Avifaunal Impact Assessment:

Amendment application for the proposed Waaihoek Wind Energy Facility

October 2021

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Executive Summary

Environmental authorisation was granted in October 2015 to the proposed Waaihoek Wind Energy Facility (WEF,) approximately 7km south-east of the town of Utrecht in the eMadlangeni Local Municipality (Amajuba District), Kwa-Zulu Natal. Prior to the authorisation, in 2013 - 2014, avifaunal pre-construction monitoring was conducted by Chris van Rooyen Consulting at the site of the proposed WEF in accordance with the *"Best practice guidelines for avian monitoring and impact mitigation at proposed wind energy development sites in southern Africa"* (Jenkins *et al.* 2011) which was published by the Endangered Wildlife Trust (EWT) and BirdLife South Africa (BLSA) in March 2011, and subsequently revised in 2011, 2012 and 2015 (third edition).

The applicant has indicated that they intend to apply for an amendment to the Environmental Authorisation to amend the authorised turbine specifications and the number of turbines. The intended changes are as follows:

Table 1: Authorised and proposed turbine specifications

Aspect	Authorised Specification	New Specification
Rotor Diameter	140 m	Up to 170 m
Number of Turbines	47	43

Chris van Rooyen Consulting was approached by the applicant to assess the potential impact of the proposed changes on avifauna. The following approach was followed, in order for a proper assessment of the proposed changes to be made:

- Nest and roost searches were repeated to look for priority species nests and roosts in and around the site.
- One seasonal survey, which includes transects counts and vantage point watches, was implemented to assess if there are any significant changes in the expected abundance and variety of avifauna compared to the original monitoring results, and to supplement the original monitoring data.

Results

1 Habitat ground truthing

The habitat had remained essentially the same since the original pre-construction motoring was conducted in 2013 - 2014. The data collected during those surveys therefore remain relevant and can be considered for this assessment as well. This is particularly relevant for the austral summer migratory species such as Amur Falcon, White Stork and Common Buzzard which were recorded during the original surveys, but not in 2021, as the surveys took place in winter.

2 Nest searches

- A Secretarybird nest was recorded that was not present during the original monitoring in 2013 - 2014. The status of the species was upgraded to Globally and Regionally Endangered in 2020.
- One Southern Bald Ibis roost (FP SBI Roost West) showed signs of heavy use and could contain breeding pairs.

3 Drive and walk transects

The transect counts produced evidence of priority species diversity and abundance broadly comparable to the original monitoring done in 2013 - 2014, thereby further reinforcing the impression that the habitat had not changed in any significant way.

4 Impact rating

In the original bird specialist report completed in August 2014 as part of the EIA procedure, the pre-mitigation turbine collision risk was rated as of **moderate** significance, which, with the application of mitigation measures, could be reduced to **low** significance. It is concluded that, should the amendment be implemented, the original pre-mitigation risk rating of **moderate** significance should remain as it currently stands, with a reduction to **low** significance, after the implementation of the additional mitigation measures proposed in this report.

Mitigation measures

Based on the results of the additional monitoring conducted at the proposed WEF, the following is recommended, in additional to the original mitigation measures:

1 Turbine collisions

- Secretarybird (*Sagittarius serpentarius*) Red Data status – Endangered (Regional and Global) nest (-27.749269°, 30.481961°)
  - A 1km infrastructure free buffer zone is recommended around the nest.
  - Turbines located outside the 1km buffer but within 2.5km from the nest be subjected to pro-active Shut-Down-on-Demand (SDoD) mitigation to prevent collisions with the turbines. SDoD can be achieved either through the deployment of an artificial intelligence camera system e.g. IdentiFlight® or a by means of a team of bio-monitors that are stationed at observation points to look out for target priority species and then issues a warning followed by shut down command if a bird approaches a turbine risk zone. The SDoD programme should be implemented and operational by the time the first turbines start turning.

- Southern Bald Ibis (*Geronticus calvus*) Red Data status – Vulnerable (Regional and Global) roost / potential breeding sites
    - A 2km turbine free buffer zone is recommended around the roost sites.
- Escarpment edge / cliff line buffer – turbine setback
    - A minimum of 400m buffer – turbine setback zone should be implemented to minimise the risk for soaring priority species which are likely to use the cliffs and ridge lines for most of their flight activity.

See Figure 9 for a sensitivity map indicating the proposed buffer zones.

2 Electrocutions

- Internal medium voltage cables that connect the respective wind turbines to the onsite substation should be buried as much as is practically possible.
- Where the medium voltage cables cannot be buried due to technical constraints, a raptor-friendly structure must be employed which must signed off by the avifaunal specialist.

Chris van Rooyen

Chris has 25 years' experience in the management of wildlife interactions with electricity infrastructure. He was head of the Eskom-Endangered Wildlife Trust (EWT) Strategic Partnership from 1996 to 2007, which has received international acclaim as a model of co-operative management between industry and natural resource conservation. He is an acknowledged global expert in this field and has worked in South Africa, Namibia, Botswana, Lesotho, New Zealand, Texas, New Mexico and Florida. Chris also has extensive project management experience and has received several management awards from Eskom for his work in the Eskom-EWT Strategic Partnership. He is the author of 15 academic papers (some with co-authors), co-author of two book chapters and several research reports. He has been involved as ornithological consultant in numerous power line and wind generation projects. Chris is also co-author of the Best Practice for Avian Monitoring and Impact Mitigation at Wind Development Sites in Southern Africa, which is currently accepted as the industry standard. Chris also works outside the electricity industry and had done a wide range of bird impact assessment studies associated with various residential and industrial developments.

Albert Froneman (Pr.Sci.Nat)

Albert has an M. Sc. in Conservation Biology from the University of Cape Town and started his career in the natural sciences as a Geographic Information Systems (GIS) specialist at Council for Scientific and Industrial Research (CSIR). In 1998, he joined the Endangered Wildlife Trust where he headed up the Airports Company South Africa – EWT Strategic Partnership, a position he held until he resigned in 2008 to work as a private ornithological consultant. Albert's specialist field is the management of wildlife, especially bird related hazards at airports. His expertise is recognized internationally; in 2005 he was elected as Vice Chairman of the International Bird Strike Committee. Since 2010, Albert has worked closely with Chris van Rooyen in developing a protocol for pre-construction monitoring at wind energy facilities, and he is currently jointly coordinating pre-construction and operational monitoring programmes at several wind farm facilities. Albert also works outside the electricity industry and had done a wide range of bird impact assessment studies associated with various residential and industrial developments. Since 2009 Albert has been a registered Professional Natural Scientist (reg. nr 400177/09) with The South African Council for Natural Scientific Professions, specialising in Zoological Science.

DECLARATION OF INDEPENDENCE

I, Chris van Rooyen as duly authorised representative of Chris van Rooyen Consulting, and working under the supervision of and in association with Albert Froneman (SACNASP Zoological Science Registration number 400177/09) as stipulated by the Natural Scientific Professions Act 27 of 2003, hereby confirm my independence (as well as that of Chris van Rooyen Consulting) as a specialist and declare that neither I nor Chris van Rooyen Consulting have any interest, be it business, financial, personal or other, in any proposed activity, application or appeal in respect of which Chris van Rooyen Consulting was appointed by Arcus Consultancy Services South Africa (Pty) Ltd, other than fair remuneration for worked performed, specifically in connection with the Amendment Application for the proposed Waaihoek wind energy facility.

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Full Name: Chris van Rooyen

Title / Position: Director

Contents

1. Introduction

Environmental authorisation was granted in October 2015 to the proposed Waaihoek Wind Energy Facility (WEF,) approximately 7km south-east of the town of Utrecht in the eMadlangeni Local Municipality (Amajuba District), Kwa-Zulu Natal. Prior to the authorisation, in 2013 - 2014, avifaunal pre-construction monitoring was conducted by Chris van Rooyen Consulting at the site of the proposed WEF in accordance with the *"Best practice guidelines for avian monitoring and impact mitigation at proposed wind energy development sites in southern Africa"* (Jenkins *et al.* 2011) which was published by the Endangered Wildlife Trust (EWT) and BirdLife South Africa (BLSA) in March 2011, and subsequently revised in 2011, 2012 and 2015 (third edition).

The applicant has indicated that they intend to apply for an amendment to the Environmental Authorisation to amend the authorised turbine specifications and the number of turbines. The intended changes are as follows:

Table 2: Authorised and proposed turbine specifications

Aspect	Authorised Specification	New Specification
Rotor Diameter	140 m	Up to 170 m
Number of Turbines	47	43

Chris van Rooyen Consulting was approached by the applicant to assess the potential impact of the proposed changes on avifauna. Although the pre-construction monitoring had already been completed at the proposed WEF in 2014, the latest edition of the guidelines (2015) state as follows:

"If there is a significant gap (i.e. more than three years) between the completion of the initial pre-construction monitoring and impact assessment, and the anticipated commencement of construction, it may be advisable to repeat the pre-construction monitoring (or parts thereof) to assess whether there have been any changes in species abundance, movements and/or habitat use in the interim."

In view of the above requirement, Chris van Rooyen Consulting suggested the following approach to be followed, before a proper assessment of the proposed changes could be made:

- Nest and roost searches must be repeated to look for priority species nests and roosts in and around the site.
- One seasonal survey, which includes transects counts and vantage point watches, needs to be implemented to assess if there are any significant changes in the expected abundance and variety of avifauna compared to the original monitoring results, and to supplement the original monitoring data.

It was deemed unnecessary to repeat the whole 12-months monitoring for the following reasons:

- The habitat at the site and immediate surroundings have not changed in any substantial manner since the original pre-construction monitoring was completed in 2013 - 2014.

2. Objectives of the report

The objectives of the report are as follows:

- To report on the ground-truthing of the habitat at the site;
- To report on any priority species nests at or close to the site;
- To report on any roost sites of priority species at or close to the site;
- To assess the priority species variety, abundance and flight movement recorded through transect counts, vantage point watches and focal point monitoring in 2021;
- To assess the potential impacts linked to the proposed, changes to the lay-out, the number of turbines and the turbine dimensions;
- To provide additional and/or revised recommendations for the mitigation of the identified impacts, based on the outcome of the nest searches and monitoring, and informed by the latest developments in the field of birds and wind energy.

3. Assumptions

It was assumed that the results of the pre-construction monitoring that was conducted in 2013 – 2014 would remain valid and relevant unless the investigations in 2021 revealed that the habitat had changed significantly in the interim.

4. Methods

The monitoring protocol for the site was based on the latest version (2015) of *Jenkins A R; Van Rooyen C S; Smallie J J; Anderson M D & Smit H A. 2011. Best practice guidelines for avian monitoring and impact mitigation at proposed wind energy development sites in southern Africa. Endangered Wildlife Trust and Birdlife South Africa.* Species were classified using the latest BLSA list of priority species for wind farms (Retief *et al.* 2014).

4.1 Habitat ground truthing

A seasonal survey was conducted from 3 – 9 June 2021 during which time the site was inspected on foot and with a vehicle. Photographs of the habitat were taken and compared with the photographs taken during the pre-construction monitoring in 2013 - 2014 to establish if the habitat had changed significantly.

4.2 Nest and roost searches

Nest and roost searches were conducted at the site and the immediate environment up to 7km from the site in the period 3 – 9 June as part of the pre-construction monitoring.

4.3 Drive and walk transects

Monitoring was conducted in the following manner:

- Four walk transects of 1km each were identified at the turbine site. Each walk transect was counted four times. All birds were recorded during walk transects.
- The following variables were recorded:
    - Species;
    - Number of birds;
    - Date;
    - Start time and end time;
    - Estimated distance from transect;
    - Wind direction;
    - Wind strength (Estimated Beaufort scale 1-7);
    - Weather (sunny; cloudy; partly cloudy; rain; mist);
    - Temperature (cold; mild; warm; hot);
    - Behaviour (flushed; flying-display; perched; perched-calling; perched-hunting; flying-foraging; flying-commute; foraging on the ground); and
    - Co-ordinates (priority species only).

4.4 Vantage point counts

Vantage point counts were conducted in the following manner:

- Four vantage points (VPs) were identified at the project site to record the flight altitude and patterns of priority species. The following variables were recorded for each flight:
    - Species;
    - Number of birds;
    - Date;
    - Start time and end time;
    - Wind direction;
    - Wind strength (estimated Beaufort scale 1-7);
    - Weather (sunny; cloudy; partly cloudy; rain; mist);
    - Temperature (cold; mild; warm; hot);
    - Flight altitude (high: above rotor altitude; medium: at rotor altitude; low: below rotor altitude);
    - Flight mode (soar; flap; glide; kite; hover); and
    - Flight time (in 15 second-intervals).

The objective of vantage point counts was to assess the potential collision risk to priority species posed by the proposed wind farm.

4.5 Focal point counts

A total of three potential focal points of bird activity were identified and monitored. The three focal points were the following:

- FP SBI Roost West: A Southern Bald Ibis roost to the west of the site.
- FP Valley: A valley to the east containing potential Southern Bald Ibis roosting and breeding habitat.
- FP SBI Roost Valley: A Southern Bald Ibis roost to the east of the site

See Figure 1 below for a map of the transects, VPs and focal points at the site.

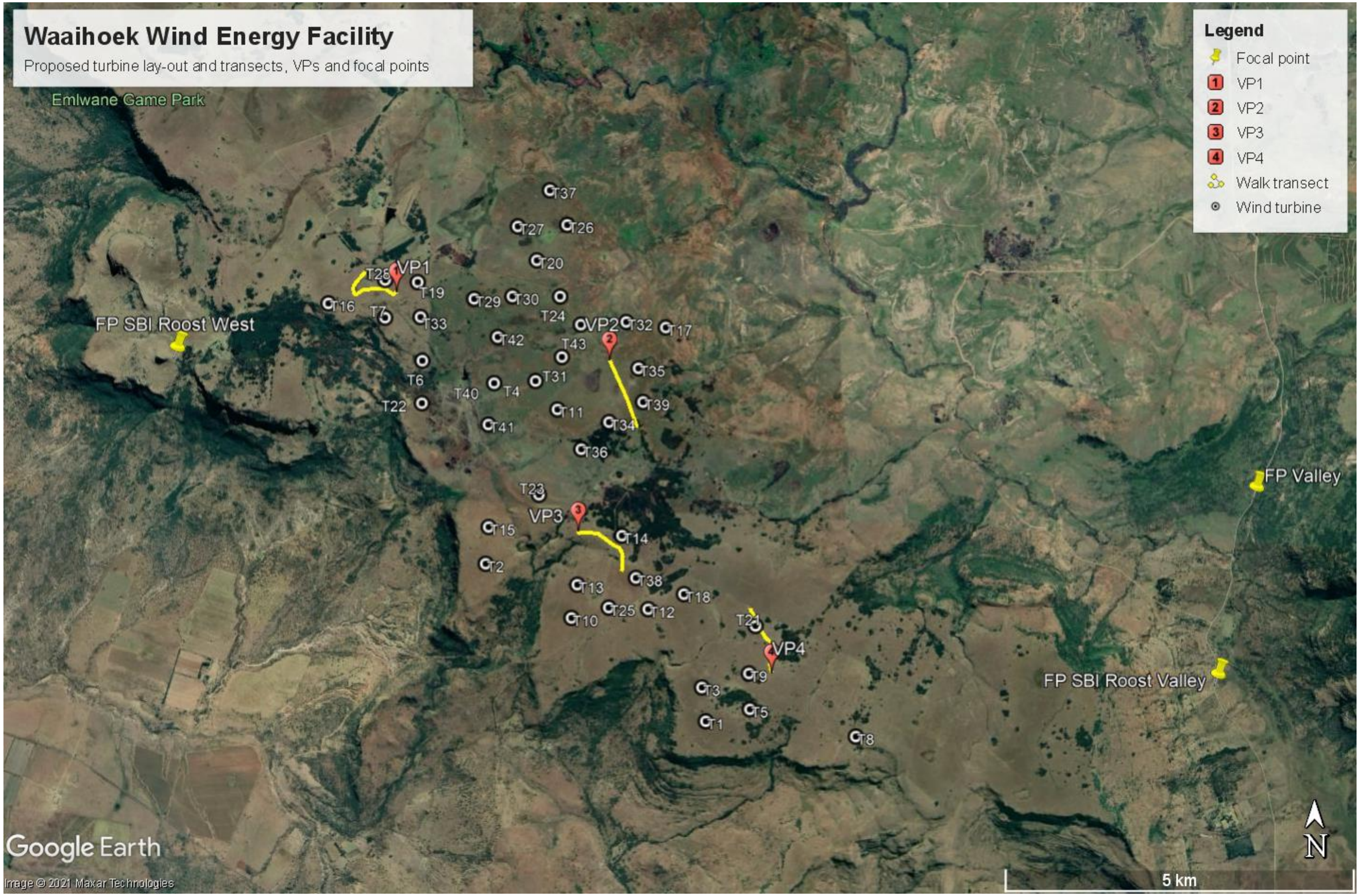

Figure 1: Transects, VPs and focal points used during the monitoring in June 2021.

5. Results

5.1 Habitat ground truthing

Physical inspection of the WEF site revealed that the habitat and land-use have remained essentially the same since the first pre-construction monitoring was completed in 2014.

The site falls entirely within the Grassland biome (Harrison *et al.* 1997; Mucina & Rutherford 2006). Vegetation structure is more critical in determining bird habitat than actual plant composition (Harrison *et al.* 1997). Therefore, the description of the bird habitat presented in this report concentrates on factors relevant to birds and does not give an exhaustive list of plant species which occur in the study area.

The following bird habitat classes are present at the site and immediate environment:

- Grassland: The proposed turbine lay-out is located in Wakkerstroom Montane Grassland, which comprises predominantly short montane grasslands on the plateaus and the relatively flat areas, with short forest and *Leucosidea* thickets occurring along steep, mostly east-facing slopes and drainage areas.
- Alien trees: The turbine area contains several clumps of invasive Australian Black Wattle *Acacia mearnsii*, Eucalyptus and pine species.
- Dams and wetlands: There are several impoundments on the site as well as natural wetlands.
- Cliffs: There are cliffs present on the south-eastern edge of the site.

5.2 Nest and roost searches

5.1.1 Nest searches

The following nests and roosts were recorded during the inspections between 3 – 9 June (see Figure 3).

- 1 x Secretarybird (*Sagittarius serpentarius*) Red Data status – Endangered (Regional and Global) nest
- 3 x Southern Bald Ibis (*Geronticus calvus*) Red Data status – Vulnerable (Regional and Global) roost / potential breeding sites

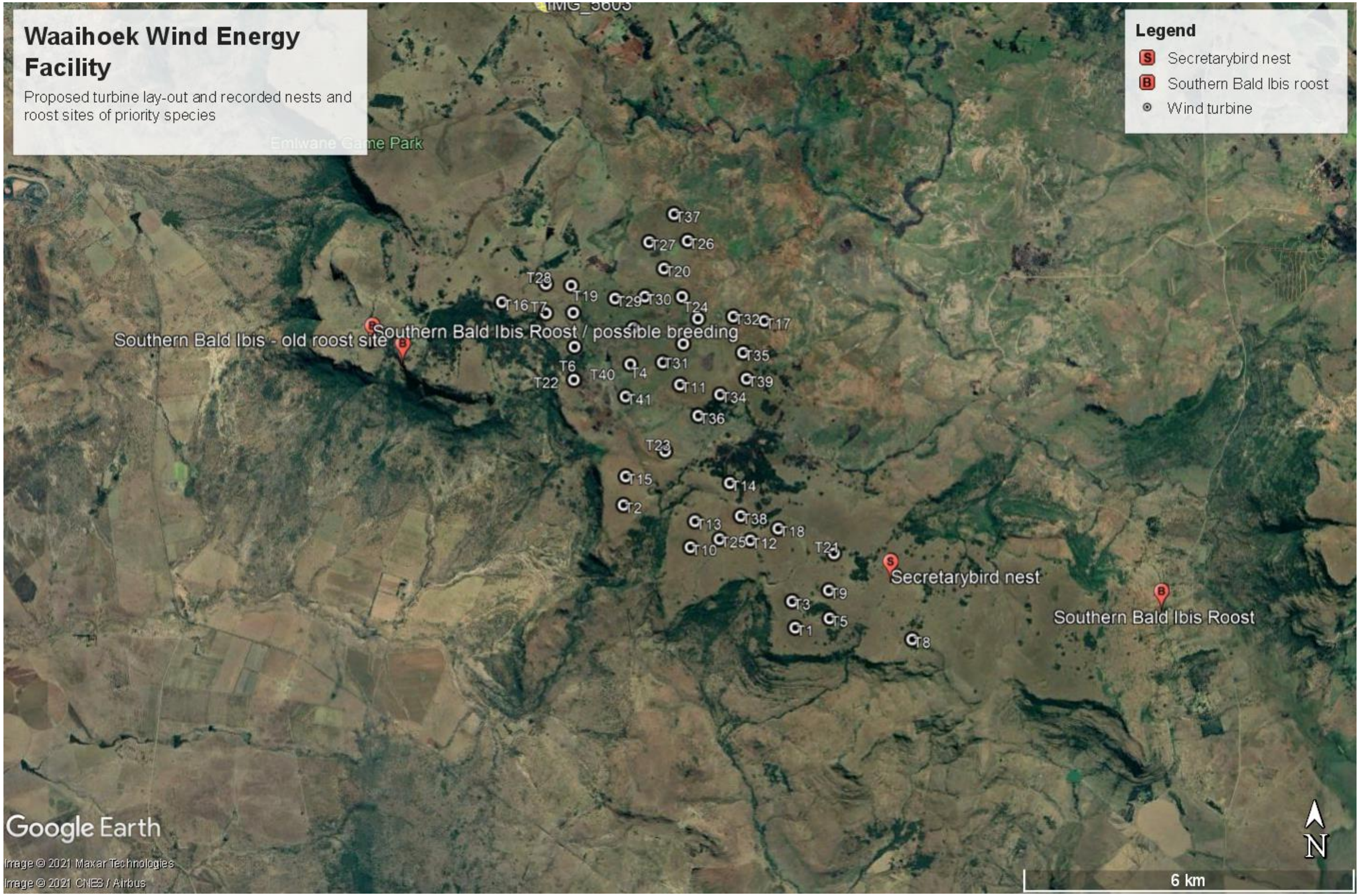

Figure 2: The location of nests and roost sites recorded in June 2021.

5.3 Drive and walk transects

The results of the transect counts performed during June 2021 are tabled in Table 2

Table 3: The results of the drive transects: June 2021

Turbine site	Number
Species composition	
All Species	66
Priority Species (23%)	15
Non-Priority Species (77%)	51
Total count	
Walk transects	402
	402

The results of the incidental counts performed during June 2021 are tabled in Table 3

Table 4: The results of the incidental counts: June 2021

Bird name	Sci name	Number
Jackal Buzzard	*Buteo rufofuscus*	16
Spotted Eagle-Owl	*Bubo africanus*	1
Southern Bald Ibis	*Geronticus calvus*	9
Black-winged Lapwing	*Vanellus melanopterus*	5
Secretarybird	*Sagittarius serpentarius*	13
Buff-streaked Chat	*Campicoloides bifasciatus*	15
Black-winged Kite	*Elanus caeruleus*	2
Martial Eagle	*Polemaetus bellicosus*	1
Cape Vulture	*Gyps coprotheres*	1
Lanner Falcon	*Falco biarmicus*	2
African Harrier-Hawk	*Polyboroides typus*	1
African Marsh Harrier	*Circus ranivorus*	1
White-bellied Bustard	*Eupodotis senegalensis*	9
Black Sparrowhawk	*Accipiter melanoleucus*	1
African Fish Eagle	*Haliaeetus vocifer*	1

See Table 4 for a consolidated list of priority species from all survey sources, and Appendix 1 for a consolidated list of all species recorded.

Table 5: Consolidated list of priority species recorded: June 2021

Priority Species	Sci names	Transects turbine	Focal points	VP	Incidental
African Fish Eagle	*Haliaeetus vocifer*				*
African Harrier-Hawk	*Polyboroides typus*			*	*
African Marsh Harrier	*Circus ranivorus*				*
Black Sparrowhawk	*Accipiter melanoleucus*				*
Black-winged Kite	*Elanus caeruleus*				*
Black-winged Lapwing	*Vanellus melanopterus*	*		*	*
Buff-streaked Chat	*Campicoloides bifasciatus*	*			*
Cape Vulture	*Gyps coprotheres*				*
Jackal Buzzard	*Buteo rufofuscus*	*		*	*
Lanner Falcon	*Falco biarmicus*		*		*
Martial Eagle	*Polemaetus bellicosus*				*
Secretarybird	*Sagittarius serpentarius*	*		*	*
Southern Bald Ibis	*Geronticus calvus*	*	*		*
Spotted Eagle-Owl	*Bubo africanus*				*
White-bellied Bustard	*Eupodotis senegalensis*	*		*	*
Total		**6**	**2**	**5**	**15**

An Index of Kilometric Abundance (IKA = birds/km) was calculated for each priority species, and also for all priority species combined, which equates to 1.44 birds/km for walk transects (see Figure 3 below). The IKA for priority species recorded through walk transects during the original pre-construction monitoring was 1.66 birds/km, which included counts in all seasons (see Figure 4 below).

Figure 5 below shows the spatial distribution of priority species at the WEF site, as recorded during transect counts and incidental sightings in June 2021.

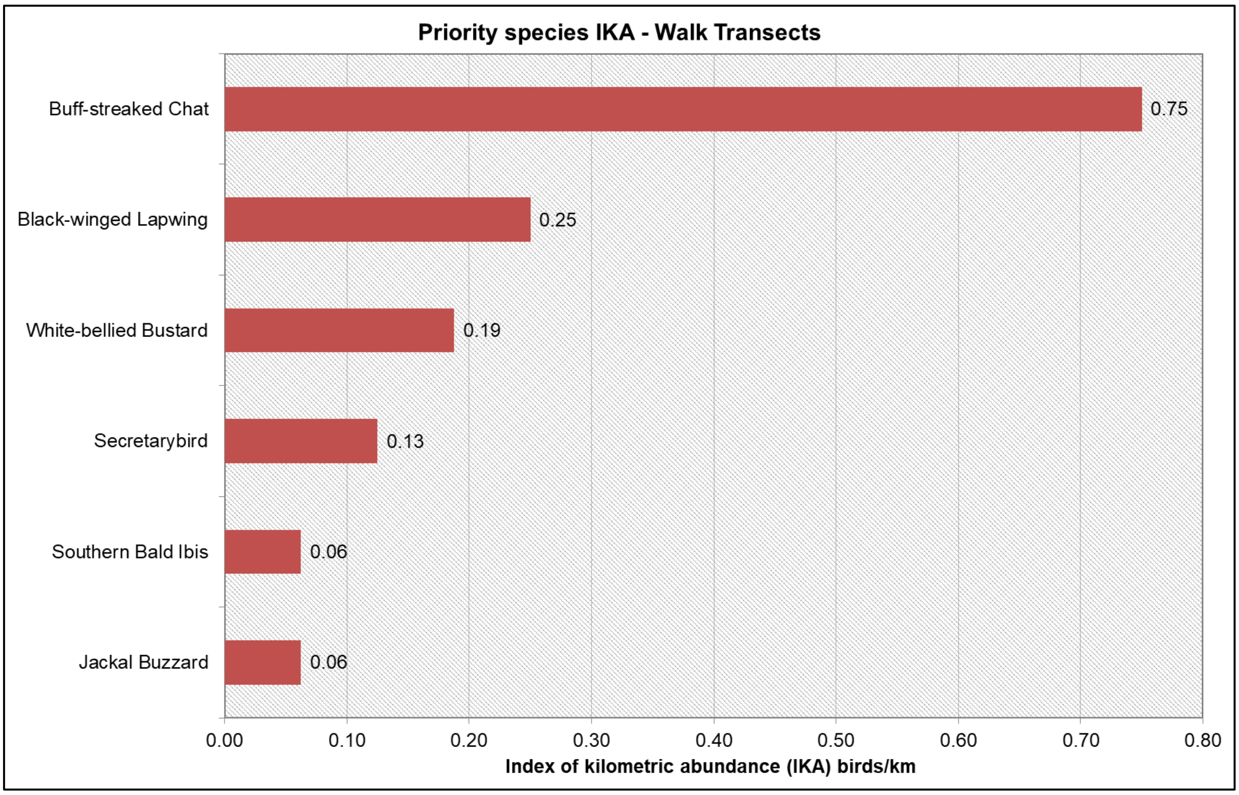

Figure 3: Index of kilometric abundance for walk transects: June 2021 (one season)

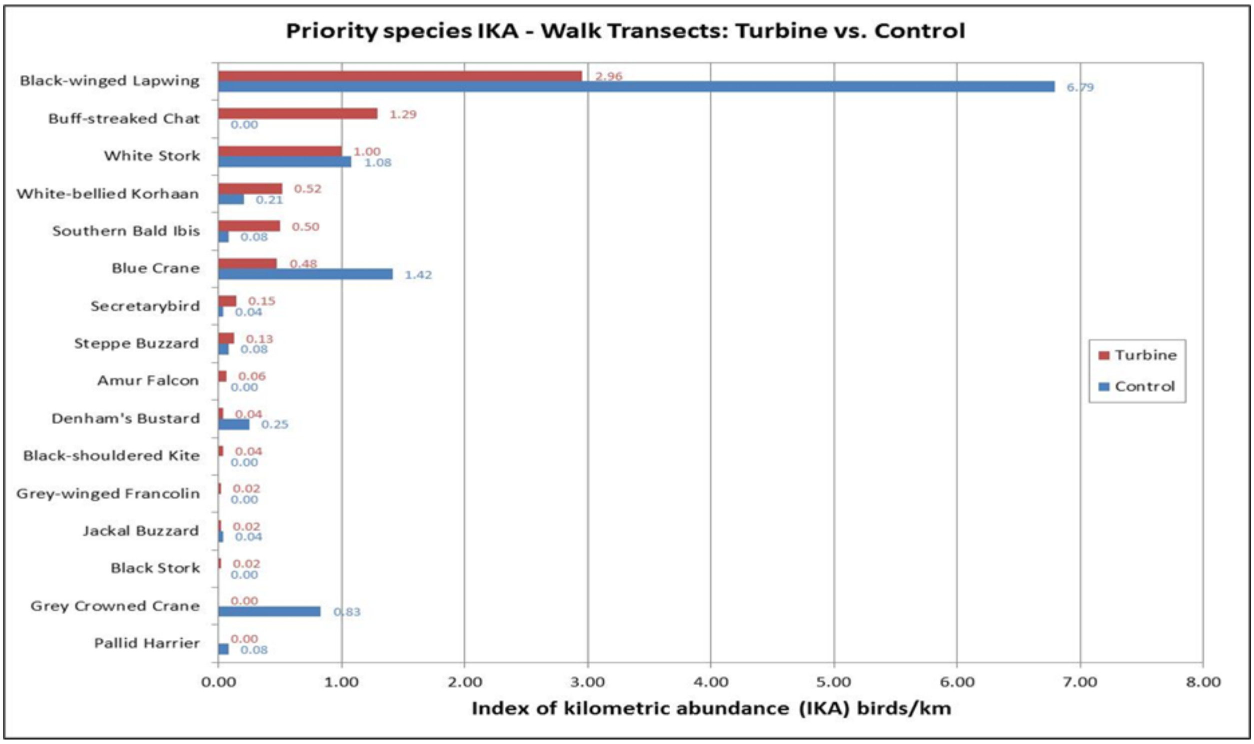

Figure 4: Index of kilometric abundance for walk transects: 2013 – 2014 (four seasons)

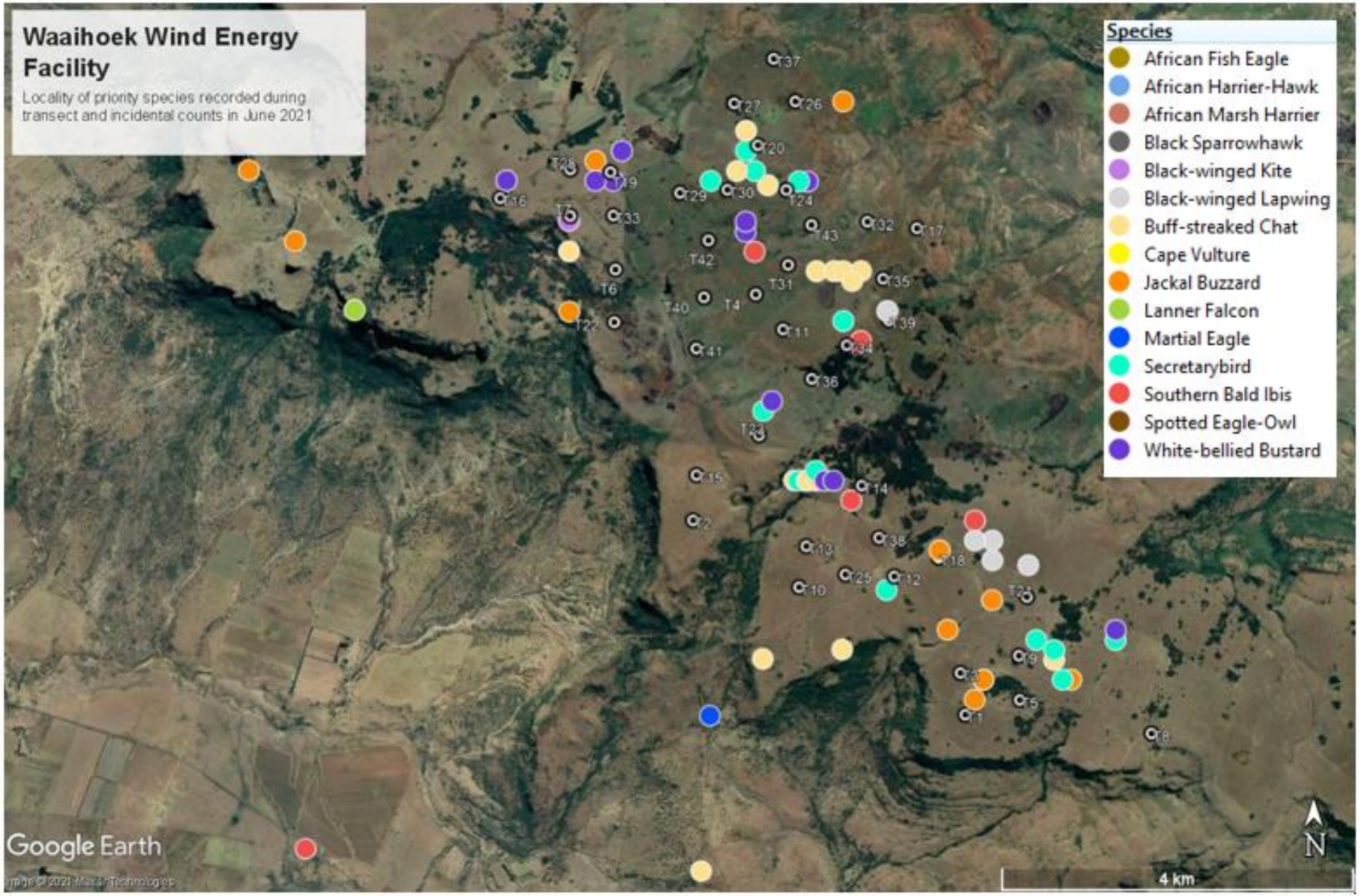

Figure 5: Spatial distribution of priority species recorded during transect counts and as incidental observations at the WEF site: June 2021

5.4 Vantage point counts

5.4.1 Passage rates

A total of 48 hours of vantage point watches (12 hours per vantage point) was completed at the WEF site in order to record flight patterns of priority species. See Table 5 for the duration of priority species flights recorded during VP watches in June 2021. See Table 6 shows the same for the for the original pre-construction monitoring in 2013 – 2014 (four seasons)

Table 6: Duration of priority species flights in June 2021 (one season)

Species	Low	Medium	Grand Total
White-bellied Bustard		0:00:30	0:00:30
Jackal Buzzard	0:01:48	0:00:54	0:02:42
African Harrier-Hawk		0:03:05	0:03:05
Secretarybird	0:06:11		0:06:11
Black-winged Lapwing	0:19:50	0:10:30	0:30:20
Grand Total	**0:27:49**	**0:14:59**	**0:42:48**

Table 7: Duration of priority species flights in 2013 – 2014 (four seasons)

Species	Low	Medium	High	Grand Total
Denham's Bustard	00:05:50			00:05:50
Blue Crane	00:02:30	00:02:50	00:01:00	00:06:20
African Harrier-Hawk	00:01:30	00:06:00		00:07:30
Black-shouldered Kite	00:03:05	00:05:00		00:08:05
Lanner Falcon	00:03:50	00:05:30		00:09:20
White-bellied Korhaan	00:13:30			00:13:30
Secretarybird	00:02:10	00:01:00	00:10:30	00:13:40
Southern Bald Ibis	00:09:10	00:14:20		00:23:30
Steppe Buzzard	00:06:53	00:29:00		00:35:53
Jackal Buzzard	00:15:40	00:18:00	00:08:35	00:42:15
Black-winged Lapwing	00:43:15			00:43:15
White Stork	00:40:40	00:41:30	00:01:30	01:23:40
Amur Falcon	04:36:00	00:16:00		04:52:00
Grand Total	**07:04:03**	**02:19:10**	**00:21:35**	**09:44:48**

The passage rate for priority species recorded in June 2021 at the turbine VP area (all flight heights) was 0.72 birds/hour[1], which translates to roughly 9 birds per day[2] . The passage rate for priority species during the original pre-construction monitoring in 2013 – 2014 was 1.34 birds per hour, which translates to roughly 17 birds per day.

[1] A distinction was drawn between passages and flights. A passage may consist of several flights e.g. every time an individual bird changes height or mode of flight, this was recorded as an individual flight, although it still forms part of the same passage.
[2] Assuming 13 hours of daylight over day averaged over all four seasons.

See Figure 6 below for the duration of recorded flights area for each species, at each height class in June 2021 (one survey) [3]. Figure 7 shows the same for the original pre-construction monitoring in 2013 – 2014 (four seasons).

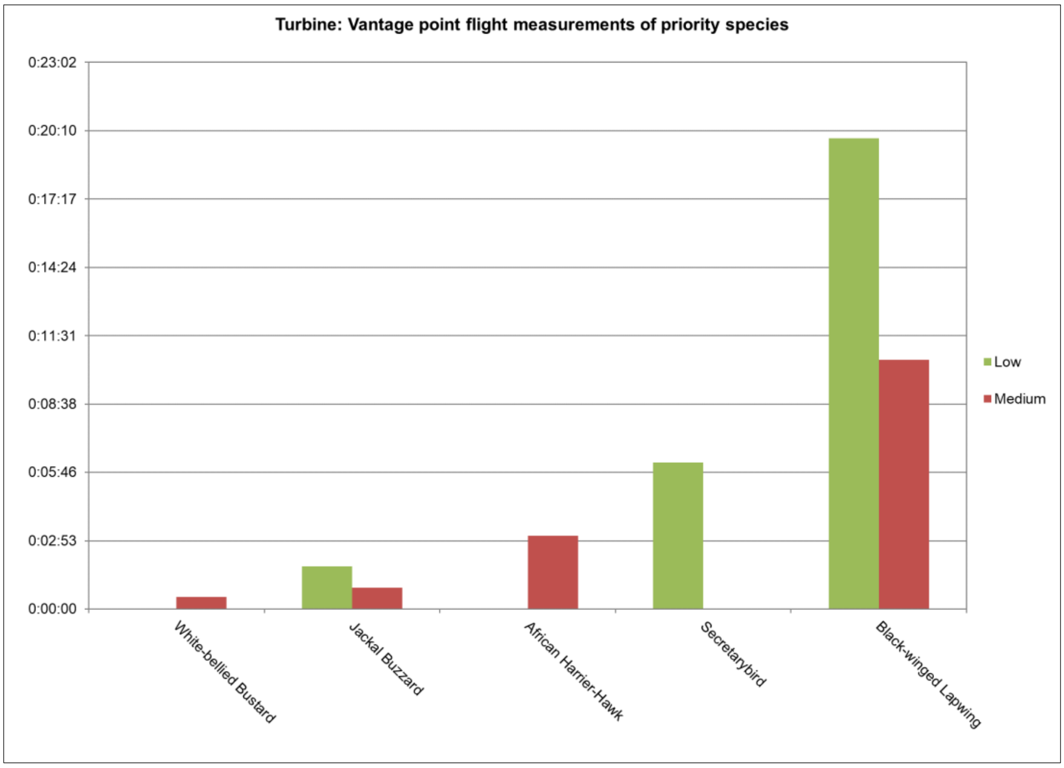

Figure 6: Flight duration of priority species recorded in June 2021 (one season)

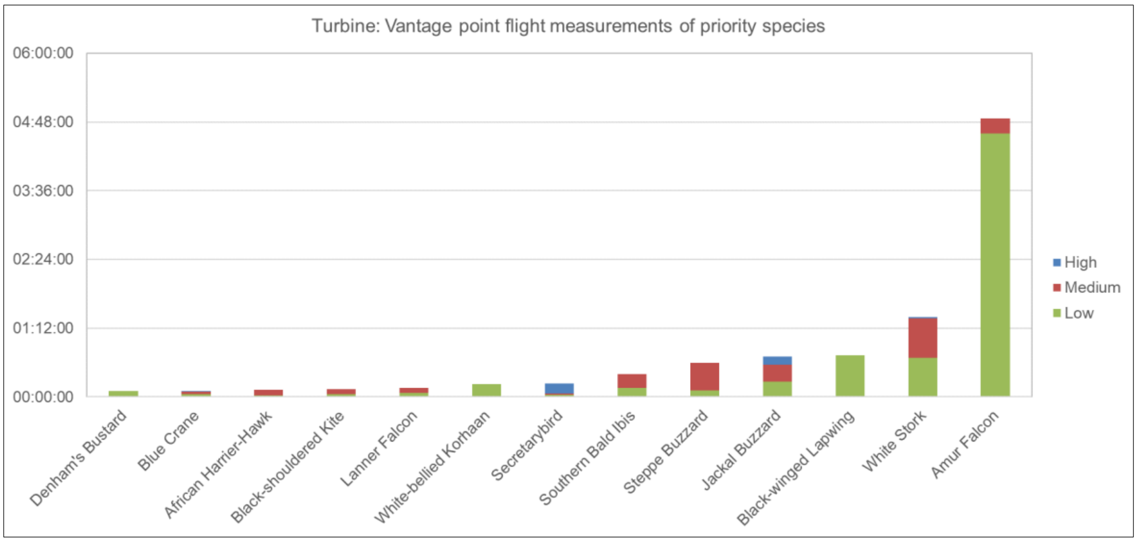

Figure 7: Flight duration of priority species recorded in 2013 - 2014 (four seasons)

[3] Flight duration was calculated by multiplying the flight time with the number of individuals in the flight e.g. if the flight time was 30 seconds and it contained two individuals, the flight duration was 30 seconds x 2 = 60 seconds.

5.4.1 Spatial distribution of flight activity

Flight maps were prepared indicating the spatial distribution and intensity of all priority species flight activity observed from the vantage points (see Appendix 2). This was done by overlaying a 100m x 100m grid over the survey area. Each grid cell was then given a weighting score (Very High; High; Medium; Low) taking into account the duration and distance of individual flight lines through a grid cell and the number of individual birds associated with each flight crossing the grid cell, to give an indication where the observed flight activity was most concentrated. It is important to interpret these maps bearing in mind the difference in flight duration for each species i.e. the categories do not indicate identical flight intensity in the same category across all species, as the flight duration for each species is different.

5.5 Focal point counts

- FP SBI Roost West: A Southern Bald Ibis roost to the west of the site. The roost showed evidence of regular use by Southern Bald Ibis in the form of ample whitewash. One Lanner Falcon *Falco biarmicus* was recorded approximately 800m away at a cliff which was previously occupied by Southern Bald Ibis.
- FP Valley: A valley to the east containing potential Southern Bald Ibis roosting and breeding habitat. Two Southern Bald Ibis were recorded.
- FP SBI Roost Valley: A Southern Bald Ibis roost to the east of the site. One Southern Bald Ibis was recorded.

6. Discussion

6.1 Habitat ground truthing

The habitat had remained essentially the same since the original pre-construction motoring was conducted in 2013 - 2014. The data collected during those surveys therefore remain relevant and can be considered for this assessment as well. This is particularly relevant for the austral summer migratory species such as Amur Falcon, White Stork and Common Buzzard which were recorded during the original surveys, but not in 2021, as the surveys took place in winter.

6.2 Nest searches

- The Secretarybird nest was not present during the original monitoring in 2013 - 2014. The status of the species was upgraded to Globally and Regionally Endangered in 2020.
- One Southern Bald Ibis roost (FP SBI Roost West) showed signs of heavy use and may contain breeding pairs.

6.3 Drive and walk transects

The transect counts produced evidence of priority species diversity and abundance broadly comparable to the original monitoring done in 2013 - 2014, thereby further reinforcing the impression that the habitat has not changed in any significant way. A notable difference between the original monitoring and the one season done in June 2021 is the absence of austral migrants. The reasons for their absence this time round have already been discussed above under 6.1. Blue Crane was also absent in June 2021, which may be linked to the time of year, when the birds form flocks and roost communally elsewhere. The same pattern was evident during the original monitoring in 2013 - 2014, with very few records in winter. Denham's Bustard was also absent in June 2021, which was the same during the original monitoring, with no records in winter for the species.

The spatial distribution of priority species recorded in June 2021 shows no discernible concentrations of priority species linked to specific habitat. This was also the case during the original monitoring in 2013 – 2014, except in the case of Common Buzzard which mostly recorded in stand of alien trees.

6.4 Vantage point counts

6.4.1 Passage rates

The passage rate for priority species recorded in June 2021 at the turbine VP area (all flight heights) was 0.72 birds/hour, which translates to roughly 9 birds per day . The passage rate for priority species during the original pre-construction monitoring in 2013 – 2014 was 1.34 birds per hour, which translates to roughly 17 birds per day. The higher passage rate during the original monitoring is to be expected as it included the summer rainy season when migrants are present, which increases the avifaunal abundance at the site.

6.4.2 Spatial distribution of flight activity

The distribution of flight activity for priority species did not display a specific discernible pattern for most species during both the original pre-construction monitoring in 2013 – 2014, and in June 2021, with flights recorded all over the site. The possible exception here are some of the raptors, notably Jackal Buzzard and Common Buzzard (during the original monitoring), with flight concentrated at the VPs closest to the escarpment side of the site. Slopes and escarpments are often favoured by soaring species for the additional lift offered by declivity currents.

7. Impact of proposed changes

7.1 Turbine lay-out

The new lay-out comprises a maximum of 43 turbines, down from the previously approved 47. No turbines will be placed within avifaunal exclusion zones (see Section 9). The new proposed lay-out should not lead to an increase in impacts on avifauna, compared to the original authorised lay-out.

7.2 Turbine dimensions

The new proposed turbine dimensions necessitate a re-assessment of the potential risk of collisions. The new turbine dimensions will result in an increase of 34% in the total rotor swept area for the 43 proposed turbines, compared to the specifications for the 47 authorised turbines, and a reduction of 8% in the number of turbines[4].

Interestingly, and counter to expectations, the majority of published scientific studies indicate that an increase in rotor swept area do not automatically translate into a larger collision risk. Most of the studies found turbine dimensions to play a less important role in the magnitude of the collision risk relative to other factors such as topography, turbine location, morphology, behaviour and a species' inherent ability to avoid the turbines, and may only be relevant in combination with other factors, particularly wind strength and topography (see Howell 1997, Barrios & Rodriguez 2004; Barclay *et al.* 2007, Krijgsveld *et al.* 2009, Smallwood 2013; Everaert 2014). Three studies found a correlation between turbine hub height and mortality (De Lucas *et al.* 2008; Loss *et al.* 2013 and Thaxter *et al*. 2017), although the latter found that collectively the number of turbines is still more important than the individual turbine size as a determinant of risk. See below a summary of published findings on the topic:

- Howell *et al.* 1997 states on p.9: "The evidence to date from the Altamont Pass does not support the hypothesis that the larger rotor swept area (RSA) of the KVS – 33 turbines contributes proportionally to avian mortality, i.e. larger area results in more mortalities. On the contrary, the ratio of K-56 turbines to KVS-33 turbines rather than RSA was approximately 3.4:1 which as consistent with the 4.1:1 mortality ratio. It appears that the mortality occurred on a per-turbine basis, i.e. that each turbine simply presented an obstacle."
- Barrios & Rodriguez 2004 states on p. 80: "Most deaths and risk situations occurred in two rows at PESUR with little space between consecutive turbines. This windwall configuration (Orloff & Flannery 1992) might force birds that cross at the blade level to take a risk greater than in less closely spaced settings. However, little or no risk was recorded for five turbine rows at PESUR having exactly the same windwall spatial arrangement of turbines. Therefore, we conclude that physical structures had little effect on bird mortality unless in combination with other factors."
- Barclay *et al.* 2007 states on p. 384: "Our analysis of the data available from North America indicates that this has had different consequences for the fatality rates of birds and bats at wind energy facilities. It might be expected that as rotor swept area increased, more animals would be killed per turbine, but our analyses indicate that this is not the case. Rotor-swept area was not a significant factor in our analyses. In addition, there is no evidence that taller turbines are associated with increased bird fatalities. The per turbine fatality rate for birds was constant with tower height."
- De Lucas *et al.* 2008 states on p. 1702: "All else being equal, more lift is required by a griffon vulture over a taller turbine at a higher elevation and we found that such turbines killed more vultures compared to shorter turbines at lower elevations".
- Krijgsveld *et al.* 2009 states on p. 365: "The results reported in this paper indicate that collision risk of birds with larger multi-MW wind turbines is similar to that with smaller earlier-generation turbines, and much lower than expected based on the large rotor surface and high altitude-range

[4] It should be borne in mind that 63 turbines were also previously authorised, which means the 43 turbines represent reduction of 31% from the 63 turbine layout.

of modern turbines… Clearly, more studies of collision victims are needed before we can confidently predict the relationship between size and configuration of wind turbines and the risk for birds to collide with a turbine”.

- Smallwood *et al*. 2013 states on p.26 – 27 (see also Fig 9 on p.30): “Red-tailed hawk (*Buteo jamaicensis*) and all raptor fatality rates correlated inversely with increasing wind-turbine size (Figs. 9A, B) … Thousands of additional MW of capacity were planned or under construction in 2012, meaning that the annual toll on birds and bats will increase. However, the expected increase of raptor fatalities could be offset by reductions of raptor fatalities as older wind projects are repowered to new, larger wind turbines, especially if the opportunity is taken to carefully site the new wind turbines (Smallwood and Karas 2009, Smallwood *et al.* 2009).”
- Loss *et al.* 2014 states on p. 208: “The projected trend for a continued increase in turbine size coupled with our finding of greater bird collision mortality at taller turbines suggests that precaution must be taken to reduce adverse impacts to wildlife populations when making decisions about the type of wind turbines to install.”
- Everaert, 2014 states on p. 228: “Combined with the mortality rates of several wind farms in the Netherlands (in similar European lowland conditions near wetlands or other areas with water), no significant relationship could be found between the number of collision fatalities and the rotor swept area of the turbines (Fig. 4). In contrast to more common landscapes, Hötker (2006) also found no significant relationship between mortality rate and the size of wind turbines near wetlands and mountain ridges.”
- In the most recent paper on the subject by Thaxter *et al*. (2017), the authors conducted a systematic literature review of recorded collisions between birds and wind turbines within developed countries. They related collision rate to species-level traits and turbine characteristics to quantify the potential vulnerability of 9 538 bird species globally. For birds, larger turbine capacity (megawatts) increased collision rates; *however, deploying a smaller number of large turbines with greater energy output reduced total collision risk per unit energy output* (my italics). In other words, even if the total output remains the same, by employing fewer, larger turbines, the collision risk will still be reduced. They also found that the relationship between the total number of turbines and the collision risk is non-linear, with the collision risk exponentially higher for more, smaller turbines vs. fewer larger turbines (see Figure 1 below, taken from their 2017 paper).

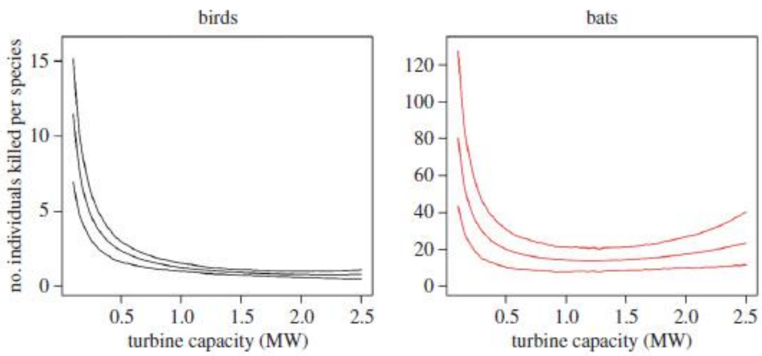

Figure 4. The mean total mortality rate across species for a hypothetical 10 MW wind farm, shown in relation to individual turbine capacities (which in turn require different numbers of wind turbines to meet the same capacity). Lines represent posterior means and 95% upper and lower credible intervals.

Figure 8: Exponential curve indicating the relationship between collision mortality and number of turbines

Based on the most recent research on this topic, it is concluded that the reduction in the number of turbines should reduce the overall risk of collision to birds, in combination with the proposed new buffer zones (see in this regard Section 8 below).

7.3 Impact rating

In the original bird specialist report completed in August 2014 as part of the EIA procedure, the pre-mitigation collision risk was rated as of **moderate** significance, which, with the application of mitigation measures, could be reduced to **low** significance. In light of the above explanation, it is concluded that should the amendment be implemented, the original pre-mitigation risk rating of **moderate** significance should remain as it currently stands, with a reduction to **low** significance, after the implementation of the additional mitigation measures proposed in this report.

Table 7 below shows the original impact assessment included in the original Bird Specialist report for turbine collisions (Chris van Rooyen Consulting 2014). Table 8 shows the revised impact assessment for collisions, including the proposed additional mitigation measures.

Table 9 shows a new impact assessment for potential electrocutions of priority species, based on the possibility of medium voltage overhead lines at the site.

Table 8: Impact rating table for mortality through turbine collisions (2014)

Description Of Impacts	Temporal scale (Duration)	Spatial Scale	Certainty Scale/ Likelihood	Severity/ Beneficial Scale	Significance Pre-Mitigation	Mitigation Measures	Significance Post-Mitigation
Issue: Avifauna							
Mortality of priority avifauna through collisions with the turbines	**Long term**	**International** due to presence of Palearctic migrants	**Probable**	**Moderately severe**	**MODERATE NEGATIVE**	• Formal monitoring should be resumed once the turbines have been constructed, as per the most recent edition of the best practice guidelines (Jenkins *et al.* 2011). The exact scope and nature of the post-construction monitoring will be informed on an ongoing basis by the result of the monitoring through a process of adaptive management. The purpose of this would be (a) to establish if and to what extent displacement of priority species has occurred through the altering of flight patterns post-construction, and (b) to search for carcasses at turbines. • As an absolute minimum, post-construction monitoring should be undertaken for the first two (preferably three) years of operation, and then repeated again in year 5, and again every five years thereafter. The exact scope and nature of the post-construction monitoring will be informed on an ongoing basis by the result of the monitoring through a process of adaptive management. • The environmental management plan should provide for the on-going inputs of a suitable experienced ornithological consultant to oversee the post-construction monitoring and assist with the on-going management of bird impacts that may emerge as the post-construction monitoring programme progresses.	**LOW NEGATIVE**

Description Of Impacts	Temporal scale (Duration)	Spatial Scale	Certainty Scale/ Likelihood	Severity/ Beneficial Scale	Significance Pre-Mitigation	Mitigation Measures	Significance Post-Mitigation
						• Depending on the results of the carcass searches, a range of mitigation measures will have to be considered if mortality levels turn out to be significant, including selective curtailment of problem turbines during high risk periods. • If turbines are to be lit at night, lighting should be kept to a minimum and should preferably not be white light. Flashing strobe-like lights should be used where possible (provided this complies with Civil Aviation Authority regulations). • Lighting of the wind farm (for example security lights) should be kept to a minimum. Lights should be directed downwards (provided this complies with Civil Aviation Authority regulations).	

Table 9: Revised Impact rating table for mortality through turbine collisions (2021) Additional mitigation measures are in bold.

Description Of Impacts	Temporal scale (Duration)	Spatial Scale	Certainty Scale/ Likelihood	Severity/ Beneficial Scale	Significance Pre-Mitigation	Mitigation Measures	Significance Post-Mitigation
Issue: Avifauna							
Mortality of priority avifauna through collisions with the turbines	**Long term**	**International** due to presence of Palearctic migrants	**Probable**	**Moderately severe**	**MODERATE NEGATIVE**	• Formal monitoring should be resumed once the turbines have been constructed, as per the most recent edition of the best practice guidelines (Jenkins *et al.* 2011). The exact scope and nature of the post-construction monitoring will be informed on an ongoing basis by the result of the monitoring through a process of adaptive management. The purpose of this would be (a) to establish if and to what extent displacement of priority species has occurred through the altering of flight patterns post-construction, and (b) to search for carcasses at turbines. • As an absolute minimum, post-construction monitoring should be undertaken for the first two (preferably three) years of operation, and then repeated again in year 5, and again every five years thereafter. The exact scope and nature of the post-construction monitoring will be informed on an ongoing basis by the result of the monitoring through a process of adaptive management. • The environmental management plan should provide for the on-going inputs of a suitable experienced ornithological consultant to oversee the post-construction monitoring and assist with the on-going management of bird impacts that may emerge as the post-construction monitoring programme progresses.	**LOW NEGATIVE**

Description Of Impacts	Temporal scale (Duration)	Spatial Scale	Certainty Scale/ Likelihood	Severity/ Beneficial Scale	Significance Pre-Mitigation	Mitigation Measures	Significance Post-Mitigation
						• Depending on the results of the carcass searches, a range of mitigation measures will have to be considered if mortality levels turn out to be significant, including selective curtailment of problem turbines during high risk periods. • If turbines are to be lit at night, lighting should be kept to a minimum and should preferably not be white light. Flashing strobe-like lights should be used where possible (provided this complies with Civil Aviation Authority regulations). • Lighting of the wind farm (for example security lights) should be kept to a minimum. Lights should be directed downwards (provided this complies with Civil Aviation Authority regulations). • **A 1km infrastructure exclusion zone is recommended around the Secretarybird nest (-27.749269°, 30.481961°).** • **Turbines located outside the 1km buffer but within 2.5km from the Secretarybird nest be subjected to pro-active Shut-Down-on-Demand (SDoD) mitigation to prevent collisions with the turbines. SDoD can be achieved either through the deployment of an artificial intelligence camera system e.g. IdentiFlight® or a by means of a team of bio-monitors that are stationed at observation points to look out for target priority species and then issues a warning followed by shut down command if a bird approaches a turbine risk zone. The**	

Description Of Impacts	Temporal scale (Duration)	Spatial Scale	Certainty Scale/ Likelihood	Severity/ Beneficial Scale	Significance Pre-Mitigation	Mitigation Measures	Significance Post-Mitigation
						SDoD programme should be implemented and operational by the time the first turbines start turning. • **A 2km turbine free buffer zone is recommended around Southern Bald Ibis roost sites.** • **A minimum of 400m buffer – turbine setback zone should be implemented along the escarpment to minimise the risk for soaring priority species which are likely to use the cliffs and ridge lines for most of their flight activity.**	

Table 10: New Impact rating table for mortality through electrocution (2021)

Description Of Impacts	Temporal scale (Duration)	Spatial Scale	Certainty Scale/ Likelihood	Severity/ Beneficial Scale	Significance Pre-Mitigation	Mitigation Measures	Significance Post-Mitigation
Issue: Avifauna							
Mortality of priority avifauna through electrocutions on the internal medium voltage cables.	**Long term**	**International** due to presence of Palearctic migrants	**Probable**	**Moderately severe**	**MODERATE NEGATIVE**	• Internal medium voltage cables that connect the respective wind turbines to the onsite substation should be buried as much as is practically possible. • Where the medium voltage cables cannot be buried due to technical constraints, a raptor-friendly structure must be employed which must signed off by the avifaunal specialist.	**LOW NEGATIVE**

8 Mitigation measures

Based on the results of the additional monitoring conducted at the proposed WEF, the following is recommended, in additional to the original mitigation measures:

8.2 Turbine collisions

- Secretarybird (*Sagittarius serpentarius*) Red Data status – Endangered (Regional and Global) nest (-27.749269°, 30.481961°)
  - A 1km infrastructure free buffer zone is recommended around the nest.
  - Turbines located outside the 1km buffer but within 2.5km from the nest be subjected to pro-active Shut-Down-on-Demand (SDoD) mitigation to prevent collisions with the turbines. SDoD can be achieved either through the deployment of an artificial intelligence camera system e.g. IdentiFlight® or a by means of a team of bio-monitors that are stationed at observation points to look out for target priority species and then issues a warning followed by shut down command if a bird approaches a turbine risk zone. The SDoD programme should be implemented and operational by the time the first turbines start turning.
- Southern Bald Ibis (*Geronticus calvus*) Red Data status – Vulnerable (Regional and Global) roost / potential breeding sites
  - A 2km turbine free buffer zone is recommended around the roost sites.
- Escarpment edge / cliff line buffer – turbine setback
  - A minimum of 400m buffer – turbine setback zone should be implemented to minimise the risk for soaring priority species which are likely to use the cliffs and ridge lines for most of their flight activity.

See Figure 9 for a sensitivity map indicating the proposed buffer zones.

8.3 Electrocutions

- Internal medium voltage cables that connect the respective wind turbines to the onsite substation should be buried as much as is practically possible.
- Where the medium voltage cables cannot be buried due to technical constraints, a raptor-friendly structure must be employed which must signed off by the avifaunal specialist.

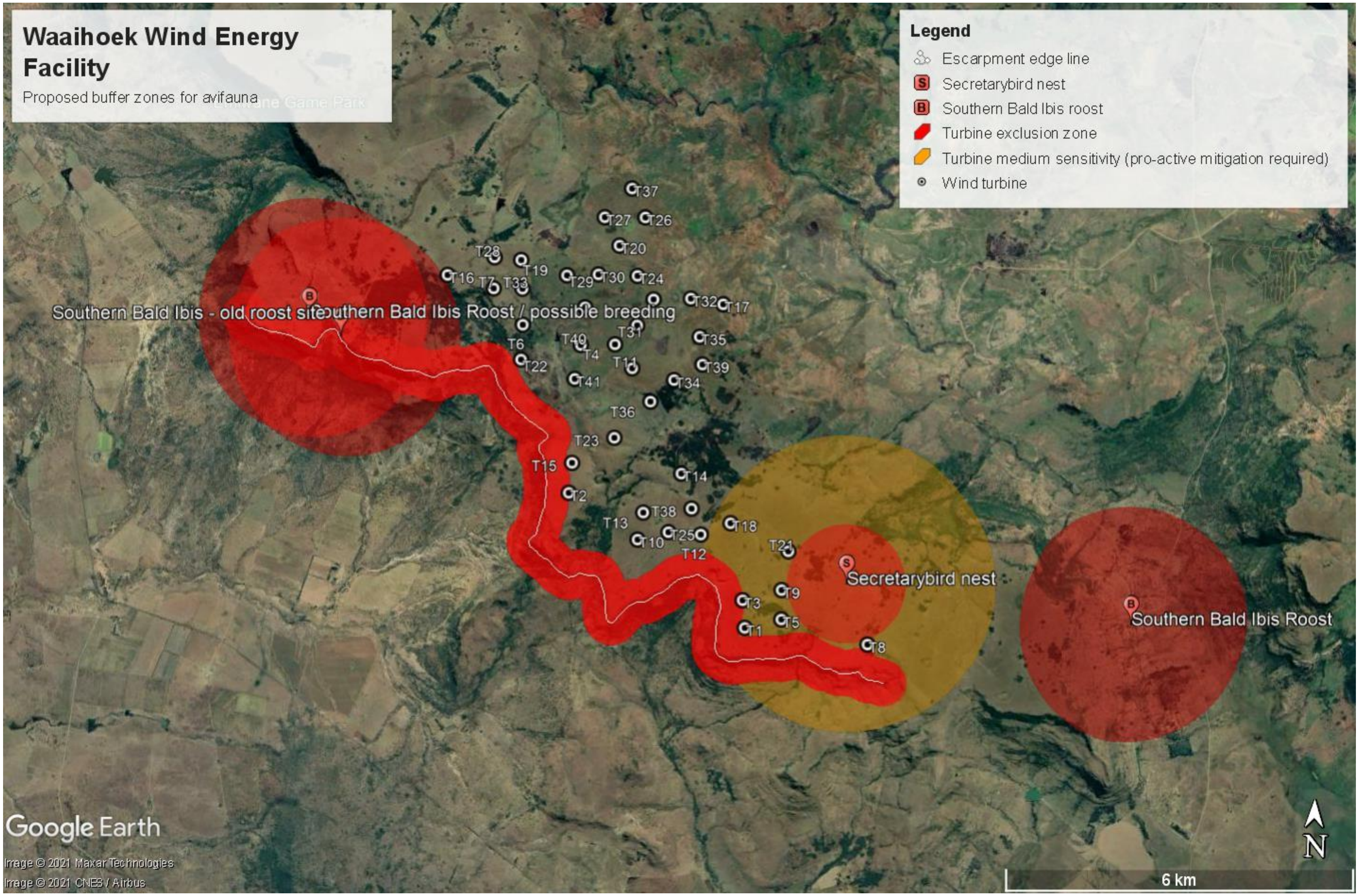

Figure 9: The proposed buffer zones at the Waaihoek Wind Energy Facility

9. References

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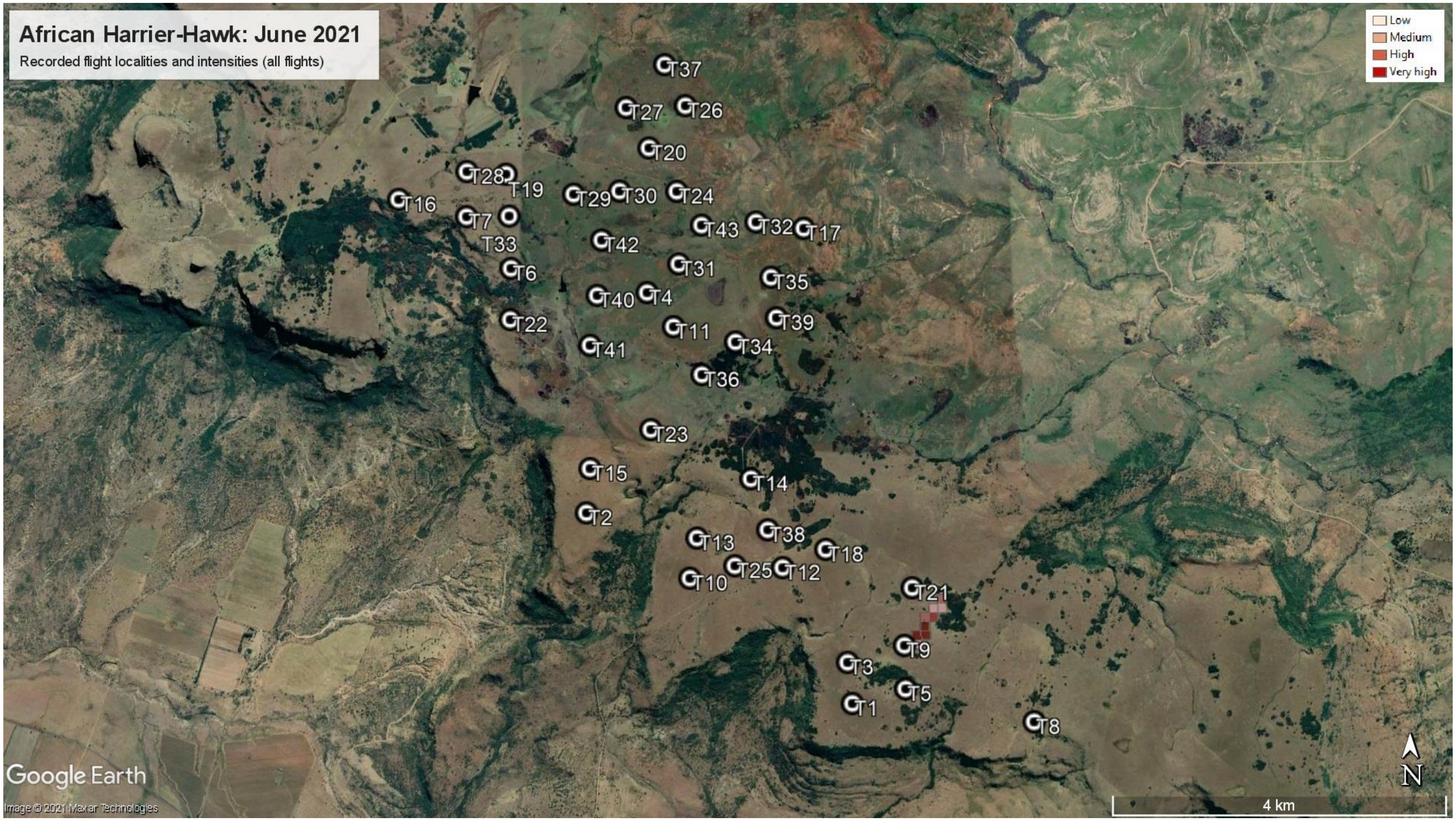
APPENDIX 1: SPECIES LIST

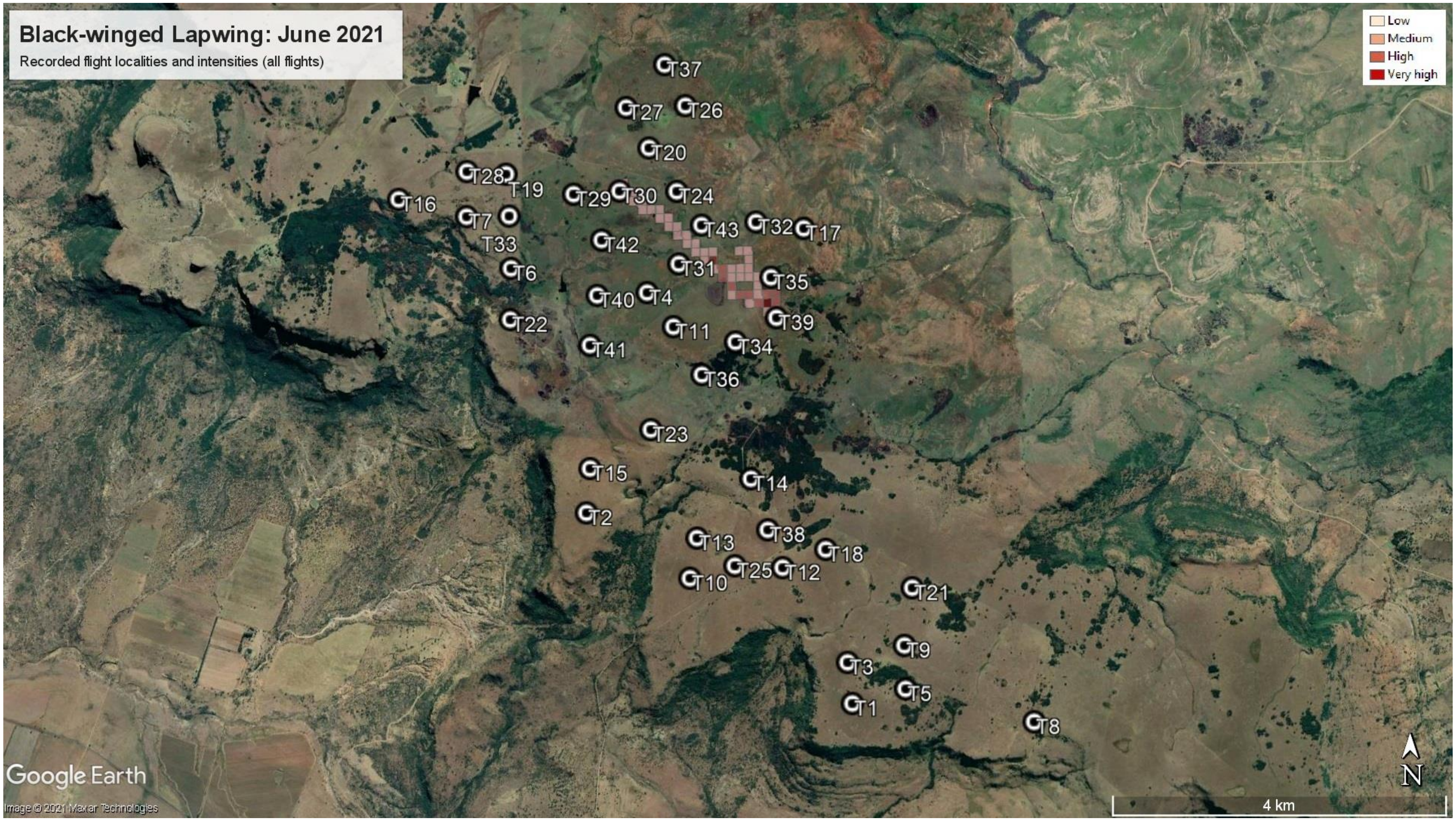
Priority Species	Sci names	Transects turbine	Focal points	VP	Incidental
African Fish Eagle	*Haliaeetus vocifer*				*
African Harrier-Hawk	*Polyboroides typus*			*	*
African Marsh Harrier	*Circus ranivorus*				*
Black Sparrowhawk	*Accipiter melanoleucus*				*
Black-winged Kite	*Elanus caeruleus*				*
Black-winged Lapwing	*Vanellus melanopterus*	*		*	*
Buff-streaked Chat	*Campicoloides bifasciatus*	*			*
Cape Vulture	*Gyps coprotheres*				*
Jackal Buzzard	*Buteo rufofuscus*	*		*	*
Lanner Falcon	*Falco biarmicus*		*		*
Martial Eagle	*Polemaetus bellicosus*				*
Secretarybird	*Sagittarius serpentarius*	*		*	*
Southern Bald Ibis	*Geronticus calvus*	*	*		*
Spotted Eagle-Owl	*Bubo africanus*				*
White-bellied Bustard	*Eupodotis senegalensis*	*		*	*
15		**6**	**2**	**5**	**15**

Non-Priority Species	*Sci names*	Transects turbine	Focal points
Acacia Pied Barbet	*Tricholaema leucomelas*	*	
African Pipit	*Anthus cinnamomeus*	*	
African Quail-finch	*Ortygospiza atricollis*	*	
African Stonechat	*Saxicola torquatus*	*	
Amethyst Sunbird	*Chalcomitra amethystina*	*	
Ant-eating Chat	*Myrmecocichla formicivora*	*	
Bar-throated Apalis	*Apalis thoracica*	*	
Black-crowned Tchagra	*Tchagra senegalus*	*	
Black-headed Oriole	*Oriolus larvatus*	*	
Bokmakierie	*Telophorus zeylonus*	*	
Cape Bunting	*Emberiza capensis*	*	
Cape Canary	*Serinus canicollis*	*	
Cape Crow	*Corvus capensis*	*	
Cape Longclaw	*Macronyx capensis*	*	
Cape Robin-Chat	*Cossypha caffra*	*	
Cape Turtle Dove	*Streptopelia capicola*	*	
Cape Wagtail	*Motacilla capensis*	*	
Cape Weaver	*Ploceus capensis*	*	
Cardinal Woodpecker	*Dendropicos fuscescens*	*	
Chinspot Batis	*Batis molitor*	*	

Non-Priority Species	*Sci names*	Transects turbine	Focal points
Common Scimitarbill	*Rhinopomastus cyanomelas*	*	
Dark-capped Bulbul	*Pycnonotus tricolor*	*	
Drakensberg Prinia	*Prinia hypoxantha*	*	
Eastern Long-billed Lark	*Certhilauda semitorquata*	*	
Egyptian Goose	*Alopochen aegyptiaca*	*	
Familiar Chat	*Oenanthe familiaris*	*	
Fiscal Flycatcher	*Melaenornis silens*	*	
Fork-tailed Drongo	*Dicrurus adsimilis*	*	
Greater Double-collared Sunbird	*Cinnyris afer*	*	
Greater Honeyguide	*Indicator indicator*	*	
Hadeda Ibis	*Bostrychia hagedash*	*	
Kurrichane Thrush	*Turdus libonyana*	*	
Lazy Cisticola	*Cisticola aberrans*	*	
Long-billed Pipit	*Anthus similis*	*	
Neddicky	*Cisticola fulvicapilla*	*	
Pied Crow	*Corvus albus*	*	
Red-capped Lark	*Calandrella cinerea*	*	
Red-eyed Dove	*Streptopelia semitorquata*	*	
Red-knobbed Coot	*Fulica cristata*	*	
Red-throated Wryneck	*Jynx ruficollis*	*	
Rock Kestrel	*Falco rupicolus*	*	
Rufous-naped Lark	*Mirafra africana*	*	
Southern Black Tit	*Melaniparus niger*	*	
Southern Boubou	*Laniarius ferrugineus*	*	
Southern Fiscal	*Lanius collaris*	*	
Speckled Pigeon	*Columba guinea*	*	
Streaky-headed Seedeater	*Crithagra gularis*	*	
Swainson's Spurfowl	*Pternistis swainsonii*	*	
White-browed Scrub Robin	*Cercotrichas leucophrys*	*	
White-rumped Swift	*Apus caffer*	*	
Wing-snapping Cisticola	*Cisticola ayresii*	*	
51	Subtotal	51	
	Grand total	**57**	**2**

APPENDIX 2: FLIGHT MAPS





Black-winged Lapwing: June 2021
Recorded flight localities and intensities (all flights)
Low
Medium
High
Very high
T37
T27
T26
T20
T28
T19
T16
T29
T30
T24
T7
T33
T43
T32
T17
T42
T6
T31
T35
T40
T4
T22
T39
T11
T34
T41
T36
T23
T15
T14
T2
T38
T13
T18
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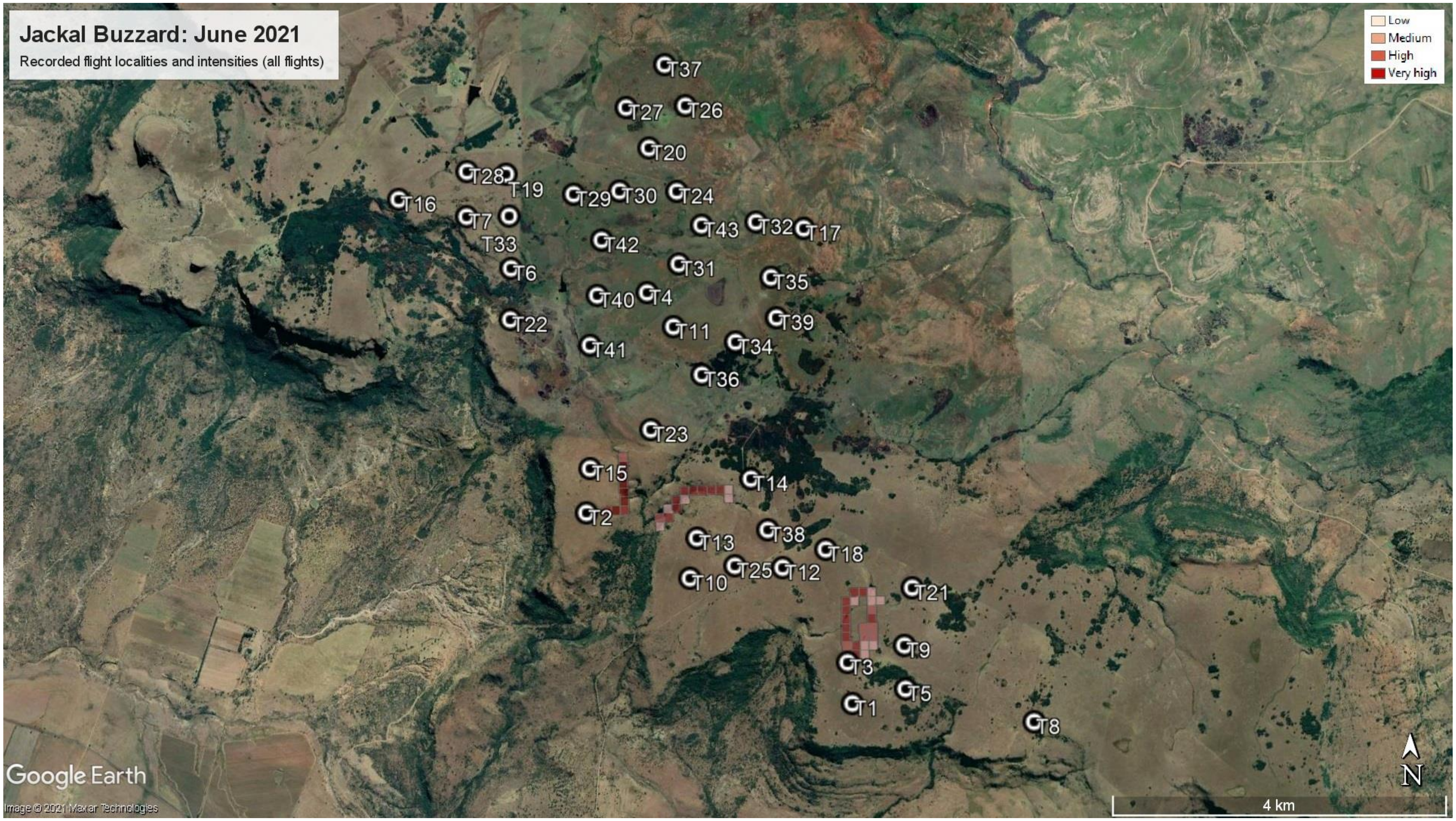
T12
T10
T21
T9
T3
T5
T1
T8
N
4 km
Google Earth
Image © 2021 Maxar Technologies



Jackal Buzzard: June 2021
Recorded flight localities and intensities (all flights)
Low
Medium
High
Very high
T37
T27
T26
T20
T28
T19
T16
T29
T30
T24
T7
T33
T43
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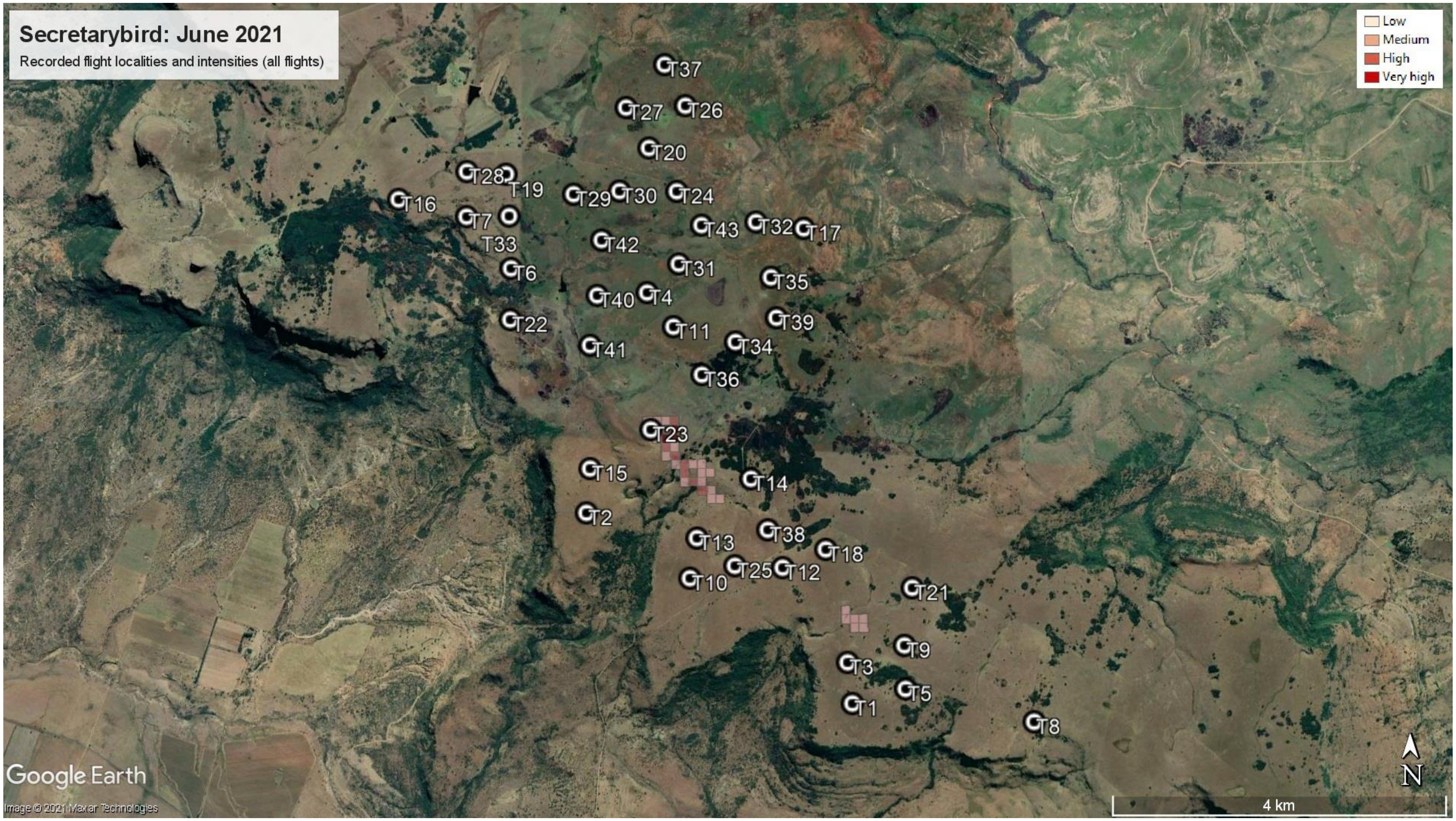
4 km
Google Earth
Image © 2021 Maxar Technologies


Secretarybird: June 2021
Recorded flight localities and intensities (all flights)
Low
Medium
High
Very high
T37
T27
T26
T20
T28
T19
T16
T29
T30
T24
T7
T43
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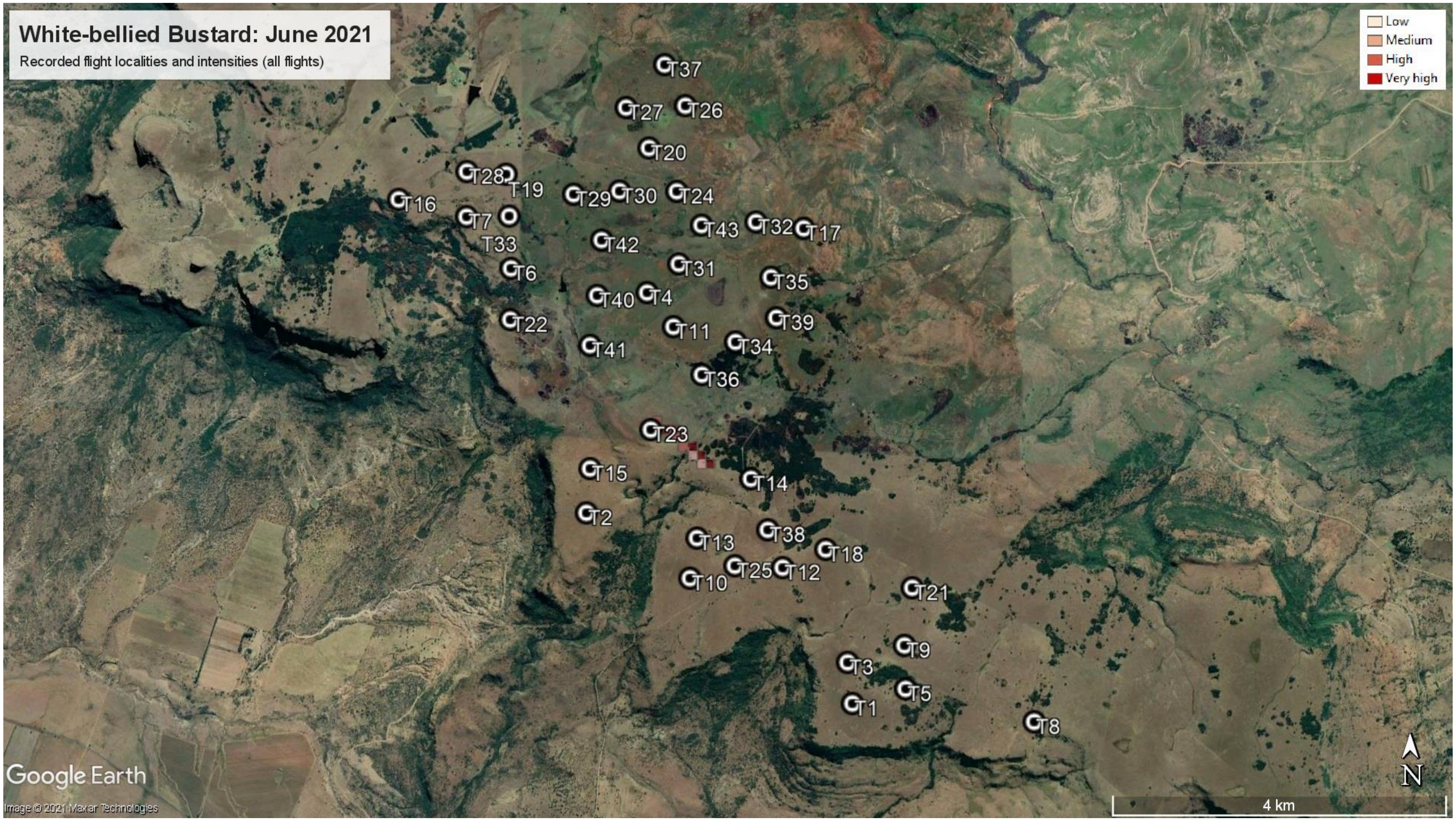
4 km
Google Earth
Image © 2021 Maxar Technologies


White-bellied Bustard: June 2021
Recorded flight localities and intensities (all flights)
Low
Medium
High
Very high
T37
T27
T26
T20
T28
T19
T16
T29
T30
T24
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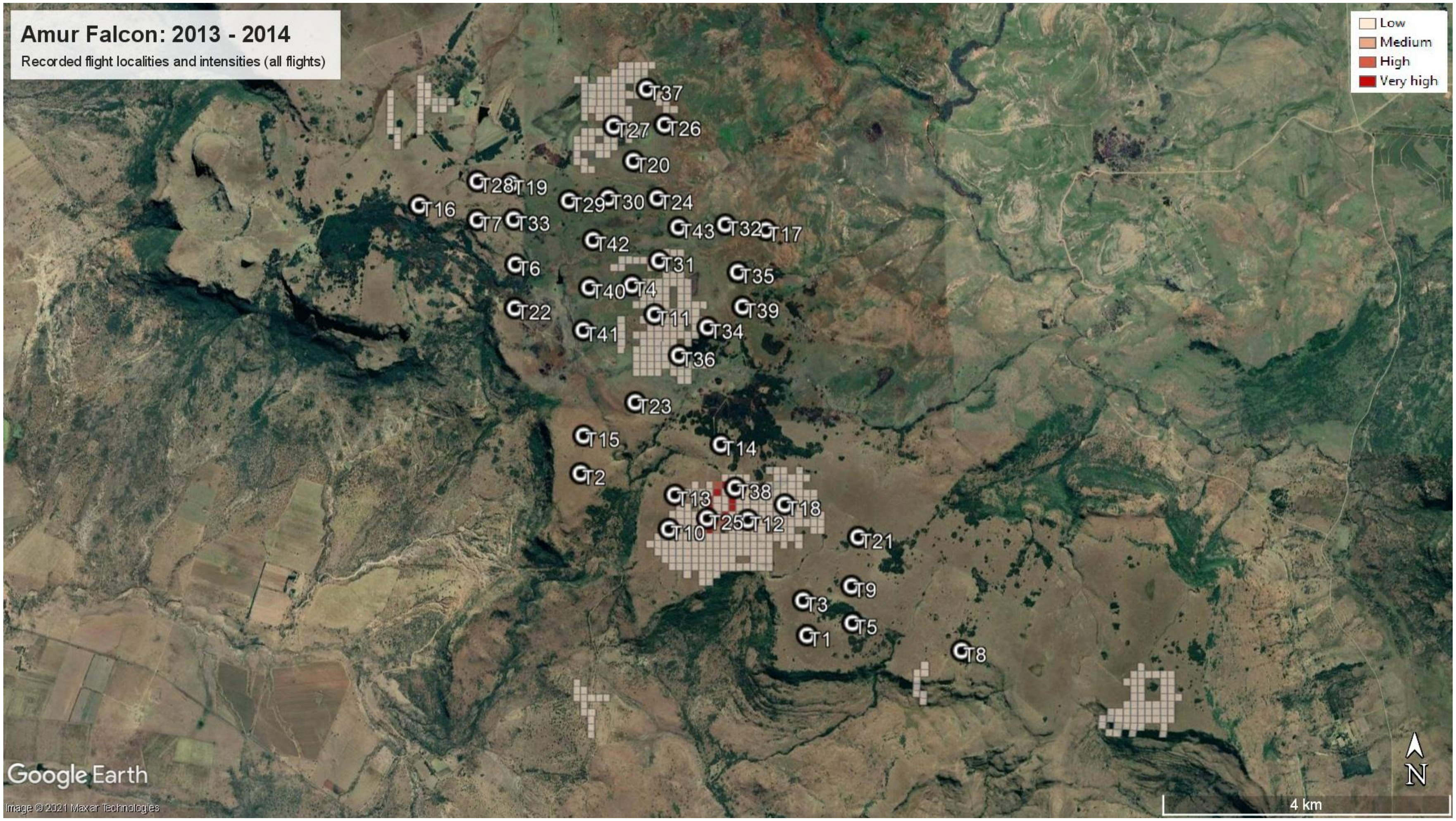
4 km
Google Earth
Image © 2021 Maxar Technologies



Amur Falcon: 2013 - 2014
Recorded flight localities and intensities (all flights)
Low
Medium
High
Very high
T37
T27
T26
T20
T28
T19
T16
T29
T30
T24
T7
T33
T43
T32
T17
T42
T6
T31
T35
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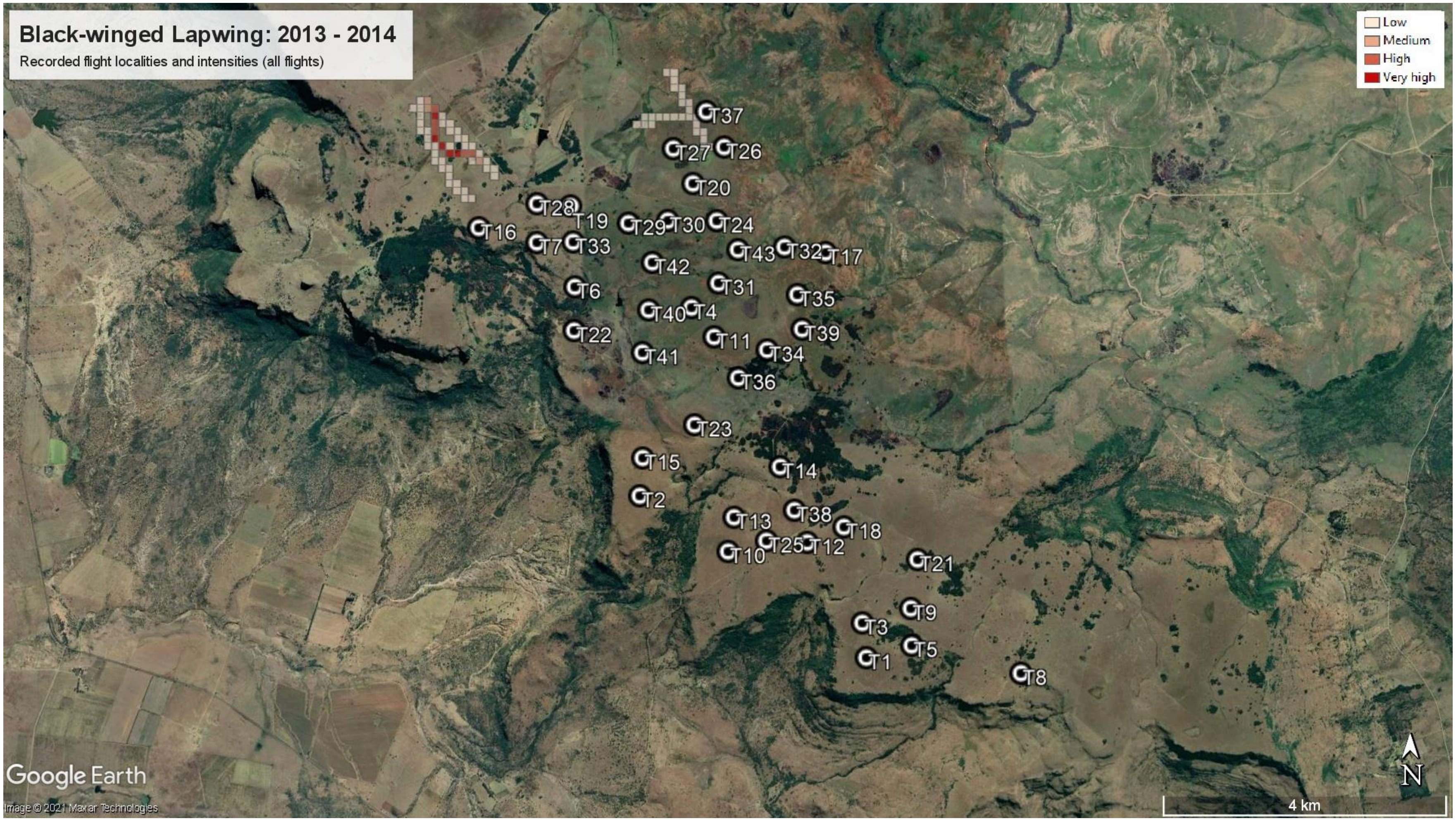
Google Earth
Image © 2021 Maxar Technologies
N
4 km


Black-winged Lapwing: 2013 - 2014
Recorded flight localities and intensities (all flights)
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Medium
High
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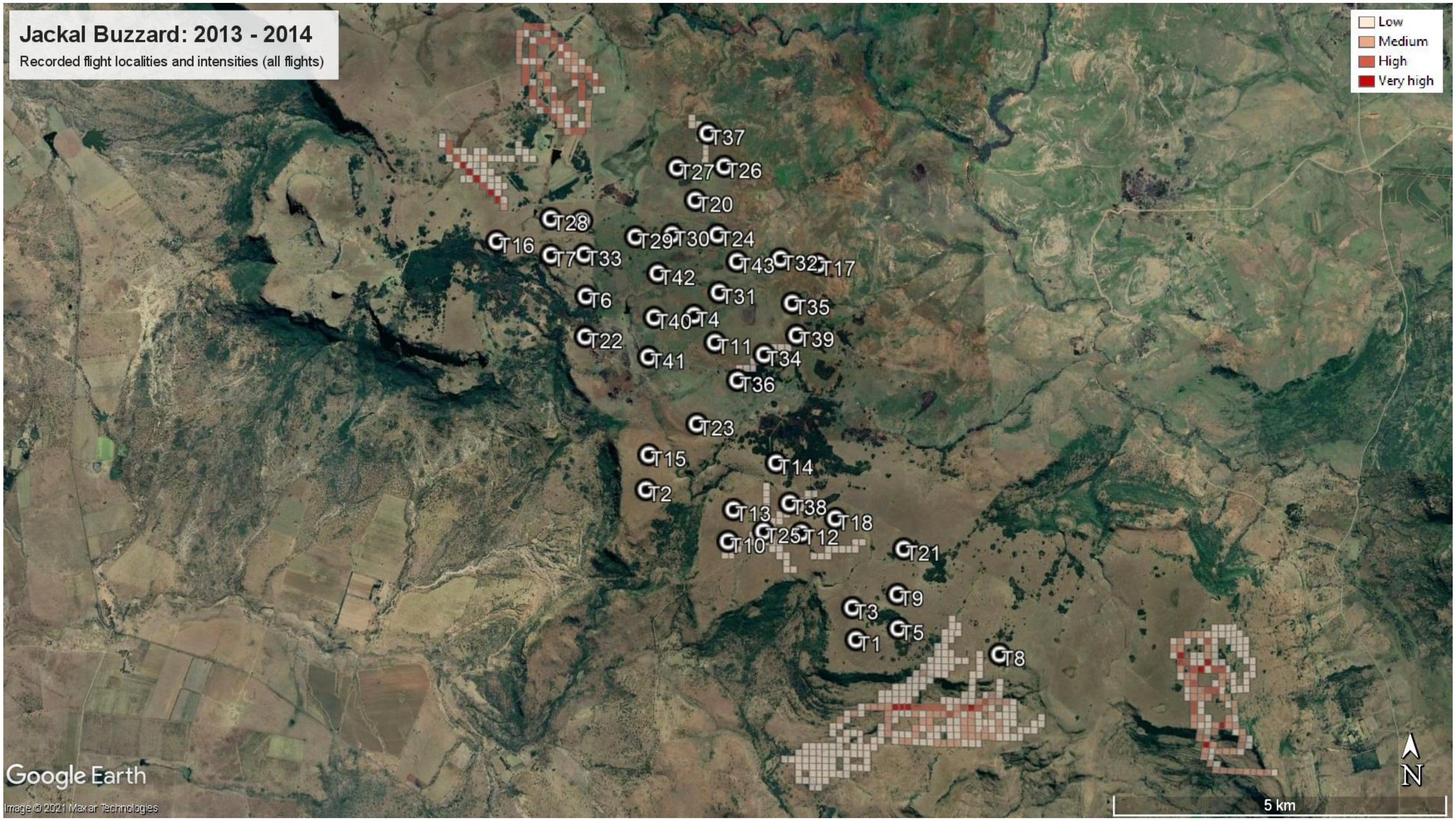
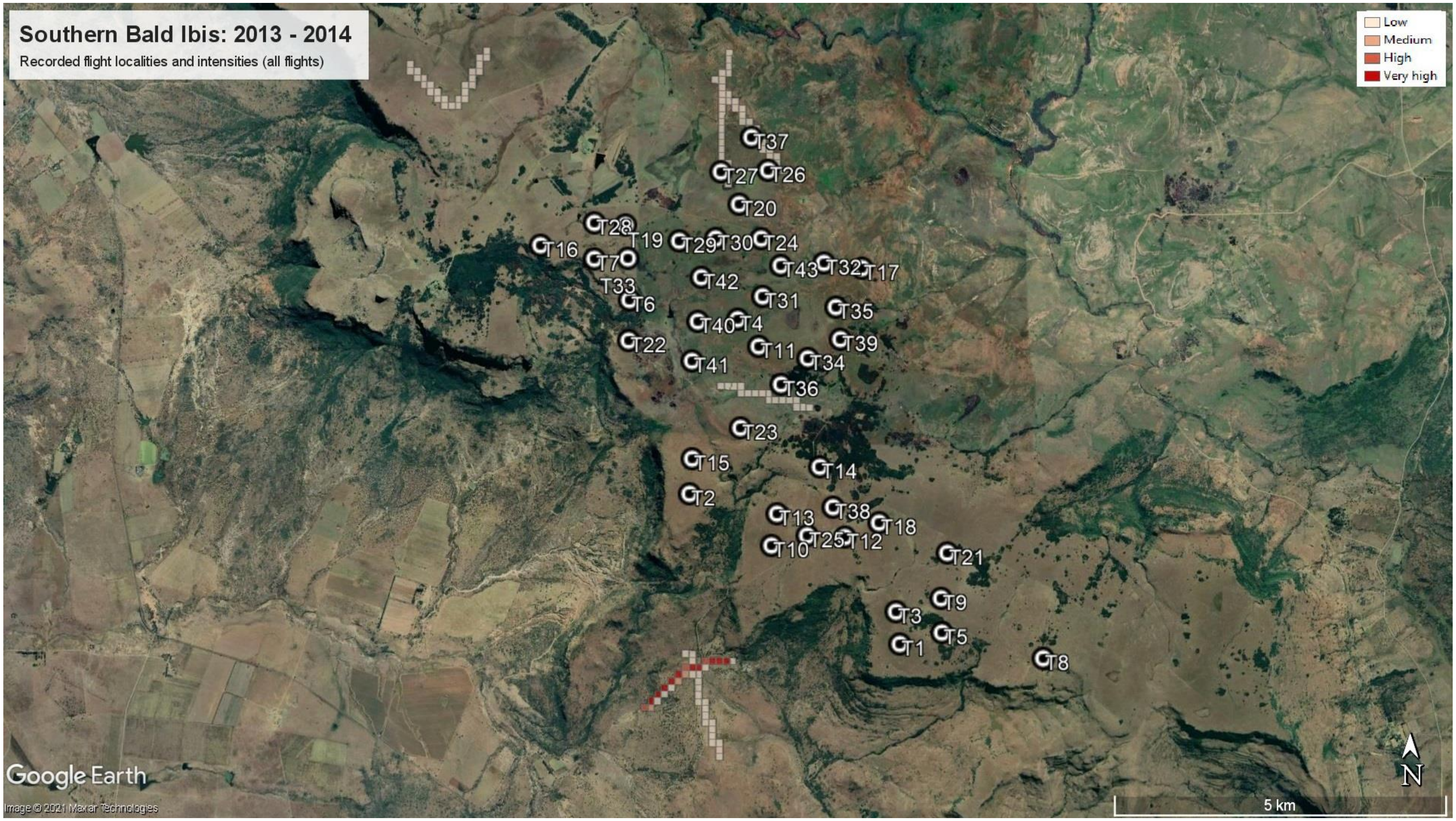
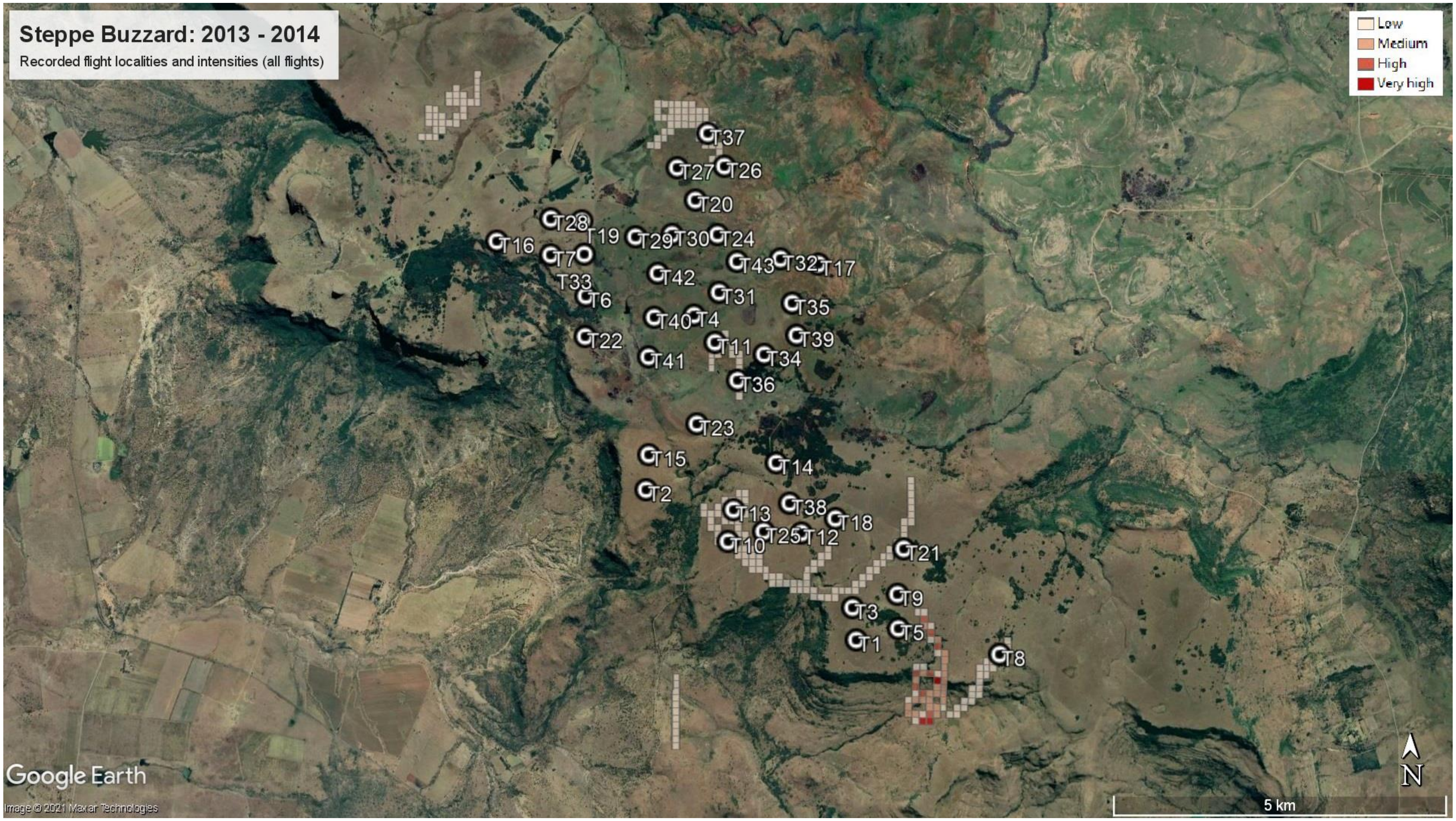
T37
T27
T26
T20
T28
T19
T29
T30
T24
T16
T7
T33
T43
T32
T17
T42
T31
T6
T35
T40
T4
T39
T22
T11
T34
T41
T36
T23
T15
T14
T2
T13
T38
T18
T25
T12
T10
T21
T9
T3
T5
T1
T8
Google Earth
Image © 2021 Maxar Technologies
4 km
N

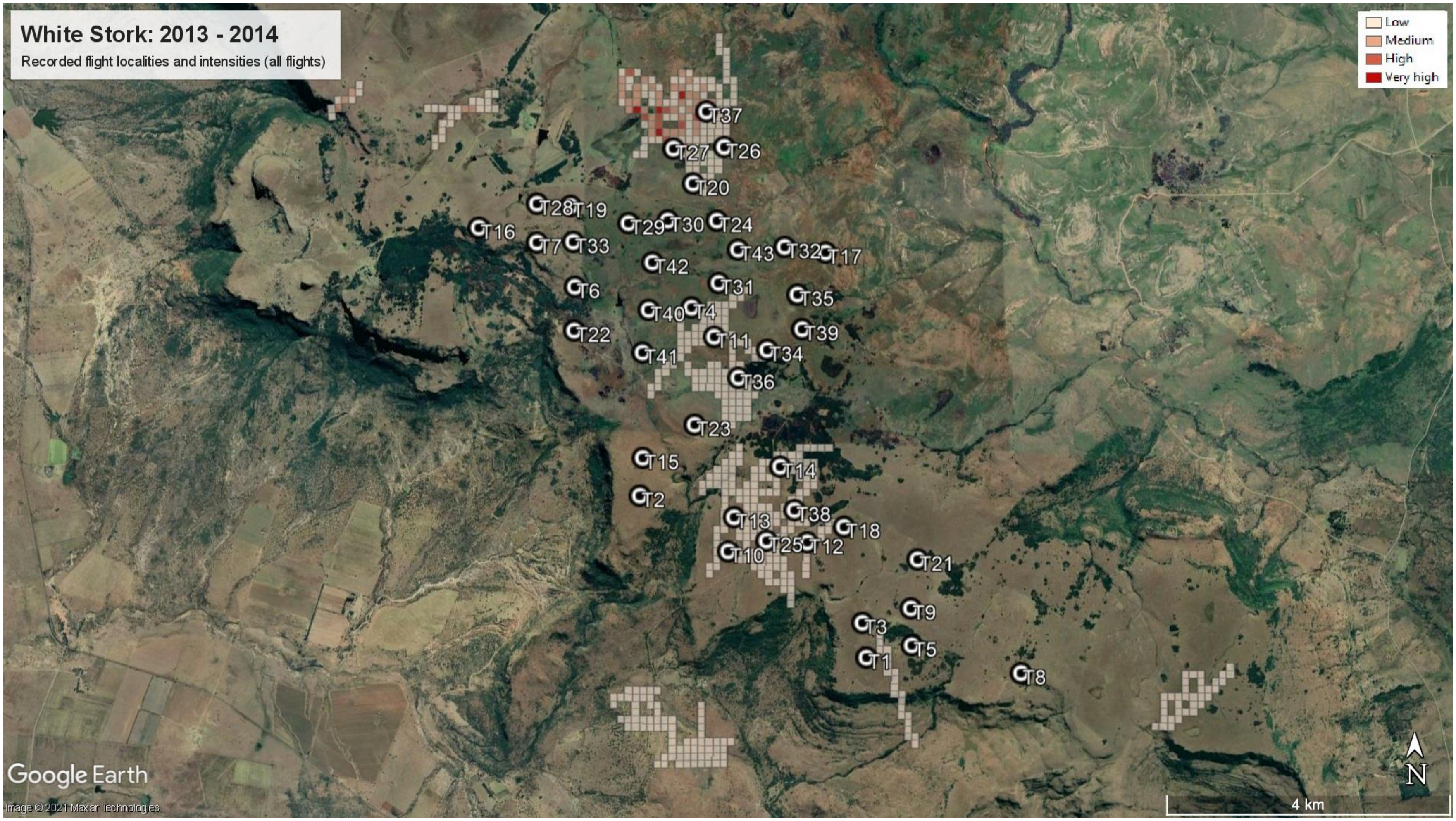

Jackal Buzzard: 2013 - 2014
Recorded flight localities and intensities (all flights)
Low
Medium
High
Very high
T37
T27
T26
T20
T28
T16
T29
T30
T24
T7
T33
T43
T32
T17
T42
T31
T6
T35
T40
T4
T39
T22
T11
T34
T41
T36
T23
T15
T14
T2
T13
T38
T18
T25
T12
T10
T21
T9
T3
T5
T1
T8
N
Google Earth
Image © 2021 Maxar Technologies
5 km



Southern Bald Ibis: 2013 - 2014
Recorded flight localities and intensities (all flights)
Low
Medium
High
Very high
T37
T27
T26
T20
T28
T19
T16
T29
T30
T24
T7
T43
T32
T17
T33
T42
T31
T6
T35
T40
T4
T22
T39
T11
T34
T41
T36
T23
T15
T14
T2
T13
T38
T18
T25
T12
T10
T21
T9
T3
T5
T1
T8
Google Earth
Image © 2021 Maxar Technologies
N
5 km



Steppe Buzzard: 2013 - 2014
Recorded flight localities and intensities (all flights)
Low
Medium
High
Very high
T37
T27
T26
T20
T28
T19
T29
T30
T24
T16
T7
T43
T32
T17
T42
T33
T6
T31
T35
T40
T4
T22
T11
T39
T41
T34
T36
T23
T15
T14
T2
T13
T38
T18
T25
T12
T10
T21
T9
T3
T5
T1
T8
Google Earth
Image © 2021 Maxar Technologies
5 km
N



White Stork: 2013 - 2014
Recorded flight localities and intensities (all flights)
Low
Medium
High
Very high
T37
T27
T26
T20
T28
T19
T16
T29
T30
T24
T7
T33
T43
T32
T17
T42
T31
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T15
T14
T2
T13
T38
T18
T25
T12
T10
T21
T9
T3
T5
T1
T8
Google Earth
Image © 2021 Maxar Technologies
N
4 km