulting, sub-contracted by The Biodiversity Company) conducted the second follow-up visit from 12-14 October 2023. The second trip focused on Nelson's Kop with the aim of assessing breeding success.

Most observation time was spent non-intrusively surveying roosting birds from a nearby vantage using a combination of spotting scopes and binoculars. Photographs were taken using both a 400 mm Canon telephoto lens on a Canon 7D DSLR Body and a 600 mm Sigma telephoto lens on a mirrorless camera body. Fieldwork was heavily contingent on suitable weather conditions, as clouds and mist can obscure entire roosts.

2.2.7 Martial Eagle Investigation

During the course of preconstruction monitoring, it became evident that Martial Eagle regularly utilise the VWC. A proposal was made by the specialist team to Kromhof WEF to conduct a Martial Eagle Nest Investigation. This nest investigation which combined prior knowledge of the area and consultation with Carina Pienaar and Bradley Gibbons from Birdlife South Africa (BLSA) yielded several nests within the greater AOI. Upon informing Kromhof WEF a decision was made to commission a Martial Eagle Tracking project run by Dr Gareth Tate from the Endangered Wildlife Trust (EWT), funded by Kromhof WEF.

2.2.7.1 Tracking Data

The objective of the EWT Martial Eagle tracking project was to assist in the capture and fitment of GPS tracking devices to six breeding eagles within the greater Amsterdam, Ultrecht and Verkykerskop regions and develop a collision risk model. The aim being to establish robust tracking datasets which could be used to inform and guide developments and planning to avoid turbine placement in areas of high utilisation within WEF development sites.

The tracking project was set to run from February 2024 to end 2025. Ultimately one adult male Martial Eagle nicknamed Brad was captured and fitted with a GPS tracking harness in the VWC area. The tracking data from Brad, used to inform this monitoring report were collected from May 2024 to April 2025. Details on capture, tracking and modelling of the data can be found in the full EWT (2025) report supplied in Appendix 3 of this report.

2.2.7.2 Nest Investigation

Kromhof WEF requested that a high-level reconnaissance survey with the specific aim of searching suitable habitat and locating Martial Eagle Nests within the AOI surrounding the Verkykerskop development be conducted. This investigation was commissioned on the basis of the large potential implications for the wind farm should Martial Eagle nests be found in or in close proximity to the proposed development.

In response, two full days were dedicated solely to finding and locating Martial Eagle Nests. The initial stages of the investigation were dedicated to collecting all known locality data on Martial Eagle Nests from the area. This involved collating data from the specialist's personal nest records as well as any information provided by locals. The rest of the field time was spent searching for new nests and visiting known nests.

2.2.8 Delineation of Key Habitats

To inform early layout planning preliminary key habitats were initially identified using a combination of kernel density distribution modelling, digital elevation analysis (>1900 masl), slope analysis (<5%) and visual delineation using satellite imagery. Given the apparent extent and suitability of key grassland and wetland habitat and the potential implications (for several Threatened species) a decision was made by the specialist team to subject the initial delineations to a more robust habitat modelling exercise conducted by AfriAvian.

2.2.8.1 Cliffs and Ridges

Important cliffs and ridgelines were modelled using slope analysis of a 30 m resolution Jaxa Digital Elevation Model to encompass all areas with a slope greater than 20%. These areas were assigned a 100 m radial buffer.

2.2.8.2 High Altitude Plateau Grasslands

To inform early layout planning (given the high degree of habitat suitability and level of threat faced by these imperilled grassland birds) preliminary core habitats were initially identified using a combination of kernel density distribution modelling, digital elevation analysis (>1900 masl), slope analysis (<5%) and visual delineation using satellite imagery. However, given the apparent extent and suitability of habitat, and the potential implications (for the species and the project) a decision was made by the specialist team to subject the preliminary delineations to a more rigorous five-year modelling exercise conducted by Dr Robin Colyn, an authority on these species (AfriAvian, 2025). The models were refined with locality records obtained during monitoring. The resultant habitat delineations are similar in extent to those initially proposed. AfriAvian was specifically tasked with conducting a dedicated modelling exercise to identify key grassland habitat for Threatened high-altitude passerines. Key grassland habitat was delineated using sophisticated species distribution modelling techniques based on a five-year habitat modelling assessment for three the South Africa's most Threatened high-altitude grassland passerines namely Botha's Lark (Critically Endangered), Rudd's Lark (Endangered) and Yellow-breasted Pipit (Vulnerable). Models were refined and validated using a combination of database records and recent in-situ point localities obtained during fieldwork for the project (habitat modelling and pre-construction monitoring). The spatial dataset includes two layers (i) very high risk core habitats and (ii) high risk connective areas between adjacent core habitats.

2.2.8.3 Wetlands

The general wetland layer for avifauna was based on spatial data provided by WSP (2025) produced as part of their wetland delineation and impact assessment for the proposed Verkykerskop WEF cluster. This layer serves as the basis for wetland habitat considered important for the persistence and movement of all potentially occurring wetland associated priority species which includes several Threatened species.

Additionally, AfriAvian was tasked with identifying and delineating key wetland habitat specifically for Species 23. For details on the methodology and key findings of their assessment see Appendix 3. The process essentially involved a three-tier approach involving (i) rapid in-situ habitat assessments (2024/2025), (ii) passive acoustic and camera trap monitoring (2024/2025), and (iii) remote-sensing-based habitat suitability modelling (2020-2025). This integrated approach was designed to facilitate a robust understanding of both current habitat condition and broader landscape-scale ecological dynamics. Dedicated in-field habitat assessments undertaken in summer (during the peak visitation and breeding period) involved evaluation of wetland type, microhabitat structure, hydroperiod and impacts. Passive monitoring involved the deployment of trail cameras and acoustic recorders in potentially suitable palustrine wetlands with the aim of detecting Species 23 and other Threatened wetland associated species. Potentially suitable wetland habitat was modelled using predictor variables derived from remote sensing of satellite (Sentinel 2) imagery. The most relevant predictor variables were selected using a stepwise approach which minimised collinearity. The resulting wetland suitability map was used to inform subsequent Habitat Suitability Index (HSI) analyses. The HSI was developed by integrating multi-year (2020–2025) remote sensing analyses (associated with peak primary productivity of wetland vegetation) with field-derived habitat and species occurrence data. Lastly a connectivity layer was created using a circuit theory approach (Colyn et al. 2020a) to identify areas of lowest resistance considered important for dispersal of the species among the identified core habitats.

2.2.9 Data Analysis

Data from the BirdLasser cards was captured into Excel. Most statistical analyses were performed in the R statistical environment. Spatial analyses and models were performed in QGIS.

3. Receiving Environment

The region is renowned for its birdlife. The greater AOI intersects with five IBAs, two KBAs and six statutorily protected areas. The Memel birding route (as described in Roberts Birds Application) traverses portions of the WEF cluster and AOI. The birding route is highlighted as one of the best and most extensive habitats for high-altitude grassland endemics in South Africa (Chittenden et al. 2017).

3.1 Free State Biodiversity Conservation Plan

At Kromhof WEF most of the central south and eastern regions of the WEF are classified as CBA1 (with a small central patch of CBA2) while the western and northern (along Muel River) boundaries are classified as ESAs (Figure 3-1).

The Free State Biodiversity Conservation spatial layer was developed to illustrate the province's most Critical Biodiversity Areas. These areas need to be maintained to meet the province's biodiversity targets. The broad categories recognised are: Protected Areas (PA), Critical Biodiversity Areas (CBAs), Ecological Support Areas (ESAs), Other Natural Areas (ONA), and Modified Areas.

CBAs represent areas of high biodiversity significance in the province (SANBI, 2017).

ESAs are not essential for meeting biodiversity targets but play an important role in supporting the ecological functioning of Critical Biodiversity Areas and/or in delivering ecosystem services. Critical Biodiversity Areas and Ecological Support Areas may be terrestrial or aquatic (SANBI, 2017).

ONAs consist of all those areas in good or fair ecological condition that fall outside the protected area network and have not been identified as CBAs or ESAs (SANBI, 2017).

Degraded Areas (sometimes called 'transformed' areas) are areas that have been heavily modified by human activity so that they are by-and-large no longer natural, and do not contribute to biodiversity targets (SANBI, 2017). Some of these areas may still provide limited biodiversity and ecological infrastructural functions but, their biodiversity value has been significantly, and in many cases irreversibly, compromised.

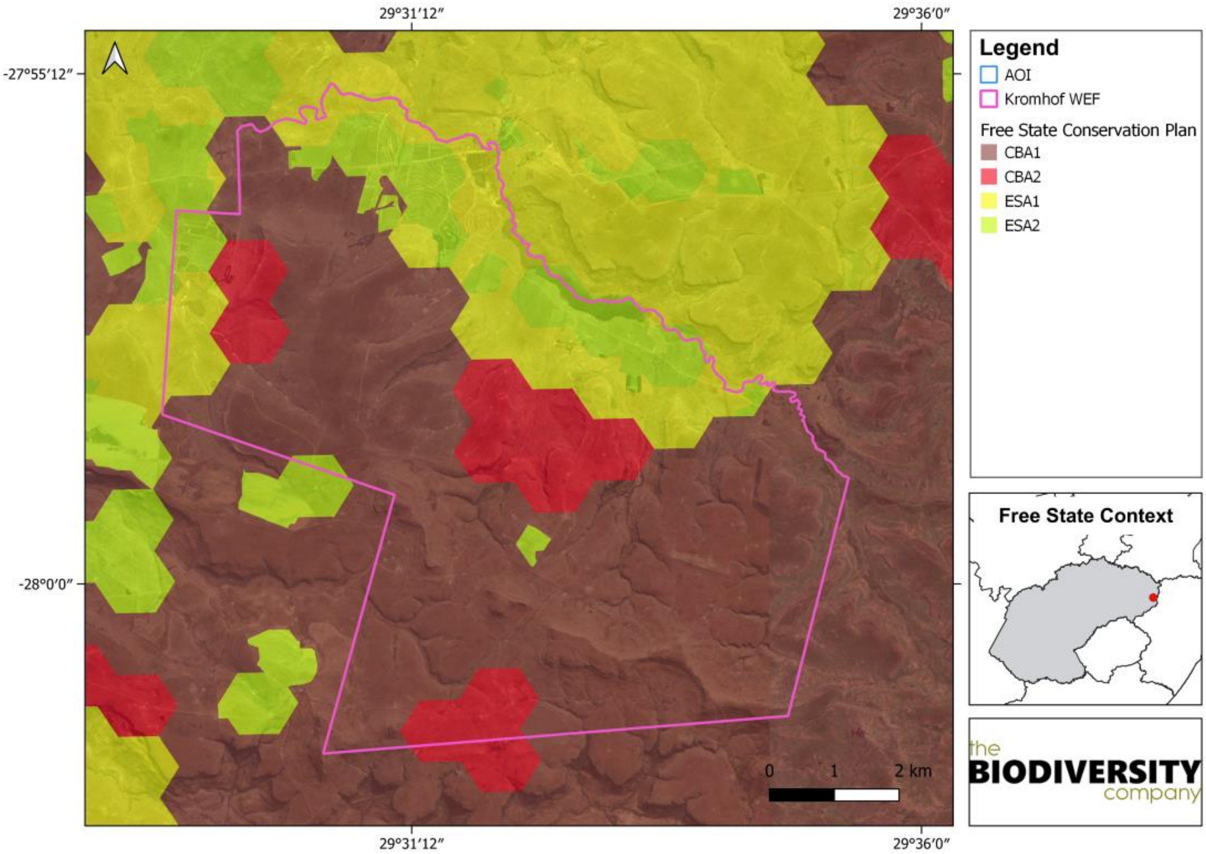

Figure 3-1 ***Project area in relation to the Free State Biodiversity Conservation Plan (note this is the provincial layer, to view the ground-truthed version see main EIA report)***

3.2 National Environmental Screening Tool

The National Environmental Screening tool is a web-based application hosted by the Department of Environmental Affairs that allows developers to screen their prospective site for environmental sensitives. Importantly, this tool now serves as the first step in the environmental authorisation process as laid out in the gazetted assessment protocols for each environmental theme. The Species Environmental Assessment Guideline (SANBI, 2020) provides guidance towards achieving these protocols for terrestrial biodiversity, which, in turn, relies on the results of the screening tool to inform the level of assessment required. The screening tool was used to inform the desktop-level assessment of the sensitivity of the AOI prior to fieldwork. There are three sensitivity layers produced by the screening tool that are of relevance for this study, namely (1) Avian Theme, (2) Animal Species Theme, and (3) Terrestrial Biodiversity Theme. The receptors triggering each sensitivity theme, their sensitivity rating and their mapped potential occurrence (i.e. modelled potentially suitable habitat) according to DFFE are summarised in Table 3-1 and spatially depicted in Figure 3-2 to Figure 3-6. The DFFE Avian Theme Screening Tool indicates the presence of a Vulture Restaurant within 20km of the site but without information on its location or activity status.

Table 3-1 ***Receptors triggering each sensitivity theme according to the DFFE data at Kromhof WEF***

Receptor	Sensitivity	DFFE Mapped Occurrence (Project Area)
Avian Theme		
Within 20 km of Vulture Restaurants	High	Large radial buffer overlapping eastern third of project area
Areas beyond buffer on Vulture Restaurants	Low	All other areas
Animal Species Theme (Avifauna)		

Receptor	Sensitivity	DFFE Mapped Occurrence (Project Area)
Southern Bald Ibis (*Geronticus calvus*)	High	Ubiquitous. Most grassland areas, excluding cultivated lands.
Black Stork (*Ciconia nigra*)	High & Medium	Wetlands and grasslands along the Muel River.
Yellow-breasted Pipit (*Anthus chloris*)	High & Medium	High altitude grasslands, particularly in the south and eastern regions, along the ridge that runs towards Mont Pelaan
Grey Crowned Crane (*Balearica regulorum*)	High & Medium	Wetlands and grasslands
White-bellied Korhaan (*Eupodotis senegalensis*)	High & Medium	High altitude grasslands, particularly in the south and eastern regions, along the ridge that runs towards Mont Pelaan
Denham's Bustard (*Neotis denhami*)	High & Medium	High altitude grasslands, particularly in the south and eastern regions, along the ridge that runs towards Mont Pelaan
Lanner Falcon (*Falco biarmicus*)	High	Restricted. Incised topography with steeper slopes in south east.
Secretarybird (*Sagittarius serpentarius*)	High & Medium	Most areas, excluding actively cultivated lands.
Bush Blackcap (*Sylvia nigricapillus*)	High & Medium	Gullies in south-eastern region.
Botha's Lark (*Spizocorys fringillaris*)	Medium	Sparse patchily distributed. North and western grasslands.
Rudd's Lark (*Heteromirafra ruddi*)	Medium	West-central plateau grasslands.
African Grass Owl	Medium	Low lying grasslands in southern half of WEF.
Terrestrial Biodiversity Theme		
CBA 1	Very High	Most of central, southern and eastern regions of WEF.
Vulture Species Theme		
Cape Vulture (*Gyps coprotheres*)	High	Affecting an area representing 10-20% of the population

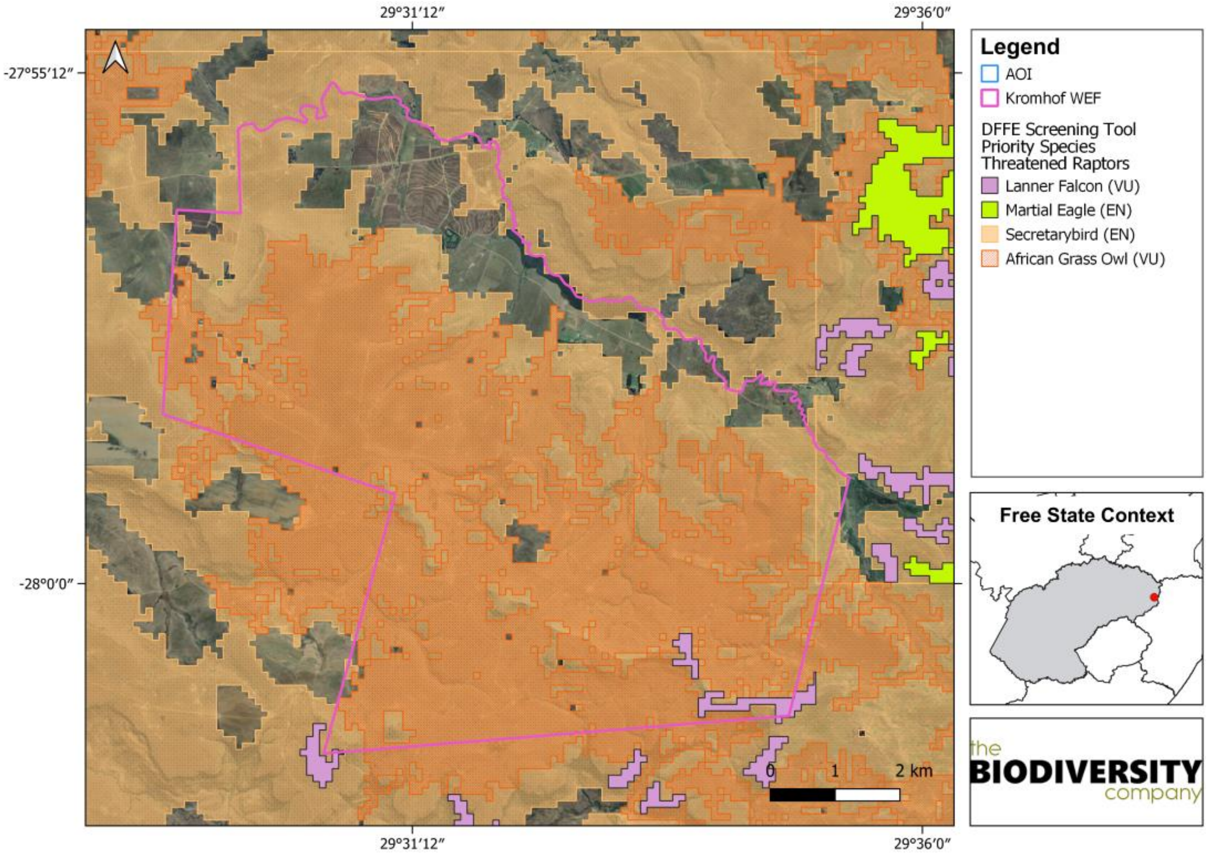

Figure 3-2 Modelled potential occurrence of threatened raptors in the project area as provided in the national screening tool (DFFE)

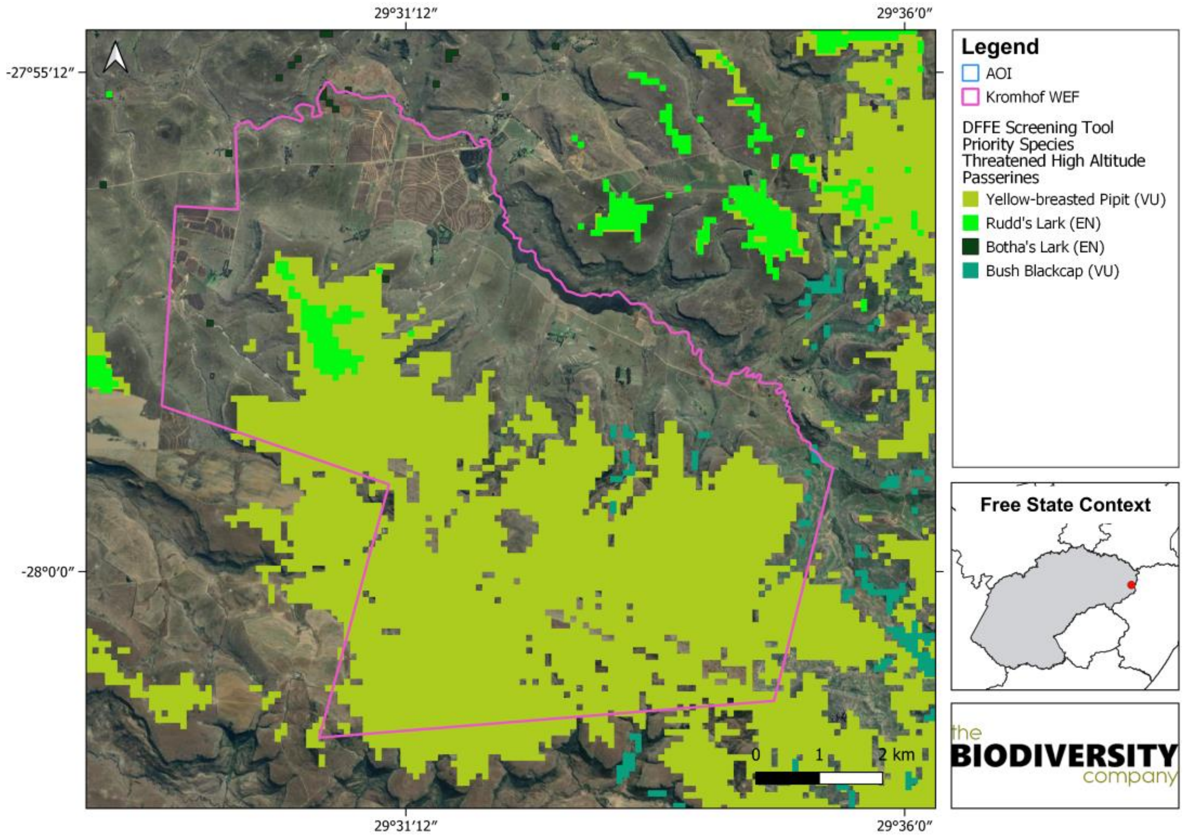

Figure 3-3 ***Modelled potential occurrence of threatened high altitude passerines in the project area as provided in the national screening tool (DFFE)***

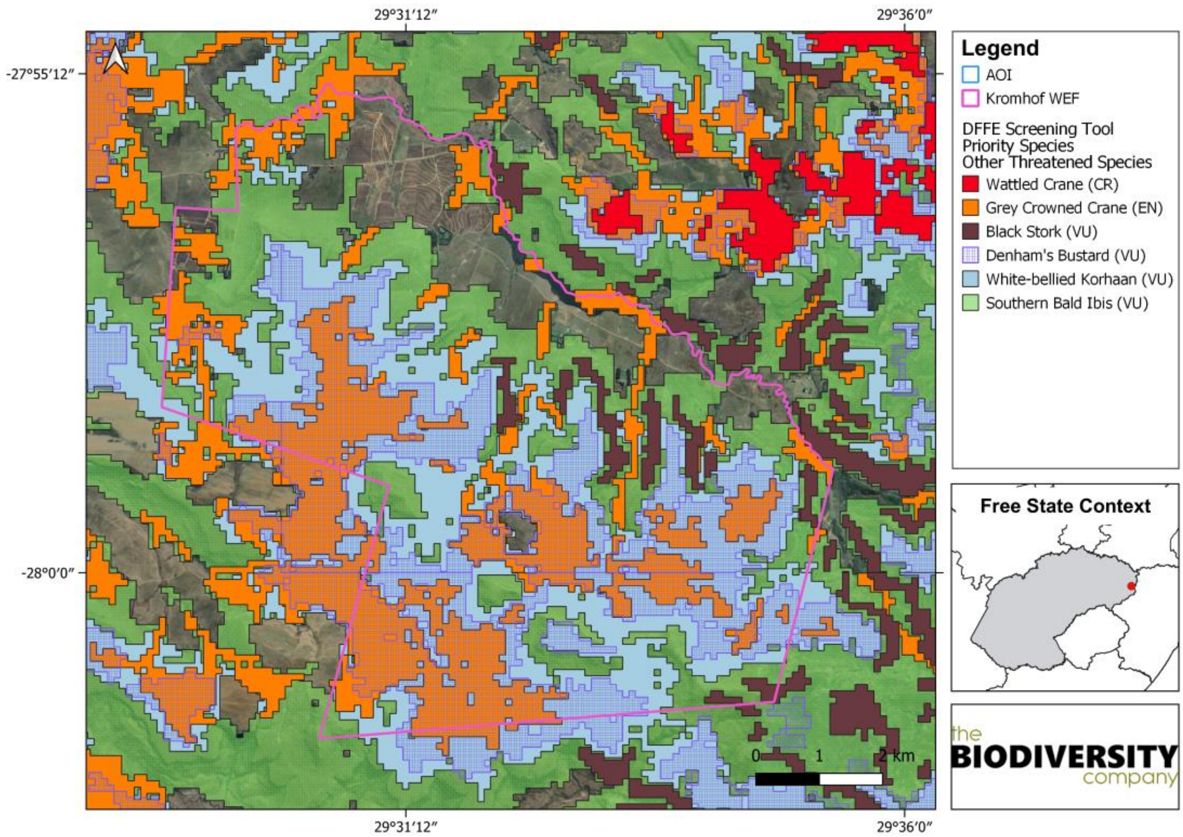

Figure 3-4 ***Modelled potential occurrence of other threatened avifauna in the project area as provided in the national screening tool (DFFE)***

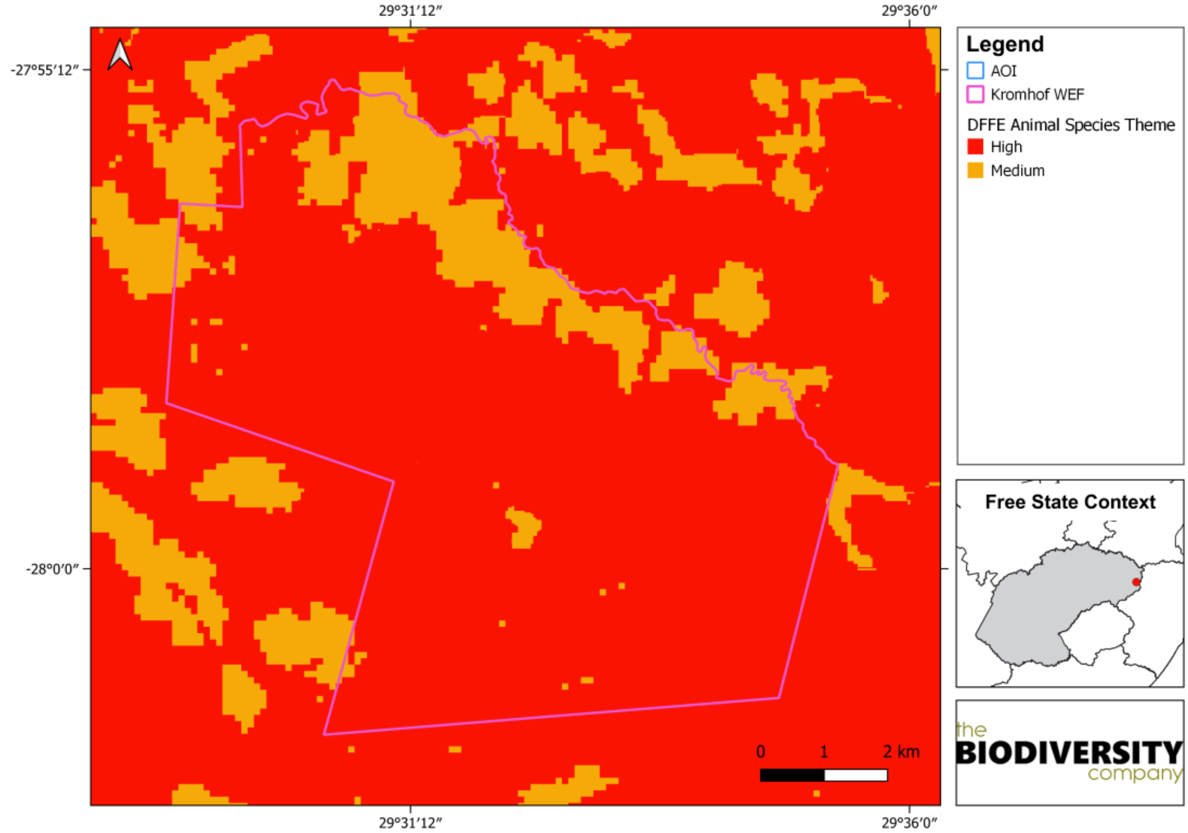

Figure 3-5 *Visual representation of the DFFE Animal Species theme of the national screening tool sensitivities as applicable to avifauna*

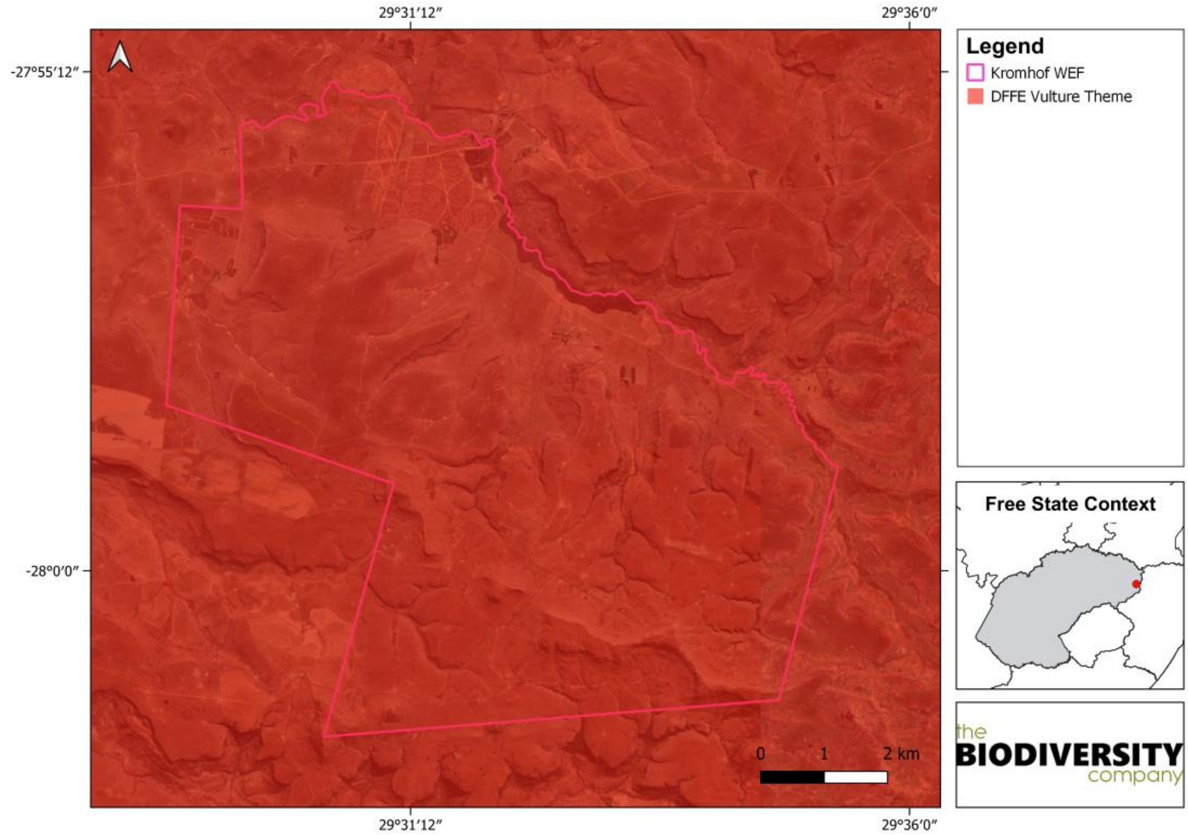

Figure 3-6 *Visual representation of the DFFE vulture sensitivity theme of the national screening tool*

3.3 Key Biodiversity Areas

Key Biodiversity Areas (KBAs) are sites which contribute most significantly to the global persistence of biodiversity in terrestrial, freshwater and marine ecosystems (IUCN, 2016). Both SANBI and BirdLife South Africa have recognised the importance of mapping, monitoring conserving these areas of global biodiversity importance through the implementation of the Key Biodiversity Areas Program. To date a network of 263 terrestrial KBAs have been identified and assessed against the global standard set by the IUCN. The areas will ultimately supersede IBAs as the main currency for identifying areas of high avian importance in the country. A large proportion (63%) of the Kromhof WEF in the south overlaps the Eastern Free State Escarpment KBA which is covers most of the WEF's plateau grasslands. This KBA is recognised primarily for its importance in supporting a high diversity of threatened and range-restricted avifauna. The KBA is classified as 100% irreplaceable. This KBA envelops the Grasslands and Alexpan IBAs (KBA Partnership, 2024).

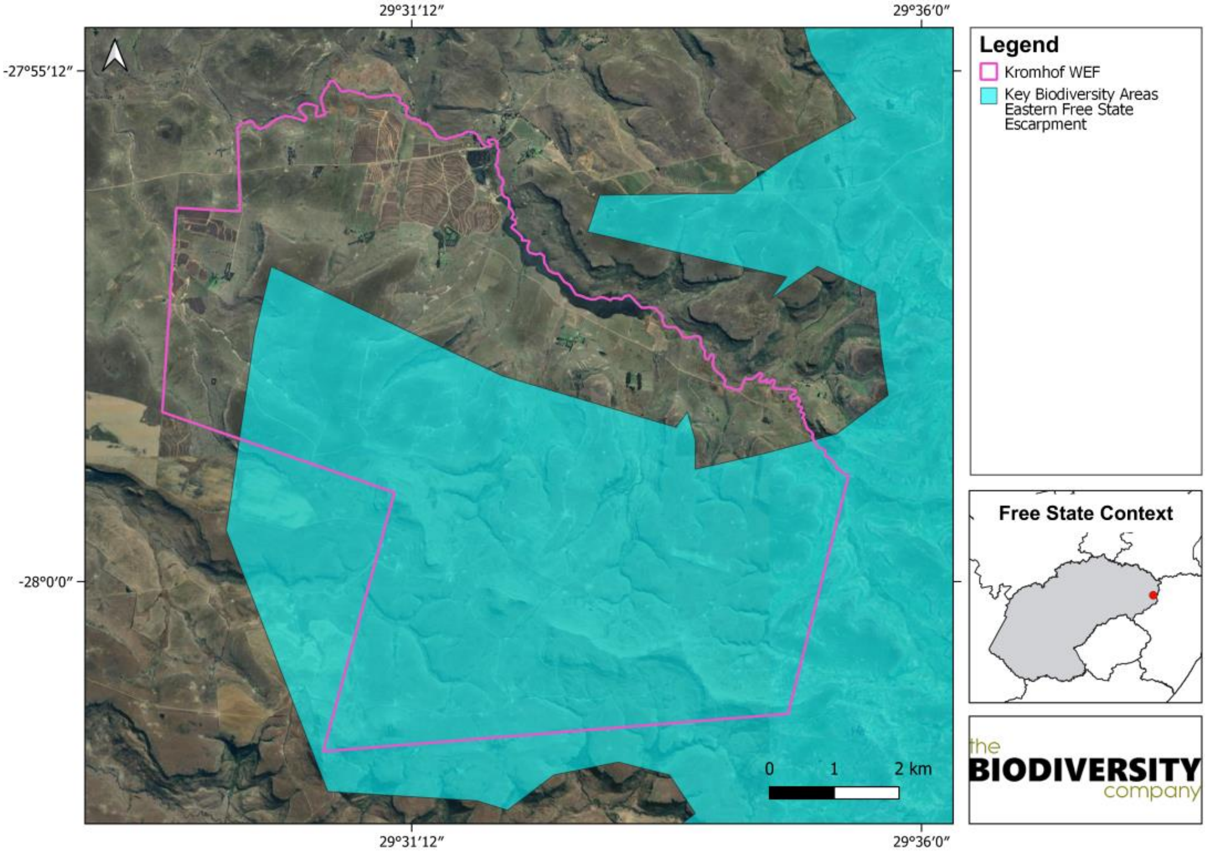

Figure 3-10 Project area in relation to Key Biodiversity Areas

3.4 Statutorily Protected Areas

The proposed WEF does not intersect any protected areas. However, the AOI intersects with seven statutorily protected areas. The most significant of which being the Upper Wilge Protected Environment championed by BirdLifeSA. The entire Kromhof WEF falls within an area identified by the National Protected Areas Expansion Strategy. These are not statutorily protected areas but rather areas earmarked for potential expansion of the protected areas network. It is important to note that, based on communications with Birdlife SA, a request has recently been submitted to declare additional properties as part of the Sneeuberg Protected Environment in the area between the existing PE and the proposed Verkykerskop WEF Cluster.

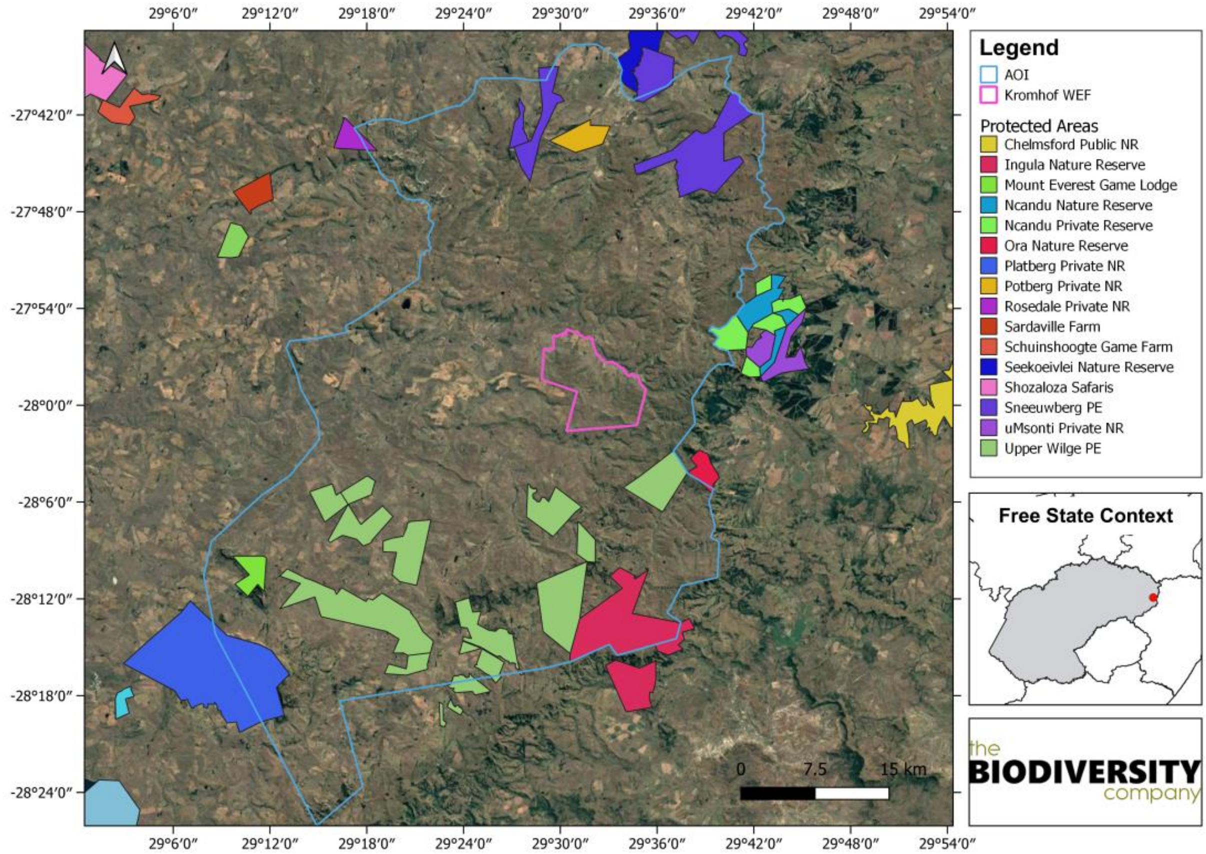

Figure 3-8 Nationally protected areas in relation to the project area

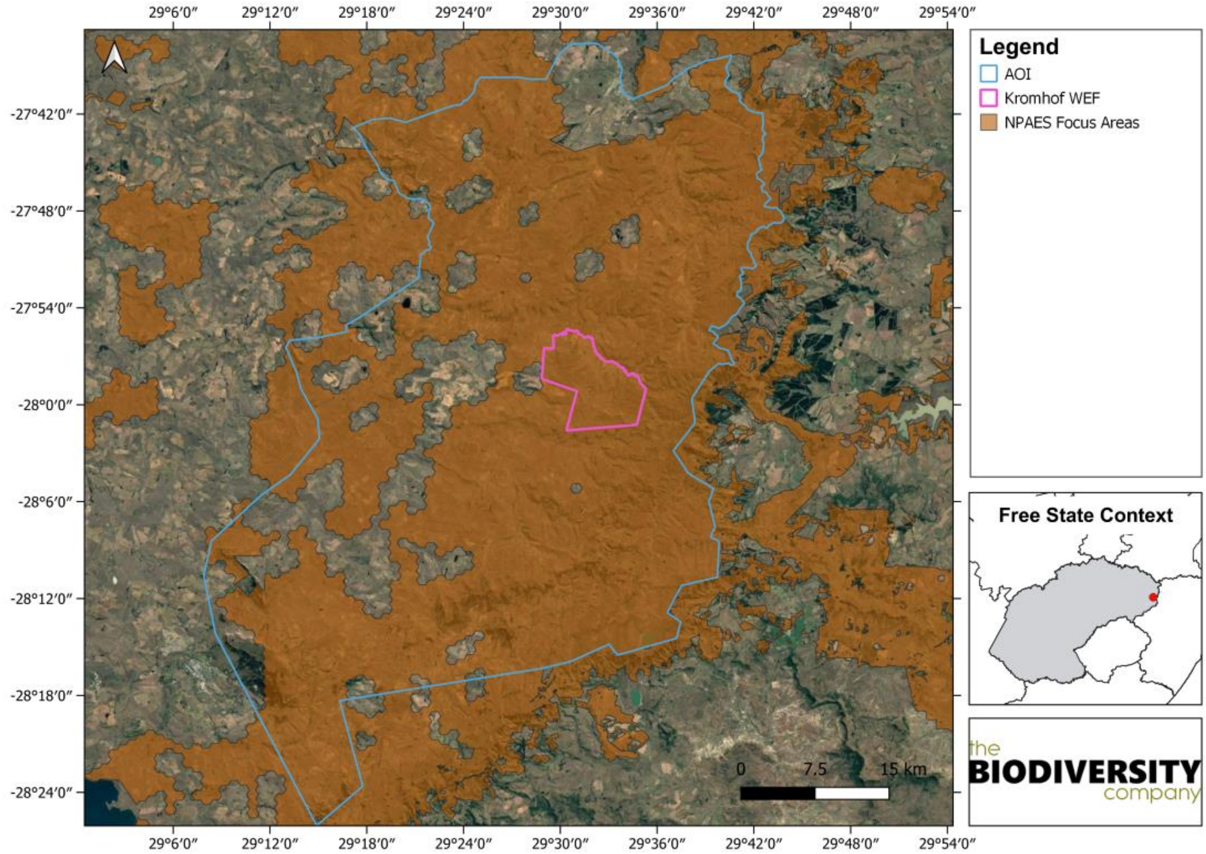

Figure 3-9 National protected areas expansion strategy in relation to the project area

4. Results

4.1 Local Avian Diversity

4.1.1 Habitats

Kromhof WEF spans an altitudinal gradient from the broad low lying Muel River floodplain in the north to the high-altitude plateau grasslands in the south, some of the most intact and conservation important to be found in the VWC. The southern plateaus are subject to harsh conditions and often receive snowfall. As such these areas support short (relatively treeless) high-altitude grasslands. The land use is predominantly natural grasslands (under grazing), interspersed with commercial croplands and pasture lands with livestock (cattle grazing). The prevailing biome is grassland. More specifically, Eastern Free State Sandy Grassland predominates (Mucina and Rutherford, 2006). At this stage at least four broad habitats as relevant to avifauna were identified. These included Open Grassland, Rocky Grassland, Wetlands and Croplands.

Figure 4-1 ***Examples of the four main avifaunal habitats identified in the project area; A) Open Grassland, B) Rocky Grassland, C) Wetlands and D) Croplands***

4.1.1.1 Open Grassland

At least two sub-classifications of grassland could be distinguished at the proposed Kromhof WEF as relevant for avifauna which include the higher altitude, short plateau grassland (to the south) and the lower altitude moist grasslands along the Muel River valley (in the north). The Plateau grasslands are likely to support most of the regionally occurring high altitude endemics and red-listed species. A prominent ridge runs along the southern border (the foot slope of Mont Pelaan). This area is the highest-lying area in the entire VWC and provides optimal; habitat for all of the regions threatened, high-altitude grassland species. It is characterised by a dense, short and relatively homogenous plateau grass sward dominated by *Eragrostis* spp. and *Themeda triadra*. Red-listed species regularly seen in this habitat include Rudd's Lark, Yellow-breasted Pipit, Denham's Bustard, Blue Korhaan, Blue Crane and Southern Bald Ibis (. Of greatest significance in this regard is the grassland's importance in terms of supporting breeding pairs of Rudd's Lark and Yellow-breasted Pipit. Blue Crane also nest in two locations near VP 11 (Nests 1 and 3). The area between the Met mast and VP 11 is particularly productive and has been designated as a Core Habitat for Threatened High Altitude species.

4.1.1.2 Rocky Grassland

The Rocky Grassland habitat typically occurs in areas with a slope gradient of more than 20 %. This habitat includes boulder strewn mid to upper slopes as well as crests which support sandstone cliff and scarp-like *Leucosidea*-dominated forest-scrub. At Kromhof WEF, the scrub is slightly more species rich than the western regions of the VWC, increasing in density and species composition towards the base of the crest especially in more fire-protected areas. Structural complexity, vegetation diversity, food, cover and microclimatic niche differentiation is highest in this habitat type. This habitat type is likely to be most important in terms of supporting rupicolous high-altitude endemics, raptors and cliff-nesting species. These scrub-forests seasonally support Bush Blackcap in summer. However, these scrub-forests appear to lack the structural complexity frequented by most of the true forest specialists such as Cape Parrot and White-starred Robin. In addition to the scrub-forest, the rocky grasslands at Kromhof WEF are important in terms of supporting rupicolous high-altitude endemics such as African Rock Pipit, as well as smaller cliff-nesting raptors such as Jackal Buzzard (Nest 3), and one Southern Bald Ibis breeding roost (Roosts 5). Flight paths of most of the regionally occurring red-listed raptor species are strongly associated with the deeply incised Rocky Grassland and associated cliffs habitat, especially in areas with a slope gradient of >20%. These include Cape Vulture, Martial Eagle, Verreaux's Eagle, Lanner Falcon, White-necked Raven and especially around VP 9 Rock Kestrel.

4.1.1.3 Wetlands

The northern boundary is marked by the perennial Muel River floodplain which flows west to east. This habitat is likely to be most significant in terms of supporting Threatened wetland species including cranes, harriers and flufftails. The Muel floodplain is very broad wetland with a shallow longitudinal gradient and as such, has an extremely high channel sinuosity. However, this wetland habitat has been threatened by the construction of a large dam wall near the western boundary of the WEF. Other wetlands include channelled and unchanneled valley-bottoms but also hillslope seeps, bench (or plateau) seeps and depressions and mountain streams cutting through gorges. The mountain streams and gorges are lined by scarp-like forest with a moderately diverse floral assemblage.

4.1.1.4 Croplands

Croplands occur in the lower lying north-western portions of the WEF. These croplands mostly produce fodder crops for livestock (mainly cattle), typically maize and oats. Many of these fields are irrigated from the dam along the Muel River. This habitat also includes patches of seeded pasture lands. Overall, it supports a high abundance but low diversity of birds comprising mainly seed-eaters. This habitat supports a high abundance but low diversity of birds comprising mainly seed-eaters but occasionally supports large flocks of Blue Crane.

4.1.2 Expected Diversity

At the start of the pre-construction monitoring (July 2022) a total of 218 bird species had been recorded during South African Bird Atlas (SABAP2, 2022) surveys within the nine pentads that overlap the VWC. This inventory was considered (at the time) to be a relatively accurate, if not slightly under-representative, portrayal of regional diversity. As such this expected species list was supplemented with additional species known to occur based on Chittenden et al. (2016) and expert knowledge of avifauna from the region. As monitoring progressed, 48 species not previously documented by SABAP2 surveys were added. This integrated inventory (including data from SABAP2, Chittenden et al. (2016) and in-field observation), totalling 321 species, was used as the project's species probability list, as presented in Appendix 1. Of these regionally occurring species, around 249 are considered highly likely to occur on a regular basis in the proposed Kromhof WEF.

4.1.3 Observed Diversity

Over the course of the pre-construction monitoring (S1-14), a total 244 species were recorded within the VWC during the pre-construction surveys. The presence of one additional species namely White-backed Vulture (an infrequent visitor) was added based on Vulpro (2025) tracking data. Of these, 190 species were recorded in the Kromhof WEF, which represents a large proportion (72%) of the 260 species recorded during monitoring projects in the AOI. It also represents a significant proportion (60%) of the expected regional diversity (318 spp.). This inventory is comprehensive and should be considered a good representation of the typical bird assemblage in the proposed WEF. It represents a moderate to high diversity in South Africa. Importantly, a very high proportion of these are red-listed and/or endemic species.

4.2 Priority Species

4.2.1 Diversity

4.2.1.1 Red-listed Species

Of the 88 regionally (Phumelela District) occurring priority species, 51 are red-listed. Of these, 37 were recorded in the VWC. Based on habitat suitability, 39 regionally red-listed species are considered highly likely to occur within the proposed Kromhof WEF. Surveys to date in the proposed Kromhof WEF have recorded 31 red-listed species of which 19 are threatened. This represents a high number in the South African context. Species which remain un-detected include Wattled Crane, Bearded Vulture, White-backed Vulture, Yellow-billed Stork and Botha's Lark.

Natural plateau grasslands south of the Muel floodplain support populations of threatened high altitude species. Of particular significance is the occurrence of a small breeding population of the Endangered Rudd's Lark. Over two surveys (S2 and 3) in the summer of 2022-2023, at least three individuals were detected in a high-altitude grassland between VP10 and 12 on a north-facing aspect at the foot of a mountain slope. On two occasions males were observed displaying at a height of 20-50 m for 5-10 min over the course of a few hours before sunset, (calm, warm evenings). The species appears to frequent lush, high-lying, plateau grasslands. Their presence in the VWC remains enigmatic with birds appearing sporadically in certain locations and seemingly not in others, a testament to the thinly distributed nature of this imperilled bird. Other threatened upland grassland species that occur at Kromhof include Denham's Bustard, White-bellied Korhaan and Yellow-breasted Pipit, all of which are currently listed as Vulnerable and, apart from Denham's Bustard (often observed in grasslands near the met mast in summer), are breeding residents. In the proposed Kromhof WEF, White-bellied Korhaan are concentrated in plateau grasslands between VP5 and 12 (ca. 1200 ha). Yellow-breasted Pipit occurs in most of the natural plateau grasslands having been observed at 47 locations spanning approximately 2000 ha, each time in short, lush high-altitude grassland. The regular observation of non-breeding males in winter reveals year-round residency. Blue Korhaan are also frequently observed in these highland grasslands. During summer visiting Red-footed Falcon forage for insects amidst large flocks of migrating Amur Falcons.

Rocky grassland within the proposed Kromhof WEF support several red-list species. Pockets of scarp thicket see occasional visitation by Bush Blackcap. A variety of raptors use the various hills and slopes to hunt and / or gain lift. Threatened raptor species closely associated with this habitat include Cape Vulture (seen regularly in the WEF, most frequently from VP 5, 10 and 9) and Verreaux's Eagle (a pair frequently patrols the gorges around VP 9 and the Muel River valley, have been observed predating on Jackal Buzzard chicks).

Other threatened species which are less tied to the highlands include Black Harrier (rare non-breeding winter visitor, observed once at VP12), Blue Crane (Confirmed multiple successful breeding attempts with chicks successfully reared), Secretarybird (observed regularly especially at VP 9 and VP11, no nests in proposed WEF), Southern Bald Ibis (multiple roosts in WEF, some breeding) and Martial Eagle (no nest in WEF).

In terms of wetlands, some of the higher-lying seeps are likely to support Striped Flufftail while the larger lower-lying wetlands associated with the Muel floodplain see visitation by Grey Crowned Crane (no nests recorded in the WEF. No suitable wetland habitat exists for Species 23 in the Kromhof WEF.A resident pair of Half-collared Kingfisher are regularly observed at low-level crossing downstream of the newly constructed large dam on the Muel River. In 2025 a pair of Maccoa Duck were recorded for the first time in the newly created dam along the Muel floodplain.

4.2.1.2 Migratory and Congregatory Species

Large flocks of migratory birds move across the project area in early summer, the most notable of which being Amur Falcons. The species arrives en-masse to forage over the grasslands on site. During S3, a very large migratory flock (numbering over a thousand birds) was observed moving across the VWC in a dense swarm. The flocks tend to aggregate and roost on powerlines along the Muel floodplain. This floodplain appears to facilitate passage over the escarpment. Migratory flocks of this size are of global significance. The potential for a significant collision event is a distinct possibility and represents a considerable risk in terms of wind farm development. Accompanying these flocks are small groups of Near-threatened Red-footed Falcon. Another seasonal visitor is Black Harrier which hunts over the grasslands in winter.

In late 2023 a large dam was created along the Muel floodplain (along the north-eastern boundary of the Kromhof WEF). In spite of a loss of sedge-dominated oxbow habitat for several threatened wetland species such as cranes and flufftails, the dam now attracts large congregations of waterfowl. Over the course of the monitoring period a gradual colonisation of the dam by various species was witnessed. After a year, counts began to yield in excess of 200 Yellow-billed Duck (NT) and over 900 Red-knobbed Coots. Additionally, flooded willow trees in the middle of the dam have created roosting habitat for large numbers of African Darter and Reed Cormorant, and now constitutes a heronry. In early 2025, 10 Cape Shoveler (NT) and at least three pairs of Maccoa Duck (VU) were observed at this dam. At present, the waterbird congregation is significant and, with time, may reach nationally or potentially globally significant thresholds for certain species as aquatic and wetland vegetation re-establishes.

4.2.1.3 Endemic Species

A total of 15 South African endemics occur in the region. Non-red listed species include Grey-winged Francolin (*Scleroptila afra*), Forest Buzzard (*Buteo trizonatus*) Cape Rock Thrush (*Monticola rupestris*), Buff-streaked Chat (*Campicoloides bifasciata*) and Pied Starling (*Lamprotornis bicolor*). All except, Forest Buzzard were recorded during the monitoring. Except for Pied Starling (which is ubiquitous) all of these species tend to frequent the higher altitude plateau grassland and rocky grassland habitat.

4.2.1.4 Other Priority Species

Other than Red-listed species, a further 32 regionally occurring species (Table 4-1) are also considered priority species. These include mainly raptors, red-listed species, large-bodied birds and other species that may be either rare, range restricted or habitat specialists. Of these, 24 species were recorded in the proposed Kromhof WEF.

Table 4-1 List of present and potentially occurring priority species

Common Name	Scientific Name	Conservation Status					LO Kromhof	VWC	VWC & Control	AOI
		Global	Regional	TOPS	FS	End.				
Grey-winged Francolin	*Scleroptila afra*	LC	LC		OG	E	1	x	x	x
White-backed Duck	*Thalassornis leuconotus*	LC	NT		PG		1	x	x	x
Maccoa Duck	*Oxyura maccoa*	EN	VU		PG		1	x	x	x
Knob-billed Duck	*Sarkidiornis melanotos*	LC	NT		PG		3			
Yellow-billed Duck	*Anas undulata*	LC	NT		PG		1	x	x	x
Cape Shoveler	*Spatula smithii*	LC	NT		PG		1	x	x	x
Red-billed Teal	*Anas erythrorhyncha*	LC	NT		OG		1	x	x	x
Southern Pochard	*Netta erythrophthalma*	LC	NT		PG		1	x	x	x
Ground Woodpecker	*Geocolaptes olivaceus*	NT	LC		PG	E	1	x	x	x
Half-collared Kingfisher	*Alcedo semitorquata*	LC	VU		PG		1	x	x	x
African Grass Owl	*Tyto capensis*	LC	VU		PG		3			
Cape Eagle-Owl	*Bubo capensis*	LC	LC		PG		2	x	x	x
Spotted Eagle-Owl	*Bubo africanus*	LC	LC		PG		1	x	x	x
Marsh Owl	*Asio capensis*	LC	NT		PG		2	x	x	x
Denham's Bustard	*Neotis denhami*	NT	VU	VU	PG		1	x	x	x
Blue Korhaan	*Eupodotis caerulescens*	NT	VU		PG	E	1	x	x	x
White-bellied Korhaan	*Eupodotis senegalensis*	LC	VU		PG		1	x	x	x
Black-bellied Bustard	*Lissotis melanogaster*	LC	LC		PG		3			x
Grey Crowned Crane	*Balearica regulorum*	EN	VU	EN	PG		1	x	x	x
Blue Crane	*Grus paradisea*	VU	VU	PS	OG		1	x	x	x
Wattled Crane	*Grus carunculata*	VU	EN	CR	PG		2	x	x	x
Striped Flufftail	*Sarothrura affinis*	LC	VU		PG		3	x	x	x
Species 23	*Sarothrura ayresi*	CR	EN		PG		3			
Baillon's Crake	*Zapornia pusilla*	LC	NT		PG		2			
Black-winged Pratincole	*Glareola nordmanni*	NT	LC		PG		4			
African Cuckoo Hawk	*Aviceda cuculoides*	LC	LC		PG		4			
Black-winged Kite	*Elanus caeruleus*	LC	NT		PG		1	x	x	x
Yellow-billed Kite	*Milvus aegyptius*	LC	LC		PG		1	x	x	x
African Fish Eagle	*Haliaeetus vocifer*	LC	LC		PG		1	x	x	x
Bearded Vulture	*Gypaetus barbatus*	NT	CR	CR	PG		2		x	x
White-backed Vulture	*Gyps Africanus*	CR	CR	EN	PG		1	x	x	x
Cape Vulture	*Gyps coprotheres*	VU	VU	EN	PG		1	x	x	x
Black-chested Snake Eagle	*Circaetus pectoralis*	LC	LC		PG		1	x	x	x
Brown Snake Eagle	*Circaetus cinereus*	LC	LC		PG		4			
African Marsh Harrier	*Circus ranivorus*	LC	VU		PG		1	x	x	x
Black Harrier	*Circus maurus*	EN	EN		PG	NE	1	x	x	x
Pallid Harrier	*Circus macrourus*	NT	NA		PG		4			
Montagu's Harrier	*Circus pygargus*	LC	LC		PG		2	x	x	x
African Harrier-Hawk	*Polyboroides typus*	LC	LC		PG		1	x	x	x
Pale Chanting Goshawk	*Melierax canorus*	LC	LC		PG		1	x	x	x
Little Sparrowhawk	*Accipiter minullus*	LC	LC		PG		2	x	x	x
Rufous-breasted Sparrowhawk	*Accipiter rufiventris*	LC	LC		PG		1	x	x	x
Black Sparrowhawk	*Accipiter melanoleucus*	LC	LC		PG		1	x	x	x
Common Buzzard	*Buteo buteo*	LC	LC		PG		1	x	x	x
Forest Buzzard	*Buteo trizonatus*	NT	NT		PG	E	3			

Common Name	Scientific Name	Conservation Status					LO Kromhof	VWC	VWC & Control	AOI
		Global	Regional	TOPS	FS	End.				
Jackal Buzzard	*Buteo rufofuscus*	LC	LC		PG	NE	1	x	x	x
Tawny Eagle	*Aquila rapax*	VU	EN	EN	PG		1	x	x	x
Verreaux's Eagle	*Aquila verreauxii*	LC	VU		PG		1	x	x	x
Booted Eagle	*Hieraaetus pennatus*	LC	LC		PG		1	x	x	x
Martial Eagle	*Polemaetus bellicosus*	EN	EN	EN	PG		1	x	x	x
Crowned Eagle	*Stephanoaetus coronatus*	NT	VU		PG		4			
Secretarybird	*Sagittarius serpentarius*	EN	VU		PG		1	x	x	x
Lesser Kestrel	*Falco naumanni*	LC	VU		PG		2	x	x	x
Rock Kestrel	*Falco rupicolus*	LC	LC		PG		1	x	x	x
Greater Kestrel	*Falco rupicoloides*	LC	LC		PG		1	x	x	x
Red-footed Falcon	*Falco vespertinus*	VU	VU		PG		1	x	x	x
Amur Falcon	*Falco amurensis*	LC	LC		PG		1	x	x	x
Eurasian Hobby	*Falco subbuteo*	LC	LC		PG		3			
Lanner Falcon	*Falco biarmicus*	LC	NT		PG		1	x	x	x
Peregrine Falcon	*Falco peregrinus*	LC	LC		PG		1	x	x	x
African Darter	*Anhinga rufa*	LC	NT		PG		1	x	x	x
Great Egret	*Ardea alba*	LC	NT		PG		1	x	x	x
Black-crowned Night Heron	*Nycticorax nycticorax*	LC	NT		PG		4			
Hamerkop	*Scopus umbretta*	LC	NT		PG		1	x	x	x
Greater Flamingo	*Phoenicopterus roseus*	LC	NT		PG		4			x
Lesser Flamingo	*Phoeniconaias minor*	NT	NT		PG		4			
Southern Bald Ibis	*Geronticus calvus*	NT	NT	VU	PG	E	1	x	x	x
Yellow-billed Stork	*Mycteria ibis*	LC	VU		PG		2		x	x
Black Stork	*Ciconia nigra*	LC	EN		PG		1	x	x	x
Abdim's Stork	*Ciconia abdimii*	LC	LC		PG		1	x	x	x
White Stork	*Ciconia ciconia*	LC	LC		PG		1	x	x	x
Marabou Stork	*Leptoptilos crumenifer*	LC	NT		PG		4			
White-necked Raven	*Corvus albicollis*	LC	LC				1	x	x	x
Barratt's Warbler	*Bradypterus barratti*	LC	LC		PG	NE	1	x	x	x
Bush Blackcap	*Sylvia nigricapillus*	VU	VU		PG	E	3	x	x	x
Melodious Lark	*Mirafra cheniana*	LC	NT		PG	NE	1	x	x	x
Rudd's Lark	*Heteromirafra ruddi*	EN	EN		PG	E	1	x	x	x
Botha's Lark	*Spizocorys fringillaris*	EN	CR		PG	E	2	x	x	x
Cape Rock Thrush	*Monticola rupestris*	LC	LC		PG	E	1	x	x	x
Sentinel Rock Thrush	*Monticola explorator*	NT	LC		PG	E	1	x	x	x
Chorister Robin-Chat	*Cossypha dichroa*	LC	LC		PG	E	4			
Sickle-winged Chat	*Emarginata sinuata*	LC	LC		PG	NE	1	x	x	x
Gurney's Sugarbird	*Promerops gurneyi*	NT	LC		PG	NE	2	x	x	x
Yellow-breasted Pipit	*Anthus chloris*	VU	VU		PG	E	1	x	x	x
African Rock Pipit	*Anthus crenatus*	LC	LC		PG	E	1	x	x	x
Mountain Pipit	*Anthus hoeschi*	NT	NT			E	2			x
Short-tailed Pipit	*Anthus brachyurus*	LC	VU		PG		3			
Forest Canary	*Crithagra scotops*	LC	LC		PG	E	1	x	x	x
Total							49	66	68	71

Key: AOI = Area of Influence. Status: CR = Critically Endangered; DD = Data Deficient; EN = Endangered; LC = Least Concern; NA = Not Applicable; NT = Near Threatened; OG = Ordinary Game; PG = Protected Game; PS = Protected Species; VU = Vulnerable. Likelihood of Occurrence (LO): 1 = Confirmed to occur; 2 = High; 3 = Moderate; 4 = Low / None.

Figure 4-2 ***Some of the red-listed raptors at Kromhof WEF; A) Lanner Falcon, B) Black Harrier, C) Verreaux's Eagle, D) Martial Eagle carrying a Denham's Bustard, E) Cape Vulture, F) Secretarybird***

Figure 4-3 ***Some of the other red-listed species at Kromhof; A) Blue Crane, A) Blue Crane, B) Grey Crowned Crane, C) Denham's Bustard, D) Blue Korhaan, E) White-bellied Korhaan, F) Black Stork, G) Southern Bald ibis***

Figure 4-4 ***Some of the other red-listed species at Kromhof; A) Bush Blackcap, B) Sentinel Rock Thrush, C) Half-collared Kingfisher, D) Ground Woodpecker, E) Rudd's Lark, F) Yellow-breasted Pipit***

4.2.2 Abundance

This section summarises the results of the walked and driven transect surveys which were conducted in tandem with the vantage point surveys by a third observer. The aim of these transects was to gain a more representative understanding of the avifaunal community (in terms of abundance and diversity) than can be achieved through vantage point surveys alone[1]. The transect results below are presented using an Index of Kilometric Abundance (IKA) or bird per km. Species in the tables are sorted from highest to lowest kilometric abundance. There is currently no guideline or consensus regarding what constitutes high or low IKA values and as such interpretation is typically interpretive and site-specific.

[1]Vantage surveys are designed primarily to detect flying birds and as such tend to be skewed towards detecting larger soaring birds whereas transects typically detect a wider spectrum of smaller species.

4.2.2.1 Walked Transects

Over the course of the two-year monitoring period 125 bird species totalling 3401 individuals were observed from 12 replicates of five walked transects covering a collective distance of 158.41 km at Kromhof WEF. The overall IKA for all avifauna species was 21.47 birds^{-km} (Table 4-2). Of these, 26 were priority species totalling 285 counted individuals. The IKA for all priority species was 1.8 birds^{-km}. This was similar to the Control transects (1.9 birds^{-km}). Ground Woodpecker was the most frequently encountered priority species (0.36 birds^{-km}) which together with Cape Vulture, Southern Bald Ibis and Amur Falcon accounted for the majority of records. Among transects, WT5 (along the Mont Pelaan ridgeline) yielded the highest abundance of priority species.

Table 4-2 Summary of walked transect results for priority species in birds per km (IKA)

Common Name	Scientific Name	Kromhof WEF						
		WT5	WT9	WT10	WT11	WT12	Total	IKA
Ground Woodpecker	*Geocolaptes olivaceus*	15	11	8	3	21	58	0.366
Cape Vulture	*Gyps coprotheres*	27	8	0	1	4	40	0.253
Southern Bald Ibis	*Geronticus calvus*	10	8	3	1	1	23	0.145
Amur Falcon	*Falco amurensis*	4	5	3	3	5	20	0.126
Blue Crane	*Grus paradisea*	7	4	6	1	0	18	0.114
Jackal Buzzard	*Buteo rufofuscus*	3	3	2	2	6	16	0.101
Rock Kestrel	*Falco rupicolus*	1	6	0	3	6	16	0.101
African Rock Pipit	*Anthus crenatus*	8	1	3	1	1	14	0.088
Cape Rock Thrush	*Monticola rupestris*	1	2	0	4	5	12	0.076
Yellow-breasted Pipit	*Anthus chloris*	1	0	2	7	2	12	0.076
Grey-winged Francolin	Scleroptila afra	4	1	1	5	0	11	0.069
Sentinel Rock Thrush	*Monticola explorator*	5	0	2	1	0	8	0.051
White-bellied Korhaan	*Eupodotis senegalensis*	0	0	6	0	1	7	0.044
Lanner Falcon	*Falco biarmicus*	0	0	3	2	0	5	0.032
White-necked Raven	*Corvus albicollis*	0	2	0	2	1	5	0.032
Grey Crowned Crane	*Balearica regulorum*	0	4	0	0	0	4	0.025
Blue Korhaan	*Eupodotis caerulescens*	0	0	0	0	3	3	0.019
Sickle-winged Chat	*Emarginata sinuata*	0	0	2	1	0	3	0.019
Black Stork	*Ciconia nigra*	0	1	0	1	0	2	0.013
Booted Eagle	*Hieraaetus pennatus*	0	2	0	0	0	2	0.013
Secretarybird	*Sagittarius serpentarius*	0	0	0	1	0	1	0.006
Forest Canary	*Crithagra scotops*	0	0	0	1	0	1	0.006
Verreaux's Eagle	*Aquila verreauxii*	1	0	0	0	0	1	0.006
Abdim's Stork	*Ciconia abdimii*	0	1	0	0	0	1	0.006
Common Buzzard	*Buteo buteo*	0	0	0	0	1	1	0.006
African Fish Eagle	*Haliaeetus vocifer*	0	1	0	0	0	1	0.006
Priority species		87	60	41	40	57	285	1.799
Other non-priority species		580	687	542	544	763	3116	19.670
All species		667	747	583	584	820	3401	21.469

4.2.2.2 Driven Transects

Over the two-year monitoring period 118 bird species totalling 5549 individuals were observed from 12 replicates of four driven transects covering a collective distance of 283.73 km. The overall IKA for all species was 39.1 birds^{-km}. Of these, 16 were priority species totalling 390 counted individuals. The IKA for all priority species was 2.75 birds^{-km} (Table 4-3), This IKA was the highest reported for driven transects across the VWC including the Control (2.4 birds^{-km}). Amur Falcon was the most frequently encountered priority species (1.542 birds^{-km}) which together with Southern Bald Ibis and Blue Crane account for the majority of records. Among the driven transects, DT8 (along the Muel floodplain) yielded the highest abundance of priority species, highlighting the importance of wetland habitats for supporting high densities of priority species mainly due to the large flocks of Amur Falcon which perch on the powerlines but also because Blue Crane and Southern Bald Ibis frequent the productive moist grasslands in this valley.

Table 4-3 Summary of driven transect results for priority species in birds per km (IKA)

Species primary name	Scientific Name	Kromhof WEF					
		DT4	DT6	DT7	DT8	Total	IKA
Amur Falcon	*Falco amurensis*	3	10	23	170	206	1.452
Southern Bald Ibis	*Geronticus calvus*	22	48	3	22	95	0.670
Blue Crane	*Grus paradisea*	19	11	4	2	36	0.254
Sentinel Rock Thrush	*Monticola explorator*	5	5	0	0	10	0.070
Jackal Buzzard	*Buteo rufofuscus*	3	4	0	2	9	0.063
Ground Woodpecker	*Geocolaptes olivaceus*	6	2	0	1	9	0.063
Grey-winged Francolin	*Scleroptila afra*	6	2	0	0	8	0.056
Secretarybird	*Sagittarius serpentarius*	2	0	0	1	3	0.021
African Rock Pipit	*Anthus crenatus*	1	2	0	0	3	0.021
Grey Crowned Crane	*Balearica regulorum*	0	0	0	3	3	0.021
Black-winged Kite	*Elanus caeruleus*	0	0	2	0	2	0.014
Black Sparrowhawk	*Accipiter melanoleucus*	0	0	1	1	2	0.014
White-necked Raven	*Corvus albicollis*	1	0	0	0	1	0.007
Greater Kestrel	*Falco rupicoloides*	0	1	0	0	1	0.007
Martial Eagle	*Polemaetus bellicosus*	0	0	1	0	1	0.007
Rufous-breasted Sparrowhawk	*Accipiter rufiventris*	0	1	0	0	1	0.007
Priority species		68	86	34	202	390	2.749
Other non-priority species		661	1219	839	2440	5159	36.366
All species		729	1305	873	2642	5549	39.115

4.2.3 Occurrence Hotspots

The precise location of every observed priority species was documented in a comprehensive database for the entire VWC, consisting of 4088 locality points representing a total count of 19145 birds. The proposed Kromhof WEF accounts for 24.2% of these records with a count of 7186 birds. This point locality data is shown in Figure 4-5 and represents the basis of the kernel density model which was used to map hotspots for priority species throughout the VWC. Note, some spatial bias is inherent in this data due to accessibility constraints imposed by terrain and the location of sampling sites. It was then subsequently used to inform the detailed habitat modelling exercise which was used to refine these core areas for the final sensitivity assessment. This data reveals that priority species are concentrated in at least six main hotspot areas in the VWC which tend to coincide with core habitat for threatened high altitude passerines, especially in areas close to cliffs or broken rocky terrain which provides nesting and foraging habitat for many priority species. One of two main hotspot areas for priority species occurs within the Kromhof WEF, the higher lying plateau grasslands in the southern half of the WEF (Figure 4-6). These largely pristine grasslands (associated with the prominent Mont Pelaan ridgeline) support an exceptionally high concentration of threatened grassland species including a breeding population of Rudd's Lark.

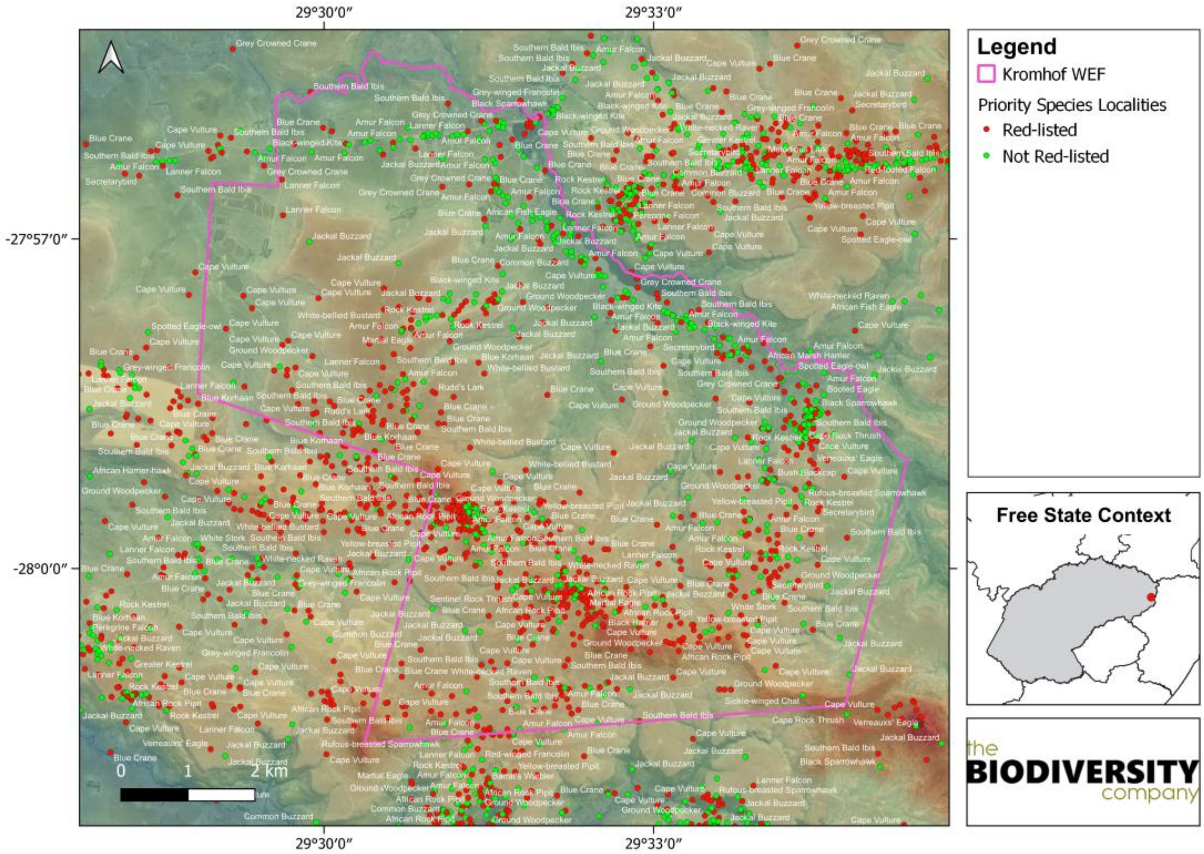

Figure 4-5 Point localities of priority species observations

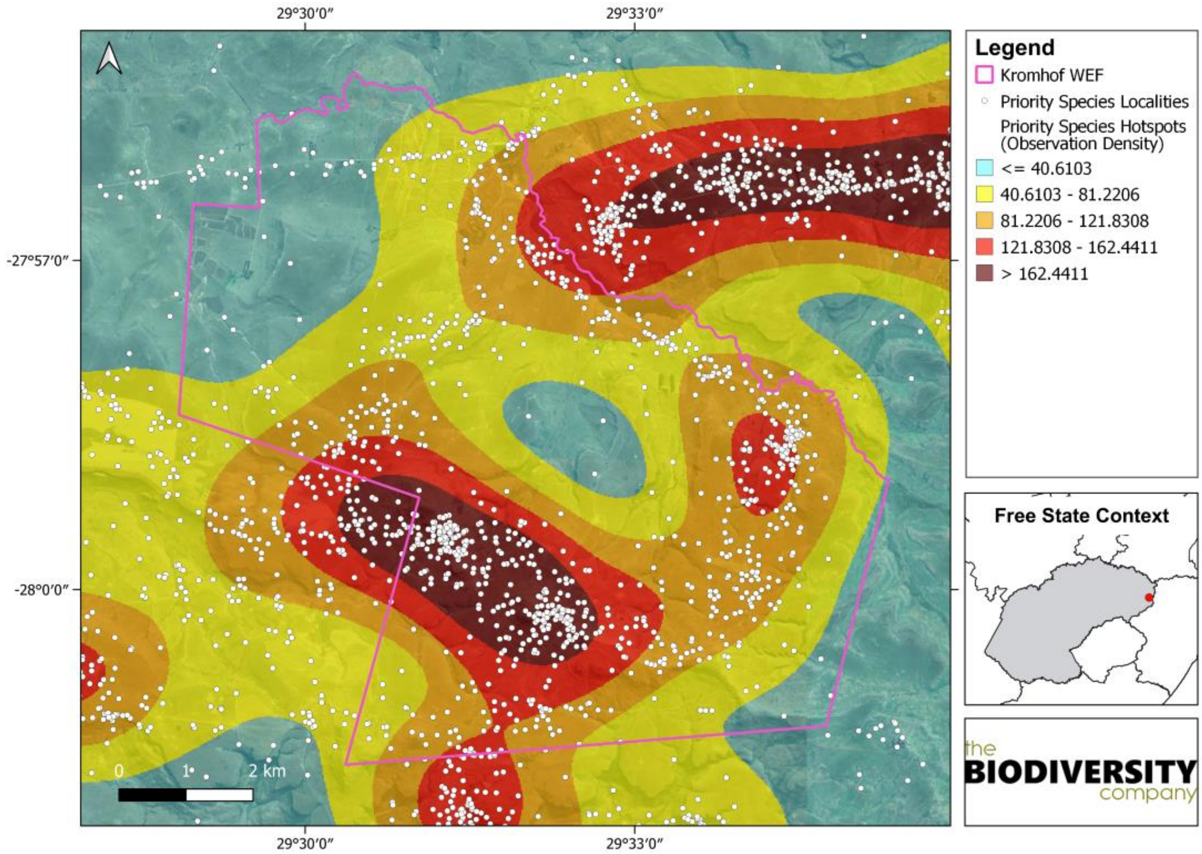

Figure 4-6 Kernel density model portraying hotspots of priority species occurrence.

4.2.4 Key Habitats

4.2.4.1 Cliffs and Ridges

Cliffs and ridges provide important nesting and / or soaring habitat for several priority species. The Mont Pelaan ridge in the south is the highest lying and most prominent ridgeline in the VWC. This ridgeline (identified as Flight Corridor 5) is a prominent regional land mark and skyline feature whose orographic winds are frequently utilised by numerous large-bodied soaring birds, (especially Cape Vulture and Jackal Buzzard) to gain lift. Additionally, a prominent cliff line occurs along the northern edge of the Kromhof plateau. This extensive series of cliffs hosts four Southern Bald Ibis Roosts (14, 16, 17 and 18), one Rock Kestrel Nest (1), one Jackal Buzzard Nest (3) and one Verreaux's Eagle Nest (4).

4.2.4.2 High Altitude Plateau Grasslands

The Kromhof WEF supports some of the best examples of intact high-altitude grasslands to be found in the VWC. Extensive areas of near pristine high-altitude plateau grassland occur in the west-central, southern and eastern highlands which represent highly suitable habitat for threatened grassland endemics. Most notable in this regard being Botha's Lark (Critically Endangered), Rudd's Lark (Endangered) and Yellow-breasted Pipit (Vulnerable). In recognition of the VWC's position with the core area of occupancy and global hotspot for all three of these species, AfriAvian was commissioned to identify and delineate key high altitude plateau grassland habitat for these three species based on a robust 5-year modelling study. These areas consist of (i) very high-risk core areas and (ii) surrounding high risk connective areas. It is important to note these areas do not represent all potential habitat for these species, only the higher risk areas. These higher risk areas occupy a large proportion of the VWC due to it being; "…*in the core area of occupancy and global hotspot for all three of these endemic, threatened and habitat specialist species. This area hosts some of the highest densities and most intact habitats for these species globally"* (Dr. R. Colyn pers. comm, 2025). These areas are also associated with a considerably higher abundance of other priority species (as evidenced through kernel density estimation and flight paths), particularly red-listed grassland species such as Denham's Bustard, White-bellied Bustard, Blue Korhaan, Southern Bald Ibis African Rock Pipit, Ground Woodpecker and Sentinel Rock Thrush. Even relatively small habitat losses or alterations in these areas could have a significant impact on these highly range-restricted and rare habitat specialists. As such, both core (very high risk) and connective habitat (high risk) as identified for Threatened high altitude passerines are considered to be all infrastructure exclusion areas (Zone 1 sensitivity) and collectively occupy a large proportion (47%, 3416 ha) of the proposed Kromhof WEF area.

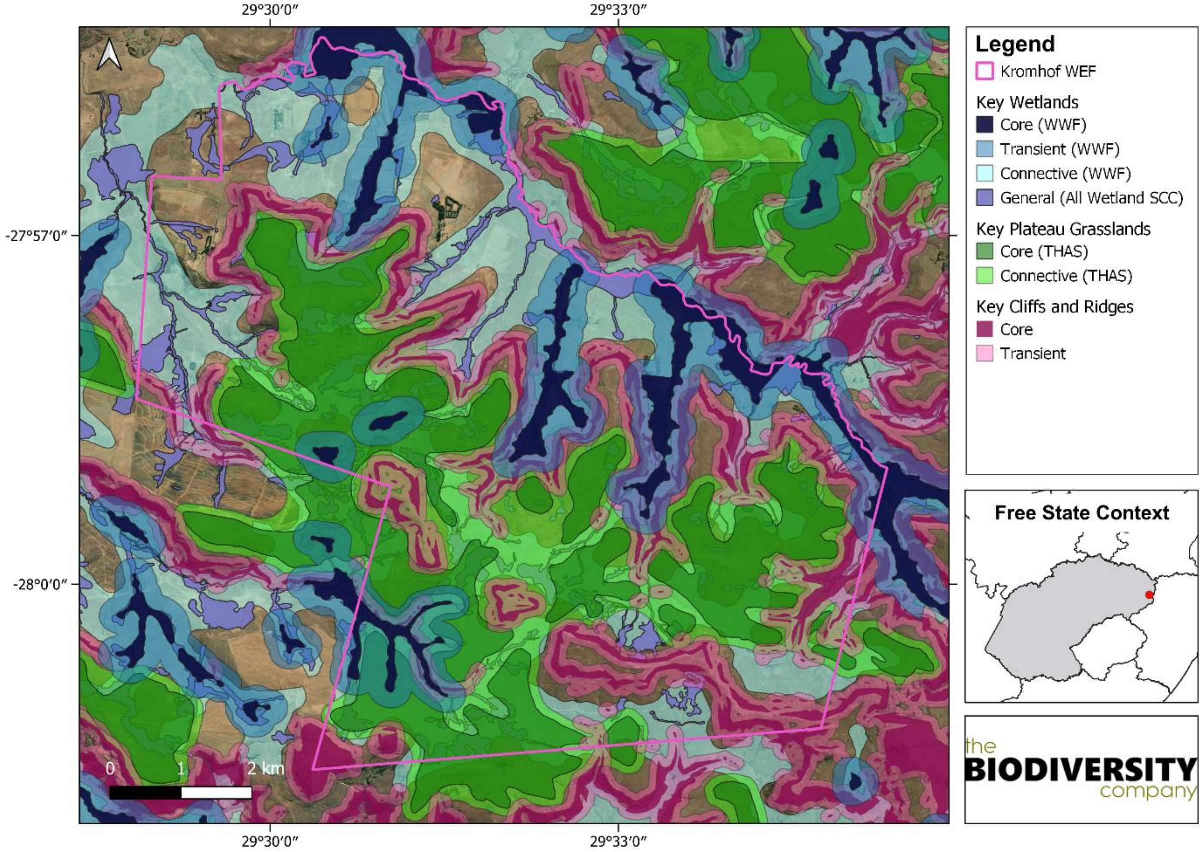

Figure 4-7 ***Key habitats for avifauna at the proposed Kromhof WEF (SPECIES 23, Species 23, THAS, Threatened High Altitude Species)***

4.2.4.3 Wetlands

Wetlands within the proposed Normandien WEF are considered important for supporting a wide diversity of wetland associated priority species including several Threatened Species. Two main subdivisions of wetland habitat are recognised namely (i) general wetlands (for all wetland associated priority species) and (ii) wetlands (and associated transient buffers and connectivity corridors) considered important for the regional persistence of Species 23 (Endangered) as modelled by AfriAvian (2025), see full report for details (Appendix 3).

4.2.4.3.1 General Wetlands

Wetlands in the proposed WEF area provide suitable habitat for all three of South Africa's crane species (all Threatened). Of these, only Blue and Grey-crowned Crane have been recorded breeding in wetlands within the VWC. The most prominent wetland feature within the proposed Kromhof WEF is the large Muel floodplain which supports an abundance of well-developed oxbow lakes, back water depressions and floodplain levees, lined by extensive sedge-dominated seeps which provide together provide the type of habitat conditions typically frequented by Species 23. These Endangered birds are known to occur in large palustrine wetlands in the region directly to the north and south of the VWC near Memel and Ingula respectively. Striped Flufftail may well occur in some of the high-altitude wetland areas. The size of the Muel floodplain with its abundance of sedges also provides suitable habitat for Endangered Wattled Crane which have been observed on the neighbouring Normandien WEF (proposed). Blue Crane breed in a number of wetlands throughout the WEF both along the Muel floodplain and in the plateau grasslands, but no sign of Crowned or Wattle Crane Breeding has yet been confirmed in the WEF. However, the wetland lacks dense stands of *Imperata cylindrica* and other rank grasses and thus appears suboptimal for breeding by African Grass Owl. In any event it would appear that their occurrence in the region is marginal. The floodplain and perennial streams at Kromhof WEF provide suitable habitat for Half-collared Kingfisher and the species has been recorded at the low-level bridge just downstream of the dam outflow.

4.2.4.3.2 Wetlands of Importance for Species 23

With regards to Species 23 (globally Critically Endangered, regionally Endangered), AfriAvian was tasked with conducting a robust assessment of the suitability of wetland habitat in the VWC and surrounding AOI for the species using a combination of passive surveillance (trail cameras and acoustic recorders), habitat modelling (using remote sensing) and in-filed site assessment.

The study revealed a large contiguous network of high to very high suitability wetland patches for the species within the AOI. Habitat suitability was highest in the central to north-eastern portions of the AOI decreasing in suitability towards the south-west. "*The central and north-eastern wetlands, forming a contiguous cluster of suitable habitat, are strongly aligned with field-verified habitat characteristics, including shallowly flooded palustrine systems with a mosaic of varied (including some low) intensity land use*" (AfriAvian, 2025). The authors cite overgrazing (trampling and defoliation), damming, artificial drainage, hayfield conversion, and recurrent mowing or burning as the main land use currently impacting habitat suitability in the AOI (particularly in the south-west).

Overall, the AfriAvian (2025) study highlights the importance of the strategical positioning of the VWC between two confirmed localities of ongoing occupancy for the species namely Seekoeivlei Nature Reserve to the north and Ingula Nature Reserve to the south (both within 30 km of the VWC). "*This central location suggests that the Verkykerskop landscape may function as a critical stepping-stone or movement corridor within the species' fragmented range, further emphasizing the need for precautionary land-use planning and the protection of identified connectivity zones*". More specifically the study singles out the north-eastern and central sections of the wetland complex as being particularly important areas of habitat suitability, *"… warranting high conservation priority and protection from further disturbance or development*". Although much of this habitat occurs outside of the VWC (towards Memel and around Ingula), several core habitat suitability areas were identified within the VWC itself. These core areas exceeded the suitability threshold, and were assigned a 250 m transient buffer to account for potential edge disturbance and indirect development impacts. Additionally, areas considered important for maintaining habitat connectivity, facilitating dispersal and promoting persistence in the broader landscape were delineated around the core areas using resistance surface modelling.

Of the various core wetland habitat areas delineated for Species 23 within the AOI, 11 distinct patches occur within the proposed Kromhof WEF area. One of which represents a wetland system prioritised for detailed sampling and assessment namely VKK 5. The wetland is recognised as being of High habitat suitability. Below is an excerpt from the AfriAvian (2025) study for this site:

Verkykerskop Site 5 (VKK5)

This site encompasses a relatively large (~156 ha) channeled valley bottom wetland system, hydrologically connected to adjacent riparian and seep habitats (Figure 18). However, over 85% of the palustrine wetland has been inundated following the recent construction of a dam (circa 2023–2024) (Figures 19 and 20). Remaining marginal habitats in the southern portion of the site continue to support notable species of conservation concern, including the Endangered Grey Crowned Crane and

Endangered African Marsh Harrier. Based on the site's former mosaic of wetland vegetation types (i.e. defined by remaining patches), structural heterogeneity, and floristic composition, it is likely that this wetland previously offered suitable habitat for additional threatened species, including the Critically Endangered Species23, Vulnerable African Grass Owl and Critically Endangered Wattled Crane.

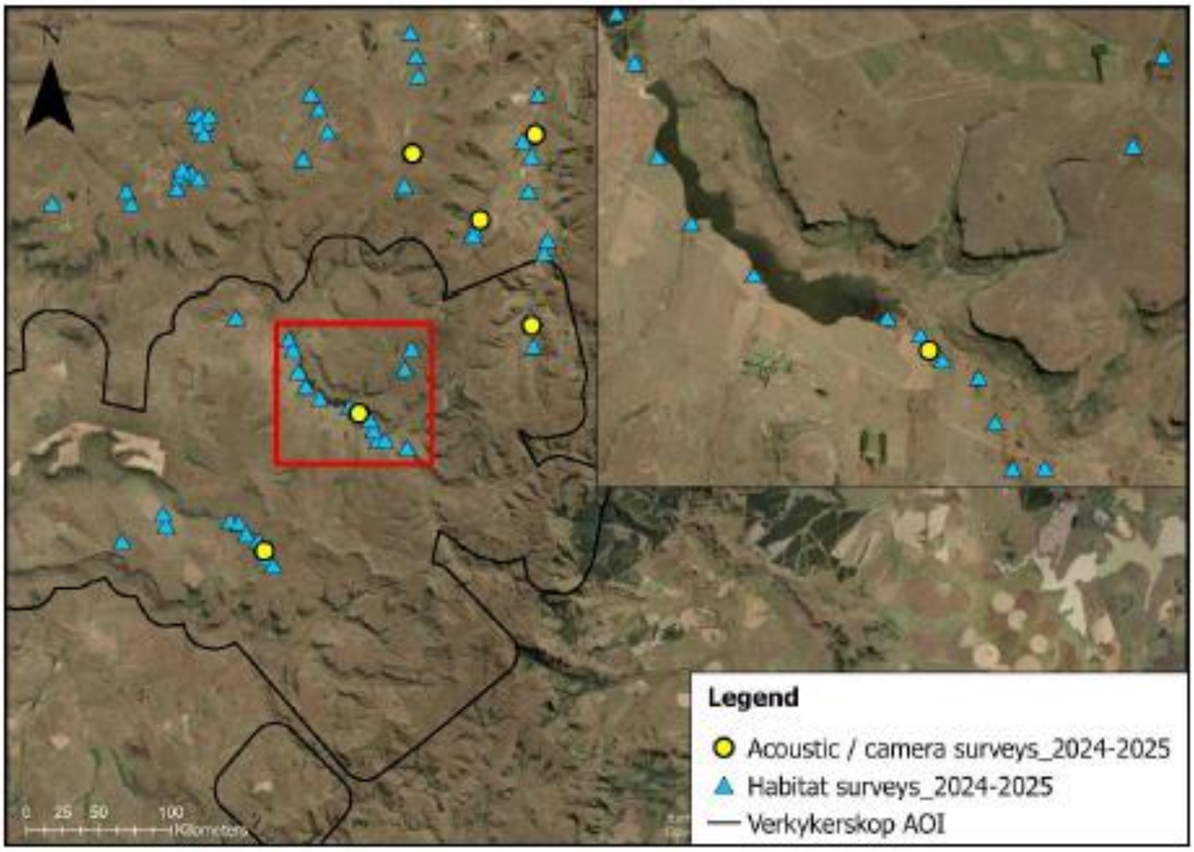

Figure 4-8 Verkykerskop (VKK5) wetland site surveyed from November 2024 to March 2025.

Figure 4-9 ***The 2024-2025 damming of VKK5 flooded large tracts of palustrine wetland habitat that would have been suitable for a range of threatened wetland species, including the focal species of this study***

Figure 4-10 ***The majority of VKK5 has been flooded due to very recent (2023-2024) damming of the downstream channel. This, together with extensive grazing has removed and/or degraded the majority of suitable palustrine wetland habitat***

Multiyear (2020–2025) Habitat Suitability Index (HSI) analysis (see methodology) indicates that VKK5 offers high seasonal suitability for the target species within the remaining patches that have not been flooded. Peak HSI values exceeded the suitability threshold (0.8) between mid-December and Mid-January (Figure 21). Suitability increases steadily from late spring (October–November), reaching a maximum in January before declining again in early autumn. The modelled HSI trend suggests that VKK5 provides favourable habitat conditions during the core summer period, likely driven by vegetation productivity, shallow inundation, and optimal cover. However, a substantial portion of the overall wetland has been inundated, and the reported suitability scores only reflect the ~15% of remaining unflooded habitat. Given the recent construction of the dam, water levels may continue to rise—particularly during periods of high rainfall—posing a risk of further inundation to the remaining suitable habitat.

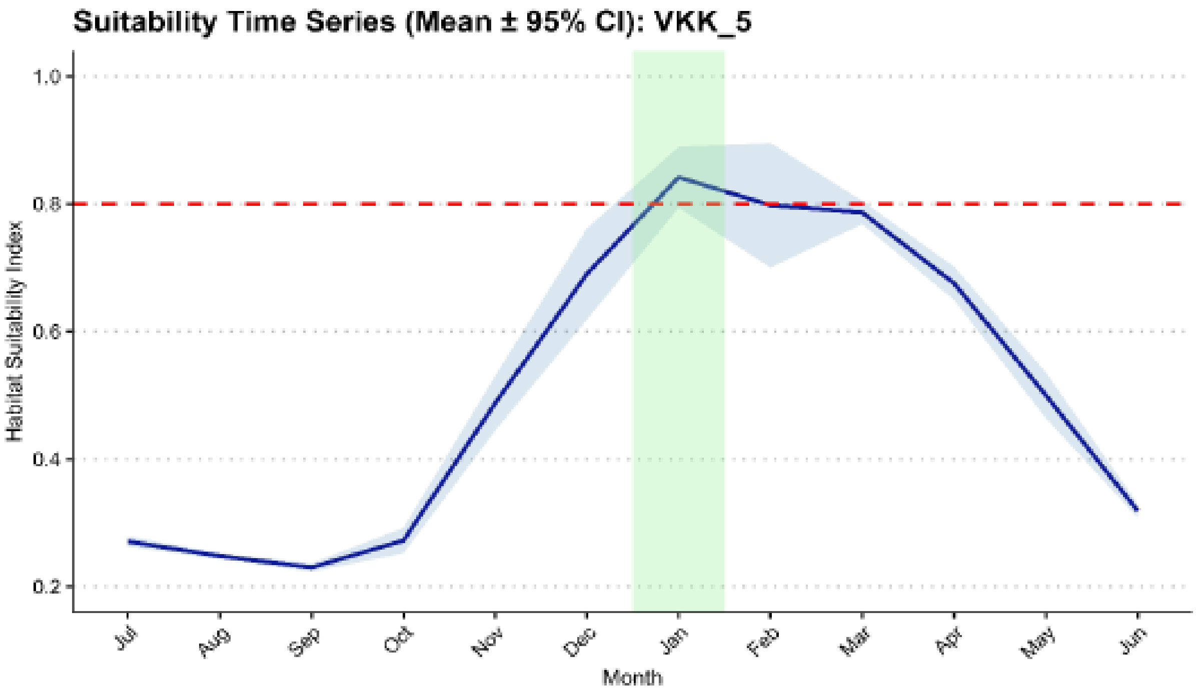

Figure 4-11 ***Seasonal habitat suitability trends for "VKK5" site based on multi-year remote sensing habitat suitability analysis (2020–2025). The blue line represents the mean suitability index across years, with shaded light-blue ribbons indicating the 95% confidence interval. The dashed red line marks the suitability threshold (0.8) derived from other sites yielding presence (Colyn et al. 2020), while the green swathe highlights the period where mean suitability values exceed this threshold, indicating peak habitat suitability***

4.2.5 Flight Activity

4.2.5.1 All Priority Species

Year 1-2 flight activity data for the Kromhof WEF (five, 12-hour VPs run over 12 surveys totalling 720 hours) and the controls (four VPs totalling 576 hours) is summarised in Table 4-4. Overall, vantage point observations in the WEF yielded a total of 1338 flights of priority species, totalling 251.33 hours with a passage rate of 1.86 birds^{-hour}. The passage rate was higher than the control (1.23 birds^{-hour}). Cape Vulture and Yellow-breasted Pipit are singled out for further analysis on flight activity as they represent two contrasting yet collision-prone flight patterns namely soaring and displaying. Aside from Cape Vulture, Southern Bald Ibis contributes most significantly to overall passage rates in the WEF. Only one Rudd's Lark flight passage was documented, highlighting the rarity of the species.

Table 4-4 ***Summarised flight activity data***

Species	VP Hours		No. Fly. Ind.		Passage Rate		Flight Hours	
	WEF	Control	WEF	Control	WEF	Control	WEF	Control
Cape Vulture	720	576	618	141	0.858	0.245	198.785	53.120
Yellow-breasted Pipit	720	576	41	5	0.026	0.057	0.912	0.280
Southern Bald Ibis	720	576	191	137	0.265	0.238	4.908	6.770
All Priority Species	720	576	1338	706	1.860	1.230	251.334	112.500

When comparing passage rates of priority species among vantage points (Table 4-5), VP5 and VP10 stand out with a passage rate of 2.11 birds^{-hour} and 2.52 birds^{-hour} respectively. This contrasts starkly with the control (highest per VP control passage rate observed at VP6 of 1.71 birds^{-hour}). When considering variation among seasons, a marked phenological response is revealed. It is clear that the by far the highest passage rates are encountered towards the end of the rainy season with a significant peak in summer (3.12 birds^{-hour}) and autumn (2.04 birds^{-hour}). This is expected given the higher activity associated with increased primary productivity (and consequently insect, seed and other food availability) during this time in this summer rainfall region, breeding and influx of migrants. This period was not only characterised by an influx of Palearctic and intra-African migrants but was found to also be also strongly influenced by altitudinal migration from several Southern African residents (species which move away from these colder highlands to warmer, moister regions below the escarpment and nearer the coast during winter). Additionally, a distinct difference in passage rate among years was observed with Year 2 yielding almost twice as many passages than Year 1, likely a consequence of the shift in southern hemisphere climate patterns from the dryer El Niño during 2023/2024 to the wetter La Niña period from late 2024 (CSIR, 2024).

Table 4-5 Comparison of passage rates of priority species among VPs per season

Site	VP	Winter	Spring	Summer	Autumn	Y1	Y2	Total
Kromhof WEF	5	0.61	0.92	2.61	4.31	1.32	2.90	2.11
	9	1.42	1.97	1.22	0.61	1.54	1.07	1.31
	10	0.53	1.36	7.08	1.11	1.92	3.13	2.52
	11	0.53	0.31	3.36	1.50	1.08	1.76	1.42
	12	2.89	0.83	1.33	2.67	0.75	3.11	1.93
	Total	1.19	1.08	3.12	2.04	1.32	2.39	**1.86**
Control	6	0.61	0.86	1.14	4.22	1.07	2.35	1.71
	7	1.94	1.50	1.11	0.89	1.88	0.85	1.36
	8	1.39	0.78	1.69	0.22	1.11	0.93	1.02
	18	0.44	0.11	1.83	0.92	0.97	0.68	0.83
	Total	1.10	0.81	1.44	1.56	1.26	1.20	**1.23**

Interspecific comparisons on passage rates among the flying priority species (30 spp.) reveal that four have notably higher passage rates than any other, Cape Vulture (0.86 birds^{-hour}) and Southern Bald Ibis (0.27 birds^{-hour}), Jackal Buzzard (0.16 birds^{-hour}) and Amur Falcon (0.15 birds^{-hour}). In terms of seasonality, winter is characterised by a noticeable reduction in the diversity and abundance of large terrestrial birds such as cranes, ibises, korhaans and bustards. In contrast, Black Harrier (observed once during S13) and Greater Kestel were exclusively winter visitors to the WEF. Most notable during winter was the notable reduction in the prevalence of Blue and Crowned Cranes (to almost zero). It was subsequently established that most of the regional crane populations that occur in the project area during summer, leave the project area to aggregate and overwinter, in large non-breeding flocks (of several hundred birds), at one of the two known congregation sites situated on Farm Nugget near Verkykerskop and the dairy farm near Memel. In contrast, summer was characterised by marked increase in local and migratory bird activity which translated into large increases in passage rate during summer and autumn. Visitors during the warmer rainy months included African Fish Eagle, Amur Falcon, Black-chested Snake Eagle, Blue Crane, Blue Korhaan, Booted Eagle, Common Buzzard, Denham's Bustard, Wahlberg's Eagle and Yellow-billed Kite. Verreaux's Eagle also visit the WEF to hunt (especially along the Mont Pelaan ridgeline and Muel valley) year-round suggesting a nearby nest nearby (likely Nest 4 situated 2.1 km east of the WEF based on proximity and flight paths). It is presumed that the juvenile frequently observed from VP 9 during 2023 came from this nest.

Table 4-6 Passage rates among the 32 priority species observed during Y1-2

Common Name	Winter	Spring	Summer	Autumn	Y1	Y2	Site	Control
	S1, 5, 10	S2, 6, 11	S3, 7, 12	S4, 8, 9				
African Fish Eagle		0.006		0.011		0.008	0.004	0.003
African Harrier-Hawk		0.011	0.006	0.011		0.014	0.007	0.012

Common Name	Winter	Spring	Summer	Autumn				
	S1, 5, 10	S2, 6, 11	S3, 7, 12	S4, 8, 9	Y1	Y2	Site	Control
Amur Falcon			0.350	0.244	0.175	0.122	0.149	0.226
Black Harrier								
Black Sparrowhawk	0.006					0.003	0.001	0.005
Black Stork	0.006	0.011	0.017			0.017	0.008	
Black-chested Snake Eagle		0.006				0.003	0.001	
Black-winged Kite	0.011	0.006			0.008		0.004	
Blue Crane		0.128	0.222		0.094	0.081	0.088	0.042
Blue Korhaan								
Booted Eagle								
Cape Vulture	0.572	0.200	1.428	1.233	0.300	1.417	0.858	0.245
Common Buzzard		0.011		0.011	0.006	0.006	0.006	0.002
Denham's Bustard			0.028		0.014		0.007	
Greater Kestrel	0.011				0.006		0.003	0.005
Grey Crowned Crane								
Grey-winged Francolin								
Ground Woodpecker								
Half-collared Kingfisher		0.011				0.006	0.003	
Jackal Buzzard	0.211	0.128	0.133	0.167	0.144	0.175	0.160	0.245
Lanner Falcon	0.056	0.072	0.044	0.017	0.042	0.053	0.047	0.026
Lesser Kestrel								
Little Sparrowhawk								
Martial Eagle	0.011	0.028	0.011	0.006	0.014	0.014	0.014	0.014
Melodious Lark								
Montagu's Harrier								
Pale Chanting Goshawk				0.011		0.006	0.003	
Peregrine Falcon	0.006		0.006			0.006	0.003	
Rock Kestrel	0.089	0.039	0.106	0.056	0.067	0.078	0.072	0.030
Rudd's Lark		0.006			0.003		0.001	
Rufous-breasted Sparrowhawk	0.006		0.006			0.006	0.003	0.007
Secretarybird	0.006		0.006	0.011	0.006	0.006	0.006	0.014
Southern Bald Ibis	0.094	0.328	0.506	0.133	0.372	0.158	0.265	0.238
Verreaux's Eagle	0.028	0.039	0.033	0.017	0.036	0.022	0.029	0.024
Wahlberg's Eagle		0.006			0.003		0.001	
White Stork				0.039		0.019	0.010	0.002
White-bellied Korhaan	0.033					0.017	0.008	
White-necked Raven	0.050	0.022	0.011	0.067	0.031	0.044	0.038	0.076
Yellow-billed Kite		0.011				0.006	0.003	
Yellow-billed Stork								0.002
Yellow-breasted Pipit		0.011	0.211	0.006	0.003	0.111	0.057	0.009

Flight activity was also found to be influenced by time of day with trends in daily activity patterns having varied significantly among the four main time slots. Early mornings (06:30-09:30), as would be expected, are characterised by a peak in total species richness and abundance (particularly with regards to small-passerines). Late mornings (09:30-12:30) are associated with a timeous and drastic increase in the prevalence of soaring birds, which appears related to an increase in temperature and, subsequently, wind speed (particularly above 10 km/h). Early afternoons (12:30-15:30) are considerably quieter with bird activity decreasing drastically. Late afternoon (15-30-18:30) bird activity starts slow before a spike in activity at and just after sunset as many species (particularly Bald Ibis and large raptors) begin their commute back to their roosts/nests.

Flight paths of all priority species observed during vantage point surveys within the project area are mapped in Figure 4-12. From this figure, it is apparent that flights by red-listed species are more numerous and generally longer than those made by other priority species. This is because a large proportion of these flights are made by Cape Vulture and Southern Bald Ibis which are gregarious soaring birds. What is also apparent is that Cape Vulture made the furthest flights.

To better understand the spatial distribution of flights over the project area a flight path intersection density model was made (Figure 4-14). This model (essentially kernel density estimation applied to intersecting lines) subsequently formed the basis of the flight corridors sensitivity layer included in the sensitivity assessment. This figure shows that although priority species flights cross the entire VWC, they are concentrated in at least 10 “hotspot” areas for flight activity, hereafter referred to as flight corridors, of which five interconnecting routes occur in the proposed Kromhof WEF namely Flight Corridors 3, 4, 5, 7, 9. Flight Corridor 3 is a large kloof area with frequent flight passages due to proximity to a Southern Bald Ibis Roost and Kestrel nests along the cliff line. Flight Corridor 4 connects the Ingula-Majuba 14 transmission lines with the Dwaalspruit valley to the west which is frequently used by Blue Crane and Cape Vulture. Flight Corridor 5 occurs along the prominent ridgeline associated with Mont Pelaan, is frequently used by Cape Vulture and other large soaring birds to gain lift, undoubtedly the most important flight corridor in the VWC which also connects several priority species nests. Flight Corridor 7 is along the Muel River valley, a large dammed floodplain lined by low cliffs. The steeper north-eastern bank of this valley is frequented used by numerous priority species and waterfowl for commuting. During summer this prominent break in topography funnels large flocks of migratory amur falcon over the escarpment into KwaZulu-natal. Flight Corridor 9 is utilised primarily by a flock of Southern Bald Ibis to access their breeding colony (Roost6). It also connects to major flight corridors to north and south.

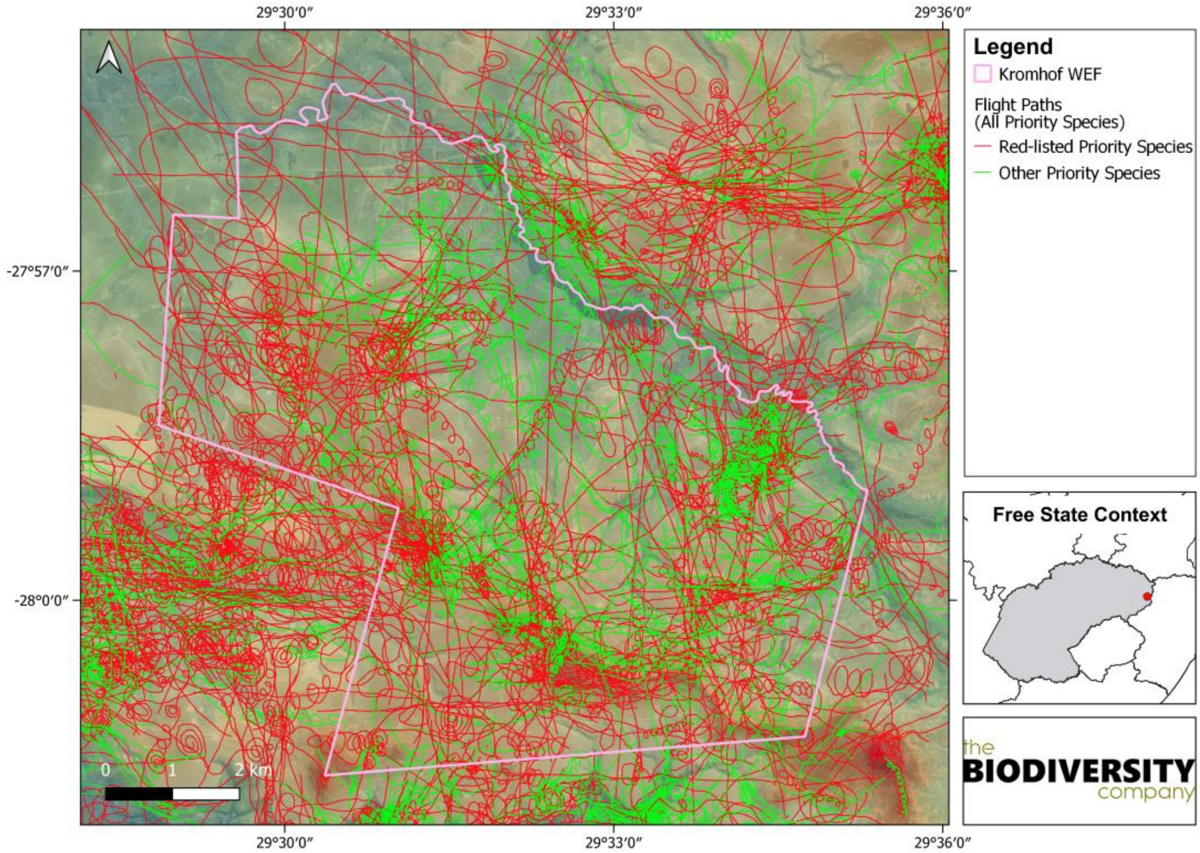

Figure 4-12 Combined flight paths of red-listed and other priority species

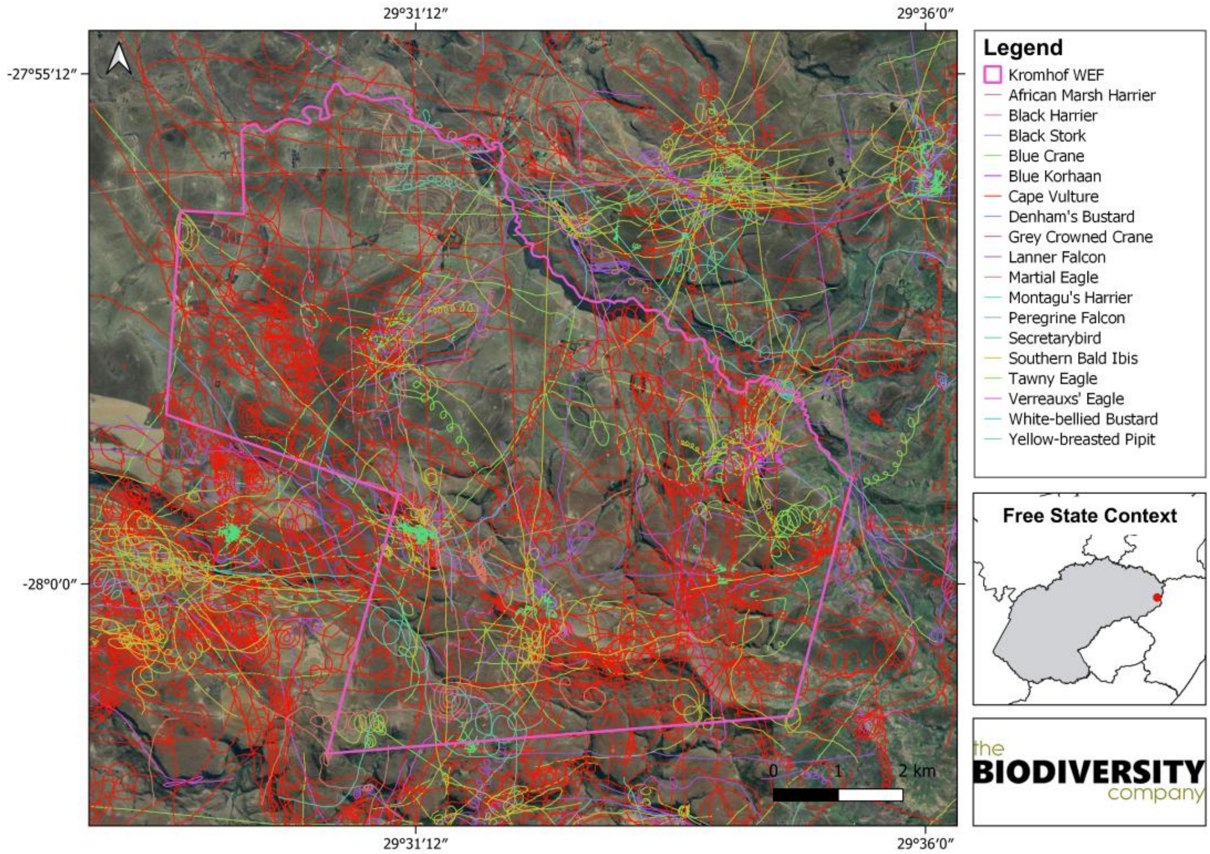

Figure 4-13 Annotated fight paths of red-listed species

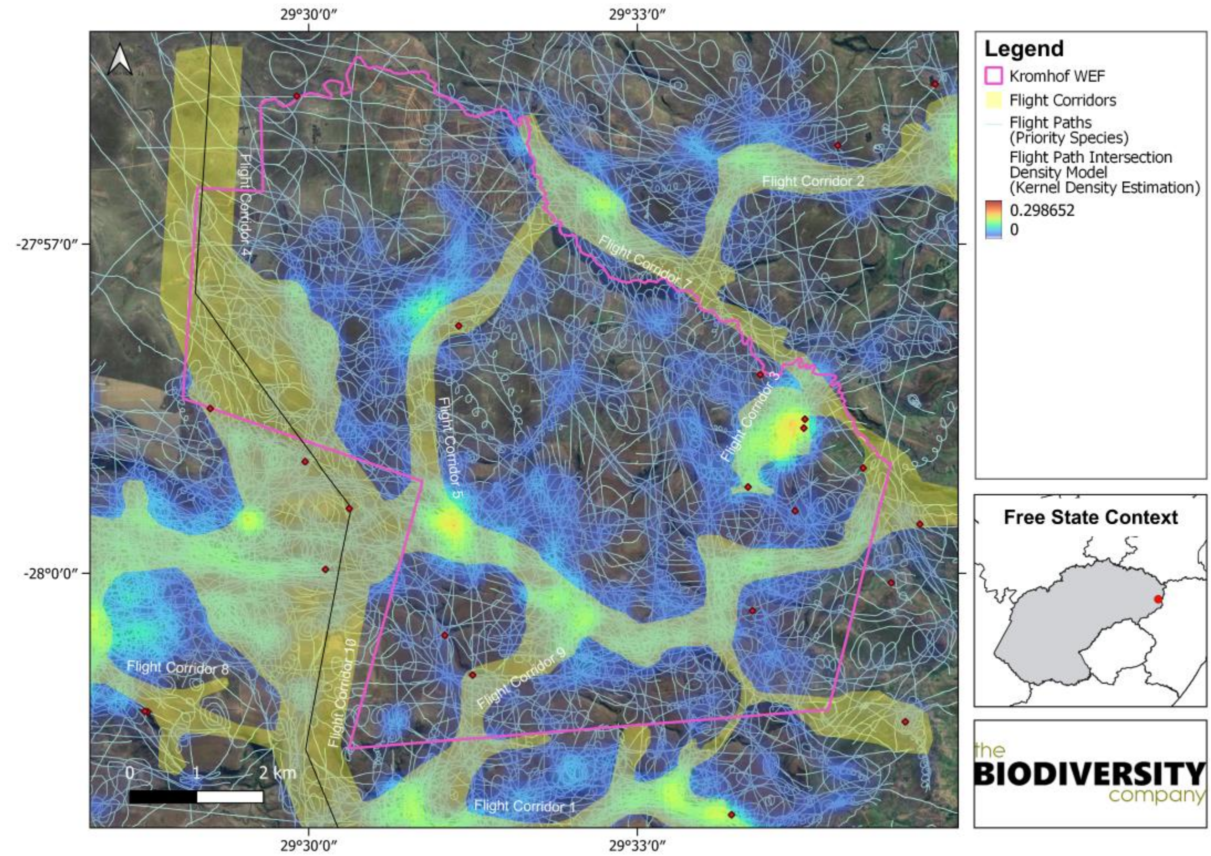

Figure 4-14 Flight path density intersection model

4.2.5.2 Cape Vulture

4.2.5.2.1 Tracking Data

Tracking data on 16 Cape and four White-backed Vultures fitted with GPS loggers (clipped to the AOI) was supplied courtesy of Vulpro (2025) to inform planning and risk assessment with regards to the VWC. The data reveals that Cape Vultures regularly fly across the VWC. As much as 94% of the CV data supplied by Vulpro for the AOI was logged during the study period (data from June 2022 till March 2025). The tracking data also shows the erratic nature of the flights which are spread across most of the VWC, as was observed in-field. Overlaying digital elevation models on flight data helps to shed light on potential flight routes and triangulation between the various roosts that was inferred from in-field observations. Of greatest potential significance to the project are the generally north/south and north-west/south-east trending flights from the breeding roost at Nelsonskop to the non-breeding Witkoppe and Verkykerskop roosts respectively. The general pattern is for the vultures to fly northwards in the morning from Nelsonskop (often low over the VWC) towards the Witkoppe following a distinct series of inselbergs which includes Waterkop and Mont Pelaan Ridge. Another flight path follows the powerline servitude. They then either head south-westwards towards Arend's Kop via Verkykerskop before circling back to Nelsonskop or continuing northwards. Tracked vultures G26904 and G36625, demonstrate this trend particularly well. At the Kromhof WEF, Cape Vulture flights are associated with Flight Corridors 4 (powerlines), 5 (Mont Pelaan ridgeline), and 7 (Muel valley). Interestingly White-backed Vulture were also tracked over the WEF, an “out of range” species more typically associated with warmer bushveld regions.

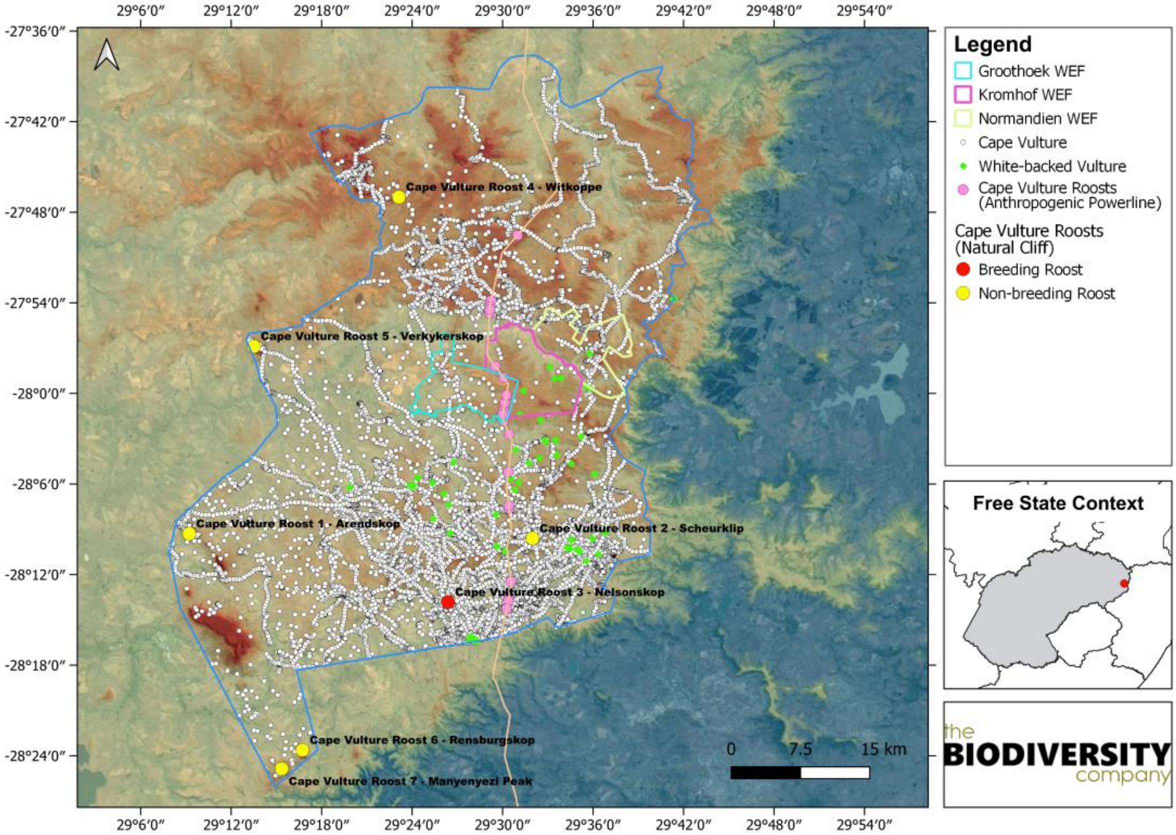

Figure 4-15 Vulture tracking localities and roosts (within 50 km). Data courtesy of Vulpro (2025).

4.2.5.2.2 Monitoring Data

Cape Vulture flight path across the Kromhof WEF are represented spatially in Figure 4-13. During the standard two-year monitoring program, 618 individual Cape Vulture passages were recorded from the five on-site vantage points at the Kromhof WEF, representing an average passage rate of 0.858 $birds^{-hour}$. This is three times greater than the combined passage rate for the four control VPs. Although Cape Vulture are present year-round in the WEF, a distinct seasonal variation in passage rate was observed. Over the two-year monitoring period, Cape Vulture passages were consistently higher during summer and autumn surveys with passage rates of 1.4 $birds^{-hour}$ and 1.2 $birds^{-hour}$ respectively more than twice that of any other season. Although the passage rate data provides information on the regularity and frequency of vulture flights it does not account for the duration and time spent flying at rotor height nor the spatial variation thereof.

Table 4-7 Cape Vulture flight time below, within and above rotor sweep height over the standard two-year monitoring period compared between the WEF (n=618 flights) and Control (n=141 flights).

Zone	Total Flight Hours		Mean Hours Per Flight	
	Kromhof VPs	Control VPs	Kromhof VPs	Control VPs
H1 (below)	62.461	9.35	0.101	0.066
H2 (within)	99.77	38.78	0.162	0.275
H3 above)	36.49	4.99	0.059	0.035
Total	198.72	53.12	0.107	0.376

The above table shows that the 618 Cape Vultures that were logged spanned 467.48 hours. Mean flight time per passage was three times higher than the control. Particularly relevant in this regard is flight height and duration within potential rotor sweep. Cape Vultures fly low across the proposed Kromhof WEF (and the VWC in general) spending most of their time (82%) either at or below rotor sweep height. Importantly, both parametric (one-way ANOVA) and non-parametric (Kruskal-Wallis) statistical tests revealed that Cape Vulture spend significantly ($p<0.001$) more time flying at potential rotor sweep height than any other height class.

This trend is visualised in Figure 4-16 below. From this graph, it is evident that more flights were recorded at rotor height and that these flights were, on average, significantly longer than at any other height class. The general trend is for the vultures to approach from the south, flying low along the gorges and cliff lines. As the day warms and thermal activity increases the groups begin to circle and gradually ascend using the ridge of VP 10 (Mont Pelaan foothills) to gain lift as they leave the project area usually in a northerly to north-westerly direction towards the Witkoppe Mountains or Arend's Kop. Dedicated roost investigations revealed that vultures tend to start returning to their roosts from midday with most having returned by around 15:30 in summer.

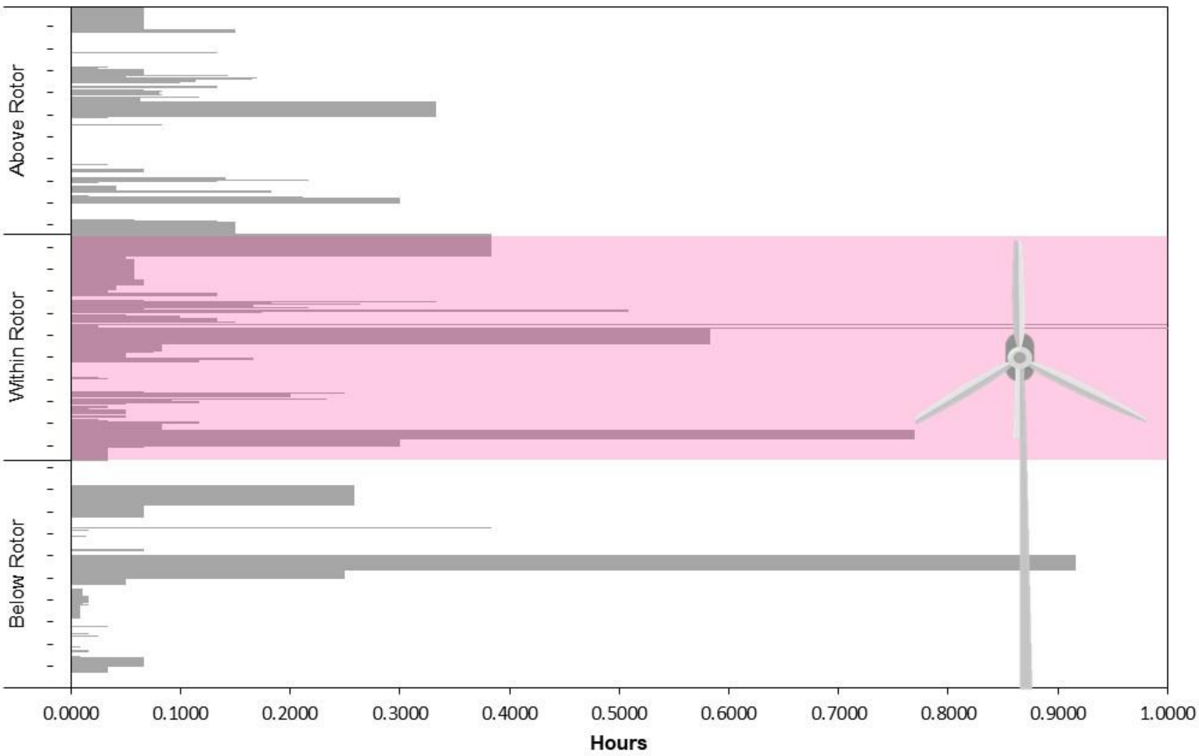

Figure 4-16 Cape vulture flight hours below, within and above rotor sweep heights

The differences in mean flight time at rotor height per VP are shown in Figure 4-17. Cape Vulture were recorded from all five WEF VPs. However, considerable variation in flight time at rotor height was observed among the VPs with VPs 5, 10 and 12 showing significantly longer flights at rotor height than most other VPs in the WEF.

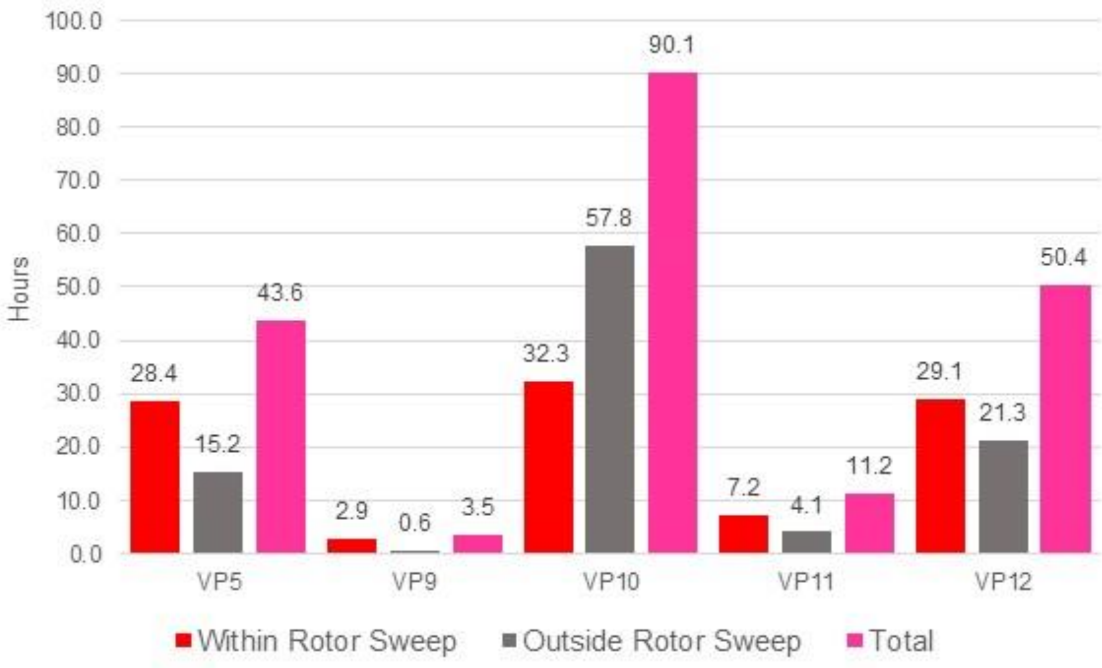

Figure 4-17 Duration of Cape Vulture flights in total and at rotor sweep height per VP

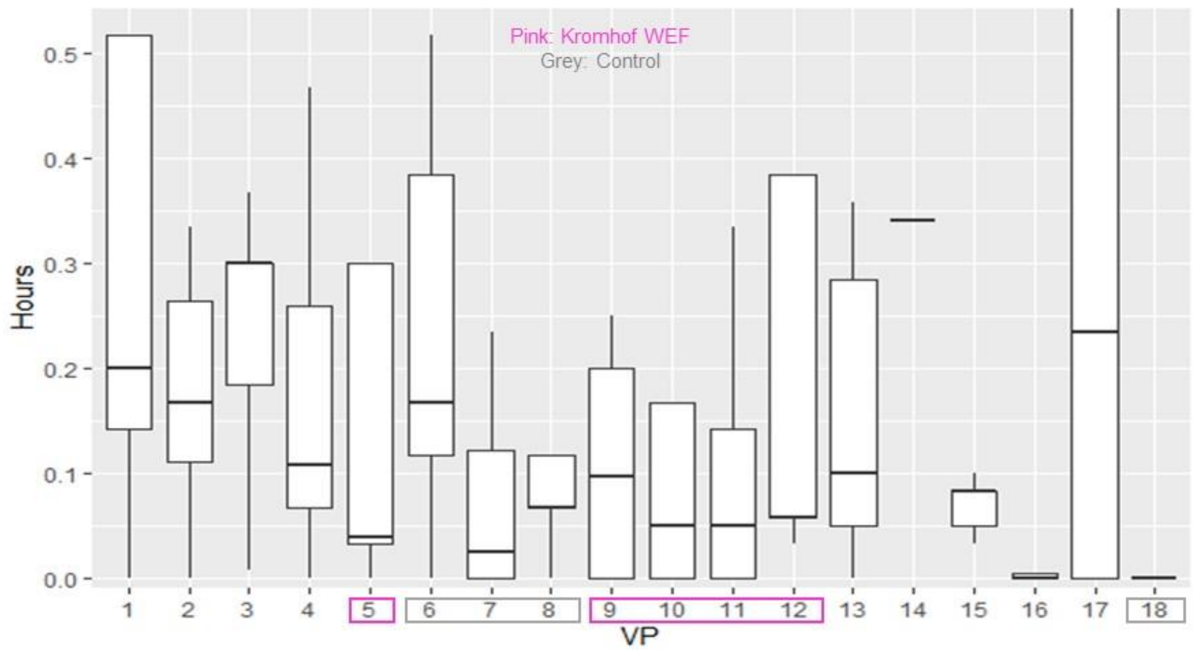

Figure 4-18 Boxplot comparing mean Cape Vulture flight time at potential rotor sweep height between Kromhof WEF (pink) and Control (grey) VPs

4.2.5.3 Martial Eagle

At least two pairs of Martial Eagle are known to make regular flights across the VWC. The pair from Nest 2 maintains a territory in the South of the VWC (nest 3.9 km south of VWC boundary) while the pair from Nest 5 maintains a territory to the north (nest 10.7 km north). Based on in-field observations from the monitoring it is suspected that another pair may be nesting to the east (near Ncandu) but no nest has been found. Tracking data from the Nest 2 male supports this theory with a distinct lack of records east of the Muel River Valley which appears to mark the north-eastern boundary of his territory.

4.2.5.3.1 Tracking Data

Dr Gareth Tate from EWT was commissioned to capture and fit GPS tracking devices to these two known pairs (with ethics clearance and handling permits in place). In May 2024 the EWT field team successfully captured and fitted a GPS tracking unit to the male from the southern pair (Nest 2) ultimately nicknamed Brad. The female of the pair to the north (Nest 5) was also captured and fitted with a tracker, but the backpack unit was found on the ground soon after. Nevertheless, the data from Brad's tracker provided insightful data. A dedicated Martial Eagle report detailing Brad's movements was produced (EWT, 2025). A summary of pertinent findings from this report is provided below.

Figure 4-19 Images of the male Martial Eagle, "Brad", who holds a territory within the Verkykerskop WEF cluster who was successfully fitted with a tracking unit in May 2024. Images taken by Dr Gareth Tate supplied courtesy of EWT (2025)

To date 322 days of tracking data from Brad have yielded 5132 GPS points, covering a distance of over 11131 km with an average daily distance of 34 km. In terms of flight patterns, the EWT (2025) tracking data revealed that most (75%) of Brad's flight time was spent in potential rotor sweep height in the period spanning May 2024 to April 2025 (Figure 4-21). Brad has three main flight routes. Of greatest potential significance to the project is the long north-western flight route which takes Brad to many parts of the proposed Groothoek WEF and the western half of the Kromhof WEF. The other two are between roost sites to the south-west and west of the nest. This Martial Eagle male does not appear to venture across the Muel River Valley into Normandien WEF which, based on monitoring observations of Martial Eagle from VP 14, 15 and 17 may be defended by another pair (either from Nest 5 or an unknown pair from the escarpment to the east (more likely based on twilight observations of eastwards commuting individuals).

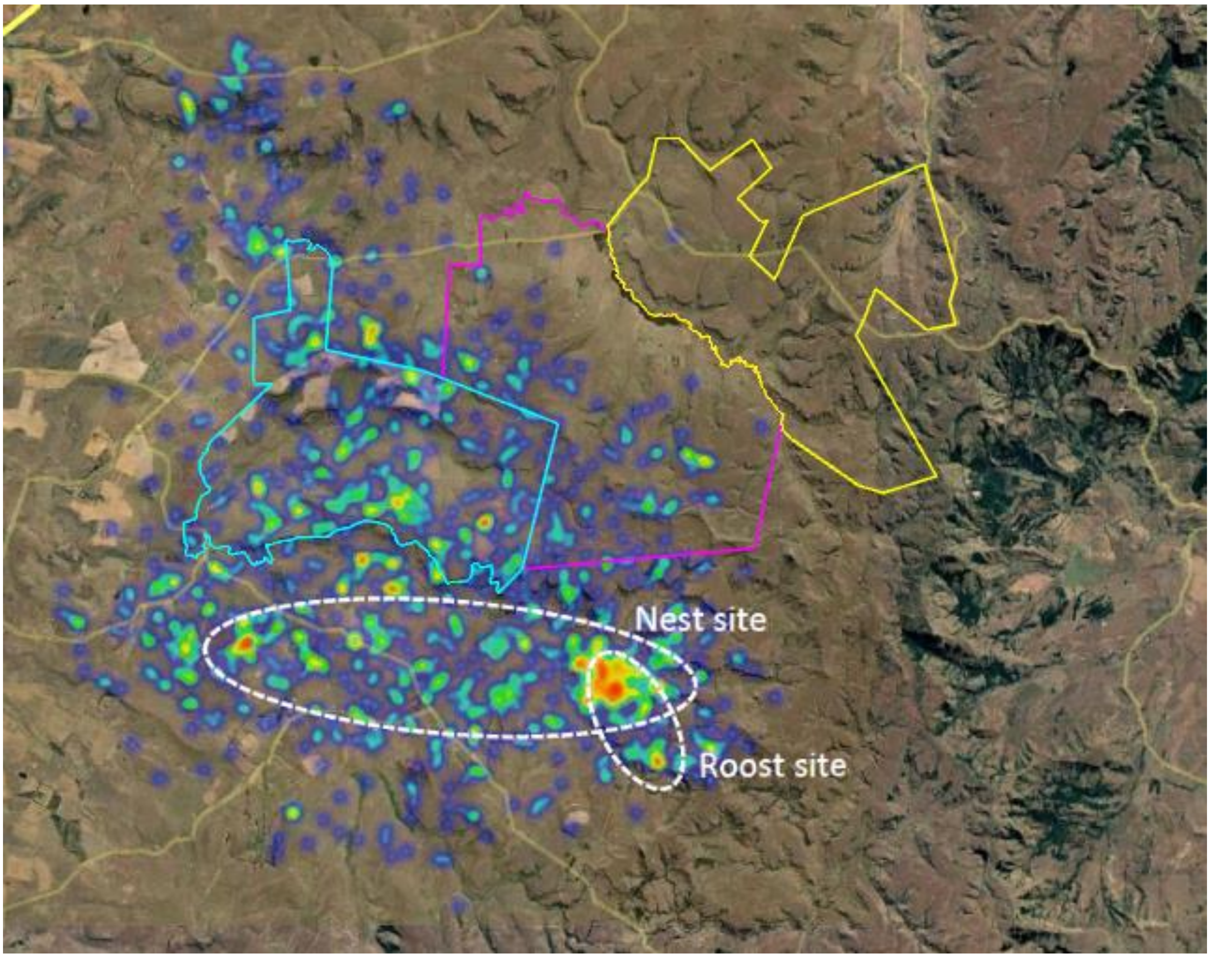

Figure 4-20 Modelled core use areas for the tracked Male Martial Eagle (EWT, 2025) in relation to the VWC, showing Groothoek (blue), Kromhof (pink) and Normandien (yellow) WEFS. Note the prevalence of use areas across Groothoek WEF and the western half of Kromhof WEF. Courtesy of EWT (2025)

The home range (assuming a 95% utilisation distribution) of Brad was estimated to be 233.92 km^2 (using Autocorrelated Kernel Density Estimation) and 251.98 km^2 (using standard kernel density estimation). The minimum convex polygon (MCP) surrounding all tracking points was 476.79 km^2. The authors highlight that males from this region appear to maintain notably smaller home ranges than compared to Karoo and Kruger populations but that the possibility of small sample size as a confounding factor can't be ruled out at this stage. Figure 4-22 below shows the kernel density estimated home range, GPS tracks overlain on modelled core use areas and the temporal variance in home range size. From the EWT (2025) report it is also evident that home range size is typically lowest during the core breeding (incubation and hatching) period in winter than other times of the year. It is mentioned that the drop steep drop in home range size in April 2025 suggests the pair may be preparing to breed again. It is also mentioned that as much as 65 % of the bird's time is spent within 5 km of the nest. The authors of the EWT (2025) report concluded that "*the tracked adult Male Martial Eagle, Brad, extensively utilises the project site, putting this individual at significant risk of turbine collisions, particularly within its core ranges (5-6 km from the active nest)*". Given the active breeding status of this pair EWT (2025) recommend a 6 km radial buffer on the nest.

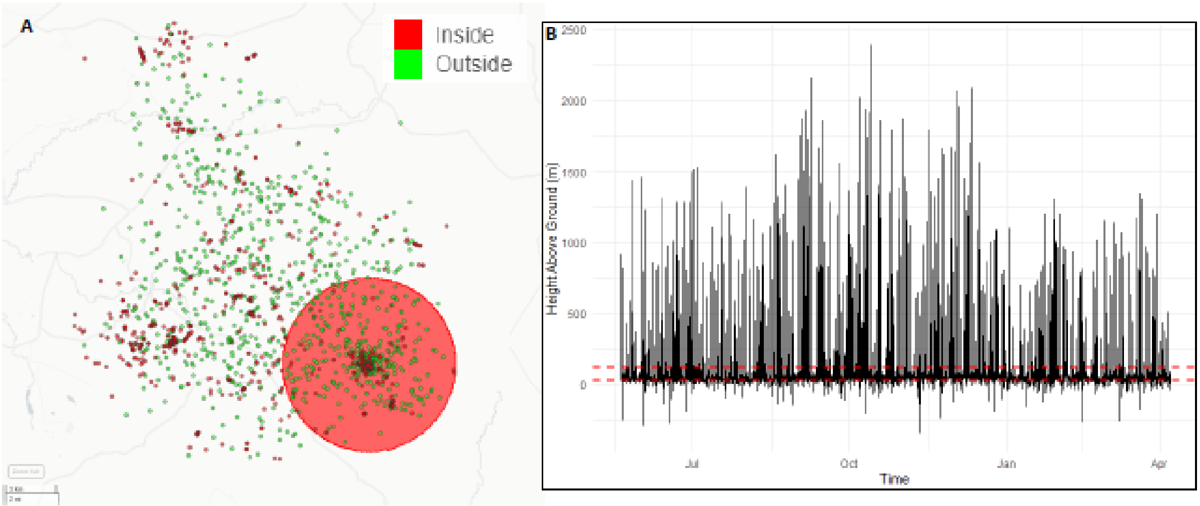

Figure 4-21 ***Martial Eagle flight data, A) Spatial visualisation of Martial Eagle flight heights, red dots represent GPS locations within rotor sweep zone and green dots outside; B) eagle flight profile, red dotted line indicates potential rotor sweep. Courtesy of EWT (2025)***

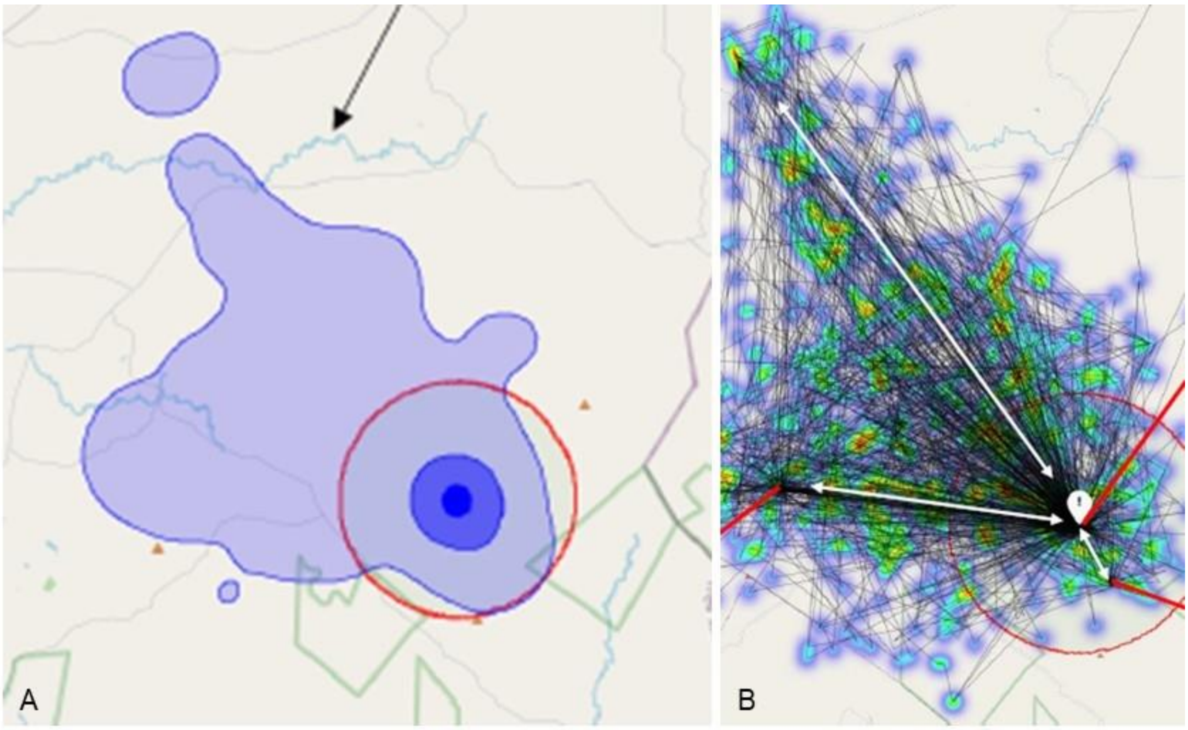

Figure 4-22 ***Martial Eagle (A) home range based on 95% KDE, B) tracked paths. Note the north-westerly flight path tracks across the Groothoek WEF and western portions of the Kromhof WEF. Courtesy of EWT (2025)***

4.2.5.3.2 Monitoring Data

Martial Eagle were recorded on 36 occasions during all sampling for the VWC, representing 10.07 hours of flight time most of which was in the potential rotor sweep zone (mean flight height, 88.86 m). Most flight paths were logged from the Control site at VP8 which is nearest the nest. At Kromhof the species was observed on 10 occasions yielding a passage rate of 0.014 birds^{-hour}. These 10 flights totalled 55.68 min, all (except 1) were within potential rotor-sweep height (mean flight height, 126.6 m). These low encounter rates reflect species' wide-ranging but low-density occurrence.

4.2.5.4 Yellow-breasted Pipit

The species breeds in intact plateau grasslands which occurs throughout most of the WEF (central, western and southern regions). Most flight activity of potential collision significance takes place during the breeding season (typically November through March on site) when males display for protracted periods at potential rotor sweep height. During the monitoring program, 41 Yellow-breasted Pipit display passages were recorded from the five on-site vantage points at the Kromhof WEF, representing an average passage rate of 0.057 birds^{-hour}. This is considerably higher than the combined passage rate for the four control VPs. These passages totalled 40.3 min with an average flight time of 1.3 min at an average height of 27.5 m. Phenological variation in passage rate is distinct with passages only being recorded in the height the rainy season in summer when these otherwise cryptic passerines display. During this time a high passage rate of 0.21 birds^{-hour} was observed.

Figure 4-23 represents the spatial distribution of their flights across the VWC, comparing flight times within or outside of potential rotor sweep height. From the figure it is evident that the Kromhof and Normandien WEFs represent strongholds for the species in the area. Display flights were documented predominantly from VPs 5 and VP11. Of the 40.3 min observed flight time the birds spent 25.5 min at potential rotor sweep height. It should be noted that, given their small size and their soft mechanical call, which is easily missed, this flight data is almost certainly an under-representation.

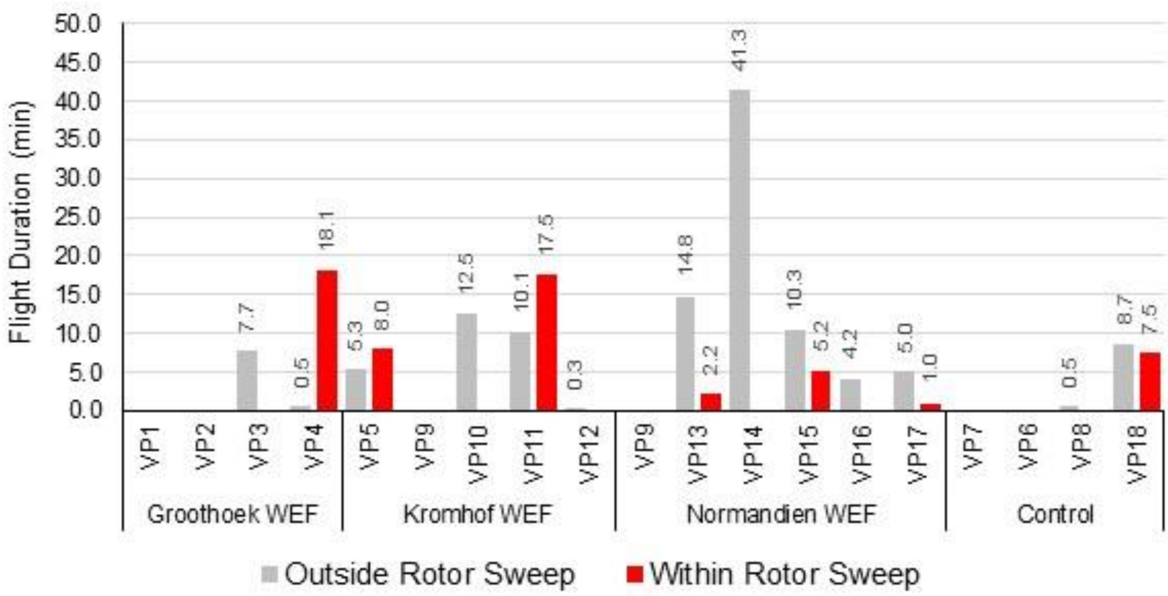

Figure 4-23 Duration of Yellow-breasted Pipit Flights at VPs across the VWC and Control areas

To better understand the temporal patterns associated with Yellow-breasted Pipit displays, flight height was plotted against time of day (Figure 4-24). Displays occur throughout the day, but tended to be concentrated in the morning between 07:00 and 10:00. Another peak in display activity typically occurs in the late afternoon between 15:30 and 17:00. Flight activity appears to be associated with climatic conditions with birds tending to display more when temperatures are cooler and wind is lower, particularly on overcast days. Also noteworthy is that, although flights at rotor sweep were less numerous than those below rotor they accounted for the majority (63%) of the total flight time. Coarse analysis of the data suggests that flight height may be positively correlated with flight duration, suggesting that the higher displaying males went, the longer they flew which likely explains this pattern.

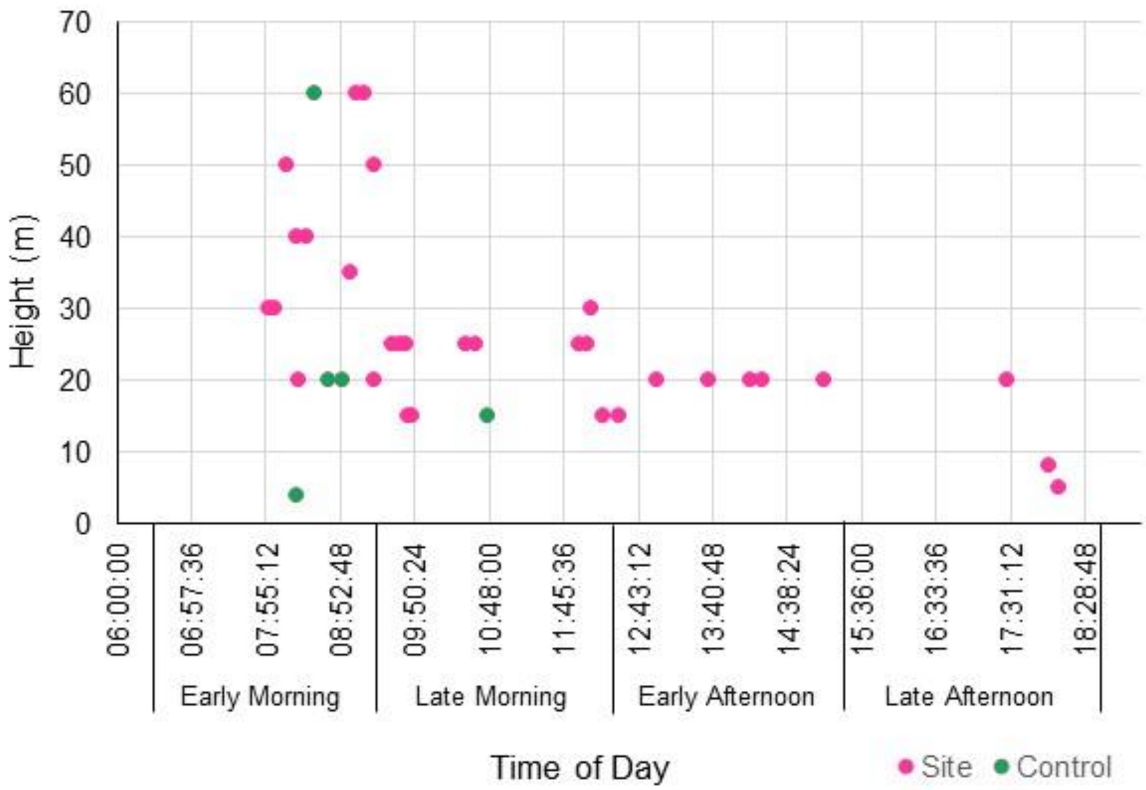

Figure 4-24 Yellow-breasted Pipit flight heights plotted against time of day at the Kromhof WEF (pink) compared to the Control (grey).

4.2.6 Breeding, Roosting and Feeding Activity

4.2.6.1 Cape Vulture

4.2.6.1.1 Natural Cliff Roosts

At present, seven Cape Vulture roosts (of which one is a confirmed breeding colony) and one Bearded Vulture nest have been confirmed to occur within 50 km of the VWC through a combination of in-field roost investigations and Vulpro tracking data. Due to the proximity of the VWC to the roosts and in accordance with the BirdLife Cape Vulture and wind energy best practice guidelines, the specialist recommended that the status of these roosts (in terms of breeding and seasonal occupancy) be thoroughly investigated. As such, a dedicated vulture roost investigation was motivated and subsequently conducted for the proposed VWC. The need for the investigation was raised during a meeting between TBC and Kromhof WEF, and a decision was made for a basic, high-level, dual-season investigation of the breeding status of the main roosts to be carried out.

This section summarises the findings of the vulture roost investigations to date. Photographs of are given in Figure 4-25 and each roost/nest is described

Table 4-8 along with its proximity to the closest boundary on Kromhof WEF. The location of each roost is represented spatially in Figure 4-15.

Table 4-8 Vulture roost details within a 50 km radius

Number	Inselberg	Description	Distance To VWC (Km)
CV Roost 1	Arendskop	Cape Vulture Roost (large, regular non-breeding). Inselberg near Harrismith. Roost is on west facing aspect on north-western end of inselberg.	37.5 sw
CV Roost 2	Scheurklip	Cape Vulture Roost (regular non-breeding). On large distinctive (lobster claw-shaped cliff) inselberg closest to project area. Roost is on north aspect.	14.8 s
CV Roost 3	Nelsonskop	Cape Vulture Breeding Roost (large colony) and Bearded Vulture Nesting Site. Roost is on the southern aspect of the north-western buttress of Nelson's Kop.	23.5 sw
CV Roost 4	Witkoppe	Cape Vulture Roost (regular non-breeding). Situated on the eastern most spur of the Witkoppe Inselberg. Roost is on north facing aspect of spur. Bearded Vulture observed nesting status uncertain.	19.5 nw
CV Roost 5	Verkykerskop	Cape Vulture Roost (small non-breeding). Situated on the western aspect of Verkykerskop Inselberg. Roost is on north facing aspect of spur.	25.2 w
CV Roost 6	Rensburgskop	Non-breeding roost	46.3 sw
CV Roost 7	Manyenyezi Peak	Non-breeding roost	49 sw
BV Nest 1	Nelsonskop	Bearded Vulture Nest on Nelson's Kop. Breeding Pair.	23.5 sw

Following several detailed visits to the roosts, evidence of breeding has only been recorded at Nelson's Kop. The remaining roosts appear, at this stage, to be non-breeding "spillover" roosts. The first official vulture roost investigation carried out in June 2023 and subsequent fieldwork in April 2024 yielded no evidence of breeding at any roosts other than Nelson's Kop. Of the non-breeding roosts Arend's Kop is the more significant. It is apparent, based on multiple season observations (focal point counts from the R722 road) that Arend's Kop roost is utilised very regularly throughout the year. The inselberg was hiked during preconstruction Survey 5 (27 July 2023). However, upon closer inspection no active nests or signs of breeding (nesting material, mating birds, eggs, chicks) were observed, although suitable nest leges do occur (although limited) and the possibility for breeding once the colony reaches critical mass should not be conclusively ruled out (Geoff Lockwood pers. comm). At Nelson's Kop, during the June 2023 vulture investigation, two breeding birds (Figure 4-26) were found to be incubating after reassessing the photographs. Approximately 200 birds were observed roosting at Nelson's Kop that trip.

The second follow-up visit to Nelson's Kop was carried out over two days. The first was a reconnaissance day (information gathering from local landowners and general scoping of the greater inselberg from afar). The second day involved a full day hike to the base of the vulture colony and a detailed count. Noteworthy findings were as follows:

- Cape Vulture breeding status: One of the two nests (that were observed on 13 June 2023) has yielded a chick. The nest is situated towards the top left-hand side of the main roost (when facing north). The chick is currently in a transition phase from downy to feathered plumage with an approximate age 50 days (as of 13 October 2023 and depending on hatch date). The chick is tended by both parents and is actively guarded. The attempt made by the second incubating pair appears to have been unsuccessful, but the pair still sit faithfully at the failed nest site. Recently the number of Cape Vultures breeding at Nelsonskop has increased to an estimated 7 nests (based on expert input received from Sonja Krueger and Brent Coverdale (Ezemvelo KZN Wildlife) during a visit in November 2024.
- Cape Vulture colony size: A detailed afternoon inbound count conducted on 13 June 2023 yielded 131 adult birds. It is, however, likely that more birds may have landed on other parts of the inselberg not visible at the time of the count and it is likely that the colony regularly supports well over 200 birds;

- Black Stork: A single individual was observed flying over the Cape Vulture colony. It is suspected that the species may be nesting on the northern aspect of Nelson's Kop;
- Lanner Falcon: A pair were observed actively fending off any birds which came to close to the western cliff face. It is suspected that they have an active nest on Nelson's Kop;
- Verreaux's Eagle: A single adult bird flew over Nelson's Kop; and
- Barrat's Warbler: A pair was heard calling from a Yellowwood tree at the base of the cliff.

Overall, the Cape Vulture roost investigation highlights the importance of Nelson's Kop in supporting breeding populations of several threatened cliff-nesting species which include Bearded Vulture (Critically Endangered), Cape Vulture (Endangered), Lanner Falcon (Vulnerable) and Black Stork (Vulnerable). The other four roosts appear, at this stage, appear to be non-breeding "spillover" roosts. The project's spatial dataset has been updated to include the Bearded Vulture nest and its recommended 10 km very high exclusion buffer as well as the two new roosts at Verkykerskop and the Witkoppe. The VWC (and therefore Kromhof WEF) falls outside of the 18 km Very High buffer zone as stipulated by BirdLife South Africa for breeding colonies of Cape Vulture. However, it does fall within the 50 km High sensitivity buffer of all five roosts. Overall, Kromhof WEF and the VWC is situated within an area likely to be frequently used by >200 Cape Vultures and infrequently used by at least a pair of Bearded Vulture from Nelson's Kop as well as their dispersing juveniles but other birds may also visit the site from the Central and Northern Drakensburg.

Figure 4-25 Photographs of the three Cape Vulture roosts; A) Roost 1 Arendskop, B) Roost 2 Scheurklip, C) Roost 3 Nelson's Kop, D) Roost 4 Witkoppe, E) temporary roost on south-western corner of Groothoek WEF

Figure 4-26 ***Photographs of the Nelson's Kop roost taken during the second follow up visit in October 2023 showing A) the location of the two breeding pairs. Note only CVN1 successfully hatched a chick, B) The chick at CVN1 and C) the nest cup of CVN1.***

4.2.6.1.2 Anthropogenic Powerline Roosts

As indicated by the Vupro (2025) tracking data and corroborated through in-field observations Cape Vultures regularly make use of the Ingula Majuba 14 Transmission Line as an overnight roost. Tracking data reveals the regular use of 21 pylons within the AOI as overnight roosts. In total 8 favoured overnight pylon roosts occur in the VWC, of which one occurs in the Kromhof WEF (near the western boundary with Groothoek WEF). On one occasion (17 May 2024) a total of 235 birds were seen roosting on these powerlines in the VWC overnight after feeding on a carcass nearby.

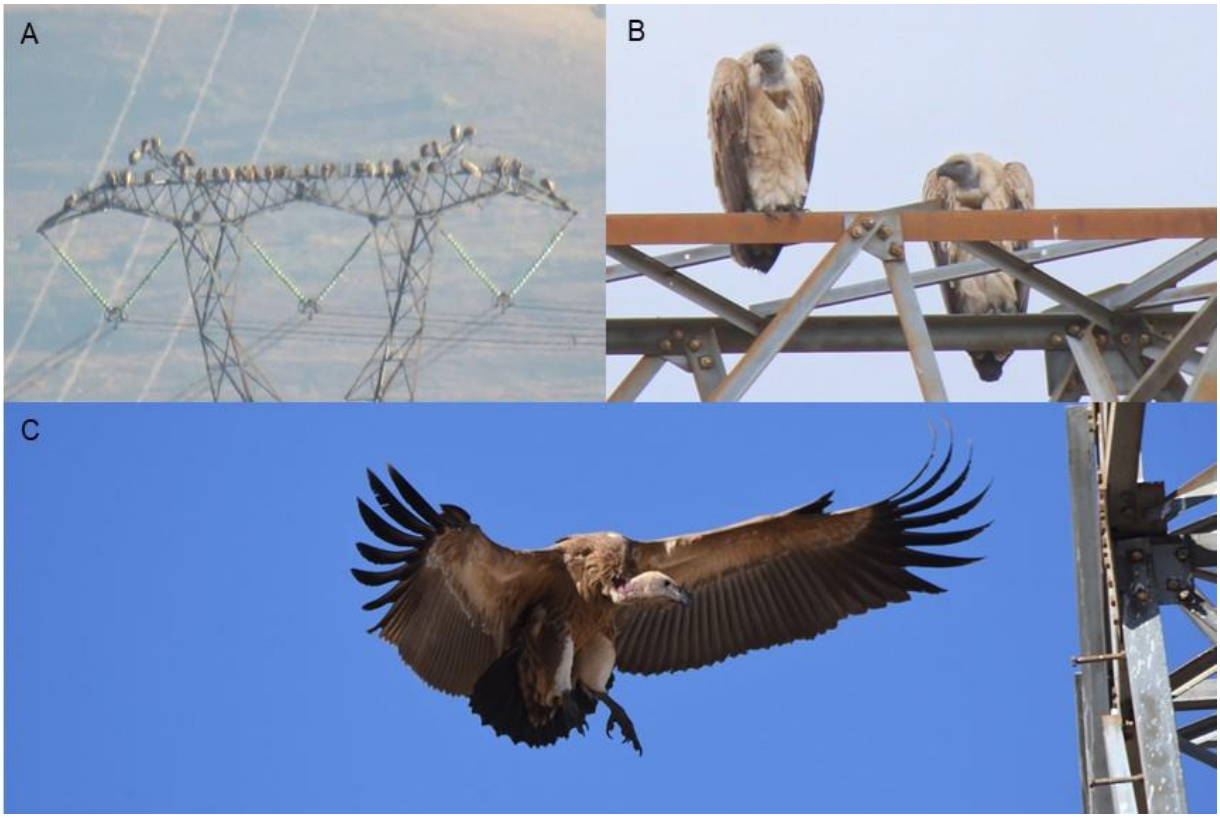

Figure 4-27 Anthropogenic vulture roosts on favoured pylons along the Ingula Majuba .14 transmission line

4.2.6.1.3 Vulture Restaurants

Two vulture restaurants feature on the Vulpro tracking data within the AOI. Both are north of the VWC, the closest being Boshoek Farm. Tracking data suggests that it may not be currently active (Vulpro, 2025). The National Environmental Screening tool features a vulture restaurant within 20 km of the western edge of the VWC in Chelmsford Nature Reserve, but this restaurant also does not appear to be currently active.

4.2.6.2 Bearded Vulture

Bearded Vulture breeding: A particularly significant finding was that Bearded Vulture (*Gypaetus barbatus*) breed at Nelson's Kop. The species is listed as Critically Endangered in South Africa. Nelson's Kop represents the most northerly breeding site for the species in the country and the only one away from the main Drakensberg escarpment. The nest has been monitored on an *ad hoc* basis by Rick Dillon (since 2006) with the last successful breeding attempt (Figure 4-28) documented in 2014 by R. Dillon and Sonja Krueger. BirdLife South Africa also monitors the nest annually on behalf of the Bearded Vulture Task Force. Following a period where no birds were present, they have returned in recent years (est. around 2021 or 2022) and have shown definite breeding behaviour (photographed mating) even though a specific nest could not be located (BirdlifeSA pers. comm. 2024). Another nest was, however, found on the western face which may represent a new nest site. A single adult was observed landing in close proximity to this nest.

Although the VWC falls beyond the 10 km suggested buffer radius for Bearded Vulture (Brink, 2020), their presence is a cause for concern given their wide-ranging nature. The sporadic occurrence of Bearded Vulture, particularly juveniles in the project area is supported by locality records as provided in Reid et al (2015).

Figure 4-28 ***Photographs of Bearded Vulture taken at Nelson's Kop. The first column represents observations of the currently presumed nest location (A and C) and the recently observed adult (E and G) while the second column represents observations of the known breeding location (B and D) and birds including the 2014 fledgling (F and H).***

4.2.6.3 Martial Eagle

Overall, five Martial Eagle occur within 40 km of the proposed WEF (Table 4-9). The nests are labelled "Martial Nests 1-5" in the project's Priority Species Nests shapefile. Of these, the most significant with regard to the VWC is Martial Eagle Nest 2**.** The presence of the nest was suspected to occur from flight activity patterns observed during Survey 6. Birdlife South Africa is aware of the nest location and the male is currently being tracked by via GPS transmitter by Dr Gareth Tate from the Endangered Wildlife Trust. The 6 km (Zone 1) nest buffer has implications for the Kromhof WEF (Figure 5-1) and tracking data shows that the Kromhof WEF falls within the unusually small territory of Brad (the male from Nest 2 who regularly visits the WEF. A very large female, presumably from this nest, was also regularly observed foraging in Kromhof WEF, on one occasion catching and flying away with a Denham's Bustard (Figure 4-2). A single juvenile fledged from the nest in October 2023.

Table 4-9 Martial Eagle nest details

Nest	Description	Status	Buffer implications for WEF
1	Nest ca 12 m high in poplar tree in a Eucalyptus bushclump on Clan Leslie Estates farm, private property. Approximately halfway between Verkykerskop and Warden.	Active, last documented activity, single juvenile flew from nest November 2022	No
2	Nest ca. 18 m high in tallest tree of Eucalyptus bushclump on land bordering Farm Bath.	Active, last documented activity, single juvenile flew from nest October 2023	No
3	Nest in *Eucalyptus* bushclump	Active, breeding success uncertain	No
4	Nest in escarpment forest in Ingula Nature Reserve.	Active, pair have successfully fledged juveniles	No
5	Nest in Eucalyptus tree at headwaters of wetland	Active	No

Figure 4-29 Photographs of Martial Eagle nests A) 2, B) 1, C) 4 and D) 3

4.2.6.4 Verreaux's Eagle

Four Verreaux's Eagle nests occur within the AOI, none of which are in the VWC. Of these, breeding has only been confirmed at Nest 3 on Verkykerskop, 25 km west of the Kromhof WEF. This nest is actively tended by a pair which successfully fledged a chick in 2024 (Figure 4-30). The occupancy and breeding status of the remaining three, remains uncertain due to the remoteness and inaccessibility of their locations. Verreaux's Eagle Nest 2 (Mont Pelaan) and 4 have the greatest potential significance for the project due to its proximity. It is important to note that the pothole nest on Mont Pelaan (Nest 2) has never been confirmed as a Verreaux's Eagle Nest (nor were any eagles seen landing on it during the survey) which leaves the possibility that it may once have been a Bearded Vulture nest which is more consistent with the nest shape (flattened as opposed to conical) and type (pothole as opposed to ledge). It is presumed that the juvenile observed from VP 9 likely came from Nest 4 located 2 km to the east of the WEF based on its and its parents flight activity.

Table 4-10 Verreaux's Eagle nest details and buffer implications

Name	Description	In WEF	Buffer Implications
Verreaux's Eagle Nest 1	Uncertain	No	No
Verreaux's Eagle Nest 2	Inactive	No	No
Verreaux's Eagle Nest 3	Active	No	No
Verreaux's Eagle Nest 4	Inactive	No	Yes

Figure 4-30 Photographs of Verreaux's Eagle Nests A) 4, B) 3, C) 1 and D) 2

4.2.6.5 Southern Bald Ibis

To date, 19 Southern Bald Ibis roosts have been found within the AOI (Table 4-11), of which 12 are confirmed breeding roosts. The most significant are roosts 8 and 9 on the Witkoppe inselberg, approximately 20 km northwest of the project area, which hosts the world's largest breeding colony of Southern Bald Ibis. Based on the high number of foraging individuals encountered within the project area it would appear that many individuals from this (and other roosts even further afield) make regular foraging excursions to the grasslands in the project area. Four of these (7, 8, 9 and 10) are actively monitored by Carina Pienaar (Ingula and Grassland Conservation Project Manager at BirdLife South Africa). Of the various roosts in the AOI, eight have buffers implications for the Kromhof WEF (Roosts 5, 6, 11, 14, 16, 17, 18, 19). Of these breeding has been confirmed at Roosts 5, 6, 11 and 19.

Southern Bald Ibis are grassland species largely endemic to the Great Escarpment of South Africa. The species has faced significant range contractions over the last century (Siegfried, 1971) with a steady recent population decline of 14.1% over the last two generations (Henderson, 2015) accompanied by colony extinctions. Threats are multifaceted with habitat transformation emerging as a primary driver. A recent study by Colyn et al. (2020b) suggests the species is likely to sustain ongoing population declines of approximately 34% over the next 3.5 generations in the face of climate and land use change.

Table 4-11 Southern Bald Ibis roost details and buffer implications

Roost	Description and Status	Significance	Buffer Implication	
			Zone 1	Zone 2
1	Uncertain. Likely breeding roost but unconfirmed. Situated in sheltered crag on Waterkop near Markgraaf's Rest WEF.	Medium	No	No
2	Breeding roost. Inactive. Evidence of nesting, but erratic. Approximately 8 birds.	High	No	No
3	Non-breeding roost. No breeding observed to date. Situated on crag on entrance road to farm Bath on Markgraaf's Rest WEF.	Low	No	No
4	Non-breeding roost behind residence.	Low	No	No
5	Breeding roost. Nesting observed 2022 but not 2023. On cliffs along river.	High	Yes	Yes
6	Breeding roost large. Active. Breeding confirmed. At least 17 individuals. Two nests observed. Pair of chicks on one and pair of eggs on other. In small gorge.	High	Yes	Yes
7	Breeding roost. Four birds observed sitting on nests. Roost monitored by Renette Steyn and Carina Nel Meissie.	High	No	No
8	Breeding roost. Active breeding colony. Witkoppe Inselberg. Part of largest in the world.	Very High	No	No
9	Breeding roost. Witkoppe Inselberg. Largest in world.	Very High	No	No
10	Breeding roost. Active. Breeding confirmed. Cliff over river near low level bridge on R722.	High	No	No
11	Breeding roost. Active. Breeding confirmed. One nest with two chicks. Centrally situated on portion land between Groethoek, Kromhom and Markgraaf's Rest WEFs	High	Yes	Yes
12	Breeding roost. Two nests with adults last observed.	High	No	No
13	Breeding roost. One adult on nest last observed.	High	No	No
14	Non-breeding roost. No breeding observed to date.	Low	Yes	Yes
15	Breeding roost. Significant Southern bald ibis roost and breeding spot - 22 birds counted	Very High	No	No
16	Non-breeding roost. No breeding observed to date.	Low	Yes	Yes
17	Uncertain breeding status. No breeding observed to date.	Low	Yes	Yes
18	Non-breeding roost. No breeding observed to date.	Low	Yes	Yes
19	Breeding Roost. Breeding erratic.	Medium	Yes	Yes

Figure 4-31 Evidence of Southern Bald Ibis breeding activity; A) adult tending nest, B) eggs on nest, C) downy chick, D) feathered chicks, E) adult incubating, F) courtship

4.2.6.6 Other priority species

A total of 31 nests of other priority species were found in the AOI (Table 4-12). Of these, eight have buffer implications for the WEF. These include Blue Crane Nests 1-3, Jackal Buzzard Nests 3-4, Lanner Falcon Nests 2-3 and Rock Kestrel Nest 1. Breeding was confirmed at all of these nests. The 2023 breeding attempt at Jackal Buzzard Nest 3 was unsuccessful due to the predation of a chick by a pair of Verreaux's Eagle. Examples of some of the cliff-nesting raptor nests are shown in Figure 4-32. All observed Blue Crane pairs that were observed nesting successfully reared their chicks. Nest sites were all selected in remote locations far from people and infrastructure. Nest site selection varied from open grassland to wetland habitats (Figure 4-33).

Table 4-12 Other priority species nest details

Name	Description	Buffer Implications
African Harrier-hawk Nest 1	Active	No
African Harrier-hawk Nest 2	Status Uncertain	No
Black Sparrowhawk Nest 1	Active	No
Black Sparrowhawk Nest 2	Status Uncertain	No
Black Sparrowhawk Nest 3	Uncertain	No
Black Sparrowhawk Nest 4	Uncertain	No
Black Sparrowhawk Nest 5	Uncertain	No
Black Sparrowhawk Nest 6	Status Uncertain	No
Black Sparrowhawk Nest 7	Status Uncertain	No
Black Sparrowhawk Nest 8	Status Uncertain	No
Blue Crane Nest 1	Two eggs November 2023. On ground in grassland no nest material.	Yes
Blue Crane Nest 2	Two eggs found November 2023. Nest significant mound in permanent zone of wetland	Yes
Blue Crane Nest 3	Chicks hatched and moved on. Nest on ground in grassland no nest material	Yes
Blue Crane Nest 4	Chicks hatched December 2023 and moved off. Nest on ground in grassland no nest material.	No
Grey Crowned Crane Nest 1	Adult on nest	No
Grey Crowned Crane Nest 2	Adult on nest	No
Ground Woodpecker Nest 1	Confirmed nest hole	No
Ground Woodpecker Nest 2	Confirmed nest hole	No
Half-collared Kingfisher Nest 1	Active nest hole in upper Klip River catchment tended by resident pair.	No
Jackal Buzzard Nest 1	Active	No
Jackal Buzzard Nest 2	Inactive	No
Jackal Buzzard Nest 3	Active	Yes
Jackal Buzzard Nest 4	Status Uncertain	Yes
Jackal Buzzard Nest 5	Inactive	No
Lanner Falcon Nest 1	Active	No
Lanner Falcon Nest 2	Active	Yes
Lanner Falcon Nest 3	Active. Pothole on cliff. Two chicks tended by both adults.	Yes
Lanner Falcon Nest 4	Active	No
Rock Kestrel Nest 1	Active	Yes
Secretarybird Nest 1	Active	No
White-necked Raven	Active. Adult on nest.	No

Figure 4-32 ***Nests of cliff-nesting raptors A) Jackal Buzzard Nest 3, B) Jackal Buzzard Nest 1 with eggs, C) Lanner Falcon Nest 1, D) Lanner Falcon Nest 3***

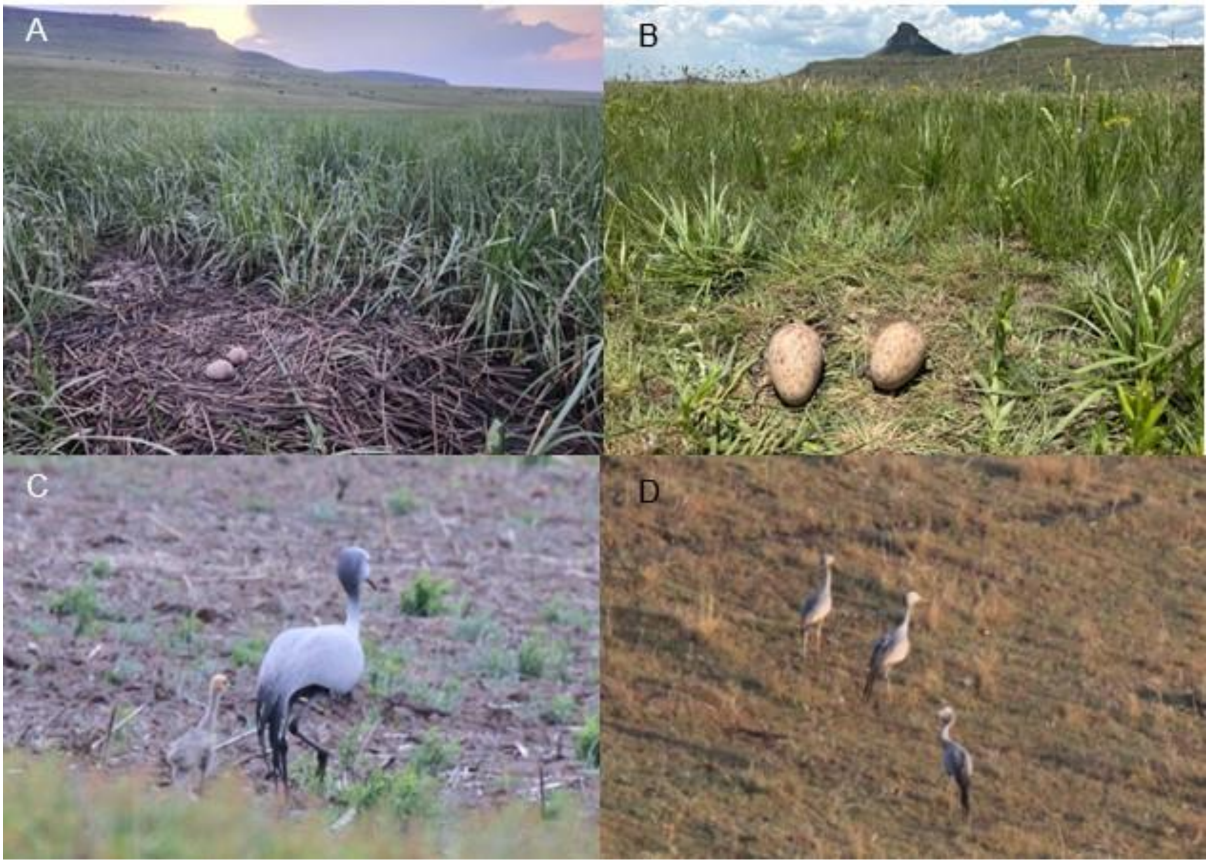

Figure 4-33 ***Evidence of Blue Crane breeding activity; A) eggs on Nest 2 in wetland, B) eggs on Nest 1 in grassland, C) downy chick, D) feathered chick***

5. Sensitivity Assessment

The integrated avifaunal sensitivity map presented in Figure 5-1 represents the culmination of data from the two-year pre-construction monitoring and is informed by several supplementary studies including nest and roost investigations, licenced aerial drone surveys, sophisticated habitat modelling and robust tracking data on key species. The map takes cognisance of the sensitive receptors as identified by the National Environmental Screening Tool but represents a more accurate, higher resolution, field-validated representation of the avifaunal sensitivity of the project area. Key receptors underpinning this map include flight corridors, key habitats and nest / roost buffers. Supplementary receptors include Key Biodiversity Areas (KBAs).

5.1 Regional Significance

The Eastern Free State is renowned for its high-altitude grassland birdlife. Several well-established birding routes traverse the AOI. The Memel birding route which traverses the AOI and portions of the proposed Kromhof WEF is highlighted as one of the best and most extensive habitats for high-altitude grassland endemics in South Africa (Chittenden et al. 2017). The global significance of this region for avifauna has recently been recognised through the designation of the Eastern Free State Escarpment KBA which overlaps 63% of the eastern region of the proposed WEF. In terms of conservation, the proposed WEF does not currently overlap any statutorily protected areas. The closest being Upper Wilge Protected Environment (4.6 km south-east). The proposed WEF area falls on land earmarked for potential future conservation by the National Protected Areas Expansion Strategy. In terms of provincial biodiversity planning, most of the central south and eastern regions of the WEF are classified as CBA1 (with a small central patch of CBA2) while the western and northern (along Muel River) boundaries are classified as ESAs. The region is considered to be of very high avifaunal importance and sensitivity.

5.2 Important Habitats

5.2.1 High Altitude Plateau Grasslands

Extensive areas of near pristine high-altitude plateau grassland occur in the proposed Kromhof WEF (mainly in the west-central, southern and eastern highlands) which represent highly suitable habitat for threatened grassland endemics. Most notable in this regard being Botha's Lark (Critically Endangered), Rudd's Lark (Endangered) and Yellow-breasted Pipit (Vulnerable). Core habitat for threatened high altitude grassland species was delineated based on a five-year modelling study by Dr R. Colyn (AfriAvian). The resultant final habitat delineations consist of (i) very high-risk core areas and (ii) surrounding high risk connective areas. It is important to note these areas do not represent all potential habitat for these species, only the higher risk areas. These higher risk areas occupy a large proportion of the VWC due to it being; "…*in the core area of occupancy and global hotspot for all three of these endemic, threatened and habitat specialist species. This area hosts some of the highest densities and most intact habitats for these species globally"* (Dr. R. Colyn pers. comm, 2025). These areas are also associated with a considerably higher abundance of other priority species (as evidenced through kernel density estimation and flight paths), particularly grassland species such as Denham's Bustard, White-bellied Bustard, Blue Korhaan, Southern Bald Ibis African Rock Pipit, Ground Woodpecker and Sentinel Rock Thrush. Even relatively small habitat losses or alterations in these areas could have a significant impact on these highly range-restricted and rare habitat specialists. As such, both core (very high sensitivity) and connective habitat (high sensitivity) as identified for Threatened high altitude passerines are considered to be all infrastructure exclusion areas (Zone 1 sensitivity) and collectively occupy a large proportion (47%, 3416 ha) of the proposed Kromhof WEF area.

5.2.2 Wetlands

Wetland receptors which contributed towards the final avifaunal sensitivity map included (i) general wetlands and three further subdivisions of wetland habitat identified as being important for Species 23 namely (ii) core, (iii) transient and (iv) connective.

General wetlands are based on spatial data provided by WSP (2025) produced as part of their wetland delineation and impact assessment for the proposed Verkykerskop WEF cluster. These wetlands are considered important for the persistence and movement of all potentially occurring wetland associated priority species which includes several Threatened species. General wetland habitat was rated as having a high avifauna sensitivity and represents a Zone 1 area (all infrastructure exclusion).

With regards to Species 23 (Endangered), a robust habitat modelling study conducted by AfriAvian (2025) revealed a large contiguous network of high to very high suitability wetland patches for the species within the AOI. Habitat suitability was found to be highest in the central to north-eastern portions of the AOI decreasing in suitability towards the south-west. Overall, the study highlights the importance of the strategical positioning of the VWC between two confirmed localities of ongoing occupancy for the species namely Seekoeivlei Nature Reserve to the north and Ingula Nature Reserve to the south (both within 30 km of the VWC). The AfriAvian (2025) report highlights that: "*This central location suggests that the Verkykerskop landscape may function as a critical stepping-stone or movement corridor within the species' fragmented range, further emphasizing the need for precautionary land-use planning and the protection of identified connectivity zones*". Although much of this habitat occurs outside of the VWC (towards Memel and around Ingula), several core habitat suitability areas were identified within the VWC itself.

Of the various core wetland habitat areas delineated for Species 23 within the AOI, 11 distinct patches of core habitat occur within the proposed Kromhof WEF area. One of which represents a wetland system prioritised for detailed sampling and assessment namely VKK 5. The wetland is recognised as being of high habitat suitability. Core habitat suitability areas are assigned a very high sensitivity. The 250 m transient buffer assigned to these core areas to account for potential edge disturbance and indirect development impacts is afforded a high sensitivity. Both core and transient habitat for Species 23 is classified as a Zone 1 all infrastructure exclusion area. Roads, laydown areas and other infrastructure could have significant implications for habitat degradation as a result of disturbance of vegetation, sedimentation, introduction of further herbaceous weeds. Furthermore, OHLs should also be excluded in these habitats as there is evidence of powerline fatality records for the species (R. Colyn pers. comm. 2025). Lastly, connective areas (delineated around the core areas using resistance surface modelling) are considered to be of medium sensitivity. These areas are important for maintaining habitat connectivity, facilitating dispersal and promoting persistence of the species in the broader landscape and are classified as Zone 2 Collision-risk infrastructure exclusion (e.g. turbines, powerlines and fences) based on recommendation form the AfriAvian (2025) study. Together these modelled habitats form a critical cluster of functionally connected suitable wetland habitat effectively connecting the two known populations within 30 km (Memel to the north and Ingula to the south).

5.2.3 Cliffs and Ridges

Important cliffs and ridgelines were modelled using slope analysis of a 30 m resolution Jaxa Digital Elevation Model to encompass all areas with a slope greater than 20%. These areas were afforded a 100 m connectivity buffer. Cliffs and ridges provide important nesting and / or soaring habitat for several priority species. The Mont Pelaan ridge in the south is the highest lying and most prominent ridgeline in the VWC. This ridgeline (identified as Flight Corridor 5) is a prominent regional land mark and skyline feature whose orographic winds are frequently utilised by numerous large-bodied soaring birds, (especially Cape Vulture and Jackal Buzzard) to gain lift. Additionally, a prominent cliff line occurs along the northern edge of the Kromhof plateau. This extensive series of cliffs hosts four Southern Bald Ibis Roosts (14, 16, 17 and 18), one Rock Kestrel Nest (1), one Jackal Buzzard Nest (3) and one Verreaux's

Eagle Nest (4). All significant cliffs and ridgelines (and their associated buffers) are identified as being of very high ecological importance and sensitivity and represent exclusion zones for all infrastructure that poses a collision risk (e.g. turbines, power lines and fences)

5.3 Important Flight Activity Areas

Hotspots of heightened flight activity, referred to as flight corridors are mapped in Figure 4-14. These flight corridors were delineated so as to best intersect with the available data in a way that is both intuitive and biologically meaningful. Input data included the flight path density intersection model (kernel density estimation based on visual observations from the two-year monitoring program), species occurrence density model (kernel density estimation), vulture tracking point clouds (Vulpro, 2025) and Martial Eagle core use areas based on kernel density estimation (EWT, 2025).

Of the 10 identified flight corridors, five interconnecting routes occur in the proposed Kromhof WEF namely Flight Corridors 3, 4, 5, 7, 9. Flight Corridor 3 is a large kloof area with frequent flight passages due to proximity to a Southern Bald Ibis Roost and Kestrel nests along the cliff line. Flight Corridor 4 connects the Ingula-Majuba 14 transmission lines with the Dwaalspruit valley to the west which is frequently used by Blue Crane and Cape Vulture. Flight Corridor 5 occurs along the prominent ridgeline associated with Mont Pelaan, is frequently used by Cape Vulture and other large soaring birds to gain lift, undoubtedly the most important flight corridor in the VWC which also connects several priority species nests. Flight Corridor 7 is along the Muel River valley, a large dammed floodplain lined by low cliffs. The steeper north-eastern bank of this valley is frequented used by numerous priority species and waterfowl for commuting. During summer this prominent break in topography funnels large flocks of migratory amur falcon over the escarpment into KwaZulu-Natal. Flight Corridor 9 is utilised primarily by a flock of Southern Bald Ibis to access their breeding colony (Roost6). It also connects to major flight corridors to north and south. Flight corridors are considered to be of very high sensitivity and represent exclusion zones for all infrastructure that poses a collision risk (e.g. turbines, power lines and fences). Additionally, it would be prudent to avoid placing collision risk infrastructure in all areas of high utilisation for the tracked Martial Eagle “Brad” that fall beyond the delineated flight corridors.

5.4 Important Breeding and Roosting Areas

The proposed Kromhof WEF occurs within 50 km of seven Cape Vulture roosts (closest being Scheurklip 14.8 km south and the closest breeding colony being Nelsonskop at 23.5 km south-west.

It also intersects 15 nest / roost buffers of other priority species of which Southern Bald Ibis Roosts 5, 11, 14, 16, 17, 18 and 19, Blue Crane Nests 1-3, Jackal Buzzard Nest 3, Lanner Falcon Nests 2 and 3, Rock Kestrel Nest 1, and Verreaux’s Eagle Nests 2 and 3 have buffer implications for the proposed Kromhof WEF.The various nests and roosts recorded within the AOI together with their prescribed buffers, justifications and Implications for the proposed WEF are shown in Table 5-1. These areas of avifaunal sensitivity within the project area spatially depicted in Figure 5-1. A very high sensitivity core buffer of 18 km is applied to known breeding colony on Nelsonskop as per Pfeiffer and Ralston-Paton (2018). This area represents an exclusion zone for all collision-risk infrastructure (e.g. turbines, powerlines and fences). The 50 km roost buffers applied to the various Cape Vulture roosts (which cover 100% of the WEF) represents a high sensitivity intensive mitigation zone. All core buffers on other priority species nests and roosts are afforded a very high sensitivity and represent all infrastructure exclusion zones while the transient buffers surrounding the core areas are afforded a high sensitivity and represent infrastructure minimisation and intensive mitigation zones.

Table 5-1 ***List of nests and roosts within the AOI, their buffer sizes, justifications and implications for the proposed Kromhof WEF***

Name	Breeding Activity	Buffer1[2] (m)	Buffer2[3] (m)	Buffer3[4] (m)	Justification	Buffer Implications for WEF
African Harrier-hawk Nest 1	Confirmed	750	0	0	Specialist recommendation. Some flexibility typically allowed.	No
African Harrier-hawk Nest 2	Unconfirmed	750	0	0	Specialist recommendation. Some flexibility typically allowed.	No
Bearded Vulture Nest 1	Confirmed	5500	10000	0	Krueger, S & Amar, A. (2021). The Ecology and Management of a Critically Endangered Population of Bearded Vultures. Imperilled: The Encyclopaedia of Conservation 10.1016/B978-0-12-821139-7.00168-9.	No
Black Sparrowhawk Nest 1	Confirmed	750	0	0	Specialist recommendation. Some flexibility typically allowed	No
Black Sparrowhawk Nest 2	Unconfirmed	750	0	0	Specialist recommendation. Some flexibility typically allowed	No
Black Sparrowhawk Nest 3	Unconfirmed	750	0	0	Specialist recommendation. Some flexibility typically allowed	No
Black Sparrowhawk Nest 4	Unconfirmed	750	0	0	Specialist recommendation. Some flexibility typically allowed	No
Black Sparrowhawk Nest 5	Unconfirmed	750	0	0	Specialist recommendation. Some flexibility typically allowed	No
Black Sparrowhawk Nest 6	Unconfirmed	750	0	0	Specialist recommendation. Some flexibility typically allowed	No
Black Sparrowhawk Nest 7	Unconfirmed	750	0	0	Specialist recommendation. Some flexibility typically allowed	No
Black Sparrowhawk Nest 8	Unconfirmed	750	0	0	Specialist recommendation. Some flexibility typically allowed	No
Blue Crane Nest 1	Confirmed	150	300	0	DFFE stipulation.	Yes
Blue Crane Nest 2	Confirmed	150	300	0	DFFE stipulation.	Yes
Blue Crane Nest 3	Confirmed	150	300	0	DFFE stipulation.	Yes
Blue Crane Nest 4	Confirmed	150	300	0	DFFE stipulation.	No
Cape Vulture Roost 1	Unconfirmed	0	0	50000	Cape Vulture species-specific guidelines (BLSA, 2018) for all colonies and roosts. Field Verified.	Yes
Cape Vulture Roost 2	Unconfirmed	0	0	50000	Cape Vulture species-specific guidelines (BLSA, 2018) for all colonies and roosts. Field Verified.	Yes
Cape Vulture Roost 3	Confirmed	18000	0	50000	Cape Vulture species-specific guidelines (BLSA, 2018) for all colonies and roosts. Field Verified.	Yes
Cape Vulture Roost 4	Unconfirmed	0	0	50000	Cape Vulture species-specific guidelines (BLSA, 2018) for all colonies and roosts. Field Verified.	Yes
Cape Vulture Roost 5	Unconfirmed	0	0	50000	Cape Vulture species-specific guidelines (BLSA, 2018) for all colonies and roosts. Field Verified.	Yes
Cape Vulture Roost 6	Unconfirmed	0	0	50000	Cape Vulture species-specific guidelines (BLSA, 2018) for all colonies and roosts. Field Verified.	Yes
Cape Vulture Roost 7	Unconfirmed	0	0	50000	Cape Vulture species-specific guidelines (BLSA, 2018) for all colonies and roosts. Field Verified.	Yes
Grey Crowned Crane Nest 1	Confirmed	1000	0	0	Specialist recommendation. Endangered species.	No
Grey Crowned Crane Nest 2	Confirmed	1000	0	0	Specialist recommendation. Endangered species.	No

[2] Buffer 1: Very High sensitivity, Zone 1 all infrastructure exclusion area.
[3] Buffer 2: High sensitivity, Zone 3 infrastructure minimisation and intensive mitigation area.
[4] Buffer 3: High sensitivity, Zone 4 intensive mitigation area (within 50 km of CV roost).

Name	Breeding Activity	Buffer1[2] (m)	Buffer2[3] (m)	Buffer3[4] (m)	Justification	Buffer Implications for WEF
Ground Woodpecker Nest 1	Confirmed	150	300	0	Specialist recommendation. Endangered species.	No
Ground Woodpecker Nest 2	Confirmed	150	300	0	Specialist recommendation. Endangered species.	No
Half-collared Kingfisher Nest 1	Confirmed	1000	0	0	Pairs typically defend a 1-3 km reach of river (Chittenden et al. 2016). Threatened Species.	No
Jackal Buzzard Nest 1	Confirmed	750	0	0	Specialist recommendation. Some flexibility typically allowed	No
Jackal Buzzard Nest 2	Unconfirmed	750	0	0	Specialist recommendation. Some flexibility typically allowed	No
Jackal Buzzard Nest 3	Confirmed	750	0	0	Specialist recommendation. Some flexibility typically allowed	Yes
Jackal Buzzard Nest 4	Unconfirmed	750	0	0	Specialist recommendation. Some flexibility typically allowed	Yes
Lanner Falcon Nest 1	Confirmed	1000	3000	0	Core turbine exclusion of 1000 m based on specialist recommendation and industry best practice. High sensitivity 3000 m buffer based on DFFE avian theme sensitivity.	No
Lanner Falcon Nest 2	Confirmed	1000	3000	0	Core turbine exclusion of 1000 m based on specialist recommendation and industry best practice. High sensitivity 3000 m buffer based on DFFE avian theme sensitivity.	Yes
Lanner Falcon Nest 3	Confirmed	1000	3000	0	Core turbine exclusion of 1000 m based on specialist recommendation and industry best practice. High sensitivity 3000 m buffer based on DFFE avian theme sensitivity.	Yes
Lanner Falcon Nest 4	Confirmed	1000	3000	0	Core turbine exclusion of 1000 m based on specialist recommendation and industry best practice. High sensitivity 3000 m buffer based on DFFE avian theme sensitivity.	No
Martial Eagle Nest 1	Confirmed	5000	0	0	DFFE stipulation and Brink, R. (2020).	No
Martial Eagle Nest 2	Confirmed	5000	0	0	DFFE stipulation and Brink, R. (2020).	Yes
Martial Eagle Nest 3	Unconfirmed	5000	0	0	DFFE stipulation and Brink, R. (2020).	No
Martial Eagle Nest 4	Confirmed	5000	0	0	DFFE stipulation and Brink, R. (2020).	No
Martial Eagle Nest 5	Confirmed	5000	0	0	DFFE stipulation and Brink, R. (2020).	No
Rock Kestrel Nest 1	Confirmed	750	0	0	Specialist recommendation. Some flexibility typically allowed	No
Secretarybird Nest 1	Unconfirmed	500	1000	0	Specialist recommendation. Some flexibility typically allowed	No
Southern Bald Ibis Roost 1	Unconfirmed	1000	2500	0	Specialist recommendation.	No
Southern Bald Ibis Roost 2	Confirmed	1000	2500	0	Specialist recommendation.	No
Southern Bald Ibis Roost 3	Unconfirmed	1000	2500	0	Specialist recommendation.	No
Southern Bald Ibis Roost 4	Unconfirmed	1000	2500	0	Specialist recommendation.	No
Southern Bald Ibis Roost 5	Confirmed	1000	2500	0	Specialist recommendation.	Yes
Southern Bald Ibis Roost 6	Confirmed	1000	2500	0	Specialist recommendation.	Yes
Southern Bald Ibis Roost 7	Confirmed	1000	2500	0	Specialist recommendation.	No
Southern Bald Ibis Roost 8	Confirmed	1000	5000	0	Specialist recommendation.	No
Southern Bald Ibis Roost 9	Confirmed	1000	5000	0	Specialist recommendation.	No

Name	Breeding Activity	Buffer1[2] (m)	Buffer2[3] (m)	Buffer3[4] (m)	Justification	Buffer Implications for WEF
Southern Bald Ibis Roost 10	Confirmed	1000	2500	0	Specialist recommendation.	No
Southern Bald Ibis Roost 11	Confirmed	1000	2500	0	Specialist recommendation.	Yes
Southern Bald Ibis Roost 12	Confirmed	1000	2500	0	Specialist recommendation.	No
Southern Bald Ibis Roost 13	Confirmed	1000	2500	0	Specialist recommendation.	No
Southern Bald Ibis Roost 14	Unconfirmed	1000	2500	0	Specialist recommendation.	Yes
Southern Bald Ibis Roost 15	Confirmed	1000	2500	0	Specialist recommendation.	No
Southern Bald Ibis Roost 16	Unconfirmed	1000	2500	0	Specialist recommendation.	Yes
Southern Bald Ibis Roost 17	Unconfirmed	1000	2500	0	Specialist recommendation.	Yes
Southern Bald Ibis Roost 18	Unconfirmed	1000	2500	0	Specialist recommendation.	Yes
Southern Bald Ibis Roost 19	Confirmed	1000	2500	0	Specialist recommendation.	Yes
Verreaux's Eagle Nest 1	Unconfirmed	3700	5200	0	Verreauxs' Eagle species-specific guidelines (BLSA, 2017) for all nests (including alternate nests).	No
Verreaux's Eagle Nest 2	Unconfirmed	3700	5200	0	Verreauxs' Eagle species-specific guidelines (BLSA, 2017) for all nests (including alternate nests).	Yes
Verreaux's Eagle Nest 3	Confirmed	3700	5200	0	Verreauxs' Eagle species-specific guidelines (BLSA, 2017) for all nests (including alternate nests).	No
Verreaux's Eagle Nest 4	Unconfirmed	3700	5200	0	Verreauxs' Eagle species-specific guidelines (BLSA, 2017) for all nests (including alternate nests).	Yes
White-necked Raven Nest 1	Confirmed	750	0	0	Specialist recommendation.	No

5.5 Combined Avifauna Sensitivity Mapping

Overall sensitivity rating per receptor is taken as a function of its Biodiversity Importance and Receptor Resilience as per the Species Environmental Assessment Guidelines (2022). To assist in the practical application of these sensitivity ratings these sensitivity ratings are further categorised into sensitivity zones based on their implications for wind energy-related infrastructure development in the proposed WEF. The various sensitivity zones as applicable to avifauna are defined in Table 5-3 which also provides a summary on their extent within the proposed WEF and the number of proposed Wind Turbine Generators (WTGs) they overlap (based on the current layout).

Table 5-2 Summary of the extent of the four sensitivity zones within the proposed WEF area (7269 ha)

Sensitivity Zone	Description	Area (ha)	Proportion of WEF (%)
Zone 1	All infrastructure exclusion	6025	83
Zone 2	Collision-risk infrastructure exclusion (e.g. turbines, powerlines and fences)	5207	72
Zone 3	Infrastructure minimisation and intensive mitigation	6967	96
Zone 4	Intensive mitigation	7269	100
Total: Combined WTG Exclusion Area		6794	93

The various receptors underpinning the combined avifaunal sensitivity map are summarised in Table 6-1. These areas are mapped in Figure 5-1.

Table 5-3 Receptors underpinning the avifaunal sensitivity mapping and their implications for Kromhof WEF (BI, Biodiversity Importance; RR, Receptor Resilience; SEI, Site Ecological Importance and Sensitivity)

Receptor	Description	Avifauna Sensitivity			Mapped Sensitivity Zones	
		BI	RR	SEI	Implications	Zone
Regional Significance						
Key Biodiversity Areas (KBAs)	Eastern Free State Escarpment. Overlaps 63% of the eastern region of the proposed Kromhof WEF.	H	M	H	Infrastructure minimisation and intensive mitigation	3
Habitats						
Key Plateau Grasslands: Core	**Areas of plateau grassland identified as core habitat for threatened high altitude grassland species based on a five-year modelling study by Dr R. Colyn (AfriAvian). Refined and validated using on-site locality records from monitoring. Falls within global hotspot for Rudd's Lark, Botha's Lark and Yellow-breasted Pipit occurrence.**	**VH**	**VL**	**VH**	**All Infrastructure exclusion**	**1**
Key Plateau Grasslands: Connective	**Areas of plateau grassland identified using the same modelling exercise as being important for buffering and maintaining connectivity between core habitats for threatened high-altitude passerines.**	**H**	**M**	**H**	**All Infrastructure exclusion**	**1**
General Wetlands	All wetlands as delineated during the wetland assessment for the VWC. Considered highly important for a wide diversity of wetland dependant priority species of which several are Threatened. Both Grey-crowned and Blue Crane breed in wetlands in the VWC.	H	M	H	All Infrastructure exclusion	1
Key Wetlands (Core)	**Areas of suitable habitat for Species 23 based on a robust, site-specific and field validated multi-tiered modelling exercise.**	**VH**	**VL**	**VH**	**All Infrastructure exclusion**	**1**

Receptor	Description	Avifauna Sensitivity			Mapped Sensitivity Zones	
		BI	RR	SEI	Implications	Zone
Key Wetlands (Transient)	**A 250 m transient buffer assigned to core areas account for potential edge disturbance and indirect development impacts.**	**H**	**M**	**H**	**All Infrastructure exclusion**	**1**
Wetlands (Connective)	**Medium risk areas identified using resistance modelling considered important for maintaining habitat connectivity and facilitate movement of the species through the broader landscape (e.g. between known populations from Memel to the north and Ingula to the south). Forms a contiguous network effectively connecting these two known populations.**	**M**	**M**	**M**	**Collision-risk infrastructure exclusion (e.g. turbines, powerlines and fences)**	**2**
Cliffs and Ridges Core	Slopes >20% modelled using analysis of 30 m resolution Jaxa Digital Elevation Model	VH	VL	VH	Collision-risk infrastructure exclusion (e.g. turbines, powerlines and fences)	2
Cliffs and Ridges Transient	100 m buffer on core cliffs and ridges habitat. Important for buffering against collision events.	H	M	H	Infrastructure minimisation and intensive mitigation	3
Other Natural Habitat	All other areas of remaining natural habitat.	M	M	M	NA: Covered by Zone 4 - Intensive Mitigation (within 50 km of CV roost)	4
Active Croplands	Areas of active crop cultivation. Frequently utilised by flocks of Blue and Grey Crowned Crane for foraging while fallow.	M	H	L	NA: Covered by Zone 4 - Intensive Mitigation (within 50 km of CV roost)	4
Transformed Areas	All areas which have been completely transformed by infrastructure such as farm buildings and gravel roads.	VL	VH	VL	NA: Covered by Zone 4 - Intensive Mitigation (within 50 km of CV roost)	4
Flight Areas						
Flight Corridors	Areas of heightened flight activity identified through a combination of flight path intersection density modelling and tracking data on Cape and White-backed Vultures (Vulpro, 2025) as well as Martial Eagle (EWT, 2025).	VH	L	VH	Collision-risk infrastructure exclusion (e.g. turbines, powerlines and fences)	2
Tracked ME Utilisation Areas (beyond corridors)	Based on modelled high utilisation areas of one tracked Martial Eagle named Brad (EWT, 2025)	H	M	H	Infrastructure minimisation and intensive mitigation	3
Breeding and Roosting Areas						
Cape Vulture Roosts: Breeding (18 km)	Core buffer of 18 km applied to known breeding colony on Nelsonskop as per Pfeiffer and Ralston-Paton (2018).	VH	VL	VH	Collision-risk infrastructure exclusion (e.g. turbines, powerlines and fences)	2
Cape Vulture Roosts: Non-breeding (50 km)	The proposed Kromhof WEF falls within the 50 km buffer zone (as per Pfeiffer and Ralston-Paton, 2018) of seven Cape Vulture roosts. Buffer coverage of WEF 100%.	H	M	H	Intensive mitigation (within 50 km of CV roost)	4
Nests and Roost Buffers: Core (Buffer 1)	Core buffers on priority species nests and roosts. See Table 5-1 for details on those with buffer implications for the WEF and justifications for buffer size.	VH	L	VH	All Infrastructure exclusion	1
Nest and Roosts Buffers: Transient (Buffer 2)	Transient buffers on priority species nests and roosts. See Table5-1 for details.	H	M	H	Infrastructure minimisation and intensive mitigation	3

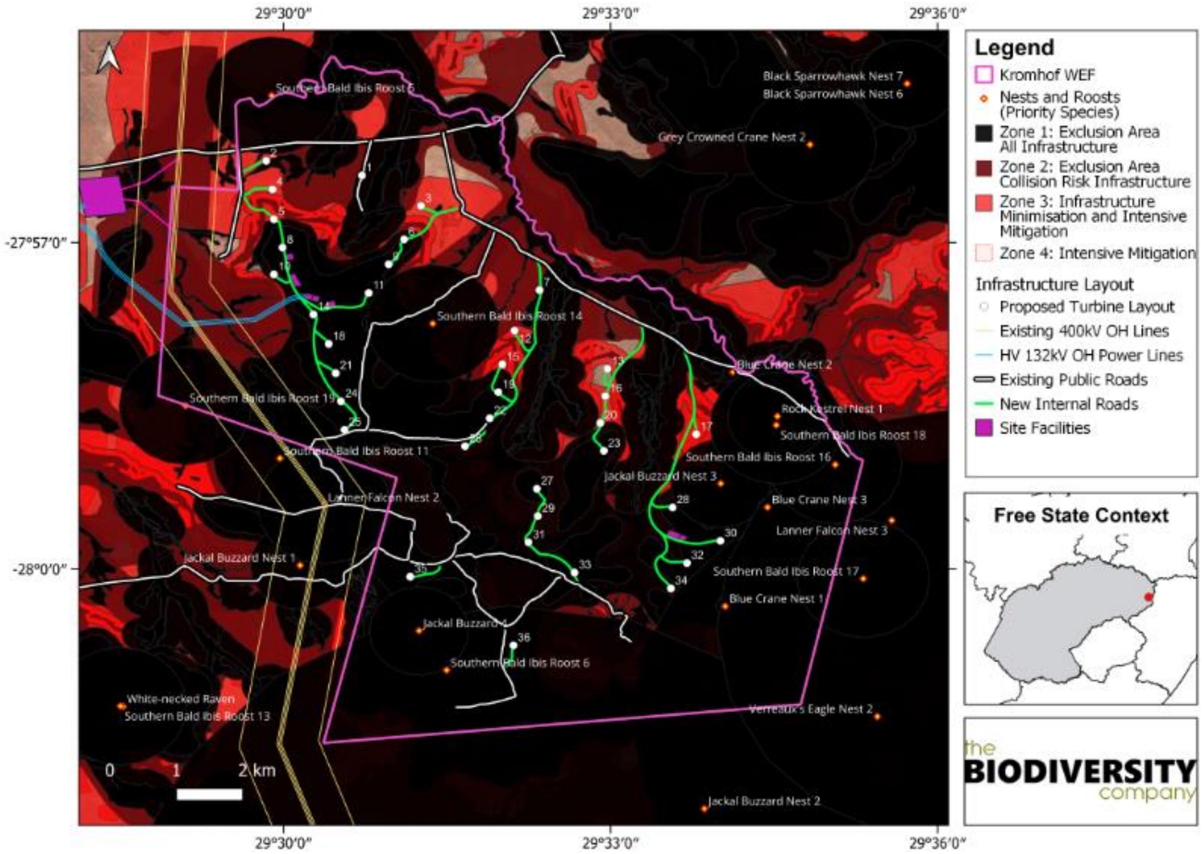

Figure 5-1 Avifaunal sensitivity map for Kromhof WEF

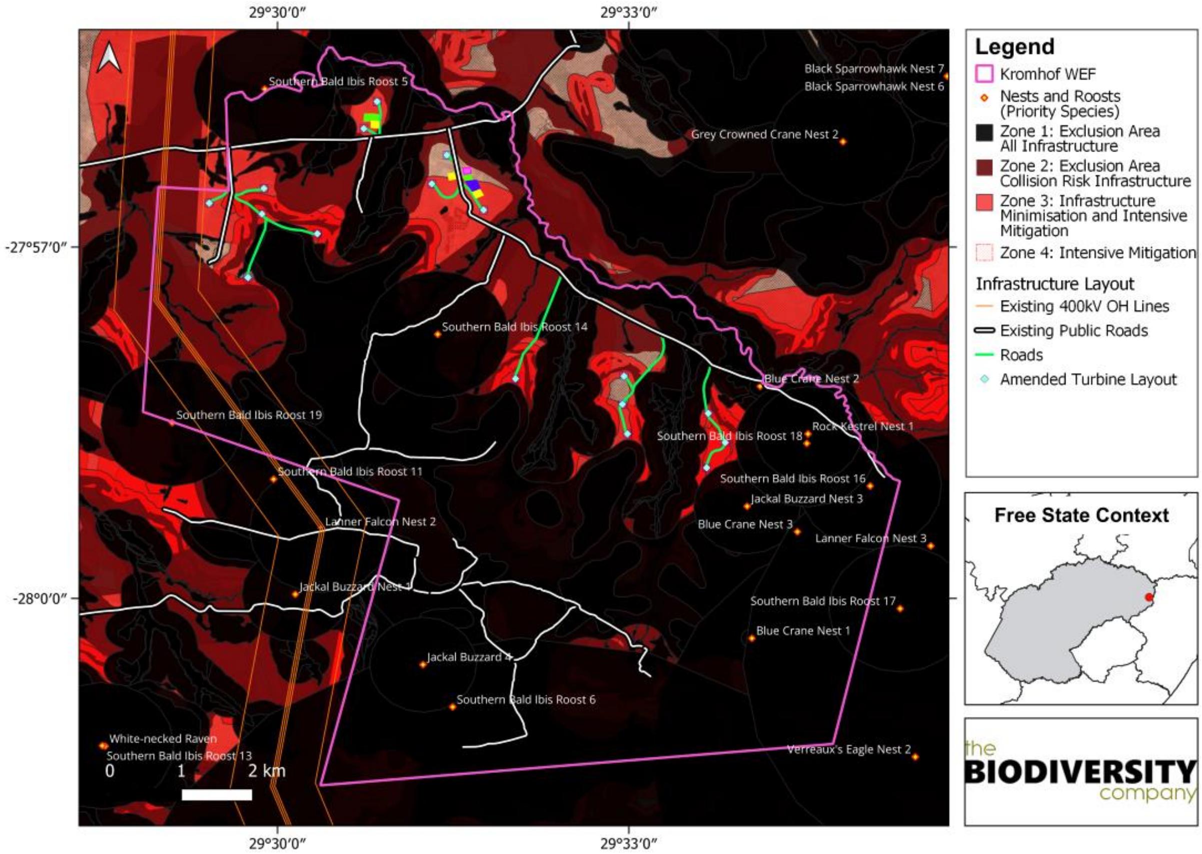

Figure 5-2 Avifaunal sensitivity map for Kromhof WEF (Amended layout)

6. Impact Assessment

6.1 Existing Impacts

The following existing impacts were observed:

- Livestock Grazing. The predominant livestock is beef cattle but sheep and horses also occur. The grazing intensity is moderate with most grasslands being kept shortly cropped. Some overgrazing in valley areas is evident and this accompanied by trampling of wetland vegetation in some wetland areas;
- Crop Cultivation. Large areas have been set aside in most of the flatter plateau areas for cattle fodder production. Most fields are under a specific maize cultivar tailored for silage production. Other crops include oats and radish. These croplands displace natural grassland habitat;
- Alien and invasive plants. Minor establishment of woody alien species is noted around homesteads and along some perennial watercourses.
- Perennial Pastures. In addition to commercial crop cultivation, large grassland areas have been converted to perennial pastures. These pastures are fenced off from the cattle and are cut and bailed regularly for hay production. Pastures also displace natural grassland habitat;
- Fences. The project area is criss-crossed by many well-maintained cattle fences (many of which are 8-stranded). These pose a risk of collision and entrapment for many bird species, particularly large-terrestrial species, such as the Secretarybird;
- Powerlines. Many powerlines occur throughout the WEF. The most significant is a large transmission line that runs along the western boundary of Kromhof WEF, traversing several wetlands and mountain slopes. No bird flappers have been installed on the earth cables along this line;
- Erosion. Most of the larger valley-bottom wetlands and many of the hillslope seeps are deeply eroded. Longstanding head cut erosion (from overgrazing) has led to the formation of very large galleys. Insufficiently designed dams in some wetlands have exacerbated the erosion, especially when they fail following high rainfall events;
- Roads. There are many sand roads in the WEF. The main roads service Normandien and Collin's Passes but also run towards Verkykerskop and Memel. These are large busy sand roads which pose a direct collision risk to many birds, especially small seed-eating passerines; and
- Dust. Large amounts of dust are generated from the strong winds moving over fallow croplands and from vehicles moving along the sand roads.

Figure 6-1 ***Existing impacts; A) Dust, B) annual burning, C) collision risks (fences and powerlines), D) earth line without flappers, E) cattle farming; F) roads***

6.2 Anticipated Impacts

6.2.1 Construction

6.2.1.1 Loss or Alteration of Habitat

6.2.1.1.1 Impact Description

Habitat loss from wind farm developments is mainly associated with the construction of access roads, the turbine footprint itself, the electrical transmission infrastructure and the Battery Energy Storage Facility. However, the turbine field is relatively large with difficult access in steep, largely pristine terrain. Without mitigation and avoidance access alone has the potential to result in a significant impact for range-restricted or threatened grassland species. Most susceptible in this regard are the Threatened high-altitude grassland passerines such as Botha's Lark (Critically Endangered), Rudd's Lark (Endangered) and Yellow-breasted Pipit (Vulnerable). All three species, particularly the latter two show a high degree of habitat specialisation tending to be restricted to small patches of more intact, high rainfall, plateau grassland with a low slope.

Given the importance of grasslands in this area, preliminarily delineations of core habitat were made by the specialist for planning purposes which were later refined based on rigorous five-year modelling exercise conducted by Dr Robin Colyn, an authority on these species (AfriAvian, 2025). The models were verified with locality records obtained during monitoring and dedicated site visits for model validation. The resultant final habitat delineations consist of very high-risk core areas and surrounding high risk areas. It is important to note these areas do represent all potential habitat for these species, only the higher risk areas. A large proportion of plateau grassland in the proposed Kromhof WEF represents suitable habitat for threatened high altitude passerines. As much as 72% (5282 ha) of the proposed area is covered by the modelled habitat exclusion zones for these species (Figure 5-1). These areas occupy a large proportion of the VWC due to it being; "…*in the core area of occupancy and global hotspot for all three of these endemic, threatened and habitat specialist species. This area hosts some of the highest densities and most intact habitats for these species globally"* (Dr. R. Colyn pers. comm, 2025). Even relatively small habitat losses or alterations in these areas could have a significant impact on these highly range-restricted and rare habitat specialists. As such, these areas are considered to be all infrastructure exclusion zones. These areas are also associated with a considerably higher abundance of other priority species (as evidenced through kernel density estimation and flight paths), particularly red-listed grassland species such as Denham's Bustard, White-bellied Bustard, Blue Korhaan, Southern Bald Ibis African Rock Pipit, Ground Woodpecker and Sentinel Rock Thrush.

Another potential impact is the possible degradation of wetland integrity for threatened wetland species through road and turbine construction. Of particular significance in this regard are Species 23. A robust habitat modelling study conducted by AfriAvian (2025) revealed a large contiguous network of high to very high suitability wetland patches for the species within the AOI. The AfriAvian (2025) report highlights that: "*This central location suggests that the Verkykerskop landscape may function as a critical stepping-stone or movement corridor within the species' fragmented range, further emphasizing the need for precautionary land-use planning and the protection of identified connectivity zones*". Of the various core wetland habitat areas delineated for Species 23 within the AOI, 11 distinct patches of core habitat occur within the proposed Kromhof WEF area. Core habitat suitability areas are assigned a very high sensitivity and together with their 250 m transient buffer represent Zone 1 all infrastructure exclusion areas. Roads, laydown areas and other infrastructure could have significant implications for habitat degradation as a result of disturbance of vegetation, sedimentation, introduction of further herbaceous weeds (R. Colyn pers. comm. 2025). Overall, in light of the global significance of the identified key habitats for threatened high-altitude grassland species and Species 23 the pre-mitigation impact for habitat loss is anticipated to be of very high significance. Through careful micro-sighting of the turbines and auxiliary infrastructure to completely avoid these habitat exclusion areas the potential residual significance of habitat loss can be reduced from High to Moderate. This design change achieved by the developer with the amended turbine layout avoiding identified Zone 1 (all infrastructure exclusion zone based primarily on core habitat for threatened high-altitude passerines and Species 23) as well as the removal of turbines from Zone 2 (collision-risk infrastructure exclusion zones). It should be noted that some internal roads traverse small portions of Zone 1 habitat. Under the assumption that this amended layout will be utilised, a Moderate residual significance is deemed possible (Low precluded by the fact that at least some core habitat, albeit minor, will be traversed by roads and some loss and fragmentation of foraging habitat inevitable). However, the large proportion of the proposed WEF area covered by core habitat for threatened grassland and wetland species places significant limitations on the extent to which this can be practically achieved. Some loss of habitat for these species is considered inevitable and therefore a Moderate residual risk is afforded.

Table 6-1 Impact rating for loss or alteration of habitat.

Loss or Alteration of Habitat	Magnitude	Extent	Reversibility	Duration	Probability		Significance	Character
Without Mitigation	5	4	5	5	5	95	Very High	(-)
With Mitigation	3	3	5	5	3	48	Moderate	(-)

6.2.1.1.2 Mitigation

- Spatial Avoidance. The establishment of any infrastructure must be avoided in all areas designated in the avifaunal sensitivity map (using the provided GIS spatial data) as all infrastructure exclusion zones (as displayed in the amended layout);
- It is recommended that all infrastructure is minimised if it cannot be completely avoided within all high sensitivity infrastructure minimisation areas. The developer has recently put forwarded an amended layout that avoids the placement of turbines and auxiliary infrastructure in Zone 1 and 2 areas which decreases the significance of the residual impact;
- It is recommended that active croplands, close to existing roads, are prioritised for auxiliary infrastructure and wherever possible turbine placement;
- The width of main existing servitudes must not be increased beyond their current width and that new or upgraded internal roads (as provided in the amended layout) will not exceed 6 m.
- The development areas and access roads should be specifically demarcated so that during the construction phase, only the demarcated areas may be impacted upon;
- A fire management plan needs to be compiled and implemented as informed by species authorities, to restrict the impact fire might have on threatened high altitude passerines;
- Effective and gazetted conservation of these and other remaining natural grasslands through conservation stewardship and appropriate land management practices could reduce the significance of the residual impact;
- In line with the Birdlife 6 October 2022 Guidance Note: Minimising the impacts of infrastructure development on Secretarybirds *Sagittarius serpentarius,* the developer should commit to respecting nest buffers and minimising the fragmentation large tracts of contiguous grassland habitat. In this regard the avoidance and protection of core habitat for threatened high altitude species and wetlands is key.
- Areas of indigenous vegetation, even secondary communities outside of the direct construction footprint, should not be fragmented or disturbed. Clearing of vegetation should be minimised and avoided where possible. All activities must be restricted to flat areas as far as possible. It is recommended that areas to be developed be specifically demarcated so that during the

construction phase, only the demarcate d areas be impacted upon. All footprints to be rehabilitated and landscaped after installation is complete. Rehabilitation of the disturbed areas existing in the project area must be made a priority. Topsoil must also be utilised, and any disturbed area must be re-vegetated with plant and grass species which are endemic to this vegetation type.

6.2.1.2 Roadkill and Other Mortalities

6.2.1.2.1 Impact Description

The influx of people and motor vehicle movement during construction will invariably increase bird-vehicle collisions. This can, however, be mitigated to a large degree through signage warning of bird hotspots along the access road and enforcing speed limits of staff and contractors in the project area and educating them on bird sensitivities during inductions. Vehicle movement, is at present, fairly frequent, and the birds on site appear fairly well adapted to vehicle movement. A slightly more pressing threat would be the destruction of nestlings of ground-nesting species during access road construction.

Table 6-2 Impact rating for roadkill and other mortalities

Roadkill and Other Mortalities	Magnitude	Extent	Reversibility	Duration	Probability		Significance	Character
Without Mitigation	2	2	5	3	2	24	Low	(-)
With Mitigation	1	1	5	3	1	10	Very Low	(-)

6.2.1.2.2 Mitigation

- It is recommended that the clearance footprints for turbines and other infrastructure be thoroughly searched through walkdown to ensure that no nests, especially of threatened high-altitude species are destroyed
- Signpost the entry of roads into areas zoned as core habitat for threatened high altitude species as “Environmentally Sensitive Area Reduce Speed”; and
- All construction and maintenance motor vehicle operators should undergo an environmental induction that includes instruction on the need to comply with speed limit (40km/h), to respect all forms of wildlife. Speed limits must still be enforced to ensure that road killings and erosion is limited.

6.2.1.3 Sensory Disturbance

6.2.1.3.1 Impact Description

At the proposed Kromhof WEF, the greatest and most potentially direct construction-related sensory threat would be the potential disturbance of breeding Rudd’s Lark, Yellow-breasted Pipit and Southern Bald Ibis. There are a particularly high number of Southern Bald Ibis roosts either in or in close proximity to the Kromhof WEF, with as many as eight having buffer implications for the WEF (breeding occurs at Roosts 5, 6, 11 and 19). Noise during construction may affect display by the grassland passerines whereas in-field observations show that roosting Southern Bald Ibis are nervous and quick to vacate their nests / roosts. It is also highly probable that large species such as cranes, korhaans, bustards and Secretarybirds may be displaced during construction. Southern Bald Ibis are largely endemic to the Great escarpment. Since, the majority of past WEF applications have been concentrated in the Western, Northern and Eastern Cape, for which the species is absent (except small intrusion into Eastern Cape) comparatively little is known regarding the interaction between Southern Bald Ibis and wind farm developments. However, their collision potential has been recognised by BirdLife who have ranked the species 8th in terms of overall collision risk priority score out of the 107 species highlighted as priority species for wind farm collisions in South Africa in Ralston Paton et al. (2017). Telemetry on tracked birds from the Witkoppe (currently being conducted by Carina Pienaar) and Modelling work (currently being conducted by AfriAvian) will help provide more informed decision-making regarding home range utilisation and buffer zones for wind farms in the near future. For the sake of this project, we have opted for a 1000 m core buffer and a 2500 m foraging and movement buffer. Disturbance associated with construction is expected to be short term and the effects largely temporary, although some of Southern Bald Ibis roosts may be more long-lasting. Most birds on site are, however, already subject to sounds and operation of heavy farming machinery (e.g. tractors, combine harvesters and graders).

Table 6-3 Scoping-level, pre-mitigation impact significance rating on sensory disturbance during construction.

Sensory Disturbance	Magnitude	Extent	Reversibility	Duration	Probability		Significance	Character
Without Mitigation	3	3	4	3	4	52	Moderate	(-)
With Mitigation	2	2	3	3	2	20	Low	(-)

6.2.1.3.2 Mitigation

- Spatial avoidance. The developer must adhere to the prescribed nest and roost buffers as well as the core habitat for wetland and grassland priority species. Staying out of the 1 km very high all infrastructure exclusion zone and 2.5 km high sensitivity infrastructure minimisation zone will reduce the disturbance to breeding colonies of Southern Bald Ibis; and
- Temporal avoidance. Construction activities (e.g. blasting, excavating, earthmoving and turbine installation) should ideally be avoided during the critical breeding window for red-listed resident species (peaks November-February). Southern Bald Ibis bread October-December on site (with a peak in November) while cranes and threatened passerines typically breed December-March with a peak in February on site.

6.2.2 Operation

6.2.2.1 Collisions With Turbines

Birds, and in particular raptors, are highly susceptible to colliding with spinning turbine blades (Thaxter et al. 2017, Perold et al. 2020). Reasons for bird collisions with turbines are multifaceted, but the current consensus suggests it’s likely to do with differences in which the way birds see the world. Raptors for example sacrifice contrast for detail (visual acuity) by having a higher density of fovea, while cranes sacrifice binocular vision directly in front of them for better field of view laterally. Impacts on raptors are of particular significance given their keystone role in their ecosystem and high degree of conservation threat. The main theory, underpinning raptors susceptibility to collision has to do with an optical phenomenon called motion smear, and the limitations of the retina in singling out spinning blades (much like how we see through a spinning fan or propellor without seeing each blade turning). A lack of contrast worsens the effect. This effect is exacerbated in raptors because their ability to see contrast, especially in low light, is 10-fold poorer than in humans (Potier *et al*. 2018). Aside from blades, some birds, especially those with poorer visual abilities (like many ground birds), are also known to collide directly with the stationary tower itself, particularly during seasons of peak activity that coincide with bad weather conditions (Pederson, 2017; Sokke et al. 2020). Priority species considered most prone to collision with stationary objects like the turbine towers under poor visibility conditions include Blue Crane (mean flight height in VWC: 105 m), Blue Korhaan (mean flight height in VWC: 9 m), White-bellied Korhaan (mean flight height in VWC: 6 m) and Southern Bald Ibis (mean flight height in VWC: 32.m).

6.2.2.1.1 Impact Description

The high abundance and diversity of priority species recorded within the Kromhof WEF (46 of which 22 were red-listed species) suggests a high potential risk for significant mortalities during operation. Vantage point data (VPs 5, 9, 10, 11 and 12) from the standard two-year (S1-12) pre-construction monitoring (576 hours) revealed a total of 1338 flights of priority species, totalling 251.33 hours with a passage rate of 1.86 birds^{-hour}. The passage rate was higher than the control (1.23 birds^{-hour}). There is currently no published guideline on passage rate interpretation. Consequently, for the purposes of contextualising the observed passage rates in this study a meta-analysis was conducted on publicly available avifauna assessments for wind energy facilities across South Africa. This investigation (n=28) revealed a median passage rate of 0.55 for all priority species, three times lower than what was observed on site. Based on this metanalysis the following preliminary South African interpretation is proposed using distributional breakpoints (quintiles) uncovered in this dataset; very low (0.2 < birds^{-hour}), low (0.2-0.5 birds^{-hour}), medium (0.5-0.7 birds^{-hour}) high (0.7-1.5 birds^{-hour}) and very high (>1.5 birds^{-hour}). As such the passage rate for all priority species at the proposed Kromhof WEF should be considered very high in the South African context.

Cape Vulture ranks first on BirdLife South Africa's priority list of collision prone species (Ralston Paton et al. 2017). This assertion, which was made 7 years ago with very limited data, is now backed by observed mortality rates from multiple wind farms. This data was recently presented in the Birdlife Conservation Conversations Webinar entitled "*Sharing the Sky*" which demonstrated that Cape Vultures have one of the highest mortality rates of any priority species in the country of 0.011 birds per turbine per year, placing them third only to Jackal Buzzard and Amur Falcon. In the project area a total of 938 individual Cape Vulture passages were recorded from the 5 on-site vantage points at a passage rate of 0.86 birds^{-hour} during the standard two-year monitoring which is higher than the national average determined through a metanalysis of 28 publicly available reports. Indeed, Cape Vulture was the most frequent flying priority species at Kromhof WEF, even more so than Jackal Buzzard and Amur Falcon. Cape Vulture are residents in the area, although a strong seasonal variation in flight activity was observed, with a significant and consistent increase in summer to 1.48 birds^{-hour}. The vultures are coming from three roosts to the south of the project area (all within a 50 km radius), with the bulk emanating from the breeding colony at Nelson's Kop (ca. 200 individuals). Importantly, vultures spent a total of 198.72 hours flying over the Kromhof WEF. This was approximately four times longer than what was observed at the Control VPs (53.12 hours).

Particularly relevant in this regard is flight height and duration within potential rotor sweep. Cape Vultures fly low across the proposed Kromhof WEF spending most of their time (87%) either at or below rotor sweep height. Importantly, both parametric (one-way ANOVA) and non-parametric (Kruskal-Wallis) statistical tests revealed that Cape Vulture spend significantly ($p<0.001$) more time flying at potential rotor sweep height than any other height class. The general trend is for the vultures to approach from the south, flying low along the gorges and cliff lines. As the day warms and thermal activity increases, the groups begin to circle and gradually ascend over the flatter regions as they leave the VWC, usually in a northerly to north-westerly direction towards the Witkoppe Mountains. A number of factors likely underpin the high attendance of Cape Vultures. These include the close proximity of roosts, ample carcass opportunities (major cattle farmers in the region), and the presence of a large Eskom Transmission line that bisects the project area and provides a corridor for movement and overnight roosting. On one occasion (17 May 2024) a total of 235 birds were seen roosting on these powerlines overnight after feeding on a carcass nearby.

Another focal species for the VWC is Martial Eagle, a large k-selected, wide-ranging species which occurs at low population densities. Their low reproduction rates and sparse populations make them prone to rapid declines, with the South African population having declined by 60% over the last 20 years (EWT, 2025). Like most raptors Martial Eagles are particularly prone to collisions with wind turbines. Although collision rates may appear low their significance is high when interpreted in the context of population viability with less than 800 adult birds estimated to remain in the country (EWT, 2025).

Southern Bald Ibis are resident and occur in fairly high abundance with several roost sites in the project area. They were observed to make routine flights back to their roosts at roughly the same time around or just after sunset every day. Other red-listed soaring species found to occur at Kromhof that are of particular concern from a collision risk perspective include Black Harrier (exclusively during winter), Verreaux's Eagle, Secretarybird and Lanner Falcon. Additionally, the WEF supports ideal habitat for several Threatened high altitude grassland passerines, namely Rudd's Lark, Botha's Lark and Yellow-breasted Pipit which are highly prone to collisions as they occupy plateau grasslands (where most of the turbines are likely to be placed) and spend a large amount of time (up to 40 min at a time) displaying at rotor sweep height.

For the DEIR assessment rudimentary extrapolations on fatality rate (assuming 98% avoidance) predict 14.1 priority species individuals may be killed in the turbine field (n=36) per year without mitigation. Species predicted to have a mortality rate of >1 bird per year at Kromhof WEF include (from highest to lowest) Cape Vulture (6.8 birds $^{-year}$), Southern Bald Ibis (2.1 birds $^{-year}$) and Jackal Buzzard (1.3 birds $^{-year}$). The reduction of turbines from 36 to 18 based on the amended layout effectively reduces this estimate by half (**Error! Reference source not found.**). However, these reduced estimates are still considered high.

Additionally, Rudd's Lark, and Yellow-breasted Pipit are prone to collisions as they occupy plateau grasslands (where most of the turbines are likely to placed) and spend a large amount of time displaying at rotor sweep height. It should be noted that Bearded Vulture maintain a nest 27 km to the south and as such the potential for collision by this species (albeit low) should not be ruled out. Verreaux's Eagle collision is a concern given the close proximity of the WEF to Nest 2 (1.1 km ESE) and 4 (2 km E). However, neither were found to be active during the survey. These projected fatality rates, particularly for Cape Vulture are high and must be avoided. Overall, the potential impact of collisions on priority species is afforded a very high significance. It is cautioned that significant mortalities of several Threatened species are likely to occur annually, in spite of mitigation, and thus a high residual rating applies.

Table 6-4 Projected fatality rates for the various priority species observed flying from vantage points at the proposed Kromhof WEF (WTGs with a rotor diameter of 200 m and hub height of 150 m).

Common Name	Birds $^{-hour}$	VP Birds $^{-year}$	Layout			
			DEIR Assessed		Amended	
			Birds at Rotor $^{-year}$	Projected Fatalities $^{-year}$	Birds at Rotor $^{-year}$	Projected Fatalities $^{-year}$
African Fish Eagle	0.004	18.250	1.642	0.03	0.821	0.02
African Harrier-Hawk	0.007	30.417	2.737	0.05	1.368	0.03
Amur Falcon	0.149	324.567	29.203	0.58	14.601	0.29
Black Harrier	0.000	0.000	0.000	0.00	0.000	0.00
Black Sparrowhawk	0.001	6.083	0.547	0.01	0.274	0.01
Black Stork	0.008	36.500	3.284	0.07	1.642	0.03
Black-chested Snake Eagle	0.001	6.083	0.547	0.01	0.274	0.01
Black-winged Kite	0.004	18.250	1.642	0.03	0.821	0.02
Blue Crane	0.088	383.250	34.483	0.69	17.241	0.34
Blue Korhaan	0.000	0.000	0.000	0.00	0.000	0.00
Booted Eagle	0.000	0.000	0.000	0.00	0.000	0.00
Cape Vulture	**0.858**	**3759.500**	**338.257**	**6.77**	169.129	3.38
Common Buzzard	0.006	24.333	2.189	0.04	1.095	0.02
Denham's Bustard	0.007	30.417	2.737	0.05	1.368	0.03
Greater Kestrel	0.003	12.167	1.095	0.02	0.547	0.01
Grey Crowned Crane	0.000	0.000	0.000	0.00	0.000	0.00
Grey-winged Francolin	0.000	0.000	0.000	0.00	0.000	0.00

Common Name	Birds^{-hour}	VP Birds^{-year}	Layout			
			DEIR Assessed		Amended	
			Birds at Rotor^{-year}	Projected Fatalities^{-year}	Birds at Rotor^{-year}	Projected Fatalities^{-year}
Ground Woodpecker	0.000	0.000	0.000	0.00	0.000	0.00
Half-collared Kingfisher	0.003	12.167	1.095	0.02	0.547	0.01
Jackal Buzzard	**0.160**	**699.583**	**62.944**	**1.26**	31.472	0.63
Lanner Falcon	0.047	206.833	18.610	0.37	9.305	0.19
Lesser Kestrel	0.000	0.000	0.000	0.00	0.000	0.00
Little Sparrowhawk	0.000	0.000	0.000	0.00	0.000	0.00
Martial Eagle	0.014	60.833	5.473	0.11	2.737	0.05
Melodious Lark	0.000	0.000	0.000	0.00	0.000	0.00
Montagu's Harrier	0.000	0.000	0.000	0.00	0.000	0.00
Pale Chanting Goshawk	0.003	12.167	1.095	0.02	0.547	0.01
Peregrine Falcon	0.003	12.167	1.095	0.02	0.547	0.01
Rock Kestrel	0.072	316.333	28.462	0.57	14.231	0.28
Rudd's Lark	0.001	6.083	0.547	0.01	0.274	0.01
Rufous-breasted Sparrowhawk	0.003	12.167	1.095	0.02	0.547	0.01
Secretarybird	0.006	24.333	2.189	0.04	1.095	0.02
Southern Bald Ibis	**0.265**	**1161.917**	**104.542**	**2.09**	52.271	1.05
Verreaux's Eagle	0.029	127.750	11.494	0.23	5.747	0.11
Wahlberg's Eagle	0.001	6.083	0.547	0.01	0.274	0.01
White Stork	0.010	42.583	3.831	0.08	1.916	0.04
White-bellied Korhaan	0.008	36.500	3.284	0.07	1.642	0.03
White-necked Raven	0.038	164.250	14.778	0.30	7.389	0.15
Yellow-billed Kite	0.003	12.167	1.095	0.02	0.547	0.01
Yellow-billed Stork	0.000	0.000	0.000	0.00	0.000	0.00
Yellow-breasted Pipit	0.057	249.417	22.441	0.45	11.221	0.22

Table 6-5 Impact rating on collisions with turbines

Collisions with Turbines	Magnitude	Extent	Reversibility	Duration	Probability		Significance	Character
Without Mitigation	4	4	5	5	5	90	Very High	(-)
With Mitigation	4	3	5	5	4	68	High	(-)

6.2.2.1.2 Mitigation

Mitigation efficacy is limited by high Cape Vulture (tracking data, passage rate and flight time at rotor height), Martial Eagle (tracking data) and Southern Bald Ibis (passage rate and flight time) flight activity over the WEF and is highlighted as a significant risk. Table 6-6 provides a summary of some of the leading forms of mitigation currently implemented at operational wind farms and their considerations with regards to the Kromhof WEF. In the event that the WEF is authorised, the following is recommended to reduce turbine-related collisions:

- Spatial avoidance is paramount;
  - Turbines and other collision-risk infrastructure (e.g. powerlines and fences) must be micro-sighted to avoid all areas designated in the sensitivity map (using the provided GIS spatial data) as very high sensitivity for priority species flights (includes flight corridors). Additionally, all collision-risks infrastructure should be minimised unless completely unavoidable in all areas of high sensitivity. Ideally it is recommended that no turbine

placements overlap with high sensitivity areas either. Turbines which are planned to be placed in areas of high sensitivity due to project feasibility constraints, must be subject to close operational shutdown monitoring using observer-based SDOD (bird spotters), backed by an automated SDOD system that uses sophisticated software (e.g. Robin Radar Systems) to integrate camera (e.g. IdentiFlight) and radar (e.g. Robin) surveillance measures; and

- All WEF-related infrastructure (e.g. OMS, BESS, other buildings, substations and roads) including collision-risk infrastructure (e.g. turbines, powerlines and fences) must also be avoided in areas designated as Very High sensitivity for priority species habitat (includes core nest buffers and core habitat for threatened wetland species and high-altitude passerines).

- Temporal avoidance is also recommended. This involves turbine curtailment during peak flight times. The vantage point data revealed a strong diurnal variation in flight activity of priority species. By far the majority of flight activity occurred between 09:30 and 12:30 in winter and 08:30 to 11:30 in summer. Another peak occurs for about an hour before and following sunset when most priority species, particularly Southern Bald Ibis and Martial Eagle, commute back from foraging. Shutdown of selected "risky" turbine locations allowing others to continue operating (provided their continuation is backed by observer and / or camera and radar surveillance), during these times will drastically reduce the risk of turbine collisions. Another key event to consider is the annual migration of Amur Falcon which peaks for about two weeks. Radar and observer-based shutdown will be critical to informing curtailment in this regard;

- Blade Painting. Due to the high avifaunal sensitivity of the proposed WEF, it is recommended that all turbines have one blade painted in alternating red and white bands during manufacture (see below for details). This recommendation is made in line with the recently published SAWEA, BLSA (2025) guidelines which stress that experimentation (leaving some blades unpainted as controls), although beneficial for research, should be avoided at high sensitivity WEFs. "*Wherever roosts, breeding colonies, or other sensitive areas for red data birds occur within the home range of that species, all blades should be patterned. Killing such species at control turbines is not acceptable and will incur future costs for additional tiers of mitigation. In these cases, BirdLife South Africa and BARESG suggest that all turbines should be patterned for conservation purposes. However, avoidance of High-Risk areas should first be prioritised and blade patterning should be complemented with additional mitigation until blade patterning as a stand-alone mitigation has been proven to be effective*" The blades should be painted during manufacturing (significantly more cost effective than once operational). The patterns must be painted in "signal red" upon an otherwise white blade front and back to comply with SACAA regulations. One blade painted per turbine is recommended following Hodos (2003) to minimise the effects of motion smear. Either a solid red blade as in McIsaac (2001) or an alternating red and white patterned blade (as is used at Umoya Energy Hopefield WEF) are acceptable depending on cost and warranty implications). However, the latter is recommended in the context of the Verkykerskop WEF Complex given its success at Hopefield (see Figure 6-1). Deviation from these proven patterns is represents an unjustifiable risk and is not advised in light of the high fatality rates predicted by the pre-construction monitoring. Anticipate and budget for communications and authorisations from SACAA with input from an appropriately qualified SACNASP registered specialist. This mitigation is not a failsafe, it has only been implemented at one operational wind farm in South Africa where Cape Vultures don't occur. Although promising, more testing is required in a wider range of species and geographical contexts, over more time before any robust assertions can be made with any confidence. As per the mitigation hierarchy, proactive avoidance through site selection and micro-sitting to avoid the potential for collisions in the first place should take precedence over reactive measures to mitigate fatalities;

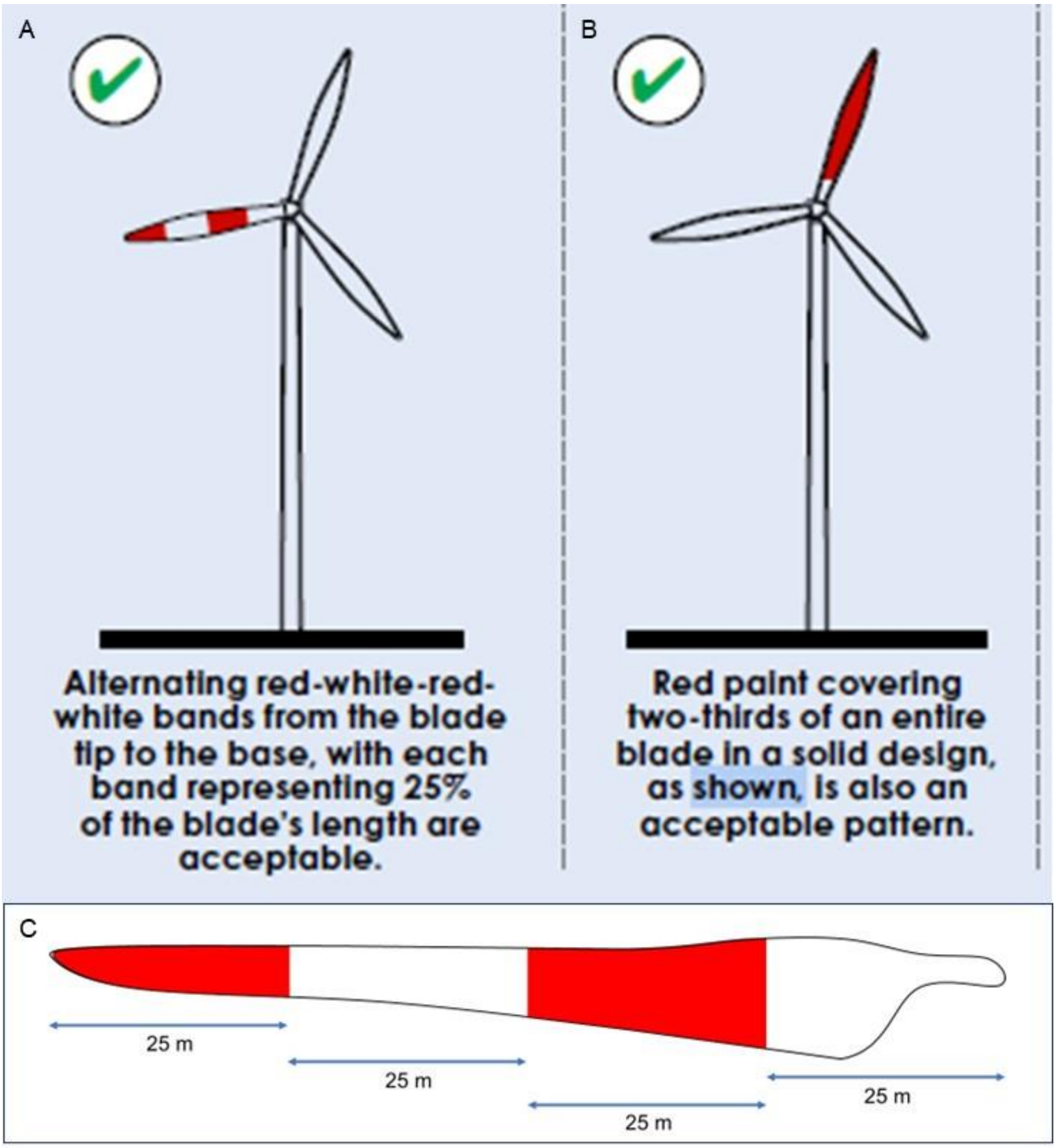

Figure 6-2 ***Blade painting patterns; A) alternating red and white bands as used in Hopefield, South Africa B) single solid band as used in Norway and C) Recommended patterning proportions for the proposed WEF assuming 100 m blades (two red bands of 25% each). Note the tip being red is important.***

- Turbine tower painting and reflectors. To maximise tower visibility and minimise direct collisions of birds, particularly priority species with poorer visual ability and lower in-flight manoeuvrability such as korhaans, bustards, cranes and grey-winged francolin it is recommended that all towers be painted or fitted with reflective stickers during manufacture in alternating red and white concentric bands up to the bottom end of the rotor sweep zone;
- Observer-based shut down on demand (OSDOD) should be implemented. It is, however, important to note that the efficacy of this system will be significantly limited by the extreme and highly erratic climatic conditions on site. Cloud, mist and rain can dramatically hamper visibility and, therefore, the efficacy of this system for several days at a time. However, vultures and other priority species were still observed flying in these conditions. It is recommended that

selected turbines may need to be shut down in periods of intense mist and cloud cover. Additionally, topography notably restricts viewshed within the WEF. As such multiple VPs would be required. The large size of the WEF, challenging terrain and weather pose logistical challenges. Distance between VPs requires careful planning. Exposure at Groothoek especially with regards to lightning and cold poses a real safety hazard which should be carefully managed. It is recommended that paid lightning warning software is used to warn and evacuate observers from hilltops as necessary during approaching lightning storms or snowfalls. Overall, observer-based SDOD would involve a intensive undertaking by a very large team (likely > 15 core staff members, one team lead and one temp to fill in per WEF) of well-trained observers capable of working (safely) at sub-zero temperatures in harsh conditions, including snow blizzards. The team would need to be employed full-time and require full company support. The team would require also require high quality long-range VHF radios as well as satellite phones (very limited reception) and be connected by cellphones too. They should also be linked to an emergency response and 4x4 recovery team. It is recommended that observer-based SDOD be the primary line of active collision avoidance, backed by camera and radar SDOD to cover periods of absence or inclement weather;

- Observer led shut down on demand (SDOD) must be implemented in line with the recently published handbook on responsive SDOD in South Africa (Smallie et al. 2025).
- It is important to note that the efficacy of SDOD is not only limited by environmental constraints which reduce visibility such as climate and topography but also by the size and behaviour of priority species. Those unlikely to be effectively protected through observer led SDOD include smaller species (e.g. Rudd's Lark, Yellow-breasted Pipit or Botha's Lark, falcons and kestrels) as well as those flying by night (e.g. Species 23);
- It is also important to consider the speed with which turbines can be shutdown and what implications SDOD may have on service agreements and manufacturer warranties.
- The SDOD program should be undertaken in collaboration with a suitably qualified Avifaunal Specialist, who should be appointed from the onset to oversee performance of the programme for its lifespan.
- The recently published SDOD handbook (Smallie et al. 2025) recommends that a detailed SDOD protocol be compiled and submitted as part of the environmental authorisation process and finalised at least six months prior to the commercial operation date. Considering that this avifaunal pre-construction monitoring report was designed implemented and completed before the publication of the SDOD handbook in June 2025, this aspect represents a separate scope of work which should be commissioned in collaboration with the Kromhof WEF design team with inputs from the automated camera system supplier (e.g. IdentiFlight). This protocol needs to:
  - Assign a priority rating to each turbine for SDOD;
  - Identify high risk target species;
  - Identify high collision risk areas
- Spatial coverage (surveillance area):
  - Optimise spatial SDOD coverage of turbine field through viewshed analysis

        - Work in tandem with Kromhof WEF planning and engineering team to optimise coverage by balancing turbines covered by automated SDOD (likely to be influenced by supplier insight and recommendation) with those covered by observer led SDOD.
        - Ground truth the location, accessibility and suitability of potential human observation stations (by an avifaunal specialist).
    - Temporal Coverage (surveillance period):
        - Specify the daily, weekly, and monthly time periods requiring reliable surveillance
        - This should account for daily or seasonal variation in collision risk, determined by the target bird species' ecology and behavioural characteristics
  - Automated shutdown on demand (ASDOD): Given the size of WEFs, terrain and inclement weather which limit human observer ability a combination of radar and intelligent camera systems (e.g. IdentiFlight) should be used in tandem to allow for near-continuous, automated SDOD. This would require an integrative software solution such as that provided by Robin Radar Systems. Automated SDOD must be conducted continually over the full lifespan of the WEF. Under a realistic scenario where budget constrains the number of cameras that can be fitted, then an experimental project would need to be designed (separate scope of work, by a suitable SACNASP registered avifauna specialist in conjunction with IdentiFlight) using statistical power analysis to decide upon the number and location of placements. Aspects regarding radar positioning, cost, mobility, frequency and training should be decided upon before construction as detailed in the Section 6.1.1 above.
- Radar should be considered for all WEFs in the VWC, given the size of WEFs, terrain and inclement weather which limit observer and camera-based surveillance. It is recommended that pre-construction radar monitoring is conducted inform final micro-sighting of turbines. Following this radar monitoring should continue for the life of the project. Radar could prove critical in detecting approaching flocks of Cape Vulture, Southern Bald Ibis and migrating Amur Falcon. It may also prove highly useful to prevent Martial Eagle strikes especially considering the territory defending male over Groothoek "Brad" has been fitted with a GPS tracker. It could also help to refine flight paths and migration routes and assist in assessing areas where Amur Falcon tend to congregate and roost. Investigation may be required to assess radar range and line of sight restriction (through GIS-based viewshed analysis) to establish number of apparatuses required and stations. The EchoTrackTM omni-directional radar-acoustic sampling system provides a range a max horizontal range of 4 km and a vertical range of 2 km (Jenkins et al. 2018). Radar frequency is also an important aspect. Balance between frequencies should be low enough to be useful during the frequent inclement weather yet high enough to detect birds at least as small as Amur Falcon is required. If flexibility and discrimination prove difficult priority should be afforded to calibrating the radar to optimise detection of Cape Vulture, Martial Eagle and Southern Bald Ibis flights. Recommended to be used in conjunction with camera and / or observer-based SDOD. This would require an integrative software solution such as that provided by Robin Radar Systems. The Site is large and topography poses line of sight challenges, may require multiple radar stations. In this regard trailer-based mobile units should be considered to test best stations or adapt seasonally to changes in flight patterns. An investigation would be required to determine the position and duration of radar surveillance if deemed necessary and / or feasible;

- A Vulture Food Management Programme will need to be implemented to ensure all dead livestock/wildlife on site are removed as soon as possible and transferred to designated vulture restaurants sufficiently far away from the WEF. Carrion removal would need to be an intensive undertaking by a team of full-time rangers working in close radio communication with the farmers and bird spotters. Although efforts have been made by Kromhof WEF to design and trial a carrion management program, it is recommended that it should only be fully implemented after environmental authorisation (if granted) to avoid the risk of imposing unnecessarily large-scale foraging habitat constraints on an already threatened species;
- Birthing of livestock near turbines should not be permitted within 2 km of operational turbines;
- As there are currently no known active vulture restaurants in the immediate vicinity, it is recommended that one be established and maintained by the WEF's bird management team. The restaurant should undergo relevant provincial permitting, veterinary inspection and be established in line with best practice (e.g. Vulpro article entitled Let Vultures Soar).The following considerations should be taken into account regarding the establishment of a suitable vulture restaurant site:
    - Location: Considering that the prevailing flight pattern is from south (typically from the breeding colony at Nelsonskop) to north (towards the non-breeding roost on the Witkoppe) across the VWC it is recommended that a site be chosen in the region between Nelsonskop and Van Reenen;
    - Protection: The vulture restaurant should preferably be located in a nature reserve or on stewardship land (that forms part of the Upper Wilge Protected Environment;
    - Risks: The area selected for the restaurant should be situated away from powerlines and at least 10 km from any large transmission line. Avoid areas close to airstrips and fences (>100 m);
    - Terrain: Open, high-lying plateau grasslands should be prioritised while low valleys should be avoided. Ideally the restaurant should be placed close to the escarpment or another large cliff or drop-off to assist vultures to utilise the prevailing orographic winds to easily take-off as required;
    - Food supply: Avoid poisoned carrion or animals which have died following use of antibiotics or non-steroidal anti-inflammatories (these animals should be buried as they can kill vultures). If shot remove the lead bullet (poisonous to vultures). Make sure to open the carcass once deployed;
- Develop a contingency mitigation budget to cater for significant mortality events (e.g. threatened species or mass strike such as migrating amur falcons). This budget should be enough to allow for research into and effective implementation of adaptive management strategies such as human-based turbine shutdown on demand, habitat alteration, bird deterrence from site, and any others identified as feasible;
- A Biodiversity Management Plan (BMP) must be compiled for the project by an ornithologist prior to construction, outlining critical thresholds for fatalities and the appropriate management response;
- Continue to collaborate with relevant NGOs such as Vulpro, BirdLife South Africa and the Endangered Wildlife Trust (EWT);
- Continue to track martial eagles within the project area. Kromhof WEF recently commissioned a study of this nature, and Dr. Gareth Tate of EWT has already captured and fitted a GPS logger on the first male eagle (May 2024); and

- Track Southern Bald Ibis. Dr Carina Pienaar is currently tracking bald ibises from the Witkoppe Roost. It is recommended that she be contacted to consider fitting GPS loggers to fledglings from within the VWC.

Table 6-6 Leading forms of mitigation currently being employed at operational wind farms detailing their successes, drawbacks, reported efficacy and considerations for the Kromhof WEF

Pros	Cons	Efficacy	Considerations for Kromhof WEF
Camera-based SDOD: Automated camera systems that detect flying objects and use algorithms to calculate collision risk and prompt shutdown as required.			
• Automated turbine SDOD functionality • High accuracy, especially at close range • Easy to install • Operationally labour uninventive • Produce high quality robust datasets	• High initial installation cost (ca. R970 000 per turbine fitment, BLSA Webinar) • Limited range • Better suited to smaller wind farms or selected higher risk turbines • Limited by terrain and inclement weather	• IdentiFlight, 82% reduction in Golden Eagle fatalities at Top of the World Wind Power, Wyoming McClure et al. (2021) • DTBird, 76-96% detection rate, Smøla wind-power plant, Norway (Hamre et al., 2012)	• Cost: size of Kromhof WEF (300 MW, 33 turbines, 7296 ha), imposes significant cost implications to achieve adequate coverage. • Coverage: Distance between turbines and number of cameras installations deemed financially feasible may impose coverage challenges. • Detection: Incised topography and inclement weather moderately limit detection. • Under a realistic scenario where budget constrains the number of cameras that can be fitted, then an experimental project would need to be designed (separate scope of work, by a suitable SACNASP registered avifauna specialist in conjunction with IdentiFlight) using statistical power analysis to decide upon the number and location of fitted turbines vs non-fitted controls. The position of non-fitted turbines should be staggered amongst fitted ones with equal numbers of control and treatment turbines in high sensitivity areas.
Observer-based SDOD: Bird spotters stationed at vantage points tasked with detecting approaching birds and issuing turbine team with shutdown warnings.			
• Can be effective with large species • Lower initial startup cost • Provides employment • Proven effective on smaller wind farms like Excelsior in South Africa and Kipeto in Kenya	• Less effective at detecting smaller t species • High management costs and management • Full testing on larger wind farms in SA still required (pilot phase at Golden Valley). • Efficacy may be reduced on larger wind farms especially in areas of incised topography and or frequent mist or rain	• Ferrer et al. (2022) report a 61.7% reduction in all bird species and a 92.8% reduction Griffon Vultures through observer shutdown over 13 years at 20 windfarms in Spain. • BLSA Conservation Conversations Webinar (17 Sep 2024): - Excelsior (13 turbines, 9 monitors, 3 VPs): Since SDOD commenced; 1371 shutdowns, 6 priority species fatalities, 0 Cape Vulture fatalities. - Golden Valley (48 turbines, 17 monitors, 9 VPs): So far 1 Cape Vulture fatality during SDOD.	• Climate: Visibility limited by the highly erratic weather on site. Cloud, mist and rain can dramatically hamper visibility and, therefore, the efficacy of this system for several days at a time. However, vultures and other priority species were still observed flying in these conditions. • Terrain: Topography notably restricts viewshed, multiple VPs required. • Logistics: Large size of WEF, terrain, road conditions and weather pose travel challenges. Distance between VPs requires careful coordination. • Safety: Exposure at Kromhof poses a real safety hazard (especially lightning and cold) which should be carefully managed. Requires large team of well-trained observers capable of working at sub-zero temperatures in harsh conditions, snow, blizzards. VP huts and basic ablutions recommended. •Recommended to be the primary line of active collision avoidance, backed by camera and radar SDOD

Pros	Cons	Efficacy	Considerations for Kromhof WEF
Radar: A system that uses radio waves to detect and track the position speed and direction of a flying objects such as birds to trigger shutdowns.			
• Good Range • Better suited to large wind farm sites • Superior, detailed flight data • Turbine SDOD functionality • Works better than most detection systems in adverse weather conditions	• Limited by line of sight • Limited species discrimination ability • Expensive units which may pose a theft risk	• Becker (2016), showed radar detected 66.4% of observed flights during the 9-month study period at the Umtathi Emonyeni WEF near Komga, EC. • Jenkins et al. (2018), used radar to accurately single out problematic turbines for Great White Pelican at the Mayong Energy WEF on the West Coast of South Africa. Their study showed that of the 35 proposed turbines, 82% of high-risk flights were associated with just three proposed turbine placements.	• Investigation may be required to assess radar range and line of sight restriction (through GIS-based viewshed analysis) to establish number of apparatuses required and stations. The EchoTrack™ omni-directional radar-acoustic sampling system provides a range a max horizontal range of 4 km and a vertical range of 2 km (Jenkins et al. 2018) • Radar frequency is also an important aspect. Balance between frequencies low enough to be useful during the frequent inclement weather yet high enough to detect birds at least as small as Amur Falcon is required. If flexibility and discrimination proves difficult priority should be afforded to calibrating the radar to optimise the recording of Cape Vulture, Martial Eagle and Southern Bald Ibis flights. • Site large and topography poses line of sight challenges, may require multiple radar stations. • Consider trailer-based mobile units to test best stations or adapt seasonally to changes in flight patterns. • Could prove critical in detecting approaching flocks of Cape Vulture and inbound migrations of Amur Falcon. • Could help to refine flight paths and migration routes • Could assist in assessing areas where Amur Falcon tend to congregate and roost. • Recommended to be used in conjunction with camera and / or observer-based SDOD. This would require an integrated software solution such as provided by Robin Radar Systems.
Blade Painting: Painting one or more of the turbines blades a different colour to increase detectability to species, particularly raptors			
• Cost effective if done during manufacturing • Durable, unlikely to affect turbine warranty if painted correctly (E.g. Hopefield) • Proven efficacy at Umoya Energy Hopefield, WC and Smola in Norway	• Labour intensive and costly to paint blades once turbines are operational (aerial platform use is costly). • Only effective by day. • Final designs of the alternative markings must be submitted to the SACAA for consideration and approval, prior to implementation	• In BLSA Conservation Conversations Webinar, Rob Simmons reports 86% reduction in raptor fatalities	Due to avifaunal sensitivity it is recommended that all turbines have one blade painted. As per SAWEA, BLSA (2025) guidelines experimentation should be avoided at high sensitivity WEFS. Blades should be painted during manufacturing to save costs. Must be signal red front and back to comply with SACAA regulations One blade best for reducing motion smear (hodos, 2003) Solid recommended based on McIsaac (2001), experimentation in patterning not advised due to high collision risk Can have different colour leading edge it does not exceed 1-2% of the blade width. Recommend patterning all blades, site to

Pros	Cons	Efficacy	Considerations for Kromhof WEF
			sensitive to afford control experimentation
Habitat Management: The alteration of habitat within a WEF to make it less suitable for priority species (typically related to the removal of food sources)			
Can reduce the sites attractiveness to target priority species	Labour intensive. May not fully reduce attractiveness of the area as other factors may influence attendance (e.g. habitual foraging patterns, migration and movement corridors)	• Pescador et al. (2019) demonstrate a 75-100% reduction in collisions of Lesser Kestrel in Spain by tilling land around turbines to reduce vegetation cover and insect prey base. • Lonsdorf et al. (2023),	Efficacy of carrion removal on decreasing vulture attendance limited by: - Habitual flight / foraging behaviour. - Cape Vulture attendance during pre-construction monitoring remained high in spite of routine cattle carcass removal by local farmers. - Both infield observations and tracking data indicate that the Cape Vulture commute between roosts across the project area. Effectively much of the vulture attendance of the WEF may be attributed to movement between roosts, and thus is likely (and been shown through monitoring data) to continue under carrion removal programs - Cape Vulture are known to habitually re-visit favoured foraging areas and move between roosts. -Project area size, ruggedness, remoteness and access place significant limitations on carcass detection..

6.2.2.2 Collisions and Electrocutions with Electrical Transmission Lines and Auxiliary Infrastructure

6.2.2.2.1 Impact Description

It is currently uncertain as to the extent, position or length of any new transmission lines to be established for the WEF or where exactly the grid connection point will be. However, the establishment of any transmission lines, and any overhead internal reticulation lines, poses a significant potential collision and electrocution risk to birds given the high prevalence of vultures, cranes, bustards, korhaans which are all larger-bodied, less manoeuvrable species. This coupled with the undulating landscape and frequent misty/rainy conditions of the Eastern Free State, contribute to high powerline collision rates for birds, even when the lines are marked with conventional flappers or alternating black/white pigtails (BirdlifeSA pers. comm. 2025). Increased wind speeds during winter, when mist/rain are less likely, makes manoeuvrability for large species more difficult. This can however be mitigated to some degree through placement (route prioritisation to avoid large wetlands, cliffs, gorges and other areas of high avian abundance or sensitivity), burying internal reticulation lines between turbines, and by installing bird diverters and flappers at strategic locations deemed to be of higher collision risk where avoidance is not possible (e.g. wetland crossings and large valley crossings). This impact is thus rated is having a high pre-mitigation impact and a moderate residual impact.

Figure 6-3 ***Existing collision and electrocution risks within the VWC; A) vulture lands on pylons, B) Lanner Falcon avoids fence, C) Jackal Buzzard mortality on fence, D) Lanner Falcon on un-insulated powerline, E) Cape vulture entrapped in fence (freed).***

Table 6-7 Impact rating on collisions and electrocutions with electrical transmission lines and auxiliary infrastructure.

Collisions and Electrocutions with Electrical Transmission Lines and Auxiliary Infrastructure	Magnitude	Extent	Reversibility	Duration	Probability		Significance	Character
Without Mitigation	4	2	5	5	4	64	High	(-)
With Mitigation	3	2	5	5	3	45	Moderate	(-)

6.2.2.2.2 Mitigation

- Install Eskom-approved flappers or coils (flight diverters), along the entire length of grid connection powerline (and any spans of overhead internal MV lines) at no more than 15 m intervals on HV lines, and 7m (preferably 5) on MV lines. Flight diverter structures should ideally alternate between light and dark shades to maximise visibility and contrast against background as seen from powerline level. The structures must be installed as the powerlines are being spanned. This will drastically help to increase the visibility of transmission lines especially the thinner earth line with which most collisions tend to be associated (Martin et al. 2010);
- Fencing should be minimised but where required the following is recommended: The top two strands must be smooth wire, minimum 300 mm between wires and place markers on fences;
- Anti-perch devices should be intensified on main Eskom powerlines to further reduce perch suitability;
- All internal MV power cables within the project area should be thoroughly insulated and buried in demarcated corridors as far as possible; except where overhead MV lines are required due to environmental requirements (e.g. water course/wetland crossings) or where trenching of lines is not technically feasible (e.g. On steep rocky slopes or where excessive rock would require blasting);
- All above ground electrical transmission infrastructure should be fitted with the latest Eskom approved anti-bird structures and anti-collision line marking devices; and
- Quarterly monitoring currently being undertaken at Ingula Nature Reserve can be used to help assess the likely significance of powerline collisions, after mitigation. An average of 5 priority threatened species (e.g. Cape Vulture, cranes, Denham's Bustard) are killed by collision per annum along the Ingula-Majuba 400kV line, which traverses a similar habitat type, land use, and avifaunal species composition (BirdlifeSA, pers. comm. 2025).

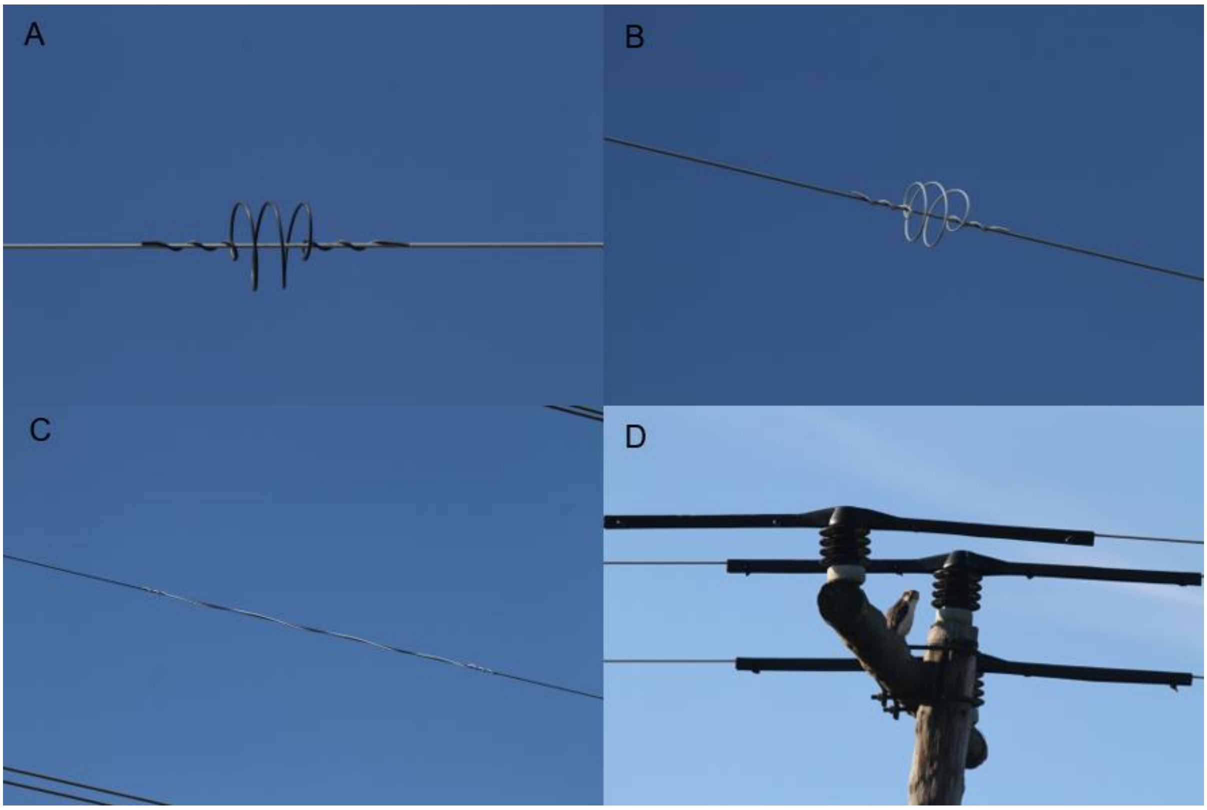

Figure 6-4 ***Examples of some of the measures currently implemented by ESKOM on site to minimise collision and / or electrocution associated with powerlines; A) Black coil diverter, B) white coil diverter, C) white spiral diverter, D) plastic perch insulators.***

6.2.2.3 Sensory Disturbance

6.2.2.3.1 Impact Description

The main sensory disturbance to birds during operation centres on the noise the turbines generate. The noise generated by a wind turbine can often exceed 30 dBA even at a distance of 800 m (Katinas et al., 2016; Rogers et al., 2006), the distance most often associated with avoidance behaviour (Santos et al., 2021). In this regard, it is important to consider that a change of 3 dBA already reduces the hearing range of birds by 50% while a change in excess of 12dBA effectively reduces the hearing range of a bird by more than 90% meaning that at the core of the wind turbine noise-polluted area, birds are expected to barely perceive any other acoustic cues in their environment at all Barber et al. (2010).

Empirical research on the effects of turbine noise nose on birds is an emerging field. The few existing studies show that turbine-related noise impacts are likely to be hardest felt by songbirds which rely on vocalisations for a wide array of critical behavioural interactions from courtship and territory defence to rearing of young and alarm signalling causing them to either vacate the area or change the acoustic parameters of their calls with behavioural consequences. For example, a study by Lehnardt et al. (2021) using a simulated broadcast of turbine noise at a site in Israel noted a 45% and 36% decrease in abundance for the lesser whitethroat (*Sylvia curruca*) and Sardinian warbler (*Sylvia melanocephala momus*), respectively. Another study by Zwart et al. (2015) showed that male European Robins (*Erithacus rubecula*) called at higher frequencies in the presence of wind turbine noise, presumably in an attempt to combat acoustic masking at the expense of lower frequency contact calls used for territorial disputes. The consequence is a decreased ability to deter a rival through scolding alone, leading to an increased energy expenditure, risks of injury, and, ultimately, breeding success.

Of the various songbirds susceptible to noise in the Kromhof WEF, two species, namely Rudd's Lark, and Yellow-breasted Pipit, are of particular significance. The males of all these species spend a considerable proportion of their time during the breeding season, calling during protracted aerial displays. Consequently, due to a combination of their Threatened status and acoustic-dependant breeding behaviour, it stands to reason that these species may be significantly adversely affected by turbine noise.

Table 6-8 Impact rating on sensory disturbance during operation.

Sensory Disturbance	Magnitude	Extent	Reversibility	Duration	Probability		Significance	Character
Without Mitigation	4	3	5	4	4	64	High	(-)
With Mitigation	4	2	5	4	3	45	Moderate	(-)

6.2.2.3.2 Mitigation

- Spatial Avoidance. Avoid the placement of turbines in areas identified as core habitats identified for threatened high-altitude grassland species; and
- Temporal Avoidance. Curtailment at selected turbines closest to the identified core habitats for threatened high altitude passerines should be implemented during peak display times during the peak breeding season (November – March). Displays occur throughout the day, but tended to be concentrated in the morning between 07:00 and 10:00. Another peak in display activity typically occurs in the late afternoon between 15:30 and 17:00.

6.2.2.4 Effect on Migratory and Congregatory Species

6.2.2.4.1 Impact Description

Many flocks of migratory birds move across the project area in early summer. One of the most potentially significant flocks in this regard is the annual migration of Amur Falcon. During Survey 3 a very large migratory flock (numbering in the thousands) was observed moving along the Meul River valley in a dense swarm numbering over a thousand birds. Migratory flocks of this size are of global significance. The potential for a large collision event is a possibility and represents a large risk in terms of wind farm development. and

Another potentially significant aspect is the VWCs proximity to the Great Escarpment (1.3 km from the westernmost corner). The escarpment is important from a national and regional bird movement perspective. Many of South Africa's resident grassland species make seasonal altitudinal movements across the escarpment in response to climate and food availability (between high-altitude grasslands and lower-altitude savannahs). Additionally, the lift created through thermals in these steep mountainous areas provides ideal conditions for large-bodied, red-listed soaring species such as Bearded Vulture, Cape Vulture, Verreaux's Eagle, Secretarybird, Martial Eagle, Black Stork and Yellow-billed Stork, which frequently move along the escarpment to access foraging grounds on either side of it.

Table 6-9 Impact rating on effect on migratory and congregatory species

Effect on Migratory and Congregatory Species	Magnitude	Extent	Reversibility	Duration	Probability		Significance	Character
Without Mitigation	4	5	5	4	4	72	High	(-)
With Mitigation	4	5	5	4	3	54	Moderate	(-)

6.2.2.4.2 Mitigation

- Due to the seasonal arrival of large migratory flocks, it is recommended that a combination of radar and observer-based shut-down on demand is employed to guide temporal avoidance (curtailment) to reduce the probability of collisions; and
- Studies from Spain (Pescador at l. 2019) report significant decreases in collision rates of Lesser Kestrel simply by keeping the soil around the turbines tilled and devoid of vegetation. This mitigation measure is only likely to be feasible at turbines situated in croplands as tilling of natural highland grassland is not recommended from an avifauna habitat destruction perspective, given the high concentrations of threatened grassland species in the region. Considering that only 6 of the 33 proposed turbines are situated in active croplands, the contribution of this mitigation measure to reducing Amur and Red-footed Falcon mortality is likely to be minimal. It would also have financial, labour and crop production implications that would likely not outweigh the benefits. As with carcass management this mitigation represents a form of habitat management and should only be implemented as a reactive measure at problematic turbines.

6.2.3 Decommissioning

6.2.3.1 Impact Description

Impacts on avifauna from the decommissioning of the wind farm are likely to centre on temporary disturbance associated with turbine removal and rehabilitation. The main stressors are likely to be related to noise, increased human activity and to some degree localised habitat degradation.

Table 6-10 Impact rating on effect on migratory and congregatory species

Temporary disturbance associated with turbine removal and rehabilitation	Magnitude	Extent	Reversibility	Duration	Probability		Significance	Character
Without Mitigation	2	2	5	3	2	24	Low	(-)
With Mitigation	1	1	5	3	1	10	Very Low	(-)

6.2.3.2 Mitigation

- Timing decommissioning to take place mainly outside of the critical breeding window for Southern Bald Ibis (near breeding roosts) and threatened high-altitude grassland species (November to February);
- Minimise the disturbance footprint associated with de-construction of the turbine field and demolition of buildings;
- Remove all redundant powerlines, turbine material and rubble from site; and
- Landscape and rehabilitate old construction footprint areas.

6.2.4 Cumulative Impact

6.2.4.1 Impact Description

The AOI is largely natural and, in most areas, pristine. There are currently no operational wind energy facilities in or within 50 km surrounding the project area. However, the Newcastle Wind Power 2 project has been approved at the bottom of the escarpment on the KZN side. There is, however, also a vested birding interest in the region (e.g. Roberts Memel Birding Site, Memel Getaway Birding Routes) and NGOs such as BirdLifeSA and EWT are distinctly aware of the avifaunal importance and are actively working in the region. The proposed VWC is not located within one of the promulgated Renewable

Energy Development Zones (REDZ). Additionally, a small portion of the VWC overlap an IBA (Grasslands) while large a large proportion of it overlaps a KBA (Eastern Frees State Grasslands). Known projects located within a 50km radius of the are listed in

Table 6-12 and mapped in Figure 6-5. Based on the information, the cumulative impact of wind energy developments in this region is likely to have a significant consequence for birdlife on a national to global scale.

Table 6-11 Impact rating on the anticipated cumulative impact

Cumulative Impact	Magnitude	Extent	Reversibility	Duration	Probability		Significance	Character
Without Mitigation	4	5	5	5	5	95	Very High	(-)
With Mitigation	4	3	5	5	4	68	High	(-)

6.2.4.2 Mitigation

- Mitigating cumulative impacts is challenging, particularly in this context and considering that there are currently no operational wind energy facilities along the Great Escarpment. There are, however, other WEF applications in the region suggesting pooling of pre-construction monitoring data on predicted fatality rates and habitat loss estimates may one day be possible.

- As the proposed development overlaps a Key Biodiversity Area (KBA), the KBA National Coordinator Group (NCG) and the KBA Regional Focal Point must be informed. This should be done during as soon as possible to allow the organisation adequate time to assess impacts on key avifauna (and other biodiversity) within the KBA as a result of the VWC and formulate a response in time for the EIA level public participation and commenting phase.

- Especially with regards to threatened, habitat-specific species (in this case Rudd's Lark, Yellow-breasted Pipit and Botha's Lark) it is imperative that projected pre-construction fatality rate estimates from the various wind farm applications within their ranges are consolidated and contextualised in terms of their contribution towards the species' overall population viability. This needs to be informed by ecological niche modelling which takes into account the combined effects of habitat loss and climate change to better understand and quantify the cumulative risks to these species from growing numbers of wind energy applications in areas such as this. For now, locality data of threatened high altitude species gathered during the two-year pre-construction monitoring has been sent to Dr Robin Colyn (AfriAvian) who's research includes climate and habitat modelling for these species, an area of research that is dependent on the availability of high-quality locality data. Additionally, all data on threatened species has been shared with the BirdLife South Africa via BirdLasser's Threatened Species cause.

Table 6-12 Lodged renewable energy applications within a 50 km radius of the VWC.

Project Name	Applicant	Status	Reference Number
Proposed Newcastle solar energy facility near Newcastle, KwaZulu-Natal Province	Building Energy (Pty) Ltd	Refused	14/12/16/3/3/1/1225
The proposed Mulilo Newcastle Wind Power Wind Energy Facility, Newcastle Local Municipality, KwaZulu Natal Province.	Mulilo Newcastle Wind Power (Pty) Ltd	Approved	14/12/16/3/3/2/2457
The proposed Mulilo Newcastle Wind Power 2 Wind Energy Facility, Newcastle Local Municipality, KwaZulu Natal Province	Mulilo Newcastle Wind Power 2 (Pty) Ltd	Approved	14/12/16/3/3/2/2458

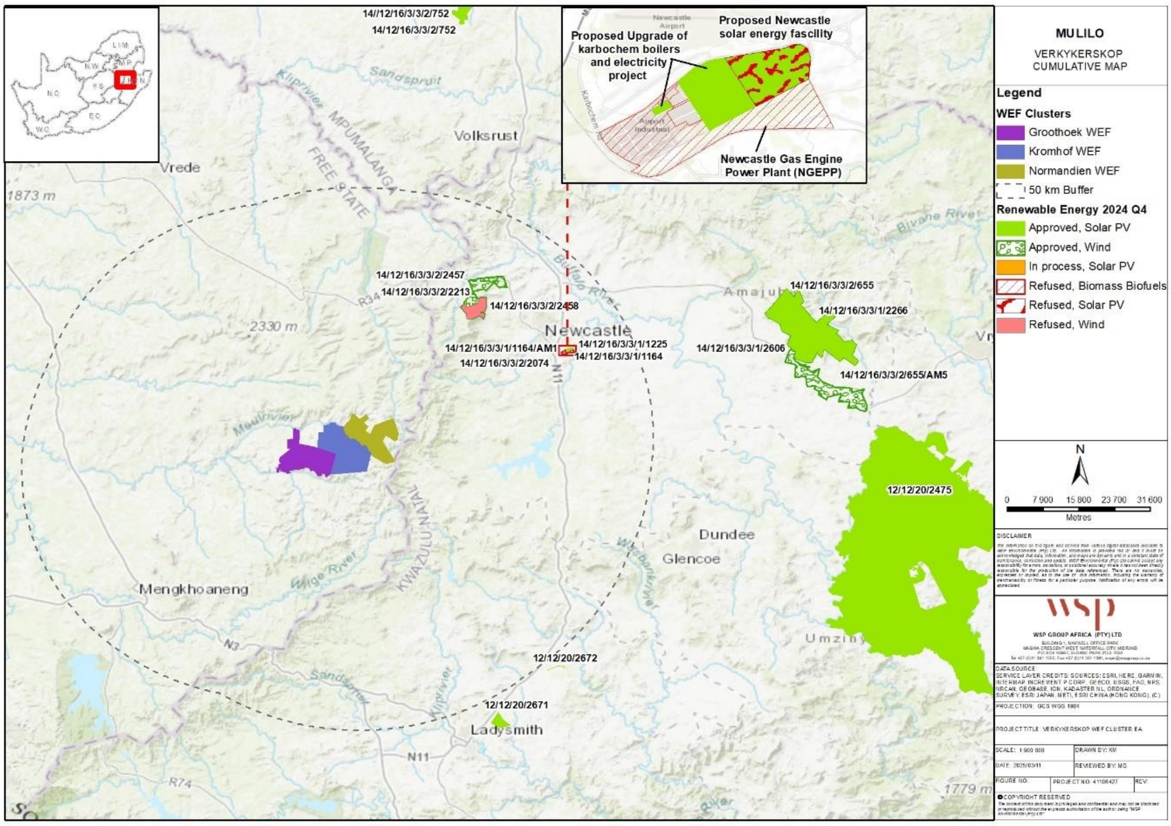

Figure 6-5 Renewable energy applications within a 50 km radius of the VWC. Note this map excludes several proposed wind energy projects in the Phumelela / Memel Area.

7. Monitoring Plan

This section serves as a preliminary and adaptive guideline to future avifaunal monitoring (construction and operational) in the event that the project is authorised. Note that, as per Jenkins et al (2015) this plan does not negate the need to first avoid, minimise and lastly mitigate risks to local avifauna. Additionally, the commencement date and precise protocol and timeframes for the monitoring activities will depend on authorisation, project schedule and available resources. The final scope of post-approval monitoring is subject updated recommendation made by the appointed (suitably qualified and independent) avifaunal specialist at the time, and to agreements between the developer and DFFE.

7.1 Compliance

This preliminary and adaptive monitoring plan is compiled in line with the protocol for specialist assessment and minimum report requirements for avifauna (Government *Gazette* No. 43110 of 20 March 2020) and best practice guidelines as presented in Jenkins et al. (2015). Additionally considering the sensitivity of the site for vultures (areas of Vey High sensitivity) as evidenced through the pre-construction monitoring data, Vulpro tracking data and as indicated in the Vulture Theme (High) of the National Environmental Screening Tool (Cervantes et al. 2022), the plan takes into account the requirements for post-construction monitoring as stipulated in the protocol for specialist assessment and minimum report requirements for Cape Vulture (Government *Gazette* No. 51022 of 8 August 2024).

7.1.1 Pre-operational Monitoring

Monitoring during the period from approval to the end of construction is critical to minimising bird mortalities during operation through planning and preparation. Initially (post approval but before construction) it will involve the utilisation of information on key hotspots and flight corridors identified during pre-construction monitoring to strategically optimise the position of vantage points used by spotters for the operational monitoring that maximises the efficacy of observer-based SDOD efforts. The following is recommended in this regard:

- Radar: Consider conducting radar monitoring to optimise the final layout and number of turbines followed by continuous radar use during operation for the life of the project. Radar could prove critical in detecting approaching flocks of Cape Vulture, Southern Bald Ibis and migrating Amur Falcon. It may also prove highly useful to prevent Martial Eagle strikes especially considering the territory defending Male over both Kromhof and Groothoek WEFs “Brad” has been fitted with a GPS tracker. It could also help to refine flight paths and migration routes and assist in assessing areas where Amur Falcon tend to congregate and roost. Aspects to consider include:
    - Positioning and number of units: An investigation would be required to assess radar range and line of sight restriction (through GIS-based viewshed analysis) to establish number of apparatuses required and stations. The EchoTrackTM omni-directional radar-acoustic sampling system provides a range a max horizontal range of 4 km and a vertical range of 2 km (Jenkins et al. 2018);
    - Cost: The number of units will naturally be constrained by cost but it is recommended that, as a minimum, enough units are purchased to cover the entire turbine field through direct line of sight;
    - Mobility: Trailer-based mobile units should be considered to test best stations or adapt seasonally to changes in flight patterns;
    - Radar frequency is also an important aspect. Balance between frequencies should be low enough to be useful during the frequent inclement weather yet high enough to detect birds at least as small as Amur Falcon is required. If flexibility and discrimination prove difficult priority should be afforded to calibrating the radar to optimise detection of Cape Vulture, Martial Eagle and Southern Bald Ibis flights; and

    - Training: Bird management staff and an avifaunal specialist will require training from the manufacturer on how to calibrate the radars as well as capture and process, store and interpret the data.
- Use the results of the radar and pre-construction monitoring to plan:
    - The final layout of the turbine field (by removing potentially problematic turbines from the layout) as well as all electrical transmission and auxiliary infrastructure;
    - The number and location of vantage points for operational bird monitoring that allow for maximal efficacy of observer-based SDOD. As a guide it is recommended that, as a minimum, enough vantage points are chosen to allow each turbine to be observed from a vantage point no further than 2 km away; and
    - The number and location of turbines that require intelligent camera systems (e.g. IdentiFlight).
- Commence construction monitoring with the aim of:
    - Establishing weather, the proposed mitigation measures and buffers are being implemented and weather they are effective, adapt as required;
    - Observe any changes in avifaunal species composition and abundance associated with construction for operational reporting;
    - Refine bird spotting protocol in preparation for operation;
    - Commencing and refining carrion management protocol;
    - Drafting and refining the annual operation (ops) reporting.
    - Identifying management or mitigation measures to be included in revisions of the EMPR.

7.1.2 Operational Monitoring

7.1.2.1 Bird Movements and Abundance

It is important to continue monitoring movements and abundance of birds during operation as part of adaptive management, temporal curtailment and observer-based SDOD. In this regard, the following considerations apply:

- Sampling protocol: The pre-construction monitoring protocol as detailed in this report should be repeated. This should include the same vantage points, transects and focal points to ensure comparability of the pre and post-construction datasets;
- Duration: Monitoring on bird movements and abundance should commence at the start of construction and continue for at least two years post-construction. The need for this detailed monitoring should be reviewed at the end of this period. Observer-based SDOD (bird spotting) and associated data collection should continue;
- Seasonality: It is recommended that the two-year post-construction survey involve 12 surveys such that each of the four seasons are sampled three times; and
- It is recommended that the abundance monitoring be conducted by a separate stand-alone team (as would be the case for carcass monitoring and carrion removal). This is needed to achieve comparability with the pre-construction monitoring dataset. This is because the location of the vantage points and the surveillance protocol employed by the bird spotters is geared towards maximising the detection of collision-bound priority species.

7.1.2.2 Observer-based Shutdown on Demand (SDOD)

Observer-based shut down on demand (SDOD) should be implemented. It should represent the primary line of active collision avoidance and be backed by automated SDOD (cameras and radar) on pre-selected turbines to cover periods of absence or inclement weather. The location of each vantage point must be carefully selected to optimise the detection of potential collision events. The results of the radar and pre-construction monitoring should be used to inform the number and location of vantage points that allow for maximal efficacy of observer-based SDOD. As a minimum, enough vantage points should be chosen to allow each turbine to be observed from a vantage point no further than 2 km away.

The efficacy of this system will, however, face challenges due to the extreme and highly erratic climatic conditions on site. Cloud, mist and rain can dramatically hamper visibility and, therefore, the efficacy of this system for several days at a time. However, vultures and other priority species were still observed flying in these conditions between breaks in the weather. It is recommended that selected turbines may need to be shut down in periods of intense mist and cloud cover. Additionally, topography notably restricts viewshed within the WEF. As such multiple VPs would be required.

The large size of the WEF, challenging terrain, road conditions and weather pose logistical challenges. Distance between VPs requires careful planning. Exposure at Kromhof especially with regards to lightning and cold poses a real safety hazard which should be carefully managed. It is recommended that paid lightning warning software is used to warn and evacuate observers from hilltops as necessary during approaching lightning storms or snowfalls.

Observer-based SDOD would involve a considerable undertaking by a very large team (likely > 15 core staff members, one team lead and one temp to fill in per WEF) of well-trained observers capable of working (safely) at sub-zero temperatures in harsh conditions, including snow blizzards. The team would need to be employed full-time and require full company support. The team would also require high quality long-range VHF radios as well as satellite phones (very limited reception) and be connected by cellphones too. They should also be linked to an emergency response and 4x4 recovery team.

7.1.2.3 Automated SDOD

Given the size of WEFs, terrain and inclement weather which limit human observer ability a combination of radar and intelligent camera systems (e.g. IdentiFlight) should be used in tandem to allow for near-continuous, automated SDOD. This would require an integrative software solution such as that provided by Robin Radar Systems. Automated SDOD must be conducted continually over the full lifespan of the WEF. Under a realistic scenario where budget constrains the number of cameras that can be fitted, then an experimental project would need to be designed (separate scope of work, by a suitable SACNASP registered avifauna specialist in conjunction with the chosen supplier) using statistical power analysis to decide upon the number and location of placements. Aspects regarding radar positioning, cost, mobility, frequency and training should be ironed out before construction as detailed in the Section 6.1.1 above.

7.1.2.4 Bird Fatalities

Monitoring of bird fatalities is of critical importance to understanding the impact of the WEF on local bird populations, adapting mitigation and contributing to our understanding of the cumulative impact of wind energy on birds in South Africa. To do this it is important to gather standardised data which quantifies which birds and how many of them are being killed at the WEF on an annual basis (typically expressed as birds per turbine per year).

7.1.2.4.1 Bird carcass searches

Bird carcass searches should be conducted in tandem with the operational abundance monitoring and observer-based SDOD. Bird carcass searches must continue for the lifespan of the WEF. As a minimum, intensive search should be conducted for the first three years and thereafter on year 5 and every five years thereafter. A balance in search effort will need to be found that represents the best compromise between accuracy and the practical constraints imposed by the size of the WEF, logistics and costs. The following considerations apply:

- Turbines to be searched:
    - All turbines should be searched within the proposed Kromhof WEF; and
- Search protocol at each turbine

- The area below each turbine should be regularly searched for bird carcasses;
- The horizontal search radius should be no less than 75% of the turbine height (ground to vertical rotor tip);
- Transects should be slowly walked at 10 m intervals apart within the search area;
- The time spent surveying will vary among turbines depending on terrain;
- It may be necessary to control for differences in detection imposed by terrain and groundcover by assigning visibility classes;
- Search interval should:
  - Be informed by the results of the initial searcher efficiency and scavenger removal bias investigations.
  - Generally, be shorter than the time taken for the carcass to disappear due to decomposition or scavengers.
- Given that the priority species most likely to collide with turbines at the WEF tend to be large-bodied soaring birds, it is recommended that search area is prioritised over search intensity.

7.1.2.4.2 Controlling for Bias

Bias associated with searcher efficiency and scavenger / decay removal need to be factored into the fatality estimates. A control sample of dead birds such non-white chickens (at least one per turbine) and other objects should be used to evaluate this during the initial scavenger removal / decay trials. This should be done under the supervision of the avifaunal specialist. These control objects should be placed randomly within the search area at intervals through the study by a non-carcass searcher. The locations of the objects must be precisely recorded and the objects themselves must be numbered and marked to identify them as controls. The controls should be bagged and logged by the searchers in the same way a real fatality would be.

7.1.2.4.3 Recording and storage of bird carcasses

All fatalities should:

- Be classified as either:
  - Intact (whole and not yet fed upon)
  - Partial (partially fed upon or decomposed); or
  - Feather Spot (>10 feathers but no carcass).
- Be mapped by recording the precise location of each fatality with a GPS;
- Photographed as found;
- It is recommended that a cellular application such as Map Marker or Avenza is used to capture the data and a photo with the associated locality point.
- Bagged and labelled (date, time, coordinates, turbine number, distance and direction from turbine).
- Preserved in a dedicated deep freeze on site.
- Check for tags, rings or GPS trackers on the birds. Report fatality to the relevant authority (the organisation who tracked the bird, if uncertain a good starting place for vultures would be Vulpro followed by EWT and for Martial Eagle EWT, for Southern Bald Ibis, Secretarybird and cranes BLSA).

7.1.2.5 Carrion Management:

A Vulture Food Management Programme will need to be implemented to ensure all dead livestock/wildlife on site are removed as soon as possible and transferred to designated vulture restaurants sufficiently far away from the WEF. The program would need to be an intensive undertaking by a team of full-time rangers working in close radio communication with the farmers and bird spotters. Although efforts have been made by Kromhof WEF to design and trial a carrion management program, it is recommended that it be halted and only be fully implemented after environmental authorisation (if granted) to avoid the risk of imposing unnecessarily large-scale foraging habitat constraints on an already threatened species. The proposed Livestock Carcass Management Plan for the Kromhof WEF Verkykerskop Wind Energy Cluster is in draft stage. Essentially, all carrion is planned to be logged on a register which records the date, time, carcass types, presence of vultures, nearest turbine number, action taken (burnt, buried, covered, taken to vulture restaurant) and response time. The vehicle/s used must be 4x4, fitted with long range UHF radios and equipped with a small first aid, puncture repair and recovery kit.

7.1.2.6 Reporting

Results of the post-construction monitoring program should be summarised in quarterly progress reports. A more detailed analysis of the monitoring results should be compiled annually detailing:

- Results of the live-bird monitoring on abundance and flight activity:
    - Avian diversity and abundance, particularly with regards to priority species;
    - Hotspots for priority species;
    - Flight activity of priority species;
    - Breeding roosting and feeding activity of priority species;
    - Overall comparison with pre-construction baseline in terms of abundance diversity, flight activity and breeding status of priority species; and
    - Changes in avifaunal sensitivity and integrity of available habitat
- Results of the bird carcass searches
    - Observer efficiency and scavenger removal rate;
    - Total numbers of bird carcasses found per species;
    - Fatality rates per species both absolute and adjusted expressed both in terms of birds; per turbine per year and birds per MW;
    - Details on bird mortalities, suspected cause of death, injuries age, sex;
    - Produce a map detailing all fatalities recorded and identify problematic areas or turbines;
    - Recommend measures to minimise further fatalities;
    - Where possible collision rates should be contextualised in terms of their cumulative effect on long term population viability for the species;
- Results of the observer-based SDOD:
    - Report on the total number of detections of priority species per risk zone:
        - Outer (greater than 2 km from turbine, be aware);
        - Middle (less than 2 km but greater than 1 km get ready); and
        - Core (less than 1 km)
    - Number of shutdowns (per vantage point, per species, per month);
    - Summary on efficacy with recommendations for improvement.
- Results of the automated SDOD (Radar and Cameras):
    - Detailed flight paths (radar)
    - Highlight trends in local and migratory bird movements across WEF (temporal and spatial)
    - Total number of detections and shutdowns;
    - Contrast with total number of camera observed bird strikes and found carcasses;
    - Recommendations for improvement or need to adapt strategies or turbine coverage.

8. Conclusion

At a regional scale, large tracts of intact plateau grasslands (4598 ha) in the southern region of the Kromhof WEF were recently zoned as global KBA (Eastern Free State Escarpment, predominantly in recognition of its avifaunal importance) effectively occupying 63% of the proposed WEF. Additionally, several well-established birding routes traverse the AOI. At a local scale 31 regionally red-listed species (of which 19 are Threatened) have been documented within the proposed Kromhof WEF, a high number in the South African context. The proposed WEF intersects 24 nest buffers of priority species namely Cape Vulture Roosts 1-5, Southern Bald Ibis Roosts 5, 11, 14, 16, 17, 18 and 19, Blue Crane Nests 1-3, Jackal Buzzard Nest 3, Lanner Falcon Nests 2-3, Rock Kestrel Nest 1, and Verreaux's Eagle Nests 2 and 3.

Three key habitats were identified in the proposed Kromhof WEF that are particularly important from an avifaunal perspective and have development implications (in terms of infrastructure exclusion) namely the cliffs and ridges, plateau grasslands and wetlands (particularly along the Muel River floodplain). Several distinct cliffs and ridgelines were identified for their importance in providing nesting and / or soaring habitat for several priority species, of which the Mont Pelaan ridge and the cliffs along the Muel floodplain are considered most significant. This habitat supports four Southern Bald Ibis Roosts (14, 16, 17 and 18), one Rock Kestrel Nest (1), one Jackal Buzzard Nest (3) and one Verreaux's Eagle Nest (4). In terms of grasslands the Kromhof WEF supports some of most extensive and representative plateau grassland habitat to be found within the VWC. The highest and most pristine plateau grassland habitat (associated with the Mont Pelaan ridge along the southern boundary) has been identified as important core habitat for threatened high-altitude grassland species. Most significant in this regard are the breeding populations of Rudd's Lark (Endangered) and Yellow-breasted Pipit (Vulnerable). Both species engage in protracted aerial displays throughout the summer months. The modelled habitat exclusion zones for these species within the proposed WEF are large due to it being; "…*in the core area of occupancy and global hotspot for all three of these endemic, threatened and habitat specialist species. This area hosts some of the highest densities and most intact habitats for these species globally"* (Dr. R. Colyn pers. comm, 2025). The plateau grasslands are also frequently used by Denham's Bustard (Vulnerable) Blue Korhaan (Near-Threatened), Blue Crane (Vulnerable) and Southern Bald Ibis (Vulnerable). Wetlands in the Kromhof WEF provides important habitat for Maccoa Duck, Southern Bald Ibis and all three of South Africa's crane species (Blue Crane, Grey-crowned Crane and Wattled Crane). The recently created dam along the Muel floodplain supports significant congregations of waterbirds (including a heronry) and may reach nationally or potentially globally significant thresholds for certain species. Additionally, a robust, field-validated habitat modelling exercise for Species 23 conducted by AfriAvian (2025) revealed a large contiguous network of suitable core wetland patches for the species within the AOI, of which 11 occur within the Kromhof WEF. Their study highlights that "… *the Verkykerskop landscape may function as a critical stepping-stone or movement corridor within the species' fragmented range, further emphasizing the need for precautionary land-use planning and the protection of identified connectivity zones*".

Tracking data from Vulpro and EWT reveal that the Kromhof WEF is actively and extensively utilised by Cape Vulture, White-backed Vulture and Martial Eagle which all showed the greatest flight activity within the potential rotor sweep height range. The Vulpro (2025) data shows significant triangulation between the various roosts in the area and reveals the regular use of at least one favoured overnight pylon roosts occur in the Kromhof WEF which has been observed to host up 235 birds. The EWT (2025) Martial Eagle tracking report shows that the western half of Kromhof is actively utilised by a tracked Martial Eagle. The report concluded that "*the tracked adult Male Martial Eagle, Brad, extensively utilises the project site, putting this individual at significant risk of turbine collisions, particularly within its core ranges (5-6 km from the active nest)*". Considering the sensitivity of the WEF for vultures as evidenced through the pre-construction monitoring data, supported by Vulpro tracking data and as indicated in the high SABAP2 reporting rates for the pentads as well as the Vulture Theme of the National

Environmental Screening Tool (high), it is our informed opinion that the project poses a significant and direct risk to these large raptors through collision with turbines.

The main impacts anticipated for avifauna at Kromhof WEF involve habitat loss, collisions and cumulative effects (all of which have a high residual impact significance). Habitat loss has significant potential implications for threatened high-altitude grassland species such as Rudd's Lark which are patchily distributed and have a small extent of occurrence on a global scale. Any loss of there already restricted range should be considered significant and any loss of core breeding habitat should be avoided all together. In terms of collision risk Southern Bald Ibis, Cape Vulture, Amur Falcon and Jackal Buzzard stand out from a passage rate perspective. In terms of Southern Bald Ibis four breeding roosts have buffer implications for the Kromhof WEF. For Cape Vulture, seven distinct roosts on separate inselbergs have been identified within a 50 km radius of the Kromhof WEF. These include five to the south of the project area one to the west and one to the north-west. Of these, successful breeding was confirmed at Roost 3 on Nelson's Kop (27 km south-west). A strong seasonal variation in their flight activity was uncovered with flight activity peaking significantly in summer. Migratory Amur Falcon visit the WEF during the summer to forage and congregate annually along the Muel River floodplain where they perch in large numbers on the powerlines and trees. A pair of Jackal Buzzard breed at Nest 3 near VP 9 and thus the species is well represented in the flight path data and susceptible to collision, particularly in the eastern regions of the WEF. Additionally, in-field observations suggest that Yellow-breasted Pipit and Rudd's Lark may also be prime candidates for collision from a flight duration perspective, particularly in the summer months due to their breeding behaviour which involves protracted aerial displays at potential rotor sweep height. Predicted pre-mitigation fatality rates (assuming 98% avoidance) are high, in spite of the amended layout. Lastly noise generated by the turbines is highlighted as a potentially significant impact for threatened songbirds. In this regard two species namely Rudd's Lark, and Yellow-breasted Pipit are particularly susceptible due to a combination of their Threatened status and call-dependant breeding behaviour. There are currently no operational wind energy facilities on high-altitude plateau grasslands associated with the Great Escarpment in the eastern Free State and the magnitude of collision risk to many of these species which occupy these areas remains unchartered territory. Considering the high degree of overlap between wind resources and the dense occurrence of threatened species along the Great Escarpment the cumulative impact of establishing wind farms in this region is anticipated to have a high cumulative impact over the long term.

Since the completion and submission of this report to the client, an effort has been made to reduce the number of turbines and amend the turbine layout so as to avoid the identified Zone 1 (all infrastructure exclusion zone based primarily on core habitat for threatened high-altitude passerines and Species 23) areas as well as Zone 2 areas (collision-risk infrastructure exclusion zones). Additionally, all planned auxiliary infrastructure has been positioned outside of the Zone 1 exclusion areas (although a few planned roads do cross portions of these areas, but largely avoided core habitat). Under this layout the residual impact of habitat loss (with mitigation) is reduced Moderate. The residual risk for collisions with turbines remains high (in spite of mitigation). This is due to the high abundance and diversity of priority species flights across the proposed WEF area. This together with the highly erratic spatial distribution of these flights and the inherent potential for stochastic events evolving the unpredictable occurrence of large flocks of Cape Vulture, Southern Bald Ibis and Amur Falcon represent a district collision risk which may be difficult to mitigate, given the visibility constraints imposed by the terrain and inclement weather of the area.

9. Specialist Statement

Given the largely intact, high-altitude grassland nature of the project area, its close proximity to the Great Escarpment (important for localised movements and actively utilised by soaring birds), high diversity and abundance of red-listed and/or endemic species and high number of priority species nests and roosts (including seven Cape Vulture roosts within 50 km of the WEF), it is apparent that the proposed WEF is situated in an area of considerable avifaunal importance and sensitivity. Aside from the high collision potential posed to several Threatened soaring birds, another significant consideration at the proposed Kromhof WEF is the large proportion of the WEF identified as being core habitat for Threatened grassland (e.g. Rudd's Lark and Yellow-breasted Pipit) and wetland species (e.g. Species 23) which significantly limits avoidance options.

Overall, based on robust, field-verified habitat modelling, intensive long term flight activity data (>2 years monitoring) and projected pre-mitigation fatality rates it is the specialist's informed opinion that (in spite of micro-siting and mitigation) the establishment of wind turbine generators (and associated infrastructure) in this area poses a significant residual risk to several Threatened species through habitat alteration and collision with turbines and associated infrastructure. It is cautioned that significant mortalities of multiple Threatened species are likely to occur annually. Although recent advances in mitigation have shown promising results in curbing fatalities, proactive planning to avoid high-risk regions for WEF development should take precedence over costly reactive measures to minimize fatalities.

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Appendix 1: Present and Potentially Occurring Avifauna

Common Name	Scientific Name	Conservation Status					Priority Species	LO Kromhof	VWC	Control	VWC & Control	AOI	SABAP (n=cards)
		Global	Regional	TOPS	FS	Endemicity							
Common Ostrich	*Struthio camelus*	LC	LC					5	x		x	x	2
Grey-winged Francolin	*Scleroptila afra*	LC	LC		OG	E	x	1	x	x	x	x	6
Red-winged Francolin	*Scleroptila levaillantii*	LC	LC		OG			1	x	x	x	x	5
Natal Spurfowl	*Pternistis natalensis*	LC	LC		OG			1	x	x	x	x	2
Red-necked Spurfowl	*Pternistis afer*	LC	LC		OG			2	x		x	x	
Swainson's Spurfowl	*Pternistis swainsonii*	LC	LC		OG			1	x	x	x	x	10
Common Quail	*Coturnix coturnix*	LC	LC		OG			1	x	x	x	x	10
Helmeted Guineafowl	*Numida meleagris*	LC	LC		OG			1	x	x	x	x	13
White-faced Whistling Duck	*Dendrocygna viduata*	LC	LC		PG			1	x		x	x	
White-backed Duck	*Thalassornis leuconotus*	LC	NT		PG		x	1	x		x	x	
Maccoa Duck	*Oxyura maccoa*	EN	VU		PG		x	1	x		x	x	
Egyptian Goose	*Alopochen aegyptiaca*	LC	LC		PG			1	x	x	x	x	15
South African Shelduck	*Tadorna cana*	LC	LC		OG			1	x	x	x	x	6
Spur-winged Goose	*Plectropterus gambensis*	LC	LC		OG			1	x	x	x	x	9
Knob-billed Duck	*Sarkidiornis melanotos*	LC	NT		PG		x	3					
African Black Duck	*Anas sparsa*	LC	LC		PG			1	x	x	x	x	6
Yellow-billed Duck	*Anas undulata*	LC	NT		OG			1	x	x	x	x	14
Cape Shoveler	*Spatula smithii*	LC	NT		PG		x	1	x		x	x	2
Red-billed Teal	*Anas erythrorhyncha*	LC	NT		OG		x	1	x	x	x	x	5
Southern Pochard	*Netta erythrophthalma*	LC	NT		PG		x	1	x		x	x	
Common (Kurrichane) Buttonquail	*Turnix sylvaticus*	LC	LC		PG			2				x	
Greater Honeyguide	*Indicator indicator*	LC	LC		PG			1	x	x	x	x	2
Lesser Honeyguide	*Indicator minor*	LC	LC		PG			3					
Brown-backed Honeybird	*Prodotiscus regulus*	LC	LC		PG			3	x		x	x	
Red-throated Wryneck	*Jynx ruficollis*	LC	LC		PG			1	x	x	x	x	10
Ground Woodpecker	*Geocolaptes olivaceus*	NT	LC		PG	E	x	1	x	x	x	x	14

Common Name	Scientific Name	Conservation Status					Priority Species	LO Kromhof	VWC	Control	VWC & Control	AOI	SABAP (n=cards)
		Global	Regional	TOPS	FS	Endemicity							
Cardinal Woodpecker	*Dendropicos fuscescens*	LC	LC		PG			3	x	x	x	x	
Bearded Woodpecker	*Chloropicus namaquus*		LC		PG			3	x		x	x	
Olive Woodpecker	*Dendropicos griseocephalus*	LC	LC		PG			2	x	x	x	x	
Acacia Pied Barbet	*Tricholaema leucomelas*	LC	LC		PG			2		x	x	x	1
Black-collared Barbet	*Lybius torquatus*	LC	LC		PG			2		x	x	x	2
Crested Barbet	*Trachyphonus vaillantii*	LC	LC		PG			2				x	
African Hoopoe	*Upupa africana*	LC	LC		PG			1	x	x	x	x	9
Green Wood-hoopoe	*Phoeniculus purpureus*	LC	LC		PG			2	x	x	x	x	2
Lilac-breasted Roller	*Coracias caudatus*	LC	LC		PG			3	x		x	x	
Half-collared Kingfisher	*Alcedo semitorquata*	LC	VU		PG		x	1	x		x	x	1
Malachite Kingfisher	*Corythornis cristatus*	LC	LC		PG			1	x		x	x	7
Brown-hooded Kingfisher	*Halcyon albiventris*	LC	LC		PG			2	x		x	x	1
Giant Kingfisher	*Megaceryle maxima*	LC	LC		PG			1	x		x	x	6
Pied Kingfisher	*Ceryle rudis*	LC	LC		PG			1	x		x	x	2
White-fronted Bee-eater	*Merops bullockoides*	LC	LC		PG			3	x		x	x	
European Bee-eater	*Merops apiaster*	LC	LC		PG			1	x	x	x	x	
Speckled Mousebird	*Colius striatus*	LC	LC					1	x	x	x	x	8
Red-faced Mousebird	*Urocolius indicus*	LC	LC					1	x	x	x	x	
Jacobin Cuckoo	*Clamator jacobinus*	LC	LC		PG			4					
Great Spotted Cuckoo	*Clamator glandarius*	LC	LC		PG			4					
Red-chested Cuckoo	*Cuculus solitarius*	LC	LC		PG			1	x	x	x	x	4
Black Cuckoo	*Cuculus clamosus*	LC	LC		PG			3					1
Common Cuckoo	*Cuculus canorus*	LC	LC		PG			4					
Klaas's Cuckoo	*Chrysococcyx klaas*	LC	LC		PG			2	x	x	x	x	
Diederik Cuckoo	*Chrysococcyx caprius*	LC	LC		PG			1	x	x	x	x	5
Alpine Swift	*Tachymarptis melba*	LC	LC		PG			1	x	x	x	x	6
Common Swift	*Apus apus*	LC	LC		PG			1	x	x	x	x	1
African Black Swift	*Apus barbatus*	LC	LC		PG			1	x	x	x	x	10

Common Name	Scientific Name	Conservation Status					Priority Species	LO Kromhof	VWC	Control	VWC & Control	AOI	SABAP (n=cards)
		Global	Regional	TOPS	FS	Endemicity							
Little Swift	*Apus affinis*	LC	LC		PG			1	x	x	x	x	2
Horus Swift	*Apus horus*	LC	LC		PG			1	x	x	x	x	2
White-rumped Swift	*Apus caffer*	LC	LC		PG			1	x	x	x	x	11
Western Barn Owl	*Tyto alba*	LC	LC		PG			2		x	x	x	
African Grass Owl	*Tyto capensis*	LC	VU		PG		x	3					
Southern White-faced Owl	*Ptilopsis granti*	LC	LC		PG			2					
Cape Eagle-Owl	*Bubo capensis*	LC	LC		PG		x	2	x		x	x	2
Spotted Eagle-Owl	*Bubo africanus*	LC	LC		PG		x	1	x	x	x	x	3
Marsh Owl	*Asio capensis*	LC	NT		PG		x	2	x		x	x	
Fiery-necked Nightjar	*Caprimulgus pectoralis*	LC	LC		PG			1	x	x	x	x	1
Freckled Nightjar	*Caprimulgus tristigma*	LC	LC		PG			2					
Rock Dove	*Columba livia*	LC	LC		PG			2	x	x	x	x	4
Speckled Pigeon	*Columba guinea*	LC	LC					1	x	x	x	x	13
African Olive Pigeon	*Columba arquatrix*	LC	LC		PG			2	x	x	x	x	2
Laughing Dove	*Spilopelia senegalensis*	LC	LC					1	x	x	x	x	10
Ring-necked Dove	*Streptopelia capicola*	LC	LC					1	x	x	x	x	16
Red-eyed Dove	*Streptopelia semitorquata*	LC	LC		PG			1	x	x	x	x	15
Namaqua Dove	*Oena capensis*	LC	LC		PG			1	x	x	x	x	3
Denham's Bustard	*Neotis denhami*	NT	VU	VU	PG		x	1	x	x	x	x	4
Blue Korhaan	*Eupodotis caerulescens*	NT	VU		PG	E	x	1	x	x	x	x	5
White-bellied Korhaan	*Eupodotis senegalensis*	LC	VU		PG		x	1	x	x	x	x	3
Black-bellied Bustard	*Lissotis melanogaster*	LC	LC		PG		x	3				x	
Grey Crowned Crane	*Balearica regulorum*	EN	VU	EN	PG		x	1	x		x	x	10
Blue Crane	*Grus paradisea*	VU	VU	PS	OG		x	1	x	x	x	x	12
Wattled Crane	*Grus carunculata*	VU	EN	CR	PG		x	2	x		x	x	1
Striped Flufftail	*Sarothrura affinis*	LC	VU		PG		x	3	x		x	x	
Species 23	*Sarothrura ayresi*	CR	EN		PG		x	3					
African Rail	*Rallus caerulescens*	LC	LC		PG			2				x	1

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		Global	Regional	TOPS	FS	Endemicity							
African Crake	*Crecopsis egregia*	LC	LC		PG			1	x		x	x	
Corn Crake	*Crex crex*	LC	LC		PG			3					
Black Crake	*Zapornia flavirostra*	LC	LC		PG			2					1
Baillon's Crake	*Zapornia pusilla*	LC	NT		PG		x	2					
African Swamphen	*Porphyrio madagascariensis*	LC	LC		PG			2	x		x	x	
African (Purple) Swamphen	*Porphyrio madagascariensis*	LC	LC		PG			2					2
Common Moorhen	*Gallinula chloropus*	LC	LC		PG			1	x	x	x	x	6
Red-knobbed coot	*Fulica cristata*	LC	LC		OG			1	x	x	x	x	13
African Snipe	*Gallinago nigripennis*	LC	LC		PG			1	x	x	x	x	1
Common Greenshank	*Tringa nebularia*	LC	LC		PG			3					1
Common Sandpiper	*Actitis hypoleucos*	LC	LC		PG			1	x		x	x	
African Jacana	*Actophilornis africanus*	LC	LC		PG			1	x		x	x	
Spotted Thick-knee	*Burhinus capensis*	LC	LC		PG			1	x		x	x	2
Black-winged Stilt	*Himantopus himantopus*	LC	LC		PG			1	x		x	x	
Pied Avocet	*Recurvirostra avosetta*	LC	LC		PG			2					
Common Ringed Plover	*Charadrius hiaticula*	LC	LC		PG			3					
Kittlitz's Plover	*Charadrius pecuarius*	LC	LC		PG			3					
Three-banded Plover	*Charadrius tricollaris*	LC	LC		PG			1	x	x	x	x	2
Blacksmith Lapwing	*Vanellus armatus*	LC	LC		PG			1	x	x	x	x	9
African Wattled Lapwing	*Vanellus senegallus*	LC	LC		PG			1	x	x	x	x	4
Black-winged Lapwing	*Vanellus melanopterus*	LC	LC		PG			2	x		x	x	2
Crowned Lapwing	*Vanellus coronatus*	LC	LC		PG			1	x	x	x	x	4
Black-winged Pratincole	*Glareola nordmanni*	NT	LC		PG		x	4					
Whiskered Tern	*Chlidonias hybrida*	LC	LC		PG			1	x		x	x	2
African Cuckoo Hawk	*Aviceda cuculoides*	LC	LC		PG		x	4					
Black-winged Kite	*Elanus caeruleus*	LC	NT		PG		x	1	x	x	x	x	15
Yellow-billed Kite	*Milvus aegyptius*	LC	LC		PG		x	1	x	x	x	x	1
African Fish Eagle	*Haliaeetus vocifer*	LC	LC		PG		x	1	x	x	x	x	4

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Bearded Vulture	*Gypaetus barbatus*	NT	CR	CR	PG		x	2		x	x	x	
White-backed Vulture	*Gyps africanus*	CR	CR	EN	PG		x	1	x		x	x	
Cape Vulture	*Gyps coprotheres*	VU	VU	EN	PG		x	1	x	x	x	x	7
Black-chested Snake Eagle	*Circaetus pectoralis*	LC	LC		PG		x	1	x		x	x	1
Brown Snake Eagle	*Circaetus cinereus*	LC	LC		PG		x	4					1
African Marsh Harrier	*Circus ranivorus*	LC	VU		PG		x	1	x		x	x	1
Black Harrier	*Circus maurus*	EN	EN		PG	NE	x	2	x		x	x	2
Pallid Harrier	*Circus macrourus*	NT	NA		PG		x	4					
Montagu's Harrier	*Circus pygargus*	LC	LC		PG		x	2	x		x	x	
African Harrier-Hawk	*Polyboroides typus*	LC	LC		PG		x	1	x	x	x	x	6
Pale Chanting Goshawk	*Melierax canorus*	LC	LC		PG		x	1	x		x	x	
Little Sparrowhawk	*Accipiter minullus*	LC	LC		PG		x	2	x		x	x	
Rufous-breasted Sparrowhawk	*Accipiter rufiventris*	LC	LC		PG		x	1	x	x	x	x	3
Black Sparrowhawk	*Accipiter melanoleucus*	LC	LC		PG		x	1	x	x	x	x	2
Common Buzzard	*Buteo buteo*	LC	LC		PG		x	1	x	x	x	x	12
Forest Buzzard	*Buteo trizonatus*	NT	NT		PG	E	x	3					2
Jackal Buzzard	*Buteo rufofuscus*	LC	LC		PG	NE	x	1	x	x	x	x	14
Tawny Eagle	*Aquila rapax*	VU	EN	EN	PG		x	1	x		x	x	
Verreaux's Eagle	*Aquila verreauxii*	LC	VU		PG		x	1	x	x	x	x	2
Booted Eagle	*Hieraaetus pennatus*	LC	LC		PG		x	1	x		x	x	
Wahlberg's Eagle	*Hieraaetus wahlbergi*	LC	LC		PG			1	x		x	x	
Martial Eagle	*Polemaetus bellicosus*	EN	EN	EN	PG		x	1	x	x	x	x	1
Long-crested Eagle	*Lophaetus occipitalis*	LC	LC		PG			3	x		x	x	
Crowned Eagle	*Stephanoaetus coronatus*	NT	VU		PG		x	4					
Secretarybird	*Sagittarius serpentarius*	EN	VU		PG		x	1	x	x	x	x	9
Lesser Kestrel	*Falco naumanni*	LC	VU		PG		x	2	x		x	x	1
Rock Kestrel	*Falco rupicolus*	LC	LC		PG		x	1	x	x	x	x	9
Greater Kestrel	*Falco rupicoloides*	LC	LC		PG		x	1	x	x	x	x	1

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		Global	Regional	TOPS	FS	Endemicity							
Red-footed Falcon	*Falco vespertinus*	VU	VU		PG		x	1	x	x	x	x	2
Amur Falcon	*Falco amurensis*	LC	LC		PG		x	1	x	x	x	x	14
Eurasian Hobby	*Falco subbuteo*	LC	LC		PG		x	3					
Lanner Falcon	*Falco biarmicus*	LC	NT		PG		x	1	x	x	x	x	7
Peregrine Falcon	*Falco peregrinus*	LC	LC		PG		x	1	x		x	x	
Little Grebe	*Tachybaptus ruficollis*	LC	LC		PG			1	x	x	x	x	7
African Darter	*Anhinga rufa*	LC	NT		PG		x	1	x		x	x	1
Reed Cormorant	*Microcarbo africanus*	LC	LC					1	x	x	x	x	11
White-breasted Cormorant	*Phalacrocorax lucidus*	LC	LC					2	x		x	x	4
Black Heron	*Egretta ardesiaca*	LC	LC		PG			4					
Little Egret	*Egretta garzetta*	LC	LC		PG			1	x		x	x	2
Yellow-billed Egret	*Ardea intermedia*	LC	LC		PG			1	x	x	x	x	4
Great Egret	*Ardea alba*	LC	NT		PG		x	1	x		x	x	1
Grey Heron	*Ardea cinerea*	LC	LC		PG			1	x	x	x	x	6
Black-headed Heron	*Ardea melanocephala*	LC	LC		PG			1	x	x	x	x	16
Goliath Heron	*Ardea goliath*	LC	LC		PG			3					
Purple Heron	*Ardea purpurea*	LC	LC		PG			2	x		x	x	
Western Cattle Egret	*Bubulcus ibis*	LC	LC		PG			1	x	x	x	x	14
Squacco Heron	*Ardeola ralloides*	LC	LC		PG			2	x		x	x	
Green-backed (Striated) Heron	*Butorides striata*	LC	LC		PG			3					
Black-crowned Night Heron	*Nycticorax nycticorax*	LC	NT		PG		x	4					
Little Bittern	*Ixobrychus minutus*	LC	LC		PG			2					
Little Bittern	*Ixobrychus minutus*	LC	LC		PG			4					
Dwarf Bittern	*Ixobrychus sturmii*	LC	LC		PG			3				x	
Eurasian Bittern	*Botaurus stellaris*	LC	LC		PG			4					
Eurasian Bittern	*Botaurus stellaris*	LC	LC		PG			4					
Hamerkop	*Scopus umbretta*	LC	NT		PG		x	1	x	x	x	x	8
Greater Flamingo	*Phoenicopterus roseus*	LC	NT		PG		x	4				x	

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Lesser Flamingo	*Phoeniconaias minor*	NT	NT		PG		x	4					
Glossy Ibis	*Plegadis falcinellus*	LC	LC		PG			1	x		x	x	2
Hadeda Ibis	*Bostrychia hagedash*	LC	LC		PG			1	x	x	x	x	16
Southern Bald Ibis	*Geronticus calvus*	VU	NT	VU	PG	E	x	1	x	x	x	x	16
African Sacred Ibis	*Threskiornis aethiopicus*	LC	LC		PG			1	x		x	x	7
African Spoonbill	*Platalea alba*	LC	LC		PG			1	x		x	x	4
Yellow-billed Stork	*Mycteria ibis*	LC	VU		PG		x	2		x	x	x	
Black Stork	*Ciconia nigra*	LC	EN		PG		x	1	x	x	x	x	1
Abdim's Stork	*Ciconia abdimii*	LC	LC		PG		x	1	x		x	x	
White Stork	*Ciconia ciconia*	LC	LC		PG		x	1	x	x	x	x	7
Marabou Stork	*Leptoptilos crumenifer*	LC	NT		PG		x	4					
Black-headed Oriole	*Oriolus larvatus*	LC	LC		PG			3	x	x	x	x	
Fork-tailed Drongo	*Dicrurus adsimilis*	LC	LC		PG			1	x	x	x	x	5
African Paradise Flycatcher	*Terpsiphone viridis*	LC	LC		PG			2		x	x	x	3
Brubru	*Nilaus afer*	LC	LC		PG			3	x	x	x	x	
Brown-crowned Tchagra	*Tchagra australis*	LC	LC		PG			3		x	x	x	
Southern Boubou	*Laniarius ferrugineus*	LC	LC		PG			1	x	x	x	x	6
Bokmakierie	*Telophorus zeylonus*	LC	LC		PG			1	x	x	x	x	17
Orange-breasted Bush-Shrike	*Chlorophoneus sulfureopectus*	LC	LC		PG			4					
Olive Bush-Shrike	*Chlorophoneus olivaceus*	LC	LC		PG			3					1
Cape Batis	*Batis capensis*	LC	LC		PG			3	x	x	x	x	2
Chinspot Batis	*Batis molitor*	LC	LC		PG			3					
Cape Crow	*Corvus capensis*	LC	LC					1	x	x	x	x	17
Pied Crow	*Corvus albus*	LC	LC					1	x	x	x	x	10
White-necked Raven	*Corvus albicollis*	LC	LC				x	1	x	x	x	x	3
Red-backed Shrike	*Lanius collurio*	LC	LC		PG			2	x	x	x	x	1
Lesser Grey Shrike	*Lanius minor*	LC	LC		PG			3					

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Southern Fiscal	*Lanius collaris*	LC	LC		PG			1	x	x	x	x	17
Black Cuckooshrike	*Campephaga flava*	LC	LC		PG			2	x		x	x	
Sand Martin	*Riparia riparia*	LC	LC		PG			2	x		x	x	1
Brown-throated Martin	*Riparia paludicola*	LC	LC		PG			1	x	x	x	x	10
Banded Martin	*Neophedina cincta*	LC	LC		PG			1	x	x	x	x	16
Barn Swallow	*Hirundo rustica*	LC	LC		PG			1	x	x	x	x	16
White-throated Swallow	*Hirundo albigularis*	LC	LC		PG			1	x	x	x	x	12
Greater Striped Swallow	*Cecropis cucullata*	LC	LC		PG			1	x	x	x	x	16
Lesser Striped Swallow	*Cecropis abyssinica*	LC	LC		PG			2	x	x	x	x	1
Red-breasted Swallow	Cecropis semirufa	LC	LC		PG			4					
South African Cliff Swallow	*Petrochelidon spilodera*	LC	LC		PG	E		1	x	x	x	x	13
Large Rock Martin	*Ptyonoprogne fuligula*	LC	LC		PG			1	x	x	x	x	12
Common House Martin	*Delichon urbicum*	LC	LC		PG			1	x	x	x	x	3
Black Saw-wing	*Psalidoprocne pristoptera*	LC	LC		PG			3	x		x	x	
Dark-capped Bulbul	*Pycnonotus tricolor*	LC	LC					1	x	x	x	x	15
African Red-eyed Bulbul	*Pycnonotus nigricans*	LC	LC					4					1
Fairy Flycatcher	*Stenostira scita*	LC	LC		PG	NE		1	x	x	x	x	
Cape Grassbird	*Sphenoeacus afer*	LC	LC		PG	NE		1	x	x	x	x	4
Long-billed crombec	*Sylvietta rufescens*	LC	LC		PG			4					
Little Rush Warbler	*Bradypterus baboecala*	LC	LC		PG			2	x		x	x	3
Barratt's Warbler	*Bradypterus barratti*	LC	LC		PG	NE	x	1	x	x	x	x	2
Common Reed Warbler	*Acrocephalus scirpaceus*	LC	LC		PG			3	x		x	x	1
Lesser Swamp Warbler	*Acrocephalus gracilirostris*	LC	LC		PG			2	x		x	x	3
Willow Warbler	*Phylloscopus trochilus*	LC	LC		PG			1	x	x	x	x	2
Arrow-marked Babbler	*Turdoides jardineii*	LC	LC		PG			4					
Bush Blackcap	*Sylvia nigricapillus*	VU	VU		PG	E	x	3	x	x	x	x	1
Cape White-eye	*Zosterops virens*	LC	LC		PG	NE		1	x	x	x	x	10
Orange River White-eye	*Zosterops pallidus*	LC	LC		PG			3					1

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Lazy Cisticola	*Cisticola aberrans*	LC	LC		PG			1	x	x	x	x	2
Wailing Cisticola	*Cisticola lais*	LC	LC		PG			1	x	x	x	x	9
Levaillant's Cisticola	*Cisticola tinniens*	LC	LC		PG			1	x	x	x	x	14
Neddicky	*Cisticola fulvicapilla*	LC	LC		PG			1	x	x	x	x	9
Zitting Cisticola	*Cisticola juncidis*	LC	LC		PG			1	x	x	x	x	12
Desert Cisticola	*Cisticola aridulus*	LC	LC		PG			3					2
Cloud Cisticola	*Cisticola textrix*	LC	LC		PG	N-end		1	x	x	x	x	12
Pale-crowned Cisticola	*Cisticola cinnamomeus*	LC	LC		PG			1	x	x	x	x	6
Wing-snapping Cisticola	*Cisticola ayresii*	LC	LC		PG			1	x	x	x	x	15
Tawny-flanked Prinia	*Prinia subflava*	LC	LC		PG			1	x	x	x	x	1
Black-chested Prinia	*Prinia flavicans*	LC	LC		PG			1	x	x	x	x	3
Drakensberg Prinia	*Prinia hypoxantha*	LC	LC		PG	E		1	x	x	x	x	8
Bar-throated Apalis	*Apalis thoracica*	LC	LC		PG			1	x	x	x	x	2
Melodious Lark	*Mirafra cheniana*	LC	NT		PG	NE	x	1	x	x	x	x	1
Rufous-naped Lark	*Mirafra africana*	LC	LC		PG			3				x	2
Eastern clapper Lark	*Mirafra fasciolata*	LC	LC		PG			1	x	x	x	x	4
Rudd's Lark	*Heteromirafra ruddi*	EN	EN		PG	E	x	1	x	x	x	x	2
Spike-heeled Lark	*Chersomanes albofasciata*	LC	LC		PG			1	x	x	x	x	8
Eastern Long-billed Lark	*Certhilauda semitorquata*	LC	LC		PG	E		1	x	x	x	x	9
Red-capped Lark	*Calandrella cinerea*	LC	LC		PG			1	x	x	x	x	14
Botha's Lark	*Spizocorys fringillaris*	EN	CR		PG	E	x	2	x		x	x	1
Cape Rock Thrush	*Monticola rupestris*	LC	LC		PG	E	x	1	x	x	x	x	5
Sentinel Rock Thrush	*Monticola explorator*	NT	LC		PG	E	x	1	x	x	x	x	3
Groundscraper Thrush	*Turdus litsitsirupa*	LC	LC		PG			2	x		x	x	1
Olive Thrush	*Turdus olivaceus*	LC	LC		PG			2	x	x	x	x	3
Southern Black flycatcher	*Melaenornis pammelaina*	LC	LC		PG			2					
Fiscal Flycatcher	*Melaenornis silens*	LC	LC		PG	NE		1	x	x	x	x	1
Spotted flycatcher	*Muscicapa striata*	LC	LC		PG			2					

Common Name	Scientific Name	Conservation Status					Priority Species	LO Kromhof	VWC	Control	VWC & Control	AOI	SABAP (n=cards)
		Global	Regional	TOPS	FS	Endemicity							
African Dusky Flycatcher	*Muscicapa adusta*	LC	LC		PG			2					1
Cape Robin-Chat	*Cossypha caffra*	LC	LC		PG			1	x	x	x	x	14
White-browed Robin-Chat	*Cossypha heuglini*	LC	LC		PG			3		x	x	x	
Chorister Robin-Chat	*Cossypha dichroa*	LC	LC		PG	E	x	4					1
African StoneChat	*Saxicola torquatus*	LC	LC		PG			1	x	x	x	x	17
Buff-streaked Chat	*Campicoloides bifasciatus*	LC	LC		PG	E		1	x	x	x	x	8
Mountain Wheatear	*Myrmecocichla monticola*	LC	LC		PG			1	x	x	x	x	12
Sickle-winged Chat	*Emarginata sinuata*	LC	LC		PG	NE	x	1	x		x	x	
Familiar Chat	*Oenanthe familiaris*	LC	LC		PG			1	x	x	x	x	9
Ant-eating Chat	*Myrmecocichla formicivora*	LC	LC		PG			1	x	x	x	x	16
Mocking Cliff Chat	*Thamnolaea cinnamomeiventris*	LC	LC					1	x	x	x	x	3
Red-winged Starling	*Onychognathus morio*	LC	LC					1	x	x	x	x	10
Cape Starling	*Lamprotornis nitens*	LC	LC		PG			1	x	x	x	x	13
Pied Starling	*Lamprotornis bicolor*	LC	LC			E		1	x	x	x	x	16
Wattled Starling	*Creatophora cinerea*	LC	LC		PG			3					
Common Myna	*Acridotheres tristis*	LC	LC					2	x		x	x	
Amethyst Sunbird	*Chalcomitra amethystina*	LC	LC		PG			1	x	x	x	x	1
Malachite Sunbird	*Nectarinia famosa*	LC	LC		PG			1	x	x	x	x	11
Southern Double-collared Sunbird	*Cinnyris chalybeus*	LC	LC		PG	NE		3					
Greater Double-collared Sunbird	*Cinnyris afer*	LC	LC		PG	E		1	x	x	x	x	1
White-bellied Sunbird	*Cinnyris talatala*	LC	LC		PG			3					
Gurney's Sugarbird	*Promerops gurneyi*	LC	LC		PG	NE	x	2	x		x	x	
White-browed Sparrow-Weaver	*Plocepasser mahali*	LC	LC					2	x		x	x	2
Lesser Masked Weaver	*Ploceus intermedius*	LC	LC					2	x		x	x	
Cape Weaver	*Ploceus capensis*	LC	LC			NE		1	x	x	x	x	16
Southern Masked Weaver	*Ploceus velatus*	LC	LC					1	x	x	x	x	16
Village Weaver	*Ploceus cucullatus*	LC	LC					2	x		x	x	

Common Name	Scientific Name	Conservation Status					Priority Species	LO Kromhof	VWC	Control	VWC & Control	AOI	SABAP (n=cards)
		Global	Regional	TOPS	FS	Endemicity							
Red-billed Quelea	*Quelea quelea*	LC	LC					1	x	x	x	x	13
Yellow-crowned Bishop	*Euplectes afer*	LC	LC					1	x	x	x	x	14
Southern Red Bishop	*Euplectes orix*	LC	LC					1	x	x	x	x	16
Yellow Bishop	*Euplectes capensis*	LC	LC					1	x	x	x	x	5
Fan-tailed Widowbird	*Euplectes axillaris*	LC	LC					2	x	x	x	x	5
White-winged Widowbird	*Euplectes albonotatus*	LC	LC					1	x		x	x	2
Red-collared Widowbird	*Euplectes ardens*	LC	LC					3	x		x	x	4
Long-tailed Widowbird	*Euplectes progne*	LC	LC					1	x	x	x	x	16
Orange-breasted Waxbill	*Amandava subflava*	LC	LC		PG			1	x	x	x	x	1
African Quail-finch	*Ortygospiza atricollis*	LC	LC		PG			1	x	x	x	x	14
Red-headed Finch	*Amadina erythrocephala*	LC	LC		PG			2	x		x	x	
Swee Waxbill	*Coccopygia melanotis*	LC	LC		PG	NE		1	x	x	x	x	1
Common Waxbill	*Estrilda astrild*	LC	LC		PG			1	x	x	x	x	14
African Firefinch	*Lagonosticta rubricata*	LC	LC		PG			3					1
Bronze Mannikin	*Spermestes cucullata*	LC	LC		PG			2	x		x	x	
Pin-tailed Whydah	*Vidua macroura*	LC	LC		PG			1	x	x	x	x	14
Shaft-tailed Whydah	*Vidua regia*	LC	LC		PG			3					1
Dusky Indigobird	*Vidua funerea*	LC	LC		PG			3					
Cuckoo Finch	*Anomalospiza imberbis*	LC	LC					3					
House Sparrow	*Passer domesticus*	LC	LC					2	x		x	x	
Cape Sparrow	*Passer melanurus*	LC	LC					1	x	x	x	x	11
Southern Grey-headed Sparrow	*Passer diffusus*	LC	LC		PG			1	x	x	x	x	12
Yellow-throated Petronia	*Gymnoris superciliaris*	LC	LC		PG			2	x	x	x	x	
African Pied Wagtail	*Motacilla aguimp*	LC	LC		PG			2	x		x	x	
Cape Wagtail	*Motacilla capensis*	LC	LC		PG			1	x	x	x	x	15
Cape Longclaw	*Macronyx capensis*	LC	LC		PG			1	x	x	x	x	17
Yellow-breasted Pipit	*Anthus chloris*	VU	VU		PG	E	x	1	x	x	x	x	5
African Rock Pipit	*Anthus crenatus*	LC	LC		PG	E	x	1	x	x	x	x	4

Common Name	Scientific Name	Conservation Status					Priority Species	LO Kromhof	VWC	Control	VWC & Control	AOI	SABAP (n=cards)
		Global	Regional	TOPS	FS	Endemicity							
African Pipit	*Anthus cinnamomeus*	LC	LC		PG			1	x	x	x	x	16
Mountain Pipit	*Anthus hoeschi*	NT	NT		PG	E	x	2				x	
Plain-backed Pipit	*Anthus leucophrys*	LC	LC		PG			1	x	x	x	x	3
Buffy Pipit	*Anthus vaalensis*	LC	LC		PG			2					5
Nicholson's Pipit	*Anthus nicholsoni*	LC	LC		PG			1	x	x	x	x	1
Short-tailed Pipit	*Anthus brachyurus*	LC	VU		PG		x	3					
Cape Canary	*Serinus canicollis*	LC	LC		PG			1	x	x	x	x	16
Yellow-fronted Canary	*Crithagra mozambica*	LC	LC		PG			1	x	x	x	x	2
Black-throated Canary	*Crithagra atrogularis*	LC	LC		PG			1	x	x	x	x	6
Forest Canary	*Crithagra scotops*	LC	LC		PG	E	x	1	x		x	x	1
Yellow Canary	*Crithagra flaviventris*	LC	LC		PG			1	x	x	x	x	1
Brimstone Canary	*Crithagra sulphurata*	LC	LC		PG			2					1
Streaky-headed Seedeater	*Crithagra gularis*	LC	LC		PG			1	x	x	x	x	1
Lark-like Bunting	*Emberiza impetuani*	LC	LC		PG			3	x		x	x	2
Cinnamon-breasted Bunting	*Emberiza tahapisi*	LC	LC		PG			1	x	x	x	x	1
Cape Bunting	*Emberiza capensis*	LC	LC		PG			1	x	x	x	x	12
Golden-breasted Bunting	*Emberiza flaviventris*	LC	LC		PG			2	x	x	x	x	

Key: Status: CR = Critically Endangered; DD = Data Deficient; EN = Endangered; LC = Least Concern; NA = Not Assessed; NT = Near Threatened; OG = Ordinary Game; PG = Protected Game; PS = Protected Species; VU = Vulnerable. Likelihood of Occurrence (LO): 1 = Present; 2 = High; 3 = Moderate. Sources; Lee et al. (2025); BirdLife South Africa (2025); SABAP 2

Appendix 2: Carrion Management Trial

In December 2024 Kromhof WEF compiled a draft livestock carcass management framework for the Mulilo Verkykerskop Wind Energy Cluster. A decision was made by Kromhof WEF to implement a pilot version of the program in early 2025 to refine techniques and evaluate its effect on vulture activity across the WEF cluster. The avifauna specialist team[5] was requested to conduct an additional two monitoring surveys (S13 and 14) conducted in the Summer and Autumn of 2025 respectively to track changes in vulture activity. Below is a summary comparison of Cape Vulture activity before and after the trial between treatment area (Kromhof VPs 5, 9, 10 ,11, 12) and control areas (VPs 6, 7, 8 and 18). To best control for seasonal variation, surveys from similar times of the year were used for comparisons. The S7 (mid-summer) and S8 (early autumn) trips were used as the "before" samples for comparison with the after samples namely S13 (mid-summer) and S14 (early autumn).

Cape Vulture passage rates recorded during the two post-treatment ("after") surveys (S13 and 14) showed mixed results when compared to pre-treatment ("before") surveys. During summer Cape Vulture activity "after" carcass management (as indicated by passage rates) within the proposed Kromhof WEF was found to be lower than "before". In contrast, during autumn the "after" activity was notably higher than the "before" activity. During S13 and 14 ("after" period) similar vulture activity was recorded in the Control Area than the WEF area. It is noted that one large flock which spent most of the day circling around VP8, which highlights the stochastic nature of their occurrence and how this noise can mask underlying trends.

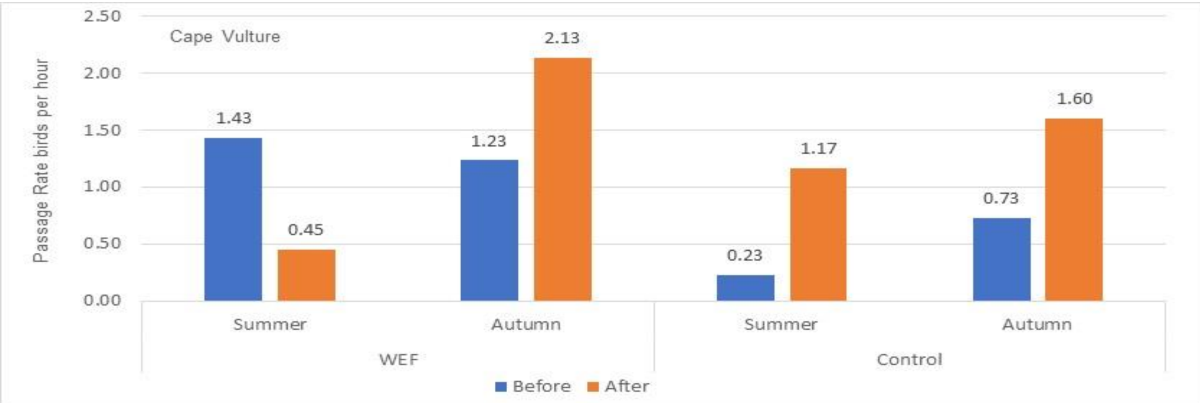


Figure1: Cape Vulture activity before and after the trial between treatment area (Kromhof VPs) and control areas (Control VPs). The S7 (mid-summer) and S8 (early autumn) trips were used as the "before" samples for comparison with the after samples namely S13 (mid-summer) and S14 (early autumn).

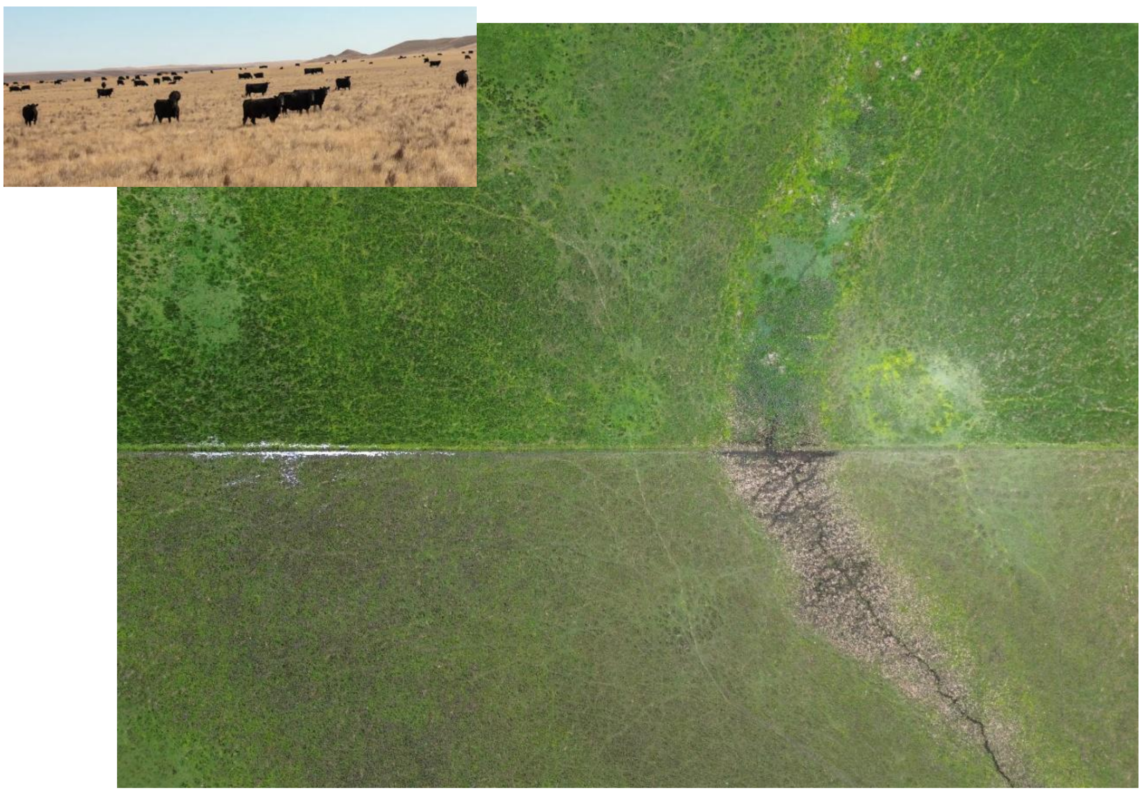
Overall, the data are insufficient to draw any robust conclusions regarding the efficacy of the carcass management program at this stage. There is an inherent variability in Cape Vulture activity which changes annually, seasonally and even diurnally. Two surveys post-treatment are too few to account for this variation. The results presented here should be considered preliminary and exploratory at best. Nevertheless, the results demonstrate how data could be collected and interpreted during the operational phase to investigate the efficacy of carrion management programs once a much larger "after" sample is gathered. Still, it may be difficult to control for the multitude of confounding factors which introduce noise and skew the results. These include, *inter-alia,* temporal variation in flight activity, climatic variation (swings in average annual precipitation and temperature), behavioural foraging habits or commutes between roosts (in spite of removed carrion). However, longer monitoring efforts, post-construction, will likely provide a rough (albeit somewhat confounded) indication of efficacy.

[5] Note the specialist does not recommend the implementation of carrion management programs by prospective developers to reduce vulture attendance over proposed development sites before environmental authorisation has been granted.

Appendix 3: Wetland Assessment Report (AfriAvian, May 2025)

Verkykerskop Mulilo WIND ENERGY FACILITY

Wetland (species 23) assessment (Nov 2024 - Mar 2025) report



May 2025

AfriAvian ENVIRONMENTAL

1. Executive summary

AfriAvian Environmental undertook a comprehensive, multi-tiered assessment of wetland habitat suitability and connectivity for the Critically Endangered Species23 across the Verkykerskop proposed wind energy facility area in the Free State Province. The approach combined in-situ field surveys, passive acoustic and camera trap monitoring, and remote sensing-based habitat modelling, providing a robust understanding of both current habitat condition and broader landscape-scale ecological dynamics.

Key Findings and Implications:

- <u>In-Situ Habitat and Species Assessments (2024/2025):</u>
  Targeted habitat surveys and passive acoustic/camera trap deployments were conducted at eight major wetland sites (VKK1–VKK8) between November 2024 and March 2025. Surveys evaluated habitat structure (e.g., vegetation height, canopy cover, water depth), land use pressures, and presence of key wetland species.
    - Grazing, trampling, and hydrological alteration were identified as primary pressures across VKK1–VKK4 and VKK7.
    - Of the sites directly within the Verkykerskop AOI, VKK4, VVK7 and VKK8 displayed the most favorable in-situ conditions, with structurally intact, shallowly flooded graminoid-dominated wetlands. Furthermore, multiple threatened wetland specialist species were also identified from acoustic surveys.
- Central and north-eastern wetland zones within Verkykerskop should be considered high conservation priorities, with active protection from further disturbance or development.
- Medium-risk connectivity corridors identified in the analysis should be avoided in wind turbine generator (WTG) siting as a precautionary measure to maintain ecological permeability.
- Land management interventions, particularly around grazing pressure, hydrological integrity, and vegetation maintenance, could help improve or sustain habitat quality across both degraded and functional patches.
- The strategic location of Verkykerskop between **two known strongholds of species presence** adds regional significance to the site, supporting its prioritization in broader species recovery and conservation planning frameworks.

2. Scope of work

AfriAvian Environmental were tasked to undertake palustrine wetland surveys for the Critically Endangered Species23 at the Verkykerskop proposed wind energy facility cadastral units, located within the Free State Province of South Africa (Figure 1).

The scope of work included:

Wetland habitat assessments:

- Conduct a combination of in-situ habitat assessments, in-situ passive acoustic and camera trap monitoring, and remote sensing-based habitat assessments.
- In-situ acoustic surveys were targeted within suitable habitat identified for Critically Endangered species 23. Passive acoustic and camera trap surveys were conducted from November 2024 to March 2025 (Figure 1).
- In-situ habitat assessments were conducted in November 2024 and March 2025 (Figure 1).

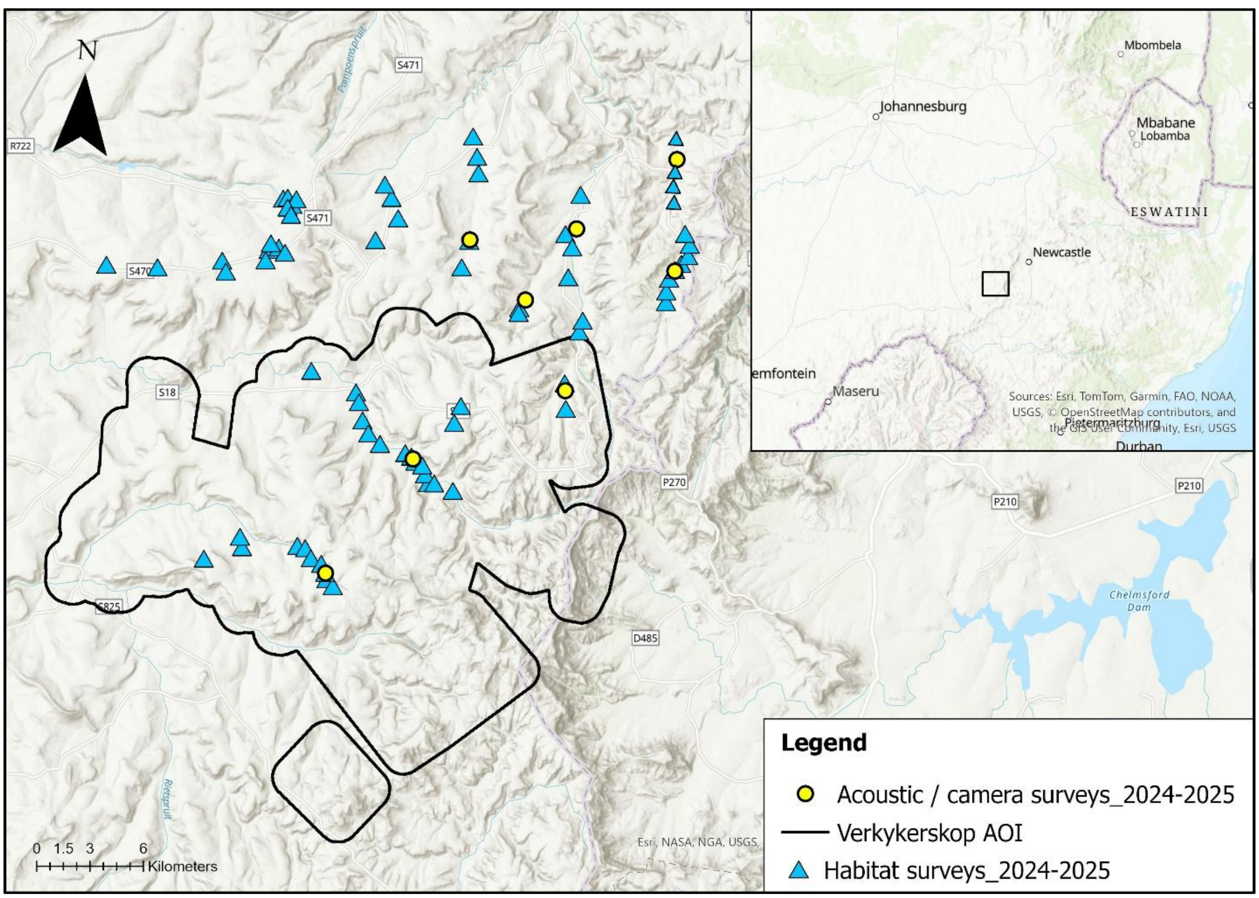


Figure 1: The locality of the proposed Verkykerskop WEF within the Free State Province.

3. Methods

To assess habitat suitability and site-specific risk for the Critically Endangered Species23, we implemented a three-tiered methodological approach: (i) rapid in-situ habitat assessments (2024/2025), (ii) passive acoustic and camera trap monitoring (2024/2025), and (iii) remote-sensing-based habitat suitability modeling (2020-2025). This integrative approach allowed for the combination of direct, indirect, and landscape-scale measures of species presence and habitat quality.

1. Rapid In-Situ Assessments

We conducted field-based rapid habitat and species assessments following methodologies outlined in Colyn et al. (2020). Surveys were undertaken during the austral summer, coinciding with the Species23's peak activity and breeding season in South Africa. Habitats were evaluated for wetland type, microhabitat structure (e.g., sedge and grass composition, height and cover), hydrology (flooding depth and permanence), and potential threats (e.g., grazing, trampling, drainage). When possible, auditory and/or visual confirmations of the target species or other focal wetland species (African Grass Owl, Grey Crown Crane, African Marsh Harrier, etc.) were recorded during habitat surveys, taking care to minimize disturbance to sensitive wetland areas.

2. Passive Acoustic and Camera Trap Monitoring

A combined passive acoustic monitoring (PAM) and camera trap survey approach was employed as a non-invasive technique to detect and document the presence and breeding status of the Species23. Following the survey design outlined in Colyn et al. (2020a), we deployed an array of camera traps in conjunction with centrally positioned autonomous acoustic recorders (Wildlife Acoustics SM4). Devices were configured to record during peak dawn and dusk activity periods (04:00–08:00 and 16:00–20:00), which coincide with the species' known vocal and movement peaks.

Camera traps were installed based on optimized placement protocols for small-bodied rallids (Colyn et al. 2020), with cameras mounted at 30–40 cm height and spaced at least 30 m apart to ensure spatial independence. These were placed in palustrine wetland microhabitats thought to generally be preferred by the target species (Colyn et al 2019; Colyn et al. 2020a; Colyn et al. 2020b).

To efficiently process the extensive camera trap dataset, a deep learning-based object detection model (YOLOv5-type architecture) was deployed to automatically filter and classify imagery into broad species guilds. This automated filtering step significantly reduced the manual review burden and allowed for the prioritization of target detections. Filtered outputs were then manually verified and classified to species level by avifaunal specialists, ensuring accuracy in detecting and confirming the presence of Species23 and other rallid species.

Acoustic recordings were processed using a deep learning classifier to initially identify candidate vocalizations. These candidate clips were then reviewed manually using Raven Pro software to verify the presence of species-specific calls. All acoustic detections were validated through spectrogram inspection and compared against known call libraries. Playback surveys were not employed due to concerns regarding disturbance during the sensitive breeding period.

3. Remote Sensing and Habitat Suitability Modeling

3.1 Wetland Boundary Classification

To delineate palustrine wetland boundaries suitable for habitat suitability modeling, we developed a remote sensing-based classification model using Sentinel-2 imagery (Copernicus 2023). Pre-processing, variable generation, and classification were conducted within a scripted R workflow.

We applied an ensemble modeling framework, combining Random Forest and Artificial Neural Network (ANN) classifiers to leverage the strengths of multiple algorithms and minimize model bias. This ensemble approach has been successfully applied in previous avian habitat studies (Colyn et al. 2020a, 2020b, 2020c). A stepwise variable selection procedure was undertaken to identify relevant predictor variables while minimizing multicollinearity, following recommendations from Vignali et al. (2020).

Occurrence data were sourced from an extensive internal database supplemented with in-situ observations collected during field assessments. Data were partitioned into training (80%) and testing (20%) subsets. Models were optimized through hyperparameter tuning using a genetic algorithm approach (Vignali et al. 2020). Final model performance was evaluated using the area under the Receiver Operating Characteristic curve (AUC-ROC) alongside additional metrics including accuracy, recall, precision, and F1 score (Freeman and Moisen 2008; Jiménez-Valverde 2012; Sofaer et al. 2018). Variable importance and partial dependence plots were generated to aid interpretation of key environmental drivers. The optimized models were then used to predict wetland habitat suitability across the broader landscape, producing the final wetland classification map used to inform subsequent HSI analyses.

3.2 Habitat Suitability Index (HSI) Development

A spatially explicit Habitat Suitability Index (HSI) was developed by integrating multi-year (2020–2025) remote sensing analyses with field-derived habitat and species occurrence data. Remote sensing analysis was conducted using Google Earth Engine (GEE). We processed Sentinel-2 SR imagery, applying cloud masking and reflectance calibration. Key vegetation indices such as the Normalized Difference Vegetation Index (NDVI) and Normalized Difference Infrared Index (NDII) were computed across multiple years and composited seasonally to capture interannual variability.

NDVI time series were extracted for each wetland region of interest using a script customized from the core GEE workflow provided above. Mean NDVI and NDII per month was calculated, and seasonal dynamics were analyzed to identify periods of peak vegetation greenness and moisture indicative of optimal habitat suitability. Wetland polygon areas (ha) and in-situ habitat survey data was incorporated as co-factors to account for wetland size, vegetation composition and vegetation structural effects on habitat suitability. Sites with consistently higher composite (NDVI, NDII) remote sensing values (>0.8) during the breeding season, high canopy cover (>70%) and yielded suitable moisture (not dry or deeply flooded) were classified as high suitability habitats.

Final habitat suitability was scored based on:

- consistency of composite remote sensing index peaks,
- Wetland area (>1 ha preferred),
- In-situ rapid assessment outcomes (vegetation structure, composition, water depth, hydrological stability, etc.).
- Acoustic detection of species presence (elevates score, however absence did not reduce score given low detection).

Sites were classified into high, medium, and low risk categories based on their HSI scores and threat exposure observed during field surveys.

4. Connectivity modelling

We used a circuit theory approach (Colyn et al. 2020c) to modelling connectivity for Species23 across the broader PAOI. A resistance layer was generated using known drivers of species occupancy and habitat suitability (Colyn et al 2019; Colyn et al. 2020a; Colyn et al. 2020b). Resistance includes landscape features that impede movement, colonization or ranging, or prevent habitat connectivity, as defined by species' ecological requirements and parameters (Colyn et al. 2020b). Barriers could be represented as strongly contrasting land use types surrounding core-habitat patches, thereby reducing the dispersal ability of the focal species (i.e. wetland core surrounded by large swathes of agricultural or wooded vegetation) (Colyn et al. 2020b). Detailed ecological requirements have been recorded for Species23 based on occupancy modelling of microhabitat and landscape-scale covariates that influence likely occurrence (Colyn et al 2019; Colyn et al. 2020a; Colyn et al. 2020b).

4. Results

3.1. In-situ assessments and habitat suitability results

Verkykerskop Site 1 (VKK1)

This site included a large (231 ha) unchanneled valley bottom wetland system that is interconnected to channelled valley bottom, riparian and seep habitats (Figure 2). The northern portion of wetland system hosted a wide array of dominant vegetation types, including sedge meadows, interspersed with Phragmites and Typha reedbeds (Figure 3). Cattle grazing pressure was noted across much of VKK1. Wetland vegetation was severely trampled in sections, particularly along wetland edges and throughout shallowly flooded sedge meadows and other graminoid dominant vegetation types. Overgrazing, particularly during spring and early summer when surveys were conducted, resulted in significant defoliation resulting in reduced basal and canopy cover, as well as reduced vegetation height (Figure 4). This impact of overgrazing on these facets of vegetation structure will likely reduce habitat quality and suitability for the focal species of concern.

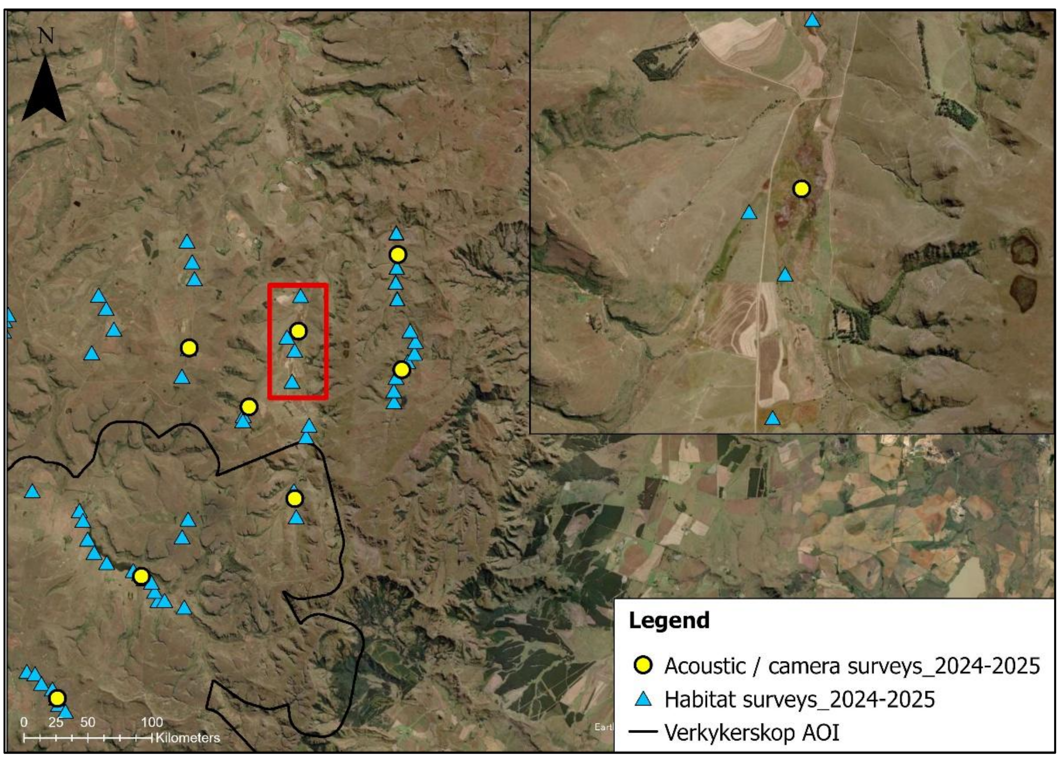


Figure 2: Verkykerskop (VKK1) wetland site surveyed from November 2024 to March 2025.

Figure 3: Wetland VKK1 hosts a wide mosaic of wetland vegetation communities, including sedge meadows, interspersed with Phragmites and Typha reedbeds.

Figure 4: Cattle grazing pressure was noted across much of VKK1. Wetland vegetation was severely trampled in sections and heavily defoliated resulting in reduced basal and canopy cover, as well as reduced height.

Multiyear (2020-2025) Habitat Suitability Index (HSI) analysis (see methodology) suggests that the VKK1 wetland system still hosts suitable habitat for the species, despite the noted grazing pressure. HSI results do however suggest that, on average, suitable conditions could be truncated to a smaller period over the peak of summer in mid-December to mid-January (Figure 5). Early summer season surveys also concluded that sedge vegetation was heavily impacted (defoliated and trampled) early in the season (Nov-Dec) and subsequently was more deeply flooded later in the season (Feb-Mar).

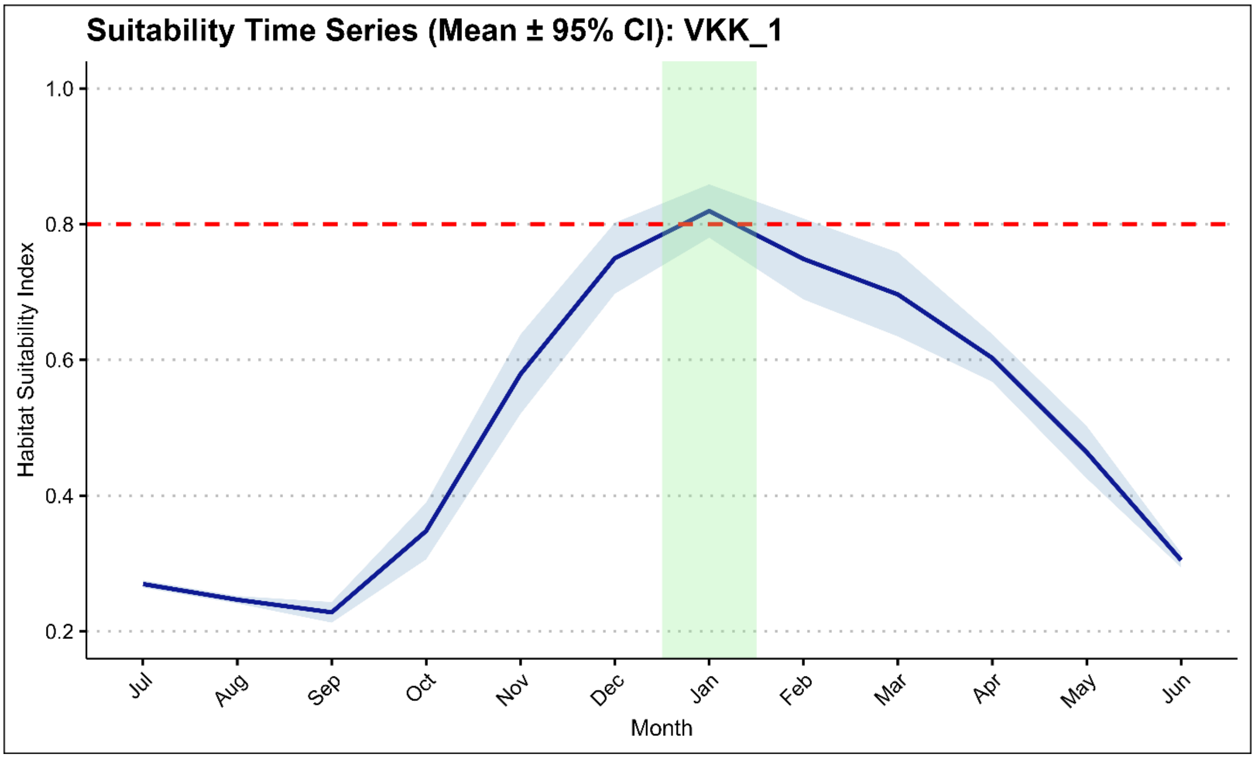


Figure 5: Seasonal habitat suitability trends for "VKK1" sites based on multi-year remote sensing habitat suitability analysis (2020–2025). The blue line represents the mean suitability index across years, with shaded light-blue ribbons indicating the 95% confidence interval. The dashed red line marks the suitability threshold (0.8) derived from other sites yielding presence (Colyn et al. 2020), while the green swathe highlights the period where mean suitability values exceed this threshold, indicating peak habitat suitability.

Verkykerskop Site 2 (VKK2)

This site included a relatively large (223 ha) unchanneled valley bottom wetland system that is interconnected to channelled valley bottom, riparian and seep habitats (Figure 6). VKK2 and VKK3 are part of a large wetland system that is interconnected by channelled valley bottom and riparian channels. VKK2 is primarily comprised of deeply flooded Typha and Phragmites reedbeds along the central channeled valley bottom wetland, but large swathes of sedge and other graminoid dominant habitats were noted along lateral seepage zones, unchanneled valley bottom, and seep habitats (Figures 6 & 7). However, many of the sedge and other graminoid dominant habitats along wetland seepage zones and edges were heavily impacted by grazing (defoliation) and trampling (reduced vegetation cover). The wetland habitats in VKK2 and VKK3 seem to be used extensively for early summer grazing by livestock farmers. Large herds (100-200) of cattle were observed being moved into these habitats during surveys (Figure 8).

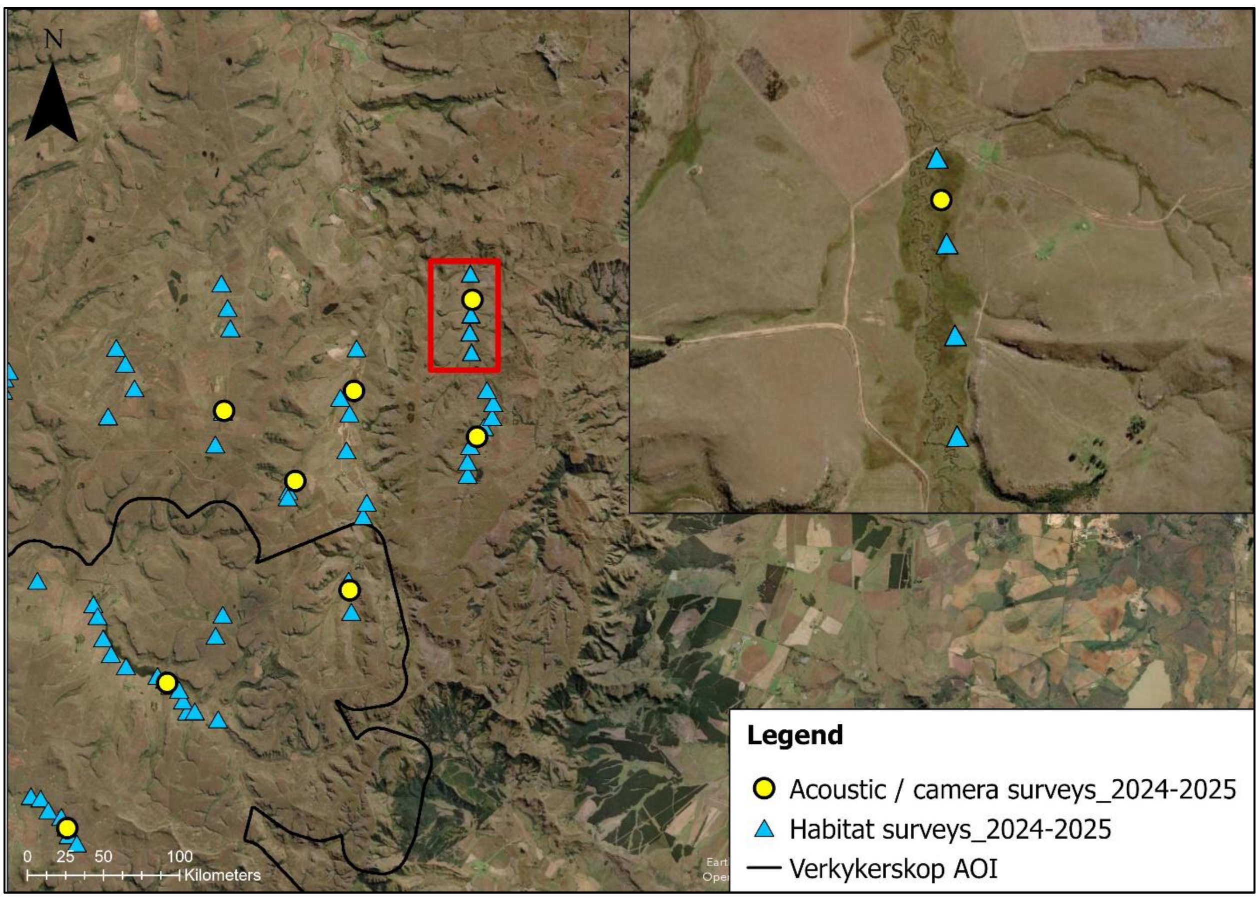


Figure 6: Verkykerskop (VKK2) wetland site surveyed from November 2024 to March 2025.

Figure 7: VKK2 is part of a large, interconnected wetland catchment system compromised of multiple large (>200ha) individual palustrine wetland habitat units. However, significant impacts associated with overgrazing and damming (flooding and sedimentation) were noted.

Figure 8: The wetlands habitats in VKK2 and VKK3 seem to be used extensively for early summer grazing by livestock farmers. Large herds (100-200) of cattle were observed being moved into these habitats during surveys.

Multiyear (2020–2025) Habitat Suitability Index (HSI) analysis (see methodology) indicates that the VKK2 wetland system (similar to VKK1) continues to provide suitable habitat for the species, despite evidence of significant annual or seasonal grazing pressure (Figure 9). HSI outputs suggest that, as with VKK1, the window of peak suitability may be constrained to a shorter period in mid-summer due to grazing and management, particularly from mid-December to mid-January (Figure 9). Field surveys during early summer confirmed substantial degradation of sedge vegetation at VKK2, with widespread defoliation and trampling observed in November and December. Later in the season (February to March), these areas experienced deeper flooding, further influencing vegetation structure and suitability.

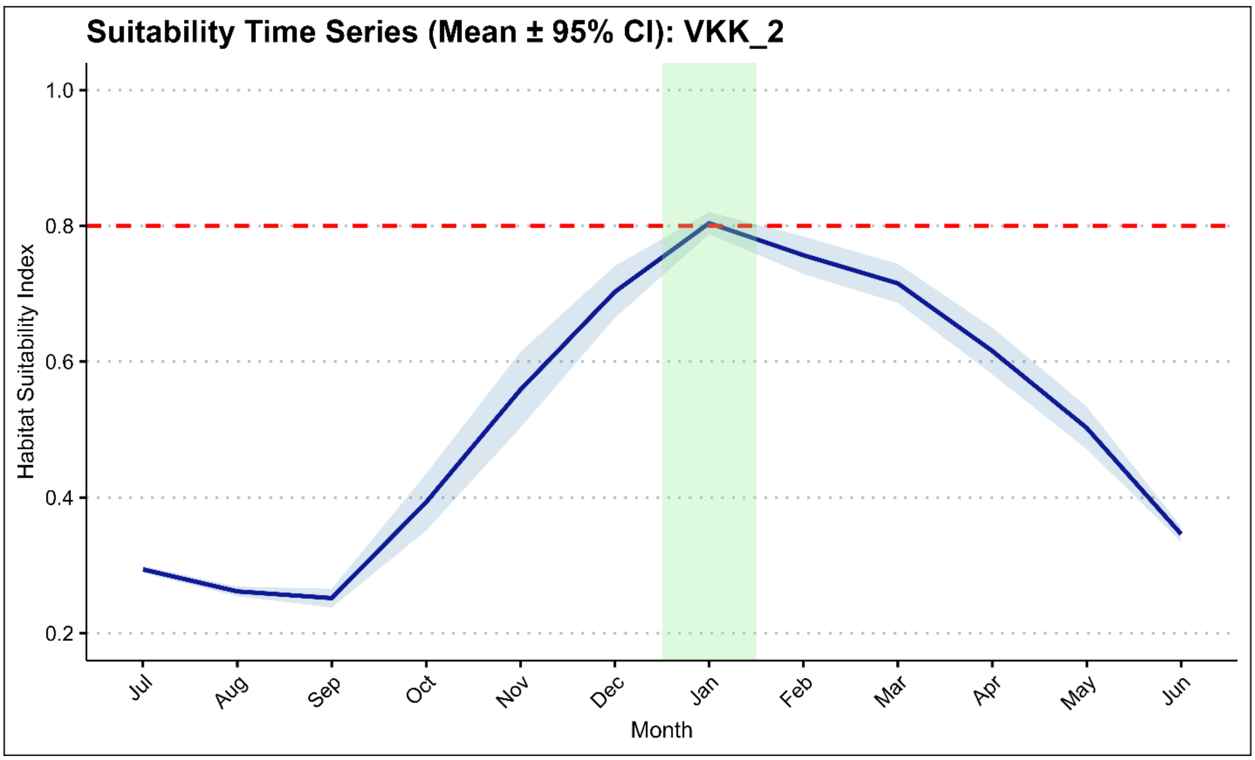


Figure 9: Seasonal habitat suitability trends for “VKK2” site based on multi-year remote sensing habitat suitability analysis (2020–2025). The blue line represents the mean suitability index across years, with shaded light-blue ribbons indicating the 95% confidence interval. The dashed red line marks the suitability threshold (0.8) derived from other sites yielding presence (Colyn et al. 2020), while the green swathe highlights the period where mean suitability values exceed this threshold, indicating peak habitat suitability.

Verkykerskop Site 3 (VKK3)

This site included a relatively large (260 ha) unchanneled valley bottom wetland system that is interconnected to channelled valley bottom, riparian and seep habitats (Figure 10). VKK2 and VKK3 are part of a large wetland system that is interconnected by channelled valley bottom and riparian channels. VKK3 is dominated by Typha and Phragmites vegetation across much of the site (ca. 70%) (Figure 11). Lateral edges running along the wetland are graminoid dominant, along with extensive seep habitats flowing into the central wetland channel. Large herds (100-200) of cattle were observed being moved into these habitats during surveys (Figure 12).

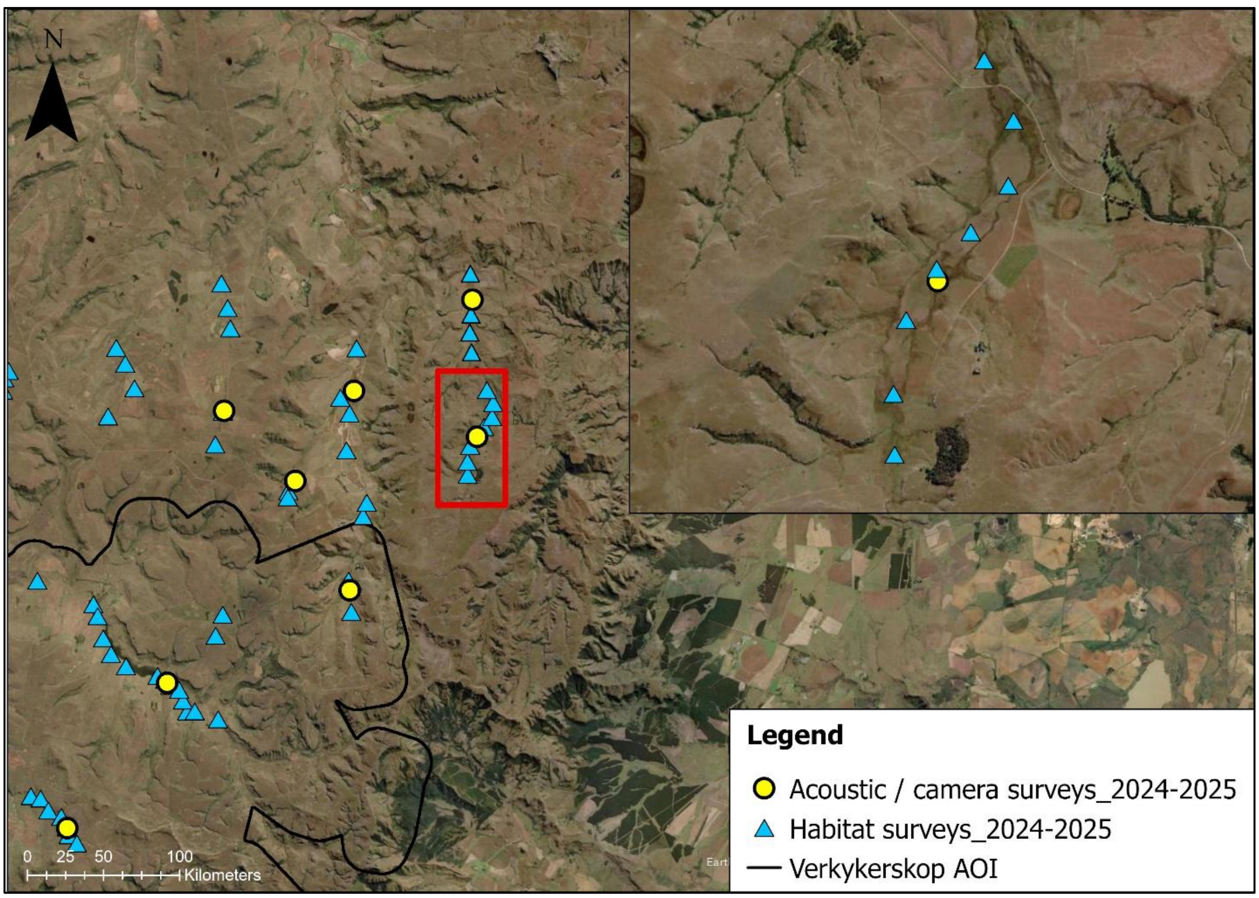


Figure 10: Verkykerskop (VKK3) wetland site surveyed from November 2024 to March 2025.

Figure 11: Much of VKK3 is dominated by Typha reedbeds, as well as pockets of Phragmites in more inundated and deeply flooded sections near the central channel.

Figure 12: Numerous observations were noted of large herds of cattle being herded into fenced units with wetland vegetation, presumably to make use of early summer grazing/fodder considering late rains (early drought conditions)

Multiyear (2020–2025) Habitat Suitability Index (HSI) analysis (see methodology) suggests that VKK3 supports suitable seasonal habitat conditions for the target species, with peak suitability concentrated over mid-summer (mid-December to mid-January; Figures 10 & 13). Although large portions of the wetland are dominated by *Typha* and *Phragmites* (ca. 70%), the HSI trends and field observations indicate that the lateral seepage edges and graminoid-dominated seep habitats likely contribute extensively to seasonal suitability. These peripheral zones provide more structurally appropriate conditions, especially during peak summer months when core reedbeds are often deeply flooded. VKK3 forms part of a larger interconnected system with VKK2, linked via channelled valley bottom and riparian corridors, and spans a mosaic of habitat types including unchanneled valley bottom, seep, and riparian zones (Figure 10). Field surveys noted that the sedge-rich margins and inflowing seeps exhibit the highest likelihood of supporting the species during the summer breeding window.

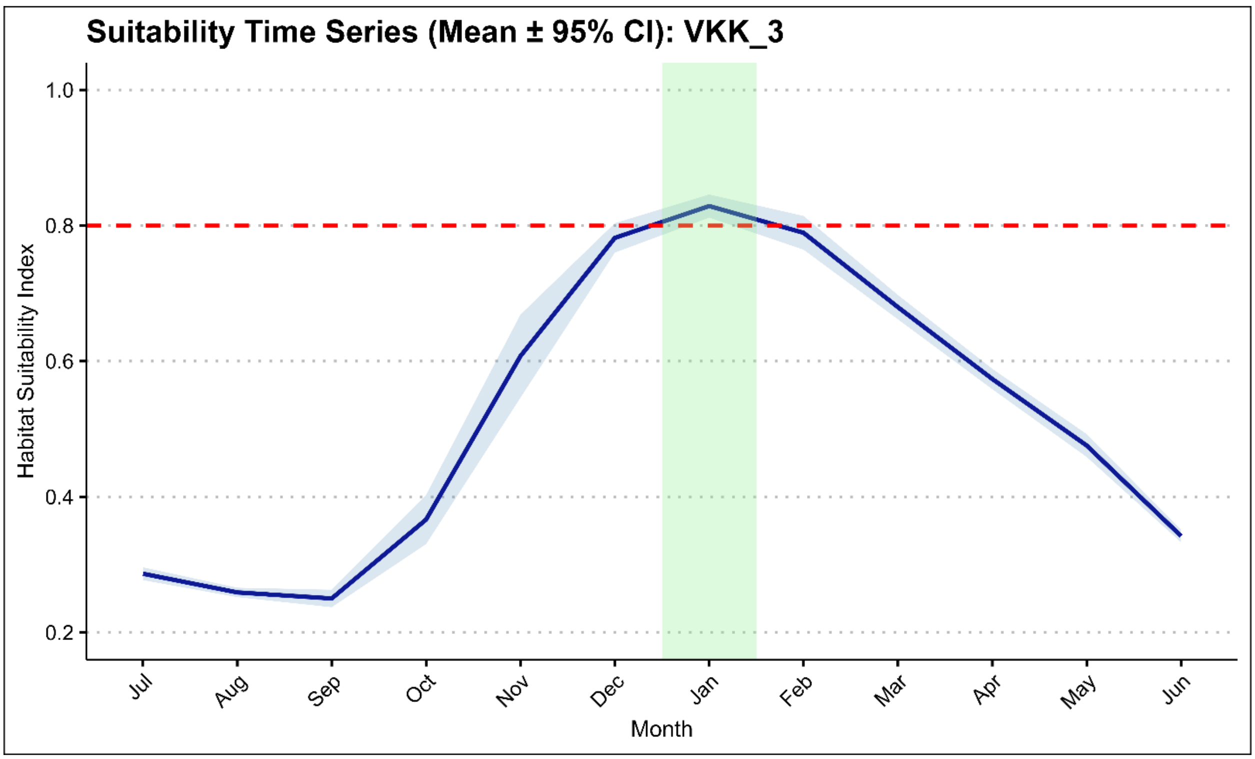


Figure 13: Seasonal habitat suitability trends for “VKK3” sites based on multi-year remote sensing habitat suitability analysis (2020–2025). The blue line represents the mean suitability index across years, with shaded light-blue ribbons indicating the 95% confidence interval. The dashed red line marks the suitability threshold (0.8) derived from other sites yielding presence (Colyn et al. 2020), while the green swathe highlights the period where mean suitability values exceed this threshold, indicating peak habitat suitability.

Verkykerskop Site 4 (VKK4)

VKK4 comprises a relatively large (~153 ha) graminoid-dominated unchanneled valley bottom and seep wetland system, hydrologically connected to adjacent channelled valley bottom and riparian habitats (Figure 14). The wetland is characterized by shallowly flooded palustrine conditions, with dominant sedge and other graminoid vegetation (Figure 15). High grazing pressure has affected parts of the system, with visible signs of trampling and extensive defoliation in several areas (Figure 16). Average vegetation height was recorded at less than 10 cm along broad sections of the wetland edge and within sedge meadows subjected to recent grazing, in contrast to approximately 30 cm in ungrazed areas.

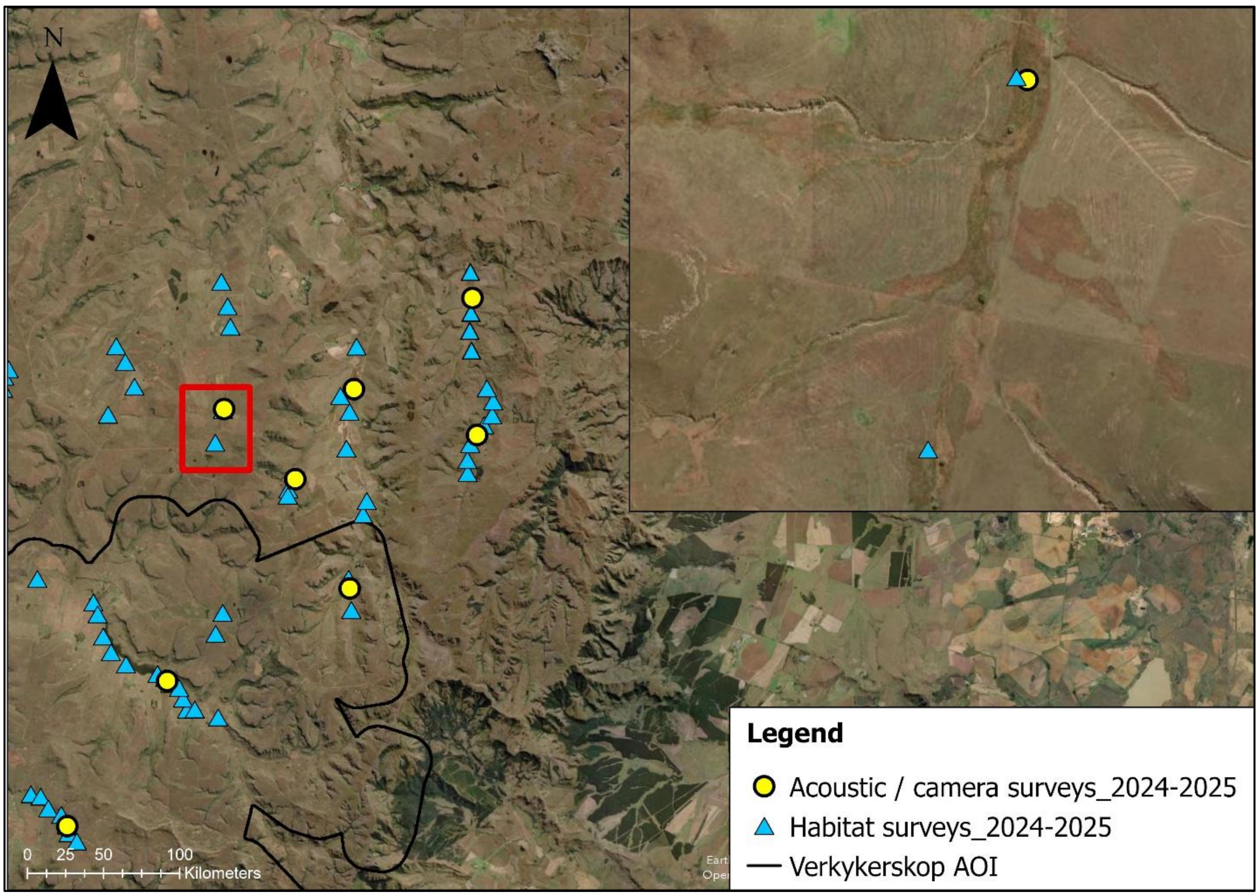


Figure 14: Verkykerskop (VKK4) wetland site surveyed from November 2024 to March 2025.

Figure 15: VKK4 was comprised of a ca. 150 ha unchanneled valley bottom palustrine wetland system dominated by shallowly flooded graminoid vegetation.

Figure 16: High livestock stocking densities were observed across the VKK4 management units, with grazing pressure remaining high during the summer growing season.

Multiyear (2020–2025) Habitat Suitability Index (HSI) analysis (see methodology) indicates that VKK4 supports high seasonal suitability for the target species, with modelled HSI values exceeding the 0.8 threshold from mid-December through February (Figure 17). The site reaches peak suitability during the core summer period, likely driven by a combination of shallow inundation, graminoid-dominated vegetation, and favorable structural attributes. Suitability gradually increases from October, peaks in mid-summer, and declines again toward late autumn. These temporal trends suggest that VKK4 provides consistently favorable conditions during the species' expected breeding and peak activity window, positioning it as a potentially important habitat node within the broader wetland network. However, field observations of extensive grazing pressure and vegetation defoliation suggest that suitability could vary locally, depending on intensity and timing of land use.

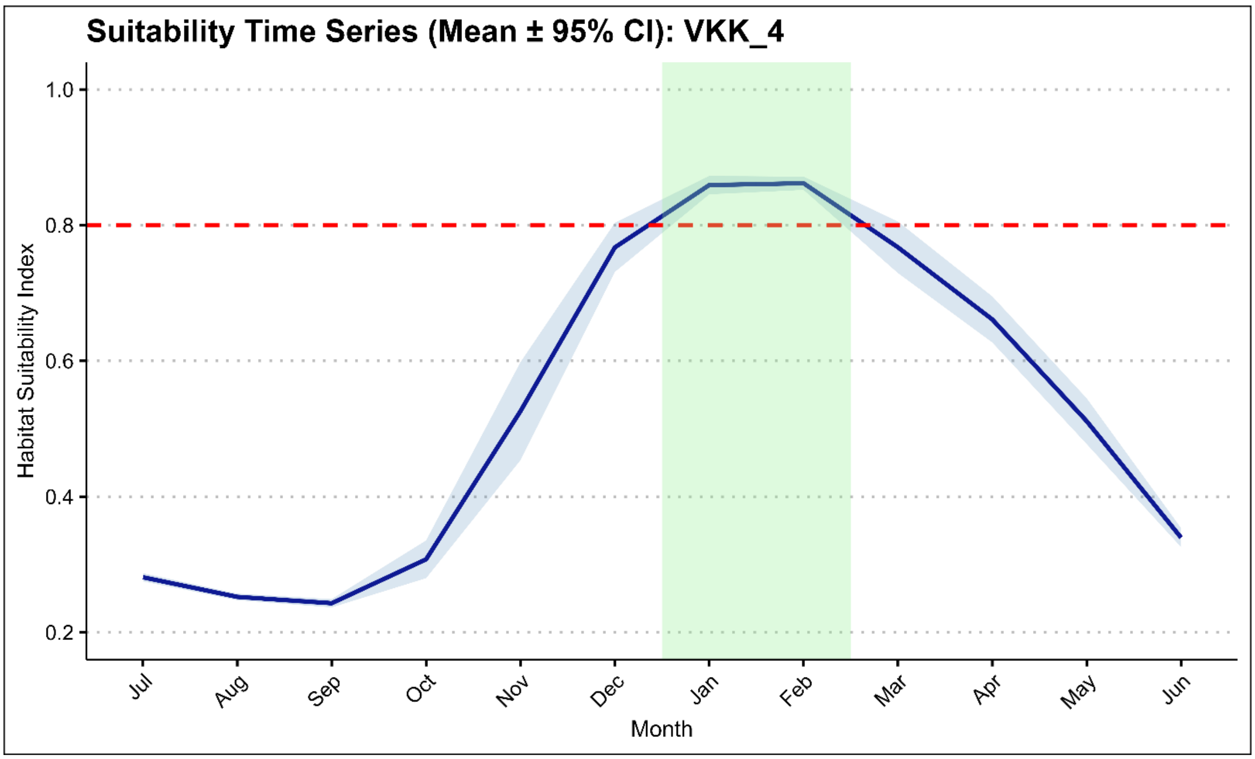


Figure 17: Seasonal habitat suitability trends for "VKK4" sites based on multi-year remote sensing habitat suitability analysis (2020–2025). The blue line represents the mean suitability index across years, with shaded light-blue ribbons indicating the 95% confidence interval. The dashed red line marks the suitability threshold (0.8) derived from other sites yielding presence (Colyn et al. 2020), while the green swathe highlights the period where mean suitability values exceed this threshold, indicating peak habitat suitability.

Verkykerskop Site 5 (VKK5)

This site encompasses a relatively large (~156 ha) channeled valley bottom wetland system, hydrologically connected to adjacent riparian and seep habitats (Figure 18). However, over 85% of the palustrine wetland has been inundated following the recent construction of a dam (circa 2023–2024) (Figures 19 and 20). Remaining marginal habitats in the southern portion of the site continue to support notable species of conservation concern, including the Endangered Grey Crowned Crane and Endangered African Marsh Harrier. Based on the site's former mosaic of wetland vegetation types (i.e. defined by remaining patches), structural heterogeneity, and floristic composition, it is likely that this wetland previously offered suitable habitat for additional threatened species, including the Critically Endangered Species23, Vulnerable African Grass Owl and Critically Endangered Wattled Crane.

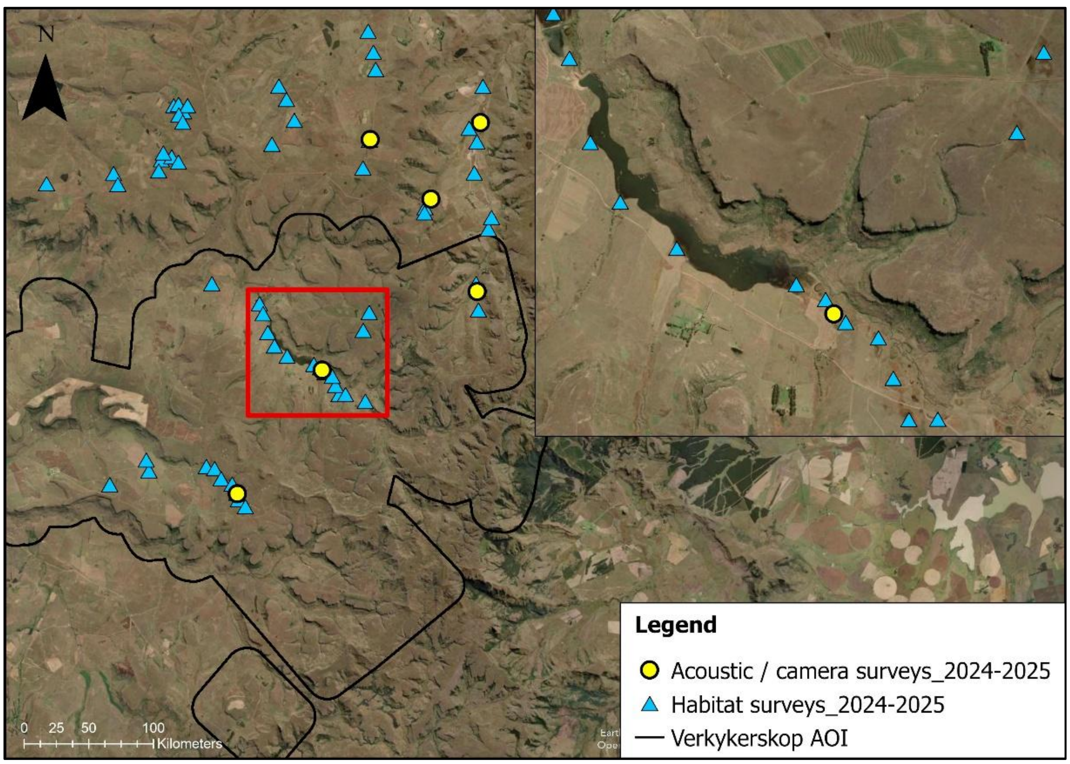


Figure 18: Verkykerskop (VKK5) wetland site surveyed from November 2024 to March 2025.

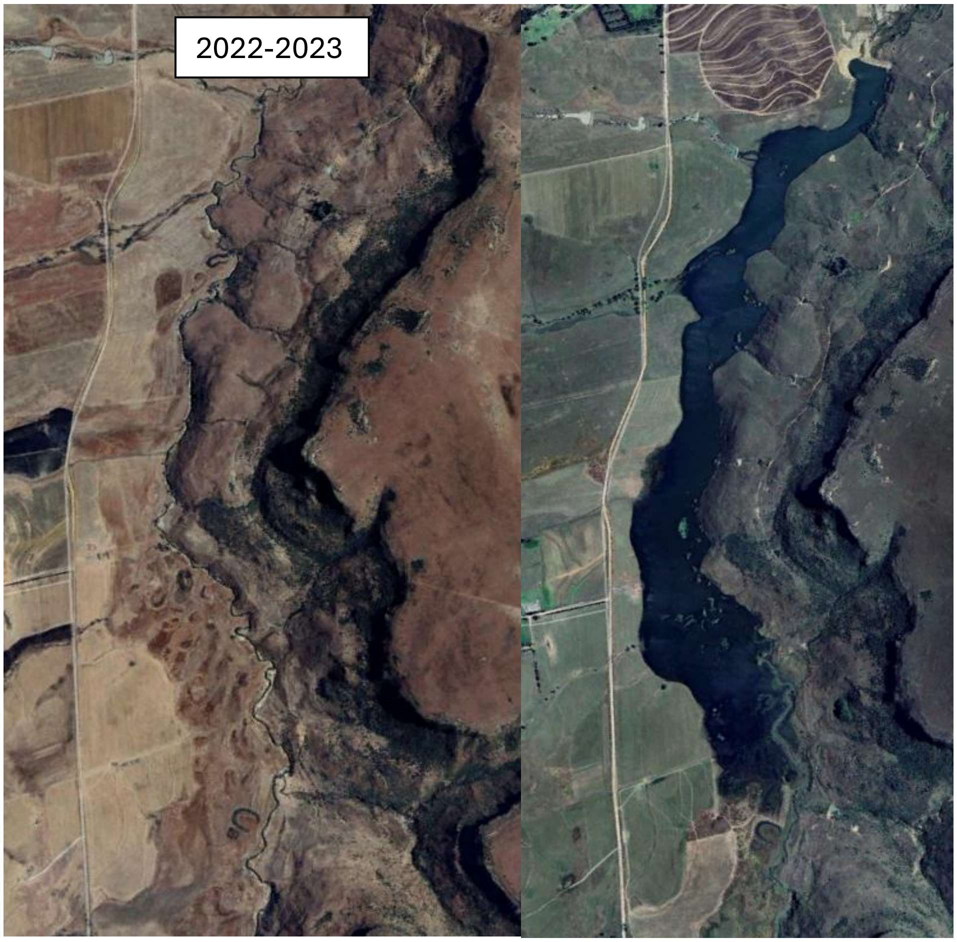


Figure 19: The 2024-2025 damming of VKK5 flooded large tracts of palustrine wetland habitat that would have been suitable for a range of threatened wetland species, including the focal species of this study.

Figure 20: The majority of VKK5 has been flooded due to very recent (2023-2024) damming of the downstream channel. This, together with extensive grazing has removed and/or degraded the majority of suitable palustrine wetland habitat.

Multiyear (2020–2025) Habitat Suitability Index (HSI) analysis (see methodology) indicates that VKK5 offers high seasonal suitability for the target species within the remaining patches that have not been flooded. Peak HSI values exceeded the suitability threshold (0.8) between mid-December and Mid-January (Figure 21). Suitability increases steadily from late spring (October–November), reaching a maximum in January before declining again in early autumn. The modelled HSI trend suggests that VKK5 provides favorable habitat conditions during the core summer period, likely driven by vegetation productivity, shallow inundation, and optimal cover. However, a substantial portion of the overall wetland has been inundated, and the reported suitability scores only reflect the ~15% of remaining unflooded habitat. Given the recent construction of the dam, water levels may continue to rise—particularly during periods of high rainfall—posing a risk of further inundation to the remaining suitable habitat.

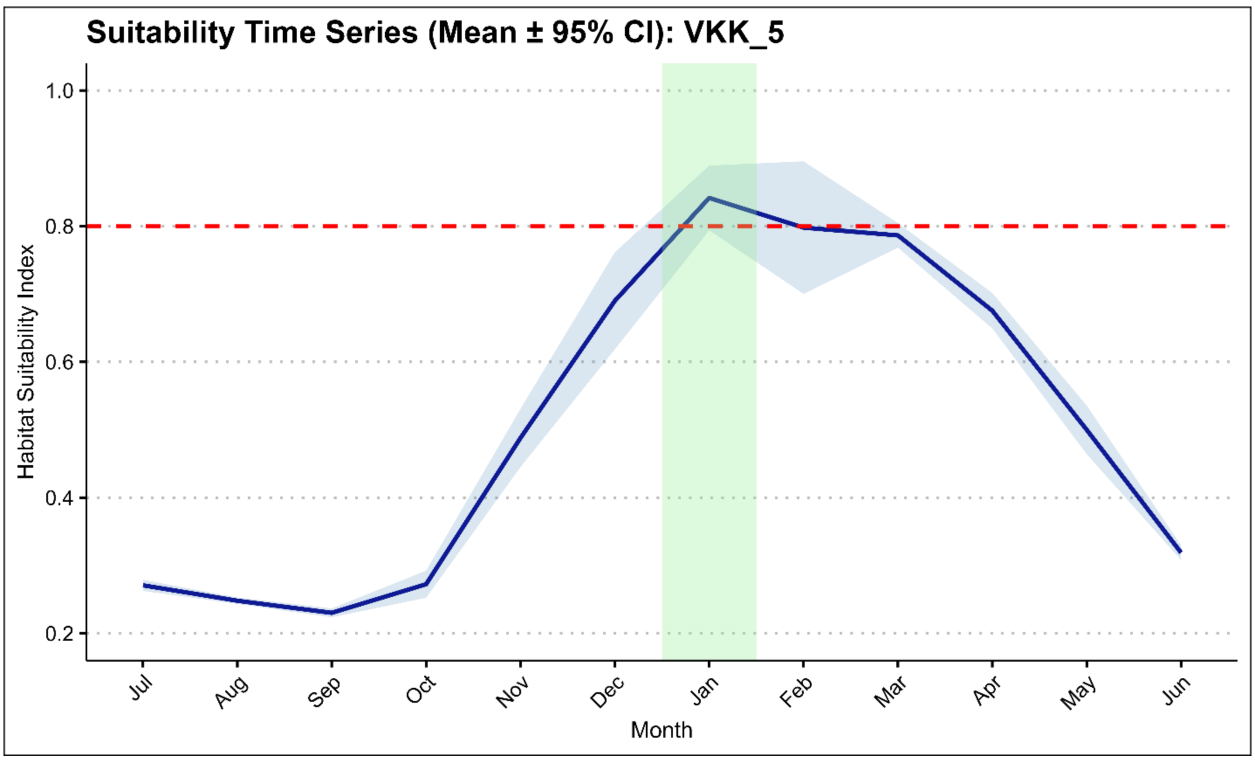


Figure 21: Seasonal habitat suitability trends for "VKK5" site based on multi-year remote sensing habitat suitability analysis (2020–2025). The blue line represents the mean suitability index across years, with shaded light-blue ribbons indicating the 95% confidence interval. The dashed red line marks the suitability threshold (0.8) derived from other sites yielding presence (Colyn et al. 2020), while the green swathe highlights the period where mean suitability values exceed this threshold, indicating peak habitat suitability.

Verkykerskop Site 6 (VKK6)

VKK6 encompasses a moderately sized (~70 ha) wetland system consisting of a mosaic of channeled and unchanneled valley bottom wetlands interlinked with riparian corridors (Figure 22). The site is defined by shallowly flooded palustrine conditions, with vegetation dominated by sedges and other graminoid species (Figure 23). Structural habitat characteristics include short to moderate vegetation height (~15–20 cm), moderate canopy cover (~50–70%), and shallow standing water (~2–5 cm)—attributes indicative of potentially suitable conditions for the focal species (Figure 23).

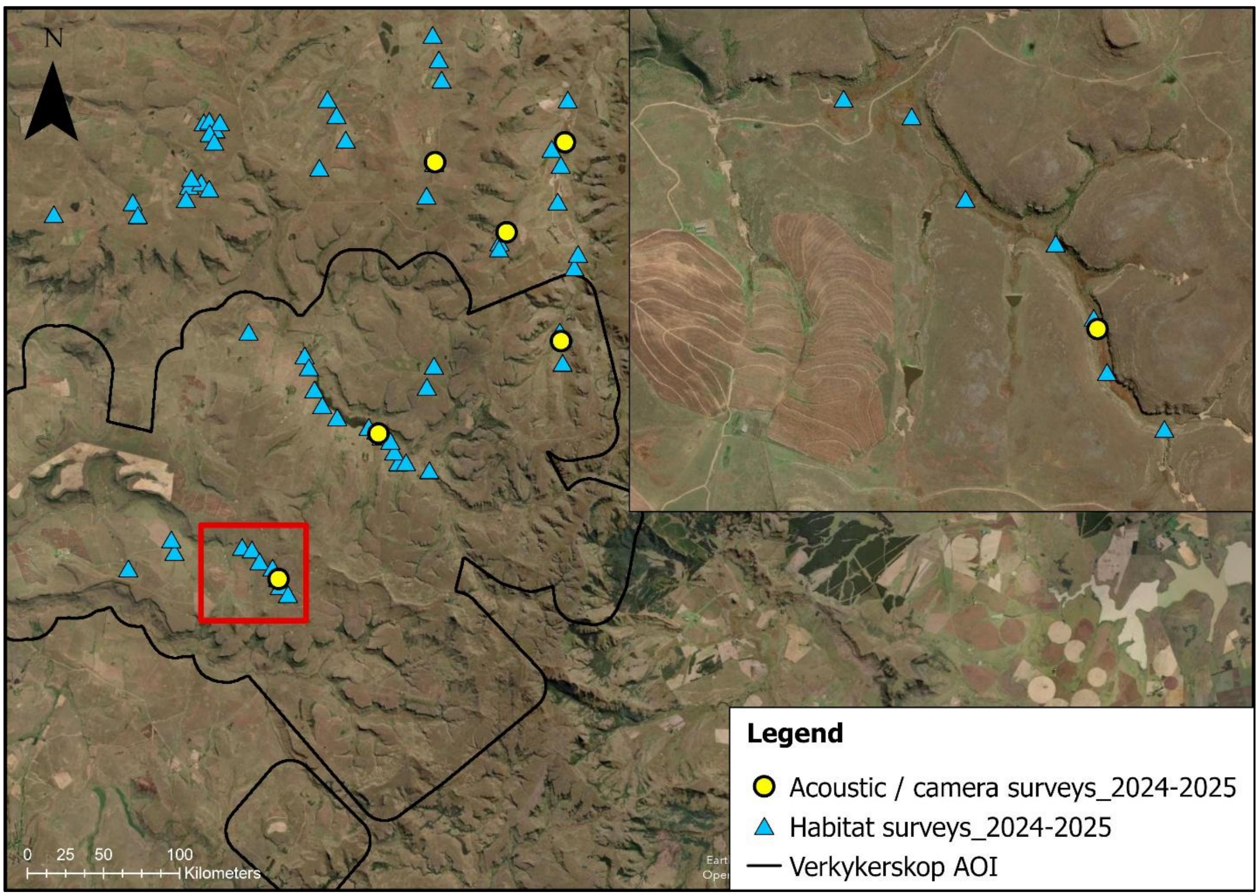


Figure 22: Verkykerskop (VKK6) wetland site surveyed from November 2024 to March 2025.

Figure 23: VKK6 is largely comprised of shallowly flooded, graminoid (sedge and other species) dominant vegetation that was in good condition in late spring (November) but was extensively grazed through the summer season.

Multiyear (2020–2025) Habitat Suitability Index (HSI) analysis (see methodology) suggests that VKK6 offers moderate seasonal habitat suitability for the target species, with peak conditions not exceeding the baseline threshold of 0.8 (Figure 24). Although HSI values remain below the high suitability threshold throughout the year, suitability increases notably in early summer, aligning with a rise in vegetation productivity and shallow inundation. The site is composed of shallowly flooded palustrine conditions with short to moderate graminoid vegetation (~15–20 cm), moderate canopy cover (~50–70%), and shallow water depths (~2–5 cm). While suitability is not as consistently high as observed at other known sites with presence/occupancy (≥ 0.8), the mosaic of channeled and unchanneled valley bottom wetlands and riparian zones (Figure 24) may still offer locally favorable microhabitats during the peak summer period, particularly where sedge cover and water persistence are maintained. An important driver impacting habitat suitability at VKK6 is grazing. Despite the rugged terrains surrounding this site, it was exposed to grazing through the summer months leading to extensive defoliation and trampling in areas. However, this could remain important as transitory habitat, where habitat plays a role in supporting connectivity and movement outside of core occupancy areas. Furthermore, if grazing were excluded or reduced, habitat suitability could improve in response to vegetation regrowth and recover.

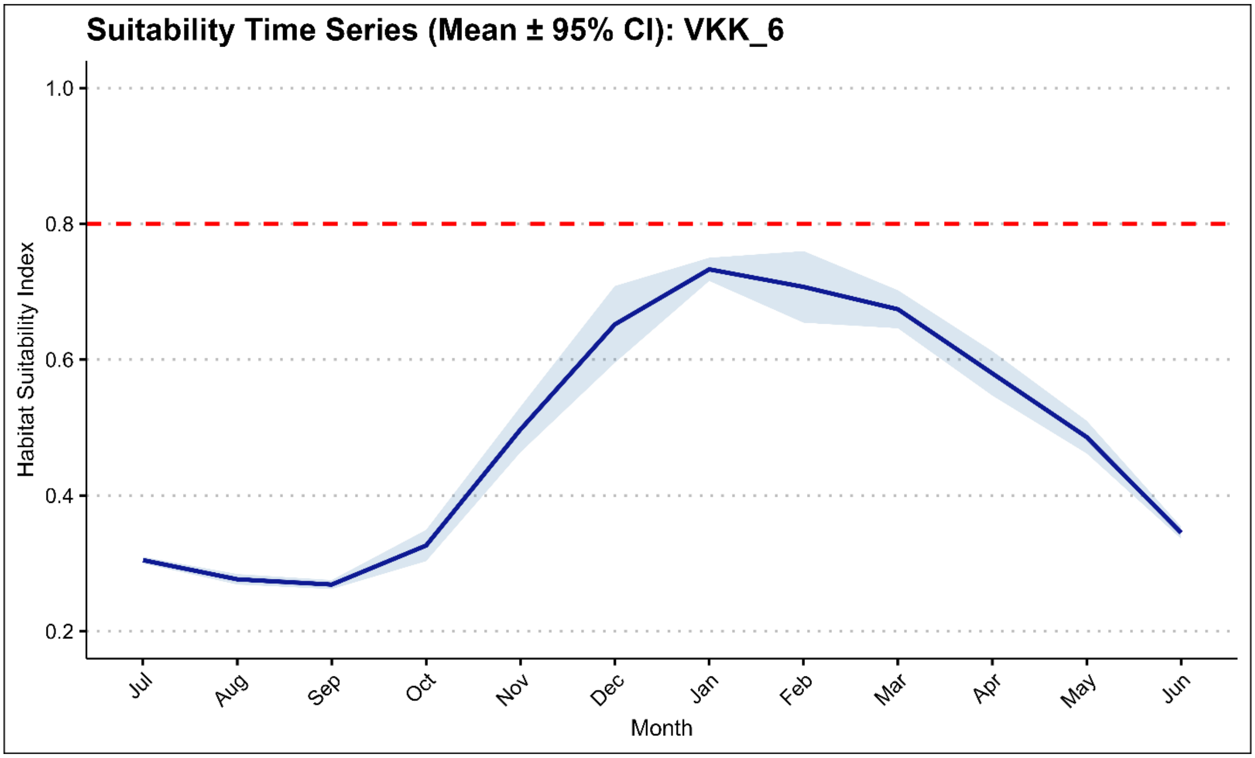


Figure 24: Seasonal habitat suitability trends for "VKK6" site based on multi-year remote sensing habitat suitability analysis (2020–2025). The blue line represents the mean suitability index across years, with shaded light-blue ribbons indicating the 95% confidence interval. The dashed red line marks the suitability threshold (0.8) derived from other sites yielding presence (Colyn et al. 2020), while the green swathe highlights the period where mean suitability values exceed this threshold, indicating peak habitat suitability.

Verkykerskop Site 7 (VKK7)

VKK7 comprises a moderately sized wetland system (~70 ha) characterized by a mosaic of channeled and unchanneled valley bottom wetlands connected through riparian corridors (Figure 25). The site has undergone substantial transformation due to agricultural land use, with approximately 50% of the lateral seepage zones within the channeled valley bottom wetland converted to cattle fodder production. Historical habitat conditions, inferred from adjacent intact areas, suggest that these lateral zones were formerly graminoid-dominated sedge meadows. At present, extensive portions of these habitats are subject to seasonal or annual mowing and baling, while the remaining wetland area is heavily grazed and certain sections are actively used as cattle winter feeding sites, further impacting vegetation structure and overall habitat quality (Figures 26 and 27). Extensive defoliation, trampling, spread of herbaceous weeds. and overall reduction in habitat quality and suitability are associated impacts of the current management and land use.

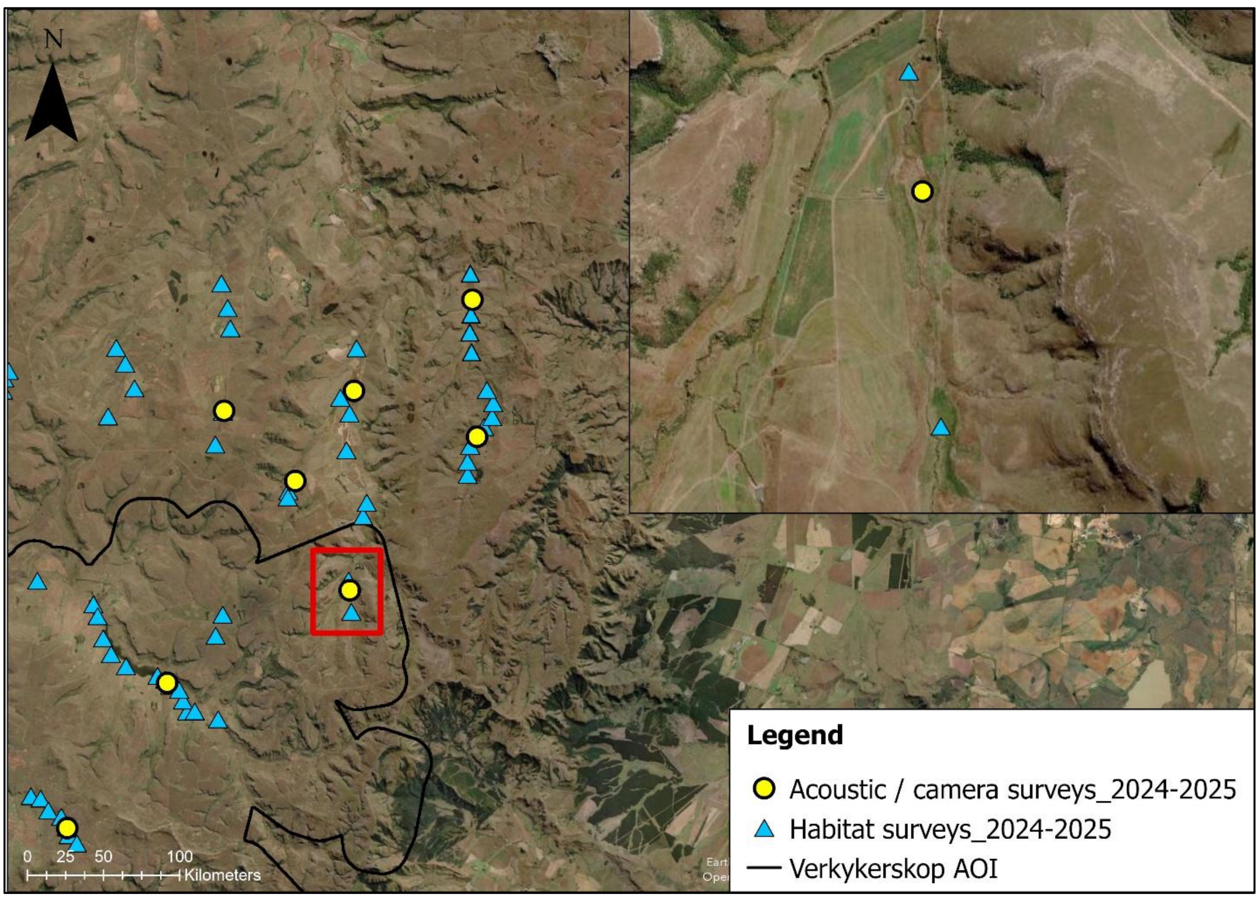


Figure 25: Verkykerskop (VKK7) wetland site surveyed from November 2024 to March 2025.

Figure 26: VKK7 features a mosaic of vegetation communities, with Phragmites and Typha reedbeds concentrated along the central channel, and extensive graminoid dominant vegetation along the lateral seepage areas.

Figure 27: Certain sections of the wetland area, particularly the moist grassland lateral seepage areas seem to be used extensively as livestock winter feeding sites.

Multiyear (2020–2025) Habitat Suitability Index (HSI) analysis (see methodology) suggests that the localised remaining intact habitats of VKK7 provides high seasonal habitat suitability for the target species, with peak conditions temporarily exceeding the suitability threshold of 0.8 between mid-December and February (Figure 28). However, while HSI values indicate potential habitat availability during the core summer window, suitability is constrained to smaller disjunct patches that have not been used for agricultural activities. VKK7 includes a mix of channeled and unchanneled valley bottom wetlands interlinked with riparian corridors, but approximately

50% of the lateral seepage zones have been converted for cattle fodder production. These areas, once sedge-rich graminoid meadows, are now subject to intensive seasonal mowing, baling, and intense seasonal grazing. As a result, key microhabitat attributes—such as vegetation height, basal cover, and floristic structure—have been significantly impacted.

The combined impacts of trampling, defoliation, and the spread of herbaceous weeds have likely reduced the actual ecological suitability of the overall site, despite localised suitability scores in fragmented, less impacted sections. However, remaining intact patches along the seepage margins and riparian edges may still function as seasonal or transitory habitat, especially in years with reduced land-use pressure. If grazing pressure and agricultural conversion were curtailed or managed, the site could demonstrate improved suitability across much larger tracts of habitat due to the underlying hydrological potential and the regrowth capacity of graminoid vegetation.

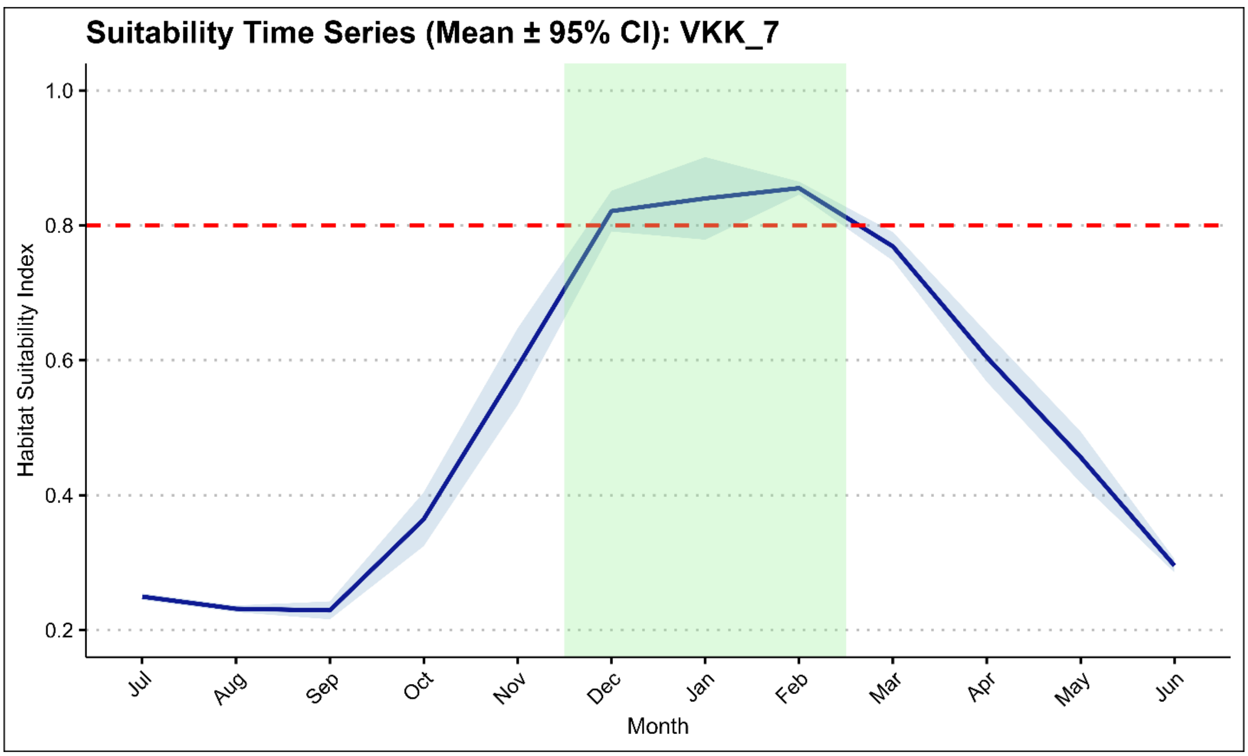


Figure 28: Seasonal habitat suitability trends for “VKK7” sites based on multi-year remote sensing habitat suitability analysis (2020–2025). The blue line represents the mean suitability index across years, with shaded light-blue ribbons indicating the 95% confidence interval. The dashed red line marks the suitability threshold (0.8) derived from other sites yielding presence (Colyn et al. 2020), while the green swathe highlights the period where mean suitability values exceed this threshold, indicating peak habitat suitability.

Verkykerskop Site 8 (VKK8)

VKK8 comprises a relatively large (~153 ha) graminoid-dominated unchanneled valley bottom and seep wetland system, hydrologically connected to adjacent channelled valley bottom and riparian habitats (Figure 29). The wetland is characterized by shallowly flooded palustrine conditions with dominant sedge and other graminoid vegetation (Figure 30). Habitat structure—including average vegetation height (~30 cm), high canopy cover (~70%), and shallow water depth (~5 cm)—indicates very high suitability for the focal species during peak summer months (Figure 30).

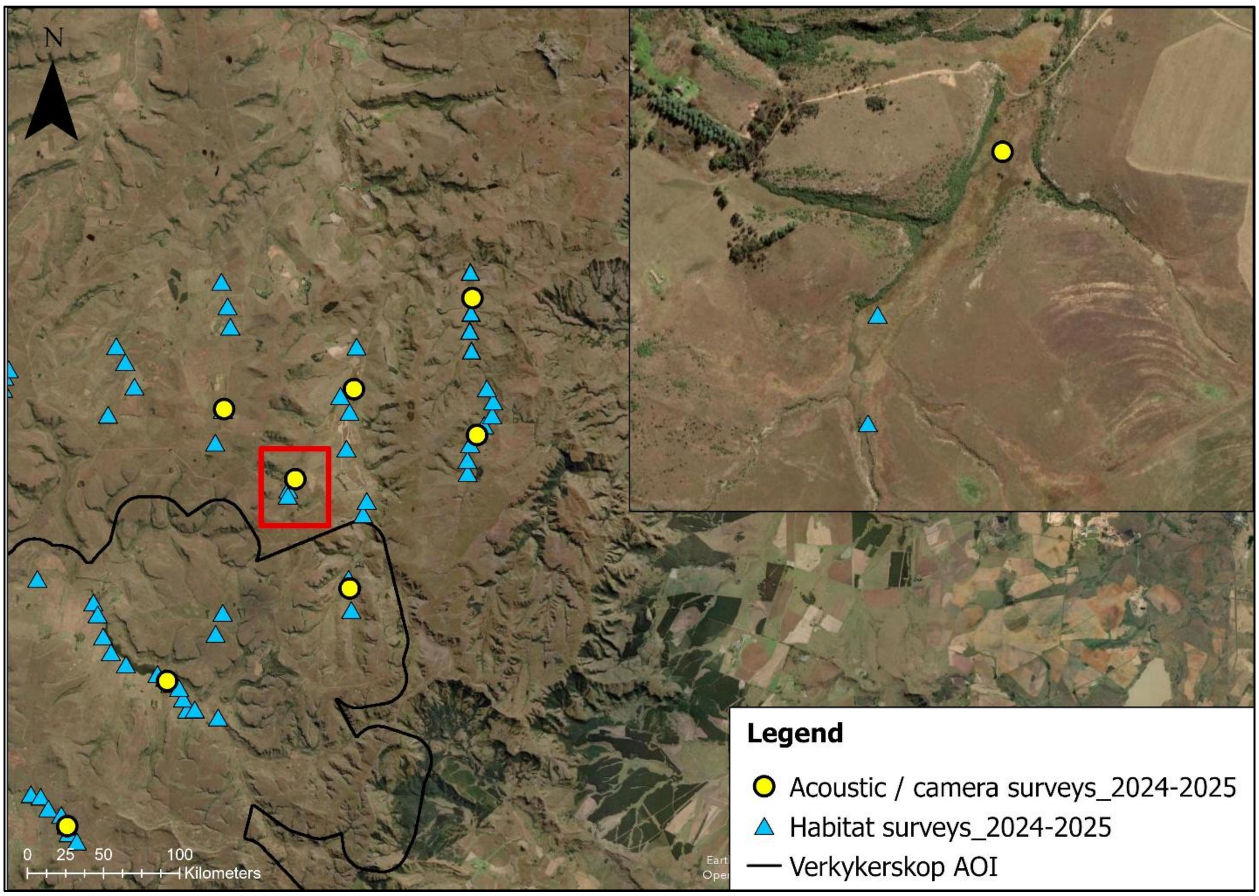


Figure 29: Verkykerskop (VKK8) wetland site surveyed from November 2024 to March 2025.

Multiyear (2020–2025) Habitat Suitability Index (HSI) analysis (see methodology) suggests that VKK8 supports high seasonal habitat suitability for the target species, with peak conditions extending from mid-December through February (Figure 30). The site is dominated by shallowly flooded graminoid vegetation, with field observations confirming key structural attributes including suitable vegetation height (~30 cm), high canopy cover (~70%), and water depth (~5 cm). VKK8 forms part of a broader wetland network connected to downstream channelled valley bottom and riparian systems (Figure 31), but its unchanneled palustrine core and seep-fed graminoid zones likely drive its high suitability. These features provide optimal microhabitat structure during the critical summer period and are likely important seasonal habitat for the species.

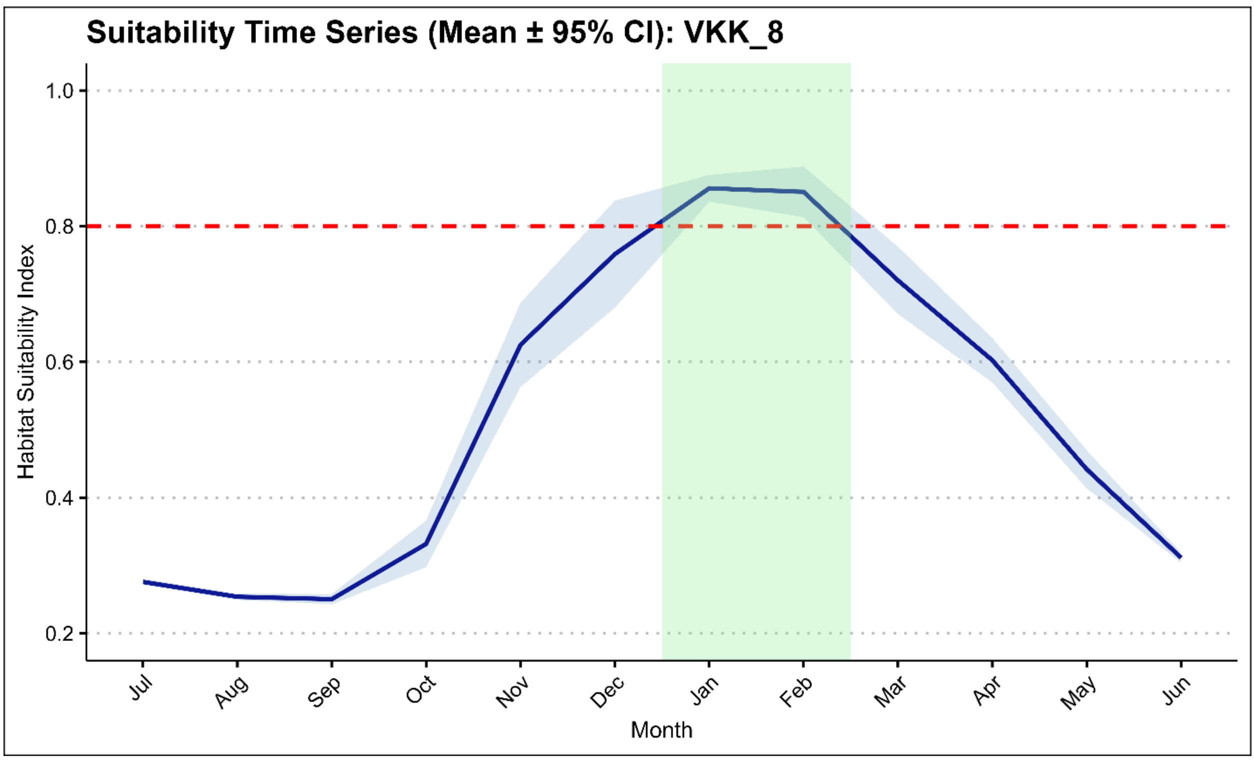


Figure 30: Seasonal habitat suitability trends for "VKK8" sites based on multi-year remote sensing habitat suitability analysis (2020–2025). The blue line represents the mean suitability index across years, with shaded light-blue ribbons indicating the 95% confidence interval. The dashed red line marks the suitability threshold (0.8) derived from other sites yielding presence (Colyn et al. 2020), while the green swathe highlights the period where mean suitability values exceed this threshold, indicating peak habitat suitability.

Signs of damming were noted further upstream and associated impacts were recorded directly above the sampled (surveyed) wetland site (Figure 31).

Figure 31: Riparian habitat further upstream from VKK8 has been dammed (left), with sedimentation impacts noted further downstream.

5. Habitat risk mapping

The habitat suitability model (HSM) identified a network of high to very high suitability patches for Species23 across the Verkykerskop area of interest (AOI), with the north-eastern portion of the AOI emerging as a key concentration of suitable habitat (Figure 32). It must be noted that some of the largest and most suitable habitats surveyed, namely VKK1-VKK4 & VKK8, are located outside of the direct Verkykerskop AOI. VKK sites 5 and 7 were the most suitable sites identified within the AOI. These areas are mapped as dark red polygons (very high risk), representing core habitat patches that exceeded the suitability threshold, and were further buffered by 250 m (light red polygons – high risk) to account for potential edge disturbance and indirect development impacts. The central and north-eastern wetlands, forming a contiguous cluster of suitable habitat, are strongly aligned with field-verified habitat characteristics, including shallowly flooded palustrine systems with a mosaic of varied (including some low) intensity land use.

The model was developed using a remote sensing-based ensemble classification framework integrating Random Forest and Artificial Neural Networks (ANNs), with inputs derived from Sentinel-2 imagery. The final ensemble output achieved high predictive performance (AUC-ROC and F1 scores >0.9), and was informed by stepwise variable selection, hyperparameter optimization using genetic algorithms, and independent test dataset and in-situ validation. Key environmental drivers included vegetation structure, hydrological persistence, and topographic position, as confirmed through variable importance and partial dependence analyses.

In contrast, the southern and western wetland areas within the AOI displayed more disjunct, fragmented and degraded habitat conditions, with lower predicted suitability. Field assessments confirmed multiple pressures compromising habitat quality, including overgrazing (trampling and defoliation), damming, artificial drainage, hayfield conversion, and recurrent mowing or burning. Despite these pressures, isolated pockets of suitable habitat persist, and may still function as seasonal refugia or movement corridors, especially during wet years or under reduced grazing pressure.

The habitat connectivity analysis, based on a circuit theory approach (Colyn et al. 2020c), revealed spatial variation in functional connectivity for Species23 across the Verkykerskop area of interest (AOI) (Figure 33). A resistance surface was constructed using empirically derived variables, including habitat suitability, land cover, and topography (Colyn et al. 2019; 2020a; 2020b). Areas of low resistance (high connectivity) are indicative of landscapes that could potentially facilitate dispersal and seasonal movement, whereas high resistance zones represent potential barriers or bottlenecks due to habitat degradation or incompatible land use. The continuous connectivity layer was subsequently converted into polygons representing the most likely low-resistance corridors between various core and transient habitat patches using threshold selection and post-processing workflows. These areas, classified as medium risk, should be avoided when siting wind turbine generators (WTGs) as a precautionary measure, given their potential role in supporting landscape-level movement and ecological connectivity.

Importantly, the Verkykerskop AOI is strategically positioned between two confirmed areas of Sepcies23 occurrence—Ingula Nature Reserve, located approximately 15 km to the south, and Seekoeivlei Nature Reserve, situated roughly 25 km to the north, where multiple presence records, including from 2024, confirm ongoing occupancy. This central location suggests that the Verkykerskop landscape may function as a critical stepping-stone or movement corridor within the species' fragmented range, further emphasizing the need for precautionary land-use planning and the protection of identified connectivity zones.

Results indicate that the central and north-eastern portions of the AOI contain both large, contiguous patches of high suitability habitat and relatively high connectivity, forming a critical cluster of functionally linked wetland systems. These areas, which include a mosaic of shallowly flooded palustrine wetlands and moderate-intensity land use, could contribute to both local persistence and broader landscape permeability. In contrast, the western portions of the AOI exhibit greater resistance to movement, largely due to fragmentation from agricultural transformation, as well as some woody vegetation encroachment, and damming, which reduce the effective connectivity between remnant wetland patches.

Collectively, the HSM and connectivity analysis outputs underscore the north-eastern and central sections of the wetland complex as locally significant potential areas for Species 23, warranting high conservation priority and protection from further disturbance or development.

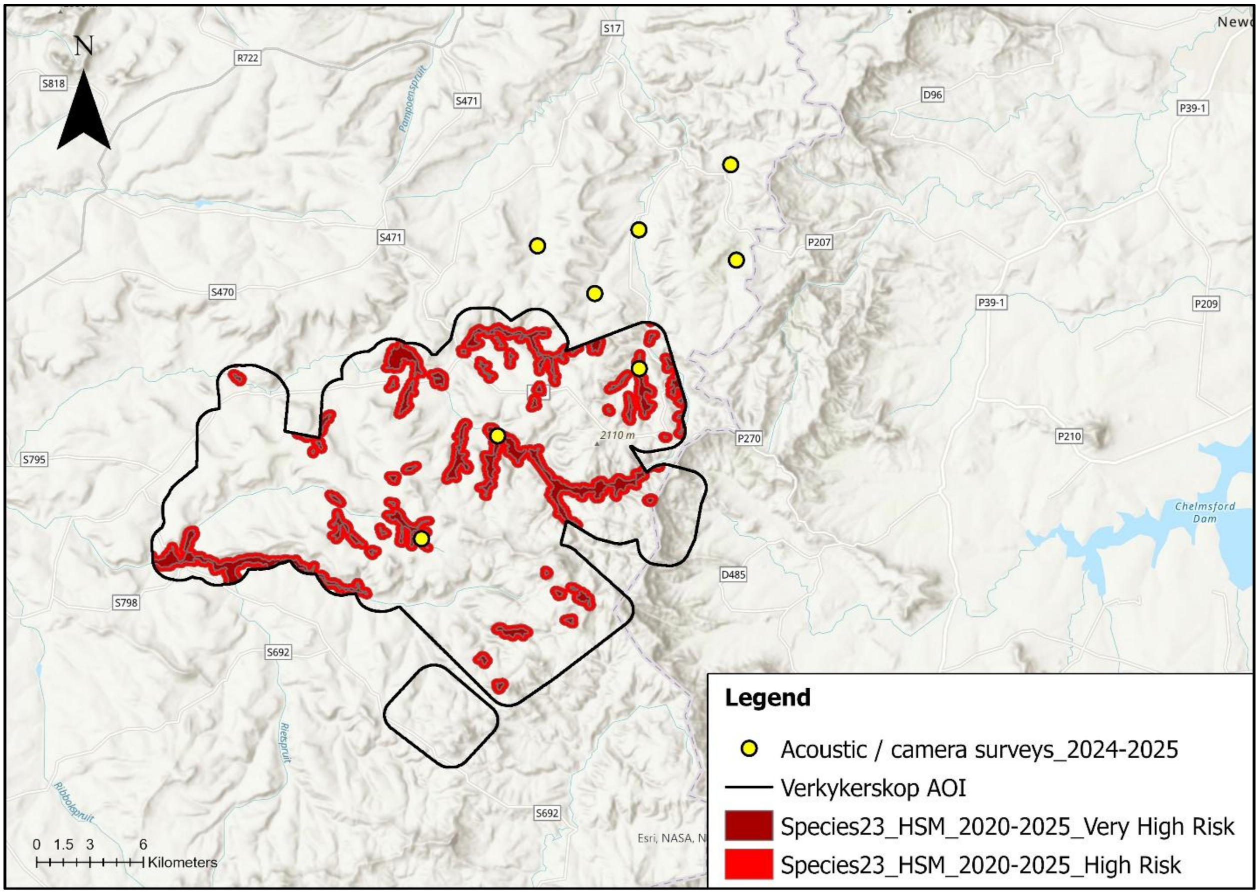


Figure 32: Suitable Species23 habitat patches (dark red polygons – very high risk) identified by the habitat suitability model and mapped across the area of interest (AOI). These patches have been buffered by 250 m to account for potential habitat disturbance from development activities, resulting in red polygons classified as high risk.

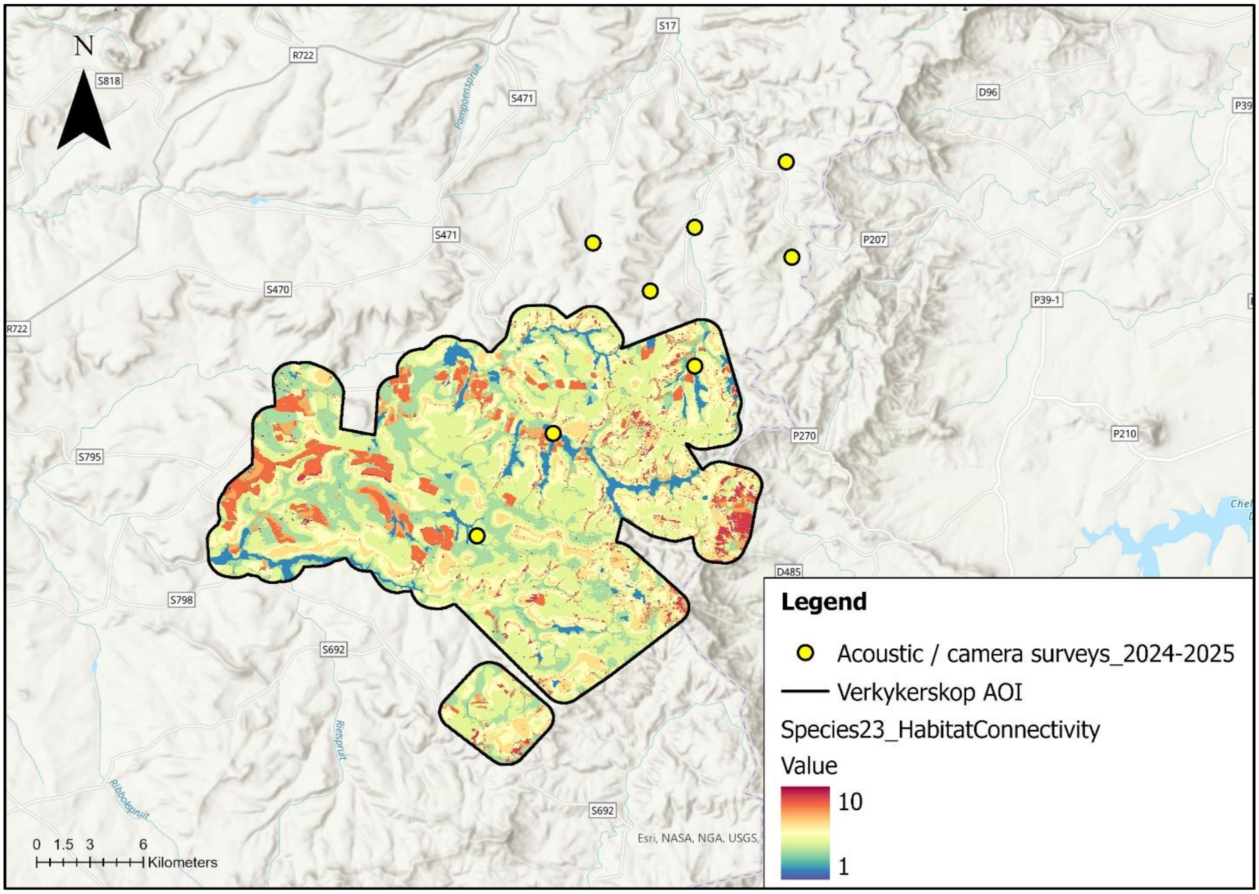


Figure 33: Species23 habitat connectivity patches mapped across the AOI.

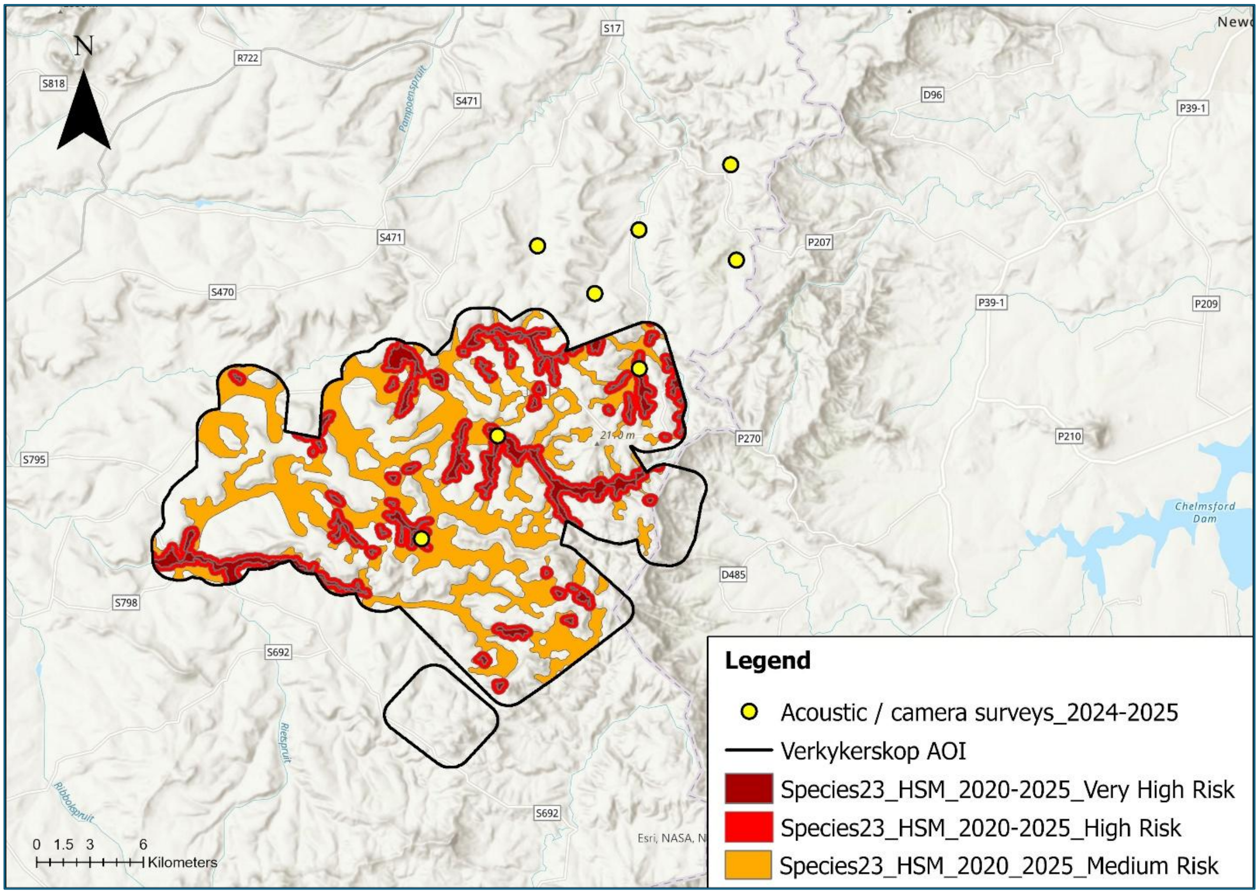


Figure 34: Species23 habitat connectivity patches mapped across the AOI.

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