



Ecological Report:

HES/748/FE



PREPARED BY:

Holistic Environmental Services
P.O.Box 1243

Parys
9585

DOCUMENT VERSION 2.0 - Final

ECOLOGICAL REPORT FOR SENSITIVE SPECIES AND ECOSYSTEMS: FAUNA, FLORA, WETLANDS AND RIPARIAN ZONES FOR THE PROPOSED PROSPECTING AT GUMBU, LIMPOPO PROVINCE, SOUTH AFRICA





DOCUMENT VERSION 1.0 – Final

ECOLOGICAL REPORT FOR SENSITIVE SPECIES AND ECOSYSTEMS: FAUNA, FLORA, WETLANDS AND RIPARIAN ZONES FOR THE PROPOSED PROSPECTING AT GUMBU, LIMPOPO PROVINCE, SOUTH AFRICA

PREPARED BY:

Holistic Environmental Services
P.O. Box 1243
Parys
9585

Compiled by:

Mr R.F. Terblanche
M.Sc Ecology
Pr. Sci. Nat, Reg. No. 400244/05
admin@holistic-services.co.za
www.holistic-servies.co.za

Document History and Distribution

TITLE:	Ecological Report for Sensitive Species and Ecosystems: Fauna, Flora, Wetlands and Riparian Zones for the proposed prospecting at Gumbu, Limpopo Province, South Africa
OUR REFERENCE NO.:	HES/748/FE

Name	Institution	Date	Versi on	Status
Me M. Botha	Naledzi Environmental Consultants	May 2018	2.0	Final

Copyright Information

This document contains intellectual property and propriety information that is protected by copyright in favour of **Holistic Environmental Services Cc** and the specialist consultants. The document may therefore not be reproduced, used or distributed to any third party without the prior written consent of **Holistic Environmental Services Cc**.

This document is prepared exclusively' for **Naledzi Environmental Consultants** and is subject to all confidentiality, copyright and trade secrets, rules, intellectual property law and practices of South Africa.

Table of Contents

1	INTRODUCTION	6
1.1	Objectives of the habitat study.....	6
1.2	Scope of study.....	6
2	STUDY AREA.....	7
3	METHODS.....	12
3.1	Habitat characteristics and vegetation.....	12
3.2	MAMMALS	12
3.3	BIRDS	12
3.4	reptiles	13
3.5	AMPHIBIANS.....	13
3.6	Butterflies	13
3.7	Fruit chafer beetles.....	13
3.8	mygalomorph spiders and rock scorpions	14
3.9	limitations	14
4	RESULTS	15
4.1	Habitat and vegetation characteristics.....	15
5	ASSESSMENT OF PLANT SPECIES OF PARTICULAR CONSERVATION PRIORITY.....	32
6	VERTEBRATE SPECIES OF PARTICULAR CONSERVATION PRIORITY	40
6.1	Mammals of particular high conservation priority	40
6.2	Birds of particular high conservation priority.....	43
6.3	Reptiles of particular high conservation priority	45
6.4	Amphibian species of particular high conservation priority	46
7	INVERTEBRATE SPECIES OF PARTICULAR CONSERVATION PRIORITY	46
7.1	Butterflies of particular conservation priority.....	46
7.2	Cicadas of particular conservation priority	48
7.3	Beetles of particular conservation priority	49

7.4	Scorpions of particular conservation importance	49
7.5	Baboon spiders of particular conservation importance	50
8	DISCUSSION.....	51
8.1	Habitat and vegetation characteristics.....	51
8.2	plant SPECIES	51
8.3	vertebrates	51
8.3.1	Mammals.....	51
8.3.2	Birds.....	52
8.3.3	Reptiles.....	52
8.3.4	Amphibians	52
8.4	invertebrateS	53
8.4.1	Butterflies	53
8.4.2	Cicadas.....	57
8.4.3	Fruit chafer beetles	58
8.4.4	Scorpions	58
8.4.5	Baboon spiders	58
9	IMPACT ASSESSMENT AND MITIGATION MEASURES	60
9.1	Anticipated risks or impacts to the loss of habitat.....	61
9.2	Anticipated risks or impacts to the loss of sensitive species.....	61
9.3	Anticipated risks or impacts to habitat connectivity and open space.....	63
9.4	Anticipated risks or impacts associated with construction (prospecting) activities	63
10	CONCLUSION.....	65
10.1	Ecological sensitivity.....	68
10.2	SENSITIVITY MAPS	69
11	REFERENCES	74

1 INTRODUCTION

An ecological assessment for sensitive areas, sensitive flora, fauna as well as watercourses was required for an area where prospecting footprints is proposed at Gumbu, Limpopo Valley in the Limpopo Province (elsewhere referred to as the site).

1.1 OBJECTIVES OF THE HABITAT STUDY

The objectives of the habitat study are to provide:

- A detailed fauna and flora habitat survey;
- A detailed habitat survey of possible threatened or localised plant species, vertebrates and invertebrates;
- Recording of possible host plants (=foodplants) of fauna such as butterflies.
- Evaluate the conservation importance and significance of the site with special emphasis on the current status of threatened species;
- Literature investigation of possible species that may occur on site;
- Make recommendations that could lead to reducing or minimising impacts, in application process for developments.

1.2 SCOPE OF STUDY

- A survey consisting of visits to investigate key elements of habitats on the site, relevant to the conservation of fauna and flora.
- Recording of any sightings and/or evidence of existing fauna and flora.
- The selective and careful collecting of voucher specimens of invertebrates where deemed necessary.
- An evaluation of the conservation importance and significance of the site with special emphasis on the current status of threatened species.
- Recording of possible host plants or foodplants of fauna such as butterflies.
- Literature investigation of possible species that might occur on site.
- Integration of the literature investigation and field observations to identify potential ecological impacts that could occur as a result of the development.
- Integration of literature investigation and field observations to make recommendations to reduce or minimise impacts or enhance further surveys towards applications for developments.

2 STUDY AREA

Site consists of a number of points at the Limpopo Valley in the northeastern extreme of South African to the north of Masisi, to the east of Popallin Ranch and to the west of Pafuri, Kruger National Park. The site is located in the Savanna Biome which is for the greater part, Gumbu PT 2-6 and Gumbu PT8-21, represented by the Limpopo Ridge Bushveld (SVcb 27) with a single restricted area, Gumbu PT 7, at the Musina Mopane Bushveld (SVmp 1) and a single restricted area, Gumbu PT 1, at the Subtropical Alluvial Vegetation (Aza 7) vegetation types (Mucina & Rutherford 2006). For the context of the landscape, climate and vegetation in which the site is located descriptions of the Limpopo Ridge Bushveld, Musina Mopane Bushveld and Subtropical Alluvial Vegetation from Mucina & Rutherford (2006) follow.

SVmp 2 Limpopo Ridge Bushveld

Distribution: In South Africa Limpopo Ridge Bushveld is found in the Limpopo Province on hills and ridges such as Madiapala in the lower Mogalakwena River basin in the west through a cluster of hills in the Pontdrif area including Poortjieberg and Tsolwe, eastwards including Mapungubwe Mountain in the Mapungubwe National Park through to the hills and ridges in the vicinity of the Limpopo River further downstream (for example Ha-Tshansi at Musina, Ha-Dowe and Maremani). Also including hills and ridges well away from the river north of Soutpansberg and generally east of the Sand River (e.g. Tshitangai, Bloukop and Ha-Manenzhe) through to some rugged areas in the far northern Kruger National Park. Altitude from 300 m in the east to 700 m with the top of a few hills in the west at around 1000 m (Mucina & Rutherford, 2006).

Vegetation and landscape features: Extremely irregular plains with ridges and hills. Moderately open savanna with poorly developed ground layer. Umbrella-shape canopied *Kirkia accuminata* is prominent on some ridge skylines with the often enormous *Adansonia digitata* on shallow calcareous gravel, the shrub *Catophractes alexandri* is dominant on calc-silicate soils. These are particularly striking landscapes with rock walls and passages within areas of sandstone of the Clarens Formation (e.g. within the Mapungubwe National Park) (Mucina & Rutherford, 2006).

Geology and soils: Mostly rocks of the Beit Bridge Complex (Swazi Erathem) as well as sediments (including sandstones of the Clarens Formation) and basalt (particularly in the east) of the Karoo Supergroup. Shallow gravel and sand (Glenrosa and Mispah soil forms) to calcareous clayey soil. Land types mainly Fc, Fb and Ib (Mucina & Rutherford, 2006).

Important taxa: Tall trees: *Adansonia digitata*, *Senegalia nigrescens*, *Sclerocarya birrea* subsp. *caffra*. Small trees: *Colophospermum mopane*, *Commiphora glandulosa*, *Commiphora tenuipetiolata*, *Terminalia prunioides*, *Senegalia senegal* var. *leiorhachis*, *Vachellia tortilis* subsp. *heteracantha*, *Boscia albitrunca*, *Combretum apiculatum*, *Combretum imberbe*, *Commiphora mollis*, *Ficus abutilifolia*, *Ficus tettensis*, *Kirkia acuminata*, *Sterculia rogersii*, *Ximenia americana*. Tall shrubs: *Catophractes alexandri*, *Commiphora pyracanthoides*, *Gardenia resiniflua*, *Grewia bicolor*, *Grewia villosa*, *Hibiscus calyphyllus*, *Hibiscus micranthus*. Low shrubs: *Barleria affinis*, *Blepharis diversispina*, *Neuracanthus africanus*, *Plinthus rehmannii*, *Ptychlobium contortum*. Woody climber: *Cissus cornifolia*. Graminoids: *Aristida adscensionis*, *Aristida stipitata* subsp. *graciliflora*, *Digitaria eriantha* subsp. *eriantha*, *Enneapogon cenchroides*, *Panicum maximum*, *Schmidtia pappophoroides*, *Stipagrostis uniplumis*. Succulent herb: *Tavaresia barklyi*.

SVmp 1 Musina Mopane Bushveld

Distribution: In South Africa Musina Mopane Bushveld is found in the Limpopo Province at undulating plains from around Baines Drift and Alldays in the west, remaining north of the Soutpansberg and south of the Limpopo River (but also occurring to the north in Zimbabwe), through to Musina and Tshipise to Malongvlakte, Masisi and Banyini Pan in the east. Altitude about 300 m (in the eastern Limpopo Valley) to 800 m (Mucina & Rutherford, 2006).

Vegetation and landscape features: Undulating to very irregular plains, with some hills. In the western section, open woodland to moderately closed shrubveld dominated by *Colophospermum mopane* on clayey bottomlands and *Combretum apiculatum* on the hills. In the eastern section on basalt, moderately closed to open shrubveld is dominated by *Colophospermum mopane* and *Terminalia prunioides*. On areas with deep sandy soils, moderately open savanna dominated by *Colophospermum mopane*, *T. sericea*, *Grewia flava* and *Combretum apiculatum*. Field layer well developed (especially on the basalt), open during the dry season; the herbaceous layer is poorly developed in areas with dense cover of *Colophospermum mopane* shrubs, for example north of Alldays bordering the Limpopo floodplain (Mucina & Rutherford, 2006).

Geology and soils: Most of the area is underlain by the Archaean Beit Bridge Complex, except where it is covered by much younger Karoo sandstones and basalts. The Beit Bridge Complex consists of gneisses and metasediments and is structurally very complex. Variable soils from deep red/brown clays, moderately deep, dark heavy clays to deep, freely drained sandy soils to shallower types including skeletal Glenrosa and Mispah soil forms. Land types mainly Ae, Ah, Fc and Db (Mucina & Rutherford, 2006).

Climate: Summer rainfall with very dry winters including the shoulder months of May and September. Mean annual precipitation (MAP) about 300-400 mm. Generally frost-free unit. Mean monthly maximum and minimum temperatures for Macuville-Agr (northwest of Musina) 39.9°C to 0.9°C for November and June, respectively (Mucina & Rutherford, 2006).

Important taxa: Tall trees: *Senegalia nigrescens*, *Adansonia digitata*, *Sclerocarya birrea* subsp. *caffra*. Small trees: *Colophospermum mopane*, *Combretum apiculatum*, *Senegalia senegal* var. *leiorhachis*, *Vachellia tortilis* subsp. *heteracantha*, *Boscia albitrunca*, *Boscia foetida* subsp. *rehmanniana*, *Commiphora glandulosa*, *Commiphora tenuipetiolata*, *Commiphora viminea*, *Sterculia rogersii*, *Terminalia prunioides*, *Terminalia sericea*, *Ximena americana*. Tall shrubs: *Grewia flava*, *Sesamothamnus lugardii*, *Commiphora pyracanthoides*, *Gardenia volkensii*, *Grewia bicolor*, *Maerua parvifolia*, *Rhigozum zambeziacum*, *Tephrosia polystachya*. Low shrubs: *Acalypha indica*, *Aptosimum lineare*, *Barleria senensis*, *Dicoma tomentosa*, *Felicia clavipilosa* subsp. *transvaalensis*, *Gossypium herbaceum* subsp. *africanum*, *Hermannia glanduligera*, *Neuracanthus africanus*, *Pechuel-Loeschia leubnitziae*, *Ptychobium contortum*, *Seddera suffruticosa*. Succulent shrub: *Hoodia currorii* subsp. *lugardii*. Herbaceous climber: *Momordica balsamina*. Graminoids: *Schmidtia pappophoroides*, *Aristida adscensionis*, *Aristida congesta*, *Bothriochloa insculpta*, *Brachiaria deflexa*, *Cenchrus ciliaris*, *Digitaria eriantha* subsp. *eriantha*, *Enneapogon cenchroides*, *Eragrostis lehmanniana*, *Eragrostis pallens*, *Fingerhuthia africana*, *Heteropogon contortus*, *Sporobolus nitens*, *Stipagrostis hirtigluma* subsp. *patula*, *Stipagrostis uniplumis*, *Tetrapogon tenellus*, *Urochloa mosambicensis*. Herbs: *Acrotome inflata*, *Becium filamentosum*,

Harpagophytum procumbens subsp. *transvaalense*, *Heliotropium steudneri*, *Hermbsstaedtia odorata*, *Oxygonum delagoense*. Succulent herbs: *Stapelia gettliffei*, *Stapelia kwebensis*.

AZa 7 Subtropical Alluvial Vegetation

Distribution: In South Africa Subtropical Alluvial Vegetation is found in the Limpopo, Mpumalanga and KwaZulu-Natal Provinces and this vegetation type is also present at Swaziland. Subtropical Alluvial Vegetation occur at broad river alluvia and around some river-fed pans in the subtropical regions of eastern South Africa, in particular in the Lowveld, Central Bushveld and in northern KwaZulu-Natal. The most important alluvia include the Limpopo, Luvubu, Olifants, Sabie, Crocodile, Phongolo, Usutu and Mkuze Rivers. This vegetation unit is fully embedded within the Savanna Biome. Altitude is ranging from 0-1000 m (Mucina & Rutherford, 2006).

Vegetation and landscape features: Flat alluvial riverine terraces supporting and intricate complex of macrophytic vegetation (channel of flowing rivers and river-fed pans), marginal reed belts (in sheltered oxbows and along very slow-flowing watercourses) as well as extensive flooded grasslands, ephemeral herblands and riverine thickets (Mucina & Rutherford, 2006).

Geology, soils and hydrology: Recent alluvial deposits with deep fine-structured sandy to loamy soils (Dundee, Estcourt, Valsriver, Sterkspruit, Oakleaf forms), waterlogged as it is often exposed to floods (especially during the rainy summer season). Salt often accumulates in the alluvial soils (due to strong evaporation), la land type (Mucina & Rutherford, 2006).

Climate: Subtropical, seasonal summer-rainfall climate with broad range of temperature (19.3°C in western Central Bushveld and 22°C in Mopane) and precipitation (MAP 311-672 mm for Limpopo Valley and Maputaland, respectively) due to large latitudinal and longitudinal ranges (Mucina & Rutherford, 2006).

Important taxa: Riparian thickets. Small Trees: *Vachellia natalitia*, *Vachellia robusta*, *Boscia foetida* subsp. *rehmanniana*, *Combretum erythrophyllum*, *Phoenix reclinata*, *Salix mucronata* subsp. *woodii*, *Ziziphus mucronata*, *Vachellia luedertizii*, *Vachellia newbournii*, *Senegalia nigrescens*, *Vachellia tortilis*, *Vachellia xanthophloea*, *Colophospermum mopane*, *Combretum hereroense*, *Philenoptera violaceae*, *Pseudoscolopia polyantha* (Pondoland, sharing with Capensis). Tall shrubs: *Salvadora angustifolia*, *Commiphora glandulosa*, *Commiphora pyracanthoides*, *Euclea divinorum*, *Grewia bicolor*, *Gymnosporia senegalensis*. Low shrubs: *Justicia flava*, *Ocimum canum*. Graminoids: *Eragrostis trichophora*, *Panicum maximum*, *Setaria incrassata*, *Sporobolus ioclados*, *Chloris virgata*, *Dactyloctenium aegyptium*, *Enneapogon cenchroides*, *Urochloa mosambicensis*. Herbs: *Commelina benghalensis*, *Abutilon austro-africanum*, *Acalypha indica*, *Achyranthes aspera*, *Boerhavia erecta*, *Commicarpus fallacisimus*, *Cucumis zeyheri*, *Heliotropium ovalifolium*, *Lobelia angolensis*, *Oxygonum sinuatum*, *Pupalia lappacea*, *Ruellia patula*. Geophytic herb: *Crinum moorei*. Succulent herb: *Portulaca quadrifida*. Reed beds: Megagraminoids: *Phragmites australis*, *Phragmites mauritanus*, *Prionium serratum* (only along few rapids in Pondoland). Flooded grasslands and herblands: Megagraminoid: *Cyperus immensus*. Graminoids: *Cynodon dactylon*, *Cyperus articulatus*, *Echinochloa pyramidalis*, *Urochloa mosambicensis*, *Bolboschoenus glaucus*, *Chloris mossambicensis*, *Chloris virgata*, *Cyperus corymbosus*, *Cyperus difformis*, *Cyperus distans*, *Cyperus fastigiatus*, *Cyperus sexangularis*, *Dactyloctenium aegyptium*, *Hemarthria altissima*, *Ischaemum afrum*, *Paspalidium obtusifolium*, *Setaria sphacelata*, *Sporobolus consimilis*,

Sporobolus fimbriatus. Herbs: *Alternanthera sessilis*, *Amaranthus praetermissus*, *Grammatotheca bergiana* (Pondoland), *Marsilea ephippiocarpa*, *Scutellaria racemosa*. Geophytic herb: *Trachyandra saltii*. Aquatic herbs: *Ceratophyllum muricatum*, *Ottelia exserta*.

Note that not all of the above plant species listed for the vegetation types are present at the site.

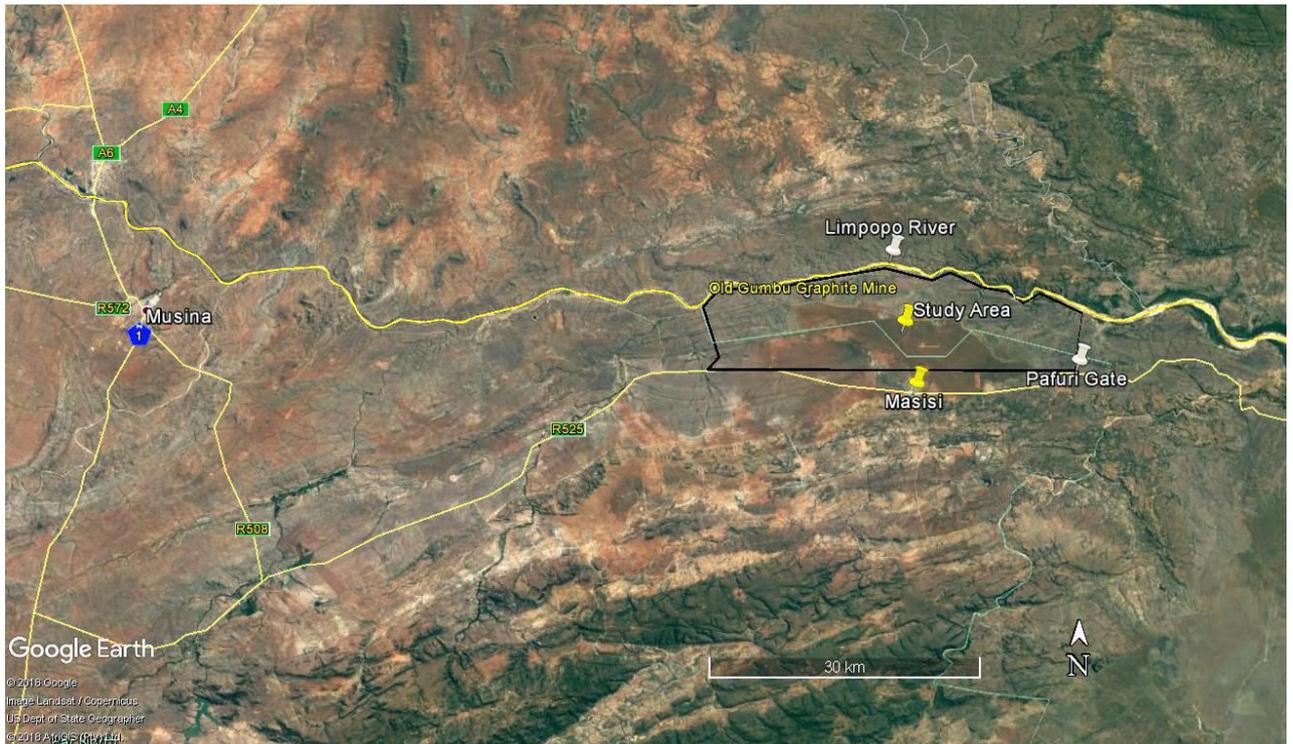


Figure 1 Map with indication of the location of the study area.

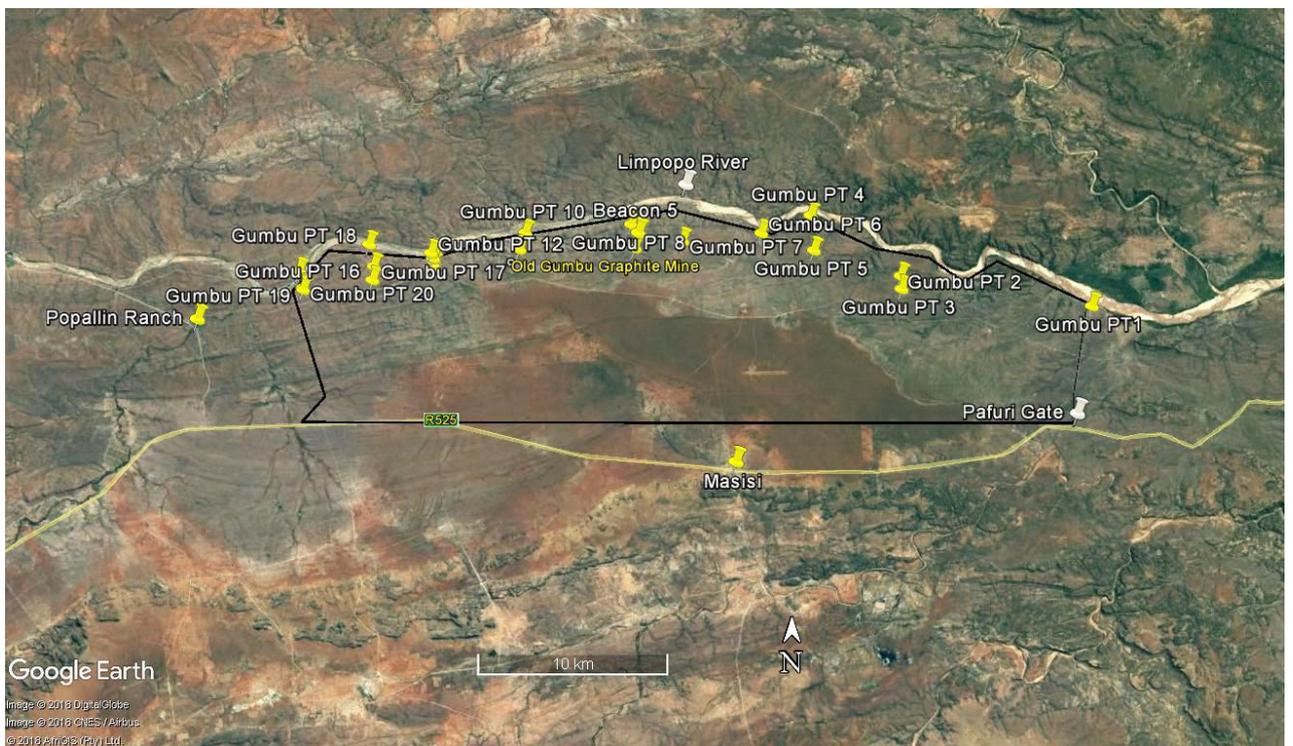


Figure 2 Map with indication of the location of the study area.

3 METHODS

A desktop study comprised not only an initial phase, but also it was used throughout the study to accommodate and integrate all the data that become available during the field observations.

Surveys by R.F. Terblanche took place during 11-15 April 2015 at the site and also surrounding areas to note key elements of habitats on the site, relevant to the conservation of fauna and flora. The main purpose of the site visits was ultimately to serve as a habitat survey that concentrated on the possible presence or not of species of particular conservation concern as well as ecosystems of particular conservation concern.

The following sections highlight the materials and methods applicable to different aspects that were observed.

3.1 HABITAT CHARACTERISTICS AND VEGETATION

The habitat was investigated by noting habitat structure (rockiness, slope, plant structure/physiognomy) as well as floristic composition. Voucher specimens of plant species were only taken where the taxonomy was in doubt and where the plant specimens were of significant relevance for invertebrate conservation. Field guides such as those by Germishuizen (2003), Manning (2003), Manning (2009), Van Oudtshoorn (1999), Van Wyk (2000), Van Wyk & Malan (1998) and Van Wyk & Van Wyk (1997) were used to confirm the taxonomy of the species. Works on specific plant groups (often genera) such as those by Goldblatt (1986), Goldblatt & Manning (1998), Jacobsen (1983), McMurtry, Grobler, Grobler & Burns (2008), Smit (2008), Van Jaarsveld (2006) and Van Wyk & Smith (2003) were also consulted to confirm the identification of species. In this case no plant specimens were needed to be collected as voucher specimens or to be send to a herbarium for identification. For the most recent treatise of scientific plant names and broad distributions, Germishuizen, Meyer & Steenkamp (2006) were followed to compile the lists of species.

3.2 MAMMALS

Mammals were noted as sight records by day. For the identification of species and observation of diagnostic characteristics Smithers (1986), Skinner & Chimimba (2005), Cillié, Oberprieler and Joubert (2004) and Apps (2000) are consulted. Sites have been walked, covering as many habitats as possible. Signs of the presence of mammal species, such as calls of animals, animal tracks (spoor), burrows, runways, nests and faeces were recorded. Walker (1996), Stuart & Stuart (2000) and Liebenberg (1990) were consulted for additional information and for the identification of spoor and signs. Trapping was not done since it proved not necessary in the case of this study.

Habitat characteristics were also surveyed to note potential occurrences of mammals. Many mammals can be identified from field sightings but, with a few exceptions bats, rodents and shrews can only be reliably identified in the hand, and even then some species needs examination of skulls, or even chromosomes (Apps, 2000).

3.3 BIRDS

Birds were noted as sight records, mainly with the aid of binoculars (10x30). Nearby bird calls of which the observer was sure of the identity were also recorded. For practical skills of noting diagnostic characteristics, the identification of species and observation techniques Ryan (2001) is followed. For information on identification, biogeography and ecology Barnes (2000), Hockey, Dean & Ryan, P.G. (2005), Cillié, Oberprieler & Joubert

(2004), Tarboton & Erasmus (1998) and Chittenden (2007) were consulted. Ringing of birds fell beyond the scope of this survey and was not deemed necessary. The site has been walked, covering as many habitats as possible. Signs of the presence of bird species such as spoor and nests have additionally been recorded. Habitat characteristics were surveyed to note potential occurrences of birds.

3.4 REPTILES

Reptiles were noted as sight records in the field. Binoculars (10x30) can also be used for identifying reptiles of which some are wary. For practical skills of noting diagnostic characteristics, the identification of species and observation techniques, Branch (1998), Marais (2004), Alexander & Marais (2007) and Cillié, Oberprieler and Joubert (2004) were followed. Sites were walked, covering as many habitats as possible. Smaller reptiles are sometimes collected for identification, but this practice was not necessary in the case of this study. Habitat characteristics were surveyed to note potential occurrences of reptiles.

3.5 AMPHIBIANS

Frogs and toads are noted as sight records in the field or by their calls. For practical skills of noting diagnostic characteristics, the identification of species and observation techniques Carruthers (2001), Du Preez (1996), Conradie, Du Preez, Smith & Weldon (2006) and the recent complete guide by Du Preez & Carruthers (2009) are consulted. CD's with frog calls by Carruthers (2001) and Du Preez & Carruthers (2009) are used to identify species by their calls when applicable. Sites are walked, covering as many habitats as possible. Smaller frogs are often collected by pitfall traps put out for epigeal invertebrates (on the soil), but this practice falls beyond the scope of this survey. Habitat characteristics are also surveyed to note potential occurrences of amphibians.

3.6 BUTTERFLIES

Butterflies were noted as sight records or voucher specimens. Voucher specimens are mostly taken of those species of which the taxa warrant collecting due to taxonomic difficulties or in the cases where species can look similar in the veldt. Many butterflies use only one species or a limited number of plant species as host plants for their larvae. Myrmecophilous (ant-loving) butterflies such as the *Aloeides*, *Chrysoritis*, *Erikssonia*, *Lepidochrysops* and *Orachrysops* species (Lepidoptera: Lycaenidae), which live in association with a specific ant species, require a unique ecosystem for their survival (Deutschländer & Bredenkaamp, 1999; Terblanche, Morghental & Cilliers, 2003; Edge, Cilliers & Terblanche, 2008; Gardiner & Terblanche, 2010). Known food plants of butterflies were therefore also recorded. After the visits to the site and the identification of the butterflies found there, a list was also compiled of butterflies that will most probably be found in the area in all the other seasons because of suitable habitat. The emphasis is on a habitat survey.

3.7 FRUIT CHAFER BEETLES

Different habitat types in the areas were explored for any sensitive or special fruit chafer species. Selection of methods to find fruit chafers depends on the different types of habitat present and the species that may be present. Fruit bait traps would probably not be successful for capturing *Ichnestoma* species in a grassland patch (Holm & Marais 1992). Possible chafer beetles of high conservation priority were noted as sight records accompanied by the collecting of voucher specimens with grass nets or containers where deemed necessary.

3.8 MYGALOMORPH SPIDERS AND ROCK SCORPIONS

Relatively homogenous habitat / vegetation areas were identified and explored to identify any sensitive or special species. Selected stones that were lifted to search for Arachnids were put back very carefully resulting in the least disturbance possible. The area was searched for possible signs of trap door spiders or other mygalomorph spiders (for example traces of wafer-lids, cork-lids or silk-lined burrows). Investigations by brushing the soil surface with a small broom/paint brush, scraping or digging into the soil with a spade, were made. All the above actions were accompanied by the least disturbance possible.

3.9 LIMITATIONS

For each site visited, it should be emphasized that surveys can by no means result in an exhaustive list of the plants and animals present on the site, because of the time constraint. Surveys on site were conducted during 11-15 April 2018 which include an optimal time of the year to find many of the habitat sensitive plant and animal species of high conservation priority, especially following late but substantial rains. Note, though that rainfall has been low for a number of years. Weather conditions during the survey were favourable for recording fauna and flora. The focus of the survey remains a habitat survey that concentrates on the possibility that species of particular conservation priority occur on the site or not. It is unlikely that more surveys would alter the outcome of this study.

Most of the study area was inaccessible during the April 2018 surveys.

4 RESULTS

4.1 HABITAT AND VEGETATION CHARACTERISTICS

Table 4.1 Outline of main landscape and habitat characteristics of the site.

HABITAT FEATURE	DESCRIPTION
Topography	The site is at rugged undulating hilly areas with moderate to steep slopes at ridges as well as for some parts at flatter areas with gentle slopes.
Rockiness	Rocky ridges are present at a number of places at the site. At the flatter areas surface rock are sparse or absent.
Presence of wetlands	Riparian zones and active channels are present at the Limpopo River and its tributaries in the study area.
Broad overview of vegetation	<p>Most of the site is present at an undulating area with a conspicuous diversity of indigenous plant species of the Limpopo Valley. Most conspicuous tree at the study area is <i>Colophospermum mopane</i> (Mopane). Large individuals of <i>Adansonia digitata</i> (Baobab) is one of the prominent features of the landscape. <i>Kirkia acuminata</i> (White-seringa) trees stand out many rocky ridges. Other indigenous trees at the rocky slopes and summits include <i>Commiphora glandulosa</i>, <i>Commiphora tenuipetiolata</i>, <i>Terminalia prunioides</i>, <i>Vachellia tortilis</i> subsp. <i>heteracantha</i>, <i>Boscia albitrunca</i>, <i>Combretum apiculatum</i>, <i>Combretum imberbe</i>, <i>Commiphora mollis</i>, <i>Ficus abutilifolia</i>, <i>Sterculia rogersii</i>, <i>Ximenia americana</i>, <i>Cassia abbreviata</i> and <i>Gardenia resiniflua</i>. A variety of shrubs and herbs are found. In some areas the grass layer is poorly developed. Grass species include <i>Aristida adscensionis</i>, <i>Aristida stipitata</i>, <i>Enneapogon cenchroides</i>, <i>Panicum maximum</i>, <i>Schmidtia pappophoroides</i> and <i>Digitaria eriantha</i>.</p> <p>Riparian vegetation also contains a conspicuous high frequency of <i>Colophospermum mopane</i>. A diversity of indigenous trees is found at riparian zones which include <i>Senegalia nigrescens</i> which is often found at along sandy riverbeds.</p> <p>Riparian vegetation along parts of the banks of Limpopo river appears flooded at and near the active channel. Patches of indigenous reed <i>Phragmites mauritianus</i> occur at the banks. Riverine bush occurs at the less flooded areas of the banks of the Limpopo River.</p>
Signs of disturbances	At some places such as the Gumbu valley there are numerous signs of mining activities of the past. Old shafts, diggings and remnants of pipeline system are visible from the Old Graphite mine to the Limpopo River. Ruins of old homesteads are also found.
Connectivity of natural vegetation in the site and between the site and surrounding areas	Rocky ridges are either as stepping-stone corridors or as directly linked corridors of conservation importance in the larger area. Streambeds and tributaries of the Limpopo River forms a vital conservation corridor network in the larger area. Limpopo river is a conservation corridor of major and fundamental importance.



Photo 1 View towards the east from a high point near the Old Graphite mine at the study area.

Photo: R.F. Terblanche



Photo 2 Ridges at the Gumbu valley area.

Photo: R.F. Terblanche



Photo 3 Sandy active channels are characteristic of many non-perennial tributaries of the Limpopo River at the study area.

Photo: R.F. Terblanche



Photo 4 Sandy riverbed at the Gumbu valley area.

Photo: R.F. Terblanche



Photo 5 View of Limpopo River towards the west.

Photo: R.F. Terblanche



Photo 6 Limpopo River flowing towards the east. Photo taken where Gumbu valley meets Limpopo River.

Photo: R.F. Terblanche



Photo 7 Foliage of *Colophospermum mopane*. Mopane is characteristic of the vegetation at the study area.

Photo: R.F. Terblanche



Photo 8 One of the indigenous stand-out trees, in particular at rocky ridges in the study area, is *Kirkia acuminata* (White-sering).

Photo: R.F. Terblanche



Photo 9 Indigenous and grotesque *Adansonia digitata* (Baobab) is listed as protected and conspicuous element of the flora of the Limpopo Valley, of which the study area is part.

Photo: R.F. Terblanche



Photo 10 Sandy riverbed at the study area with typical riparian vegetation which includes tree species such as *Senegalia nigrescens* (Knob Thorn).

Photo: R.F. Terblanche



Photo 11 Ruins of old homestead at the Gumbu valley.

Photo: R.F. Terblanche



Photo 12 Concrete structures at Old Gumbu Graphite Mine at study area.

Photo: R.F. Terblanche



Photo 13 Old diggings at Gumbu valley at study area.

Photo: R.F. Terblanche



Photo 14 Remnants of large pipeline-structure near banks of Limpopo River where the Gumbu valley meets the Limpopo River.

Photo: R.F. Terblanche



Photo 15 Bark of indigenous *Adansonia digitata*, Baobab, a feature of the vegetation in the study area.

Photo: R.F. Terblanche



Photo 16 Fallen leaf of *Adansonia digitata*, Baobab. In the winter the grotesque trees are without leaves which results in the trees being a prominent feature of the winter landscapes at the study area.

Photo: R.F. Terblanche



Photo 17 Protected tree, *Boscia albitrunca* (Shepherd's Tree) at a ridge at the Gumbu valley.

Photo: R.F. Terblanche



Photo 18 Foliage of indigenous and protected tree, *Boscia albitrunca* (Shepherd's Tree) at the Gumbu valley.

Photo: R.F. Terblanche



Photo 19 Foliage and fruit of indigenous *Gardenia resiniflora* (Gummy Gardenia) at the Gumbu valley in the study area. This small tree is found in southern Africa across a fairly wide in countries such as Zimbabwe in in South Africa is limited to the extreme northeastern parts of which the study area is part.

Photo: R.F. Terblanche



Photo 20 Foliage of indigenous tree, *Senegalia nigrescens*, Konob Thorn. *Senegalia nigrescens* is conspicuous at banks of sandy riverbeds at the study area.

Photo: R.F. Terblanche



Photo 21 Foliage and fruit of indigenous *Terminalia prunioides* (Purple-pod Clusterlead) at Gumbu valley in the study area.

Photo: R.F. Terblanche



Photo 22 *Hippocratea longipetiolata*, an indigenous shrub which is conspicuous at some riparian zones at the study area.

Photo: R.F. Terblanche



Photo 23 Flowers of *Anisotes rogersii*, an indigenous woody shrub that is distributed in mopane veld in the far northern parts of South Africa.

Photo: R.F. Terblanche



Photo 24 Striking flowers of *Cleome angustifolia*, an indigenous herb which are often particularly visible following rains, such as during this study in April 2018.

Photo: R.F. Terblanche



Photo 25 Skull of African Elephant, *Loxodonta africana*, at the study area.

Photo: R.F. Terblanche



Photo 26 Part of footprint of African Elephant, *Loxodonta africana*, at the banks of the Limpopo River at the study area.

Photo: R.F. Terblanche



Reinier F. Terblanche

Photo 27 Somewhat faded track of *Crocuta crocuta*, the Spotted Hyaena, at the site.

Photo: R.F. Terblanche



Photo 28 Little Bee-eater.

Photo: R.F. Terblanche



Photo 29 Mopane worm, the larva of the Mopane Emperor Moth, *Gonimbrasia belina*, on Mopane tree, *Colophospermum mopane* in the study area.

Photo: R.F. Terblanche



Photo 30 *Colotis evenina* (Orange Tip), one of the several butterfly species of which the larvae use the protected tree, *Boscia albitrunca* (Shepherd's Tree) as host-plant species.

Photo: R.F. Terblanche

5 ASSESSMENT OF PLANT SPECIES OF PARTICULAR CONSERVATION PRIORITY

Plant species of the Limpopo Province of high conservation priority which were extracted from (Raimondo *et al.* 2009) are listed in the tables beneath. Many of these plant species could be easily eliminated from occurring in the study area based on habitat type and distributional range by a relatively quick scan to make sure these are not present on the site. For others, a habitat survey during the site visits confirms likely presence or absence.

Table 4.2 Threatened (= red listed) plant species of the Limpopo Province that are listed in the **Critically Endangered** category. The list here follows the most recent updated red list of South African plant species (Raimondo *et al.* 2009). No = Plant species is unlikely to be a resident on the site; Yes = Plant species is a resident on the site.

Species	Status:	Resident
	Global status or national status indicated	at the site
<i>Brackenridgea zanguebarica</i>	Critically Endangered	No
<i>Chlorophytum radula</i>	Critically Endangered	No
<i>Encephalartos cupidus</i>	Critically Endangered	No
<i>Encephalartos dolomiticus</i>	Critically Endangered	No
<i>Encephalartos dyerianus</i>	Critically Endangered	No
<i>Encephalartos eugene-maraisii</i>	Critically Endangered	No
<i>Encephalartos hirsutus</i>	Critically Endangered	No
<i>Encephalartos inopinus</i>	Critically Endangered	No
<i>Encephalartos laevifolius</i>	Critically Endangered	No
<i>Euphorbia clivicola</i>	Critically Endangered	No
<i>Euphorbia groenewaldii</i>	Critically Endangered	No
<i>Gladiolus macneilii</i>	Critically Endangered	No
<i>Gladiolus pavonia</i>	Critically Endangered	No
<i>Kniphofia crassifolia</i>	Critically Endangered	No
<i>Oberonia disticha</i>	Critically Endangered	No
<i>Orbea elegans</i>	Critically Endangered	No
<i>Raphionacme villicorona</i>	Critically Endangered	No
<i>Siphonochilus aethiopicus</i>	Critically Endangered	No
<i>Vachellia sekhukhuniensis</i>	Critically Endangered	No

Table 4.3 Threatened plant species of the Limpopo Province that are listed in the **Endangered** category. The list here follows the most recent updated red list of South African plant species (Raimondo *et al.* 2009). No = Plant species is unlikely to be a resident on the site; Yes = Plant species is a resident on the site.

Species	Status: Global status or national status indicated	Resident at the site
<i>Argyrobium muddii</i>	Endangered	No
<i>Asparagus sekukuniensis</i>	Endangered	No
<i>Aster nubimontis</i>	Endangered	No
<i>Brachystelma gerrardii</i>	Endangered	No
<i>Cineraria cyanomontana</i>	Endangered	No
<i>Euphorbia barnardii</i>	Endangered	No
<i>Inezia speciosa</i>	Endangered	No
<i>Ledebouria crispa</i>	Endangered	No
<i>Leucospermum saxosum</i>	Endangered	No
<i>Mondia whitei</i>	Endangered	No
<i>Nemesia zimbabwensis</i>	Endangered	No
<i>Ocotea bullata</i>	Endangered	No
<i>Ophioglossum gracillimum</i>	Endangered	No
<i>Pearsonia callistoma</i>	Endangered	No
<i>Plinthus rehmannii</i>	Endangered	No
<i>Warburgia salutaris</i>	Endangered	No

Table 4.4 Threatened plant species of the Limpopo Province that are listed in the **Vulnerable** category. The list here follows the most recent updated red list of South African plant species (Raimondo *et al.* 2009). No = Plant species is unlikely to be resident on the site; Yes = Plant species is a resident on the site.

Species	Status: Global status or national status indicated	Resident at the site
<i>Alepidea amatymbica</i>	Vulnerable	No
<i>Aloe chortolirioides</i> var. <i>chortolirioides</i>	Vulnerable	No
<i>Aloe monotropa</i>	Vulnerable	No
<i>Asparagus fouriei</i>	Vulnerable	No
<i>Asparagus hirsutus</i>	Vulnerable	No

<i>Barleria dolomiticola</i>	Vulnerable	No
<i>Bowiea volubilis</i> subsp. <i>volubilis</i>	Vulnerable	No
<i>Brachycorythis conica</i> subsp. <i>transvaalensis</i>	Vulnerable	No
<i>Ceropegia cimiciodora</i>	Vulnerable	No
<i>Ceropegia stentiae</i>	Vulnerable	No
<i>Cheilanthes deltoidea</i> subsp. nov.	Vulnerable	No
<i>Crassula setulosa</i> var. <i>deminuta</i>	Vulnerable	No
<i>Cucumis humifructus</i>	Vulnerable	No
<i>Cullen holubii</i>	Vulnerable	No
<i>Cyphostemma hardyi</i>	Vulnerable	No
<i>Cyrtanthus junodii</i>	Vulnerable	No
<i>Diplolophium buchananii</i> subsp. <i>swynnertonii</i>	Vulnerable	No
<i>Dioscorea sylvatica</i>	Vulnerable	No
<i>Disa aristata</i>	Vulnerable	No
<i>Disa cernua</i>	Vulnerable	No
<i>Elytrophorus globularis</i>	Vulnerable	No
<i>Eulophia coddii</i>	Vulnerable	No
<i>Festuca dracomontana</i>	Vulnerable	No
<i>Gladiolus sekukuniensis</i>	Vulnerable	No
<i>Huernia nouhuysii</i>	Vulnerable	No
<i>Jamesbrittenia bergae</i>	Vulnerable	No
<i>Ledebouria dolomiticola</i>	Vulnerable	No
<i>Lithops coleorum</i>	Vulnerable	No
<i>Marsilea farinosa</i>	Vulnerable	No
<i>Plectranthus porcatus</i>	Vulnerable	No
<i>Prunus africana</i>	Vulnerable	No
<i>Rhynchosia vendae</i>	Vulnerable	No
<i>Sartidia jucunda</i>	Vulnerable	No
<i>Searsia batophylla</i>	Vulnerable	No
<i>Streptocarpus longiflorus</i>	Vulnerable	No
<i>Streptocarpus makabengensis</i>	Vulnerable	No
<i>Thesium davidsonae</i>	Vulnerable	No
<i>Thesium gracilentum</i>	Vulnerable	No
<i>Zantedeschia jucunda</i>	Vulnerable	No

Table 4.5 Near Threatened plant species of the Limpopo Province. The list here follows the most recent updated red list of South African plant species (Raimondo *et al.* 2009). No = Plant species is unlikely to be a resident on the site; Yes = Plant species is a resident on the site.

Species	Status: Global status or national status indicated	Resident at the site
<i>Adenia fruticosa</i> subsp. <i>fruticosa</i>	Near Threatened	No
<i>Alepidea attenuata</i>	Near Threatened	No
<i>Brachystelma hirtellum</i>	Near Threatened	No
<i>Ceropegia turricula</i>	Near Threatened	No
<i>Clivia caulescens</i>	Near Threatened	No
<i>Curtisia dentata</i>	Near Threatened	No
<i>Disa extincoria</i>	Near Threatened	No
<i>Drimia sanguinea</i>	Near Threatened	No
<i>Elaeodendron transvaalense</i>	Near Threatened	No
<i>Eulalia aurea</i>	Near Threatened	No
<i>Euphorbia rowlandii</i>	Near Threatened	No
<i>Gasteria batesiana</i> var. <i>batesiana</i>	Near Threatened	No
<i>Habenaria kraenzliniana</i>	Near Threatened	No
<i>Holothrix randii</i>	Near Threatened	No
<i>Isoetes transvaalensis</i>	Near Threatened	No
<i>Jamesbrittenia macrantha</i>	Near Threatened	No
<i>Kniphofia typhoides</i>	Near Threatened	No
<i>Lithops leslei</i> subsp. <i>leslei</i>	Near Threatened	No
<i>Lydenburgia cassinoides</i>	Near threatened	No
<i>Mystacidium brayboniae</i>	Near Threatened	No
<i>Panicum dewinteri</i>	Near Threatened	No
<i>Vachellia ormocarpoides</i>	Near Threatened	No

Table 4.6 Plant species of the Limpopo Province which are not threatened but of particular conservation concern and listed in the **Critically Rare** category. The list here follows the most recent red list of South African plant species (Raimondo *et al.* 2009). No = Plant species is unlikely to be a resident on the site; Yes = Plant species is a resident on the site.

Species	Conservation status	Resident at the site
<i>Cineraria erodioides</i> var. <i>tomentosa</i>	Critically Rare	No
<i>Crassula cymbiformis</i>	Critically Rare	No
<i>Dicliptera fionae</i>	Critically Rare	No
<i>Drimiopsis burkei</i> subsp. <i>stolonissima</i>	Critically Rare	No
<i>Gasteria batesiana</i> var. <i>dolomitica</i>	Critically Rare	No
<i>Lotononis pariflora</i>	Critically Rare	No
<i>Plectranthus dolomiticus</i>	Critically Rare	No
<i>Thorncroftia media</i>	Critically Rare	No

Table 4.7 Plant species of the Limpopo Province which are however of particular conservation concern and listed in the **Rare** category. The list here follows the most recent red list of South African plant species (Raimondo *et al.* 2009). No = Plant species is not a resident on the site; Yes = Plant species is a resident on the site.

Species	Conservation status	Resident at the site
<i>Angraecum stella-africae</i>	Rare	No
<i>Agapanthus coddii</i>	Rare	No
<i>Aloe hardyi</i>	Rare	No
<i>Aloe soutpansbergensis</i>	Rare	No
<i>Aloe thompsoniae</i>	Rare	No
<i>Asparagus elephantinus</i>	Rare	No
<i>Berkheya radyeri</i>	Rare	No
<i>Blepharis uniflora</i>	Rare	No
<i>Brachystelma inconspicuum</i>	Rare	No
<i>Brachystelma minor</i>	Rare	No
<i>Brachystelma villosum</i>	Rare	No
<i>Ceratotheca saxicola</i>	Rare	No
<i>Combretum petrophilum</i>	Rare	No
<i>Dicoma montana</i>	Rare	No
<i>Dracaena transvaalensis</i>	Rare	No
<i>Euphorbia louwii</i>	Rare	No
<i>Euphorbia grandialata</i>	Rare	No
<i>Euphorbia restricta</i>	Rare	No

<i>Euphorbia sekukuniensis</i>	Rare	No
<i>Euphorbia waterbergensis</i>	Rare	No
<i>Euphorbia grandialata</i>	Rare	No
<i>Freylinia tropica</i>	Rare	No
<i>Gladiolus dolomiticus</i>	Rare	No
<i>Gladiolus pardalinus</i>	Rare	No
<i>Gymnosporia oxycarpa</i>	Rare	No
<i>Helichrysum junodii</i>	Rare	No
<i>Hesperantha brevicaulis</i>	Rare	No
<i>Ipomoea bisavium</i>	Rare	No
<i>Isoetes schweinfurthii</i>	Rare	No
<i>Justicia minima</i>	Rare	No
<i>Justicia montis-salinarum</i>	Rare	No
<i>Kalanchoe crundallii</i>	Rare	No
<i>Khadia borealis</i>	Rare	No
<i>Ledebouria lepida</i>	Rare	No
<i>Monsonia lanuginosa</i>	Rare	No
<i>Nesaea alata</i>	Rare	No
<i>Orbea gerstneri elongata</i>	Rare	No
<i>Orbea hardyi</i>	Rare	No
<i>Pavetta tshikondeni</i>	Rare	No
<i>Peristrophe cliffordii</i>	Rare	No
<i>Peristrophe gillilandiorum</i>	Rare	No
<i>Plectranthus venterii</i>	Rare	No
<i>Rhoicissus laetans</i>	Rare	No
<i>Searsia sekhukhuniensis</i>	Rare	No
<i>Senecio hederiformis</i>	Rare	No
<i>Syncolostemon rugosifolius</i>	Rare	No
<i>Tylophora coddii</i>	Rare	No
<i>Vangueria soutpansbergensis</i>	Rare	No
<i>Woodia singularis</i>	Rare	No

Table 4.8 Plant species of the Limpopo Province which are not threatened but of particular conservation concern and listed in the **Declining** category. The list here follows the most recent red list of South African plant species (Raimondo *et al.* 2009). No = Plant species is unlikely to be a resident on the site; Yes = Plant species is a resident on the site.

Species	Conservation status	Resident at the site
<i>Acridocarpus natalitius</i>	Declining	No
<i>Adenia gummifera</i> subsp. <i>gummifera</i>	Declining	No
<i>Aloe cooperi</i> subsp. <i>cooperi</i>	Declining	No
<i>Ansellia africana</i>	Declining	No
<i>Balanites maughanii</i>	Declining	No
<i>Boophone disticha</i>	Declining	No
<i>Callilepis leptophylla</i>	Declining	No
<i>Cassipourea malosana</i>	Declining	No
<i>Crinum macowanii</i>	Declining	No
<i>Crinum stuhlmanii</i>	Declining	No
<i>Cryptocarya transvaalensis</i>	Declining	No
<i>Cyathea capensis</i> var. <i>capensis</i>	Declining	No
<i>Drimia altissima</i>	Declining	No
<i>Elaeodendron croceum</i>	Declining	No
<i>Eucomis autumnalis</i>	Declining	No
<i>Eulophia speciosa</i>	Declining	No
<i>Gunnera perpensa</i>	Declining	No
<i>Hypoxis hemerocallidea</i>	Declining	No
<i>Ilex mitis</i>	Declining	No
<i>Pterocelastrus rostratus</i>	Declining	No
<i>Rapanea melanophloeos</i>	Declining	No
<i>Vachellia erioloba</i>	Declining	No

Table 4.9a Plant species of the Limpopo Province of which the conservation status is uncertain owing to a lack of information and which are listed in the **Data Deficient** category. The list here follows the most recent red list of South African plant species (Raimondo *et al.* 2009). No = Plant species is unlikely to be a resident on the site; Yes = Plant species is a resident on the site.

Species	Conservation status	Resident at the site
<i>Adenia fruticosa</i> subsp. <i>simplicifolia</i>	Data Deficient	No
<i>Asclepias nana</i>	Data Deficient	No
<i>Blepharis spinipes</i>	Data Deficient	No
<i>Buchnera remotiflora</i>	Data Deficient	No
<i>Cephalaria armerioides</i>	Data Deficient	No
<i>Christella altissima</i>	Data Deficient	No
<i>Cephalaria amerioides</i>	Data Deficient	No
<i>Cyphia corylifolia</i>	Data Deficient	No
<i>Delosperma rileyi</i>	Data Deficient	No
<i>Dicoma prostrata</i>	Data Deficient	No
<i>Eriosema fasciculatum</i>	Data Deficient	No
<i>Pentatrachia alata</i>	Data Deficient	No
<i>Plectranthus esculentus</i>	Data Deficient	No
<i>Schistostephium scandens</i>	Data Deficient	No

Table 4.9b Tree species of the North West Province which are listed as **Protected Species** under the National Forests Act No. 84 of 1998, Section 51(1). No = Plant species is unlikely to be a resident on the site; Yes = Plant species is a resident at the site.

Species	Conservation status	Resident at the site
<i>Adansonia digitata</i> (Baobab)	Protected	Yes
<i>Boscia albitrunca</i> (Shepherd's tree)	Protected	Yes
<i>Combretum imberbe</i> (Leadwood)	Protected	Yes
<i>Philenoptera violacea</i> (Apple-leaf)	Protected	Yes
<i>Sclerocarya birrea</i> (Marula)	Protected	Yes
<i>Vachellia erioloba</i> (= <i>Acacia erioloba</i>) (Camel Thorn Tree)	Protected	No

6 VERTEBRATE SPECIES OF PARTICULAR CONSERVATION PRIORITY

6.1 MAMMALS OF PARTICULAR HIGH CONSERVATION PRIORITY

Table 4.10 Threatened mammal species in the Limpopo Province. Literature sources Skinner & Chimimba (2005), Wilson & Reeder and Friedman & Daly (2004). Historically red data species (that includes the old rare category) have also been included. No = Not recorded/ Unlikely to be resident at the site; Yes = Recorded at the site during the survey/ Resident at the site.

Species	Red Listed Status	Recorded at site during survey	Resident at the site
<i>Acinonyx jubatus</i> Cheetah	Vulnerable	No	No
<i>Chrysothalax villosus</i> Rough-haired Golden Mole	Vulnerable	No	No
<i>Cloeotis percivali</i> Short-eared Trident Bat	Vulnerable/ Near-threatened	No	No
<i>Diceros bicornis</i> Black rhinoceros	Critically Endangered	No	No
<i>Lycaon pictus</i> African wild dog	Endangered	No	No
<i>Loxodonta africana</i> African elephant	Vulnerable	Yes (Tracks, Skull)	Yes
<i>Neamblysomus julianae</i> Juliana's Golden Mole	Critically Endangered	No	No
<i>Ourebia ourebi</i> Oribi	Vulnerable	No	No
<i>Proteles cristatus</i> Aardwolf	"Rare"	No	No
<i>Panthera leo</i> Lion	Vulnerable	No	Possibly
<i>Panthera pardus</i> Leopard	"Rare"	Yes (Faint tracks)	Yes
<i>Rhinolophus blasii</i> Blasi's Horseshoe Bat	Vulnerable	No	No

Table 4.11 Near threatened mammal species of the Limpopo Province. Literature sources Skinner & Chimimba (2005), Wilson & Reeder and Friedman & Daly (2004). No = Not recorded/ Unlikely to be resident at the site; Yes = Recorded at the site during the survey/ Resident at the site.

Species	Conservation Status	Recorded at site during survey	Likely to be found based on habitat assessment
<i>Aonyx capensis</i> African Clawless Otter	Near Threatened	No	No
<i>Ceratotherium simum</i> White Rhinoceros	Near Threatened	No	No
<i>Dasymys incomtus</i>	Near Threatened	No	No
<i>Lutra maculicollis</i> Spotted-necked Otter	Near Threatened	No	No
<i>Manis temminckii</i> Ground Pangolin	Near Threatened	No	No
<i>Miniopterus schreibersii</i> Schreiber's Long-fingered Bat	Near Threatened	No	No
<i>Parahyaena brunnea</i> Brown Hyaena	Near Threatened	Yes	Yes
<i>Pipistrellus rusticus</i> Rusty Pippistelle	Near Threatened	No	No
<i>Rhinolophus darlingi</i> Darling's Horseshoe Bat	Near Threatened	No	No

Table 4.12 Data Deficient mammal species of the Limpopo Province. Literature sources Skinner & Chimimba (2005), Wilson & Reeder and Friedman & Daly (2004). With mammal species which normally needs a large range their occurrence does not always imply that they are exclusively dependent on the site or use the site as important shelter or for reproduction. No = Not recorded/ Unlikely to be resident at the site; Yes = Recorded at the site during the survey/ Resident at the site.

Species		Red Listed Status	Recorded at site during survey	Resident at the site
<i>Crocidura cyanea</i> Musk Shrew	Reddish-grey	Data Deficient	No	No
<i>Crocidura fuscomurina</i> Musk Shrew	Tiny	Data Deficient	No	No
<i>Crocidura hirta</i> Musk Shrew	Lesser Red	Data Deficient	No	No
<i>Crocidura mariquensis</i> Musk Shrew	Swamp	Data Deficient	No	No
<i>Crocidura maquassiensis</i> Musk Shrew	Maquassie	Data Deficient	No	No
<i>Elephantulus brachyrhynchus</i> snouted Elephant Shrew	Short-	Data Deficient	No	No
<i>Gerbilliscus leucogaster</i> Gerbil	Bushveld	Data Deficient	No	No
<i>Graphiurus platyops</i> Dormouse	Rock	Data Deficient	No	No
<i>Lemniscomys rosalia</i> Grass Mouse	Single-striped	Data Deficient	No	No
<i>Myosorex varius</i> shrew	Forest	Data Deficient	No	No
<i>Poecilogale albinucha</i> Weasel	African	Data Deficient	No	No

6.2 BIRDS OF PARTICULAR HIGH CONSERVATION PRIORITY

Table 4.13 Threatened bird species of the Limpopo Province. Literature sources Barnes (2000), Hockey, Dean & Ryan, P.G. (2005) and Chittenden (2007).

Species	Common name	Conservation Status	Recorded on site	Resident at the site
<i>Aquila rapax</i>	Tawny Eagle	Vulnerable (Nationally)	No	No
<i>Ardeotis kori</i>	Kori Bustard	Vulnerable	No	No
<i>Botaurus stellaris</i>	Eurasian Bittern	Critically Endangered	No	No
<i>Buphagus africanus</i>	Yellow-billed Oxpecker	Vulnerable (Nationally)	No	No
<i>Circus ranivorus</i>	African Marsh- Harrier	Vulnerable (Nationally)	No	No
<i>Crex crex</i>	Corn Crane	Vulnerable (Globally)	No	No
<i>Ephippiorhynchus senegalensis</i>	Saddle-billed Stork	Endangered (Nationally)	No	No
<i>Eupodotis senegalensis</i>	White-bellied Korhaan	Vulnerable (Nationally)	No	No
<i>Falco naumanni</i>	Lesser Kestrel	Vulnerable (Globally)	No	No
<i>Gorsachius euconotus</i>	White-backed Night-heron	Vulnerable (Nationally)	No	No
<i>Gyps africanus</i>	White-backed Vulture	Critically Endangered (Nationally)	No	Yes
<i>Gyps coprotheres</i>	Cape Vulture	Vulnerable (Globally)	No	No
<i>Necrosyrtes monachus</i>	Hooded Vulture	Critically Endangered	No	Yes
<i>Neophron percnopterus</i>	Egyptian Vulture	Regionally almost extinct	No	No
<i>Neotis denhami</i>	Denham's Bustard	Vulnerable	No	No
<i>Pelecanus rufescens</i>	Pink-backed Pelican	Vulnerable	No	No
<i>Polemaetus bellicosus</i>	Martial Eagle	Vulnerable (Nationally)	No	No
<i>Rynchops flavirostris</i>	African Skimmer	Endangered	No	No
<i>Sagittarius serpentarius</i>	Secretarybird	Near Threatened (Nationally)	No	No
<i>Sarothrura affinis</i>	Striped Flufftail	Vulnerable	No	No
<i>Scotopelia peli</i>	Pel's Fishing Owl	Endangered (Nationally)	No	Yes
<i>Terathopius ecaudatus</i>	Bateleur	Vulnerable (in southern Africa)	Yes	Yes
<i>Torgos tracheliotos</i>	Lappet-faced Vulture	Endangered (Nationally)	No	Yes

<i>Trigonoceps occipitalis</i>	White-headed Vulture	Critically Endangered (Nationally)	No	Yes
<i>Tyto capensis</i>	African Grass-Owl	Vulnerable (Nationally)	No	No

Table 4.14 Near threatened bird species of the Limpopo Province. Literature sources Barnes (2000), Hockey, Dean & Ryan, P.G. (2005) and Chittenden (2007).

Species	Common name	Conservation Status	Recorded on site	Likely to be resident
<i>Alcedo semitorquata</i>	Half-collared Kingfisher	Near Threatened	No	Yes
<i>Anastomus lamelligerus</i>	African Openbill	Near Threatened (Nationally)	No	No
<i>Aquila ayresii</i>	Ayres's Hawk-Eagle	Near Threatened (Nationally)	No	No
<i>Buphagus erythrorhynchus</i>	Red-Billed Oxpecker	Near Threatened (Nationally)	No	No
<i>Certhilauda chuana</i>	Short-clawed Lark	Near Threatened	No	No
<i>Ciconia nigra</i>	Black Stork	Near Threatened (Nationally)	No	No
<i>Circus macrourus</i>	Pallid Harrier	Near Threatened (Globally)	No	No
<i>Crithagra citrinipectus</i>	Lemon-breasted Canary	Near Threatened (Nationally)	No	Yes
<i>Falco biarmicus</i>	Lanner Falcon	Near Threatened (Nationally)	No	No
<i>Falco peregrinus</i>	Peregrine Falcon	Near Threatened (Nationally)	No	No
<i>Glareola nordmanni</i>	Black-winged Pratincole	Near Threatened	No	No
<i>Leptoptilos crumeniferus</i>	Marabou Stork	Near Threatened (Nationally)	No	Yes
<i>Lissotis melanogaster</i>	Black-bellied Bustard	Near Threatened (Nationally)	No	No
<i>Macheiramphus alcinus</i>	Bat Hawk	Endangered	No	?
<i>Mirafraga cheniana</i>	Melodious Lark	Near Threatened	No	No
<i>Mycteria ibis</i>	Yellow-billed Stork	Near Threatened (Nationally)	No	No
<i>Pelecanus onocrotalus</i>	Great White Pelican	Near Threatened	No	No
<i>Phoenicopterus minor</i>	Lesser Flamingo	Near Threatened	No	No
<i>Phoenicopterus ruber</i>	Greater Flamingo	Near Threatened	No	No
<i>Pterocles gutturalis</i>	Yellow-throated Sandgrouse	Near Threatened	No	No
<i>Rostratula benghalensis</i>	Greater Painted-snipe	Near Threatened (Nationally)	No	No
<i>Stephanoaetus coronatus</i>	African Crowned Eagle	Near Threatened (Nationally)	No	No

6.3 REPTILES OF PARTICULAR HIGH CONSERVATION PRIORITY

Table 4.15 Reptile species of particular high conservation priority in the Limpopo Province. Main source: Bates, Branch, Bauer, Burger, Marais, Alexander & De Villiers (2014).

Species	Red Listed Status	Recorded at site during survey	Residential status at the site: Confirmed, Highly likely, Likely, Medium possibility, Unlikely, Highly unlikely
<i>Afroedura multiporis multiporis</i> Woodbush Flat Gecko	Vulnerable	No	Highly unlikely
<i>Acontias richardi</i> Richard's Legless Skink	Near Threatened	No	Highly Unlikely
<i>Acontias rieppeli</i> Woodbush Legless Skink	Endangered	No	Highly Unlikely
<i>Chamaesaura aenea</i> Coppery Grass Lizard	Near Threatened	No	Highly Unlikely
<i>Chamaesaura macrolepis</i> Large Scaled Grass Lizard	Near Threatened	No	Highly Unlikely
<i>Chirindia langi occidentalis</i> Western Round-headed Worm Lizard	Vulnerable	No	Highly Unlikely
<i>Homopholis mulleri</i> Muller's Velvet Gecko	Vulnerable	No	Possible
<i>Homoroselaps dorsalis</i> Striped Harlequin Snake	Near Threatened	No	Highly unlikely
<i>Lygodactylus graniticolus</i> Granite Dwarf Gecko	Near Threatened	No	Highly unlikely
<i>Lygodactylus methueni</i> Methuen's Dwarf Gecko	Vulnerable	No	Highly unlikely
<i>Lygodactylus soutpansbergensis</i> <i>ocellatus</i> Soutpansberg Dwarf Gecko	Near Threatened	No	Highly unlikely
<i>Lygodactylus waterbergensis</i> Waterberg Dwarf Gecko	Near Threatened	No	Highly unlikely
<i>Vhembelacerta rupicola</i> Soutpansberg Rock Lizard	Near Thretaened	No	Highly Unlikely
<i>Pseudocordylus transvaalensis</i> Northern Crag Lizard	Near Threatened	No	Highly Unlikely
<i>Platysaurus intermedius inopinus</i> Unexpected Flat Lizard	Endangered	No	Highly unlikely
<i>Platysaurus monotropis</i> Orange-throated Flat Lizard	Endangered	No	Highly unlikely
<i>Platysaurus orientalis fitsimensi</i> Fitzsimon's Flat Lizard	Near Threatened	No	Highly unlikely
<i>Scelotes limpopoensis albiventris</i> White-bellied Dwarf Burrowing Skink	Near Threatened	No	Highly unlikely

6.4 AMPHIBIAN SPECIES OF PARTICULAR HIGH CONSERVATION PRIORITY

Table 4.16 Threatened or Near-threatened amphibian species in Limpopo Province. Literature sources (Minter, Burger, Harrison, Braack, Bishop. & Kloepfer 2004; Du Preez & Carruthers 2009). No = Amphibian species is not a resident on the site; Yes = Amphibian species is found to be resident on the site.

Species	Conservation status	Recorded at site during survey	Residential status at the site: Confirmed, Highly likely, Likely, Medium possibility, Unlikely, Highly unlikely
<i>Breviceps sylvestris</i> Northern Forest Rain Frog	Vulnerable	No	No

7 INVERTEBRATE SPECIES OF PARTICULAR CONSERVATION PRIORITY

7.1 BUTTERFLIES OF PARTICULAR CONSERVATION PRIORITY

Table 4.17 Threatened: Globally Critically Endangered butterfly species of the Limpopo and Mpumalanga Provinces combined. Sources: Mecenero *et al.* (2013), Henning, Terblanche & Ball (2009). Invertebrates such as threatened butterfly species are often very habitat specific and residential status implies a unique ecosystem that is at stake.

Species	Red List Status	Recorded at site during survey	Residential status at the site: Confirmed, Highly likely, Likely, Medium possibility, Unlikely, Highly unlikely
<i>Alaena margaritacea</i> Wolkberg Zulu	Critically Endangered	No	Highly unlikely
<i>Anthene crawshayi juanita</i> Juanita's Ciliated Blue/ Juanita's Hairtail	Critically Endangered	No	Unlikely
<i>Erikssonia edgei</i> Waterberg Copper	* Critically Endangered	No	Highly unlikely

* Formerly this butterfly species has been known as the Waterberg population of *Erikssonia acraeina*. The Waterberg population of *Erikssonia*, known from only one locality, has recently been described as a new species, *Erikssonia edgei* by Gardiner & Terblanche (2010).

Table 4.18 Threatened: Regionally Critically Endangered butterfly species of the Limpopo and Mpumalanga Provinces combined. Sources: Mecenero *et al.* (2013).

Species	Red List Status (Global unless stated otherwise)	Recorded at site during survey	Residential status at the site: Confirmed, Highly likely, Likely, Medium possibility, Unlikely, Highly unlikely
<i>Acada biseriata</i> Axehead Orange	Regionally Critically Endangered	No	Possibly
<i>Charaxes guderiana guderiana</i> Blue-spangled Charaxes	Regionally Critically Endangered	No	Possibly

Table 4.19 Threatened: Endangered butterfly species of the Limpopo and Mpumalanga Provinces combined. Sources: Mecenero *et al.* (2013), Henning, Terblanche & Ball (2009).

Species	Red List Status (Global status)	Recorded at site during survey	Residential status at the site: Confirmed, Highly likely, Likely, Medium possibility, Unlikely, Highly unlikely
<i>Aloeides stevensoni</i> Stevenson's Copper	Endangered	No	Highly unlikely
<i>Dingana clara</i> Wolkberg Widow	Endangered	No	Highly unlikely
<i>Lepidochrysops lotana</i> Lotana Blue	Endangered	No	Highly unlikely
<i>Telchinia induna salmontana</i> Soutpansberg Acraea	Endangered	No	Highly unlikely

Table 4.20 Extremely Rare or Rare butterfly species of the Limpopo and Mpumalanga Provinces combined. Source: Mecenero *et al.* (2013).

Species	Red List Status (Global unless stated otherwise)	Recorded at site during survey	Residential status at the site: Confirmed, Highly likely, Likely, Medium possibility, Unlikely, Highly unlikely
<i>Anthene minima minima</i> Little Ciliated Blue/ Little Hairtail	Rare (Low density)	No	Possibly
<i>Charaxes druceanus solitarius</i> Blouberg Silver-barred Charaxes	Rare (Restricted range)	No	Highly unlikely
<i>Charaxes xiphares staudei</i> Blouberg Forest-king Charaxes	Rare (Restricted range)	No	Highly unlikely

<i>Colotis celimene amina</i> Tip	Lilac	Rare (Low density)	Yes	Yes
<i>Dingana jerinae</i> Widow	(Kransberg)	Rare (Restricted range)	No	Highly unlikely
<i>Dira swanepoeli isolata*</i> Widow	Blouberg	Rare (Restricted range)	No	Highly unlikely
<i>Metisella meninx</i> Sylph	Marsh	Rare (Habitat specialist)	No	Highly unlikely
<i>Orachrysops regalis</i>	Royal Blue	Rare (Habitat specialist)	No	Highly unlikely
<i>Papilio ophidicephalus entabeni</i> Entabeni Emperor Swallowtail		Rare (Habitat specialist)	No	Highly unlikely
<i>Papilio transvaalensis</i> Emperor Swallowtail	<i>ophidicephalus</i> Woodbush	Rare (Habitat specialist)	No	Highly unlikely

Table 4.21 Data deficient butterfly species of the Limpopo and Mpumalanga Provinces combined. Source: Mecenero *et al.* (In press.).

Species	Red Listed Status	Recorded at site during survey	Residential status at the site: Confirmed, Highly likely, Likely, Medium possibility, Unlikely, Highly unlikely
<i>Coenyropsis natalii poetulodes</i>	Data Deficient	No	Highly unlikely
<i>Pseudonympha swanepoeli</i> *	Data Deficient	No	Highly unlikely

* See discussion about taxonomic impediments surrounding *Pseudonympha swanepoeli* in the text. If the Wolkberg population is proved to be a unique taxon it is already Critically Endangered such as assessed by Henning, Terblanche & Ball (2009).

7.2 CICADAS OF PARTICULAR CONSERVATION PRIORITY

Table 4.22 Data deficient but possibly highly localised cicada species of the Limpopo Province which is of conservation priority.

Species	Red Listed Status	Recorded at site during survey	Residential status at the site: Confirmed, Highly likely, Likely, Medium possibility, Unlikely, Highly unlikely
<i>Pycna sylvia</i> Giant Cicada	Data Deficient but possibly has restricted distribution in Sekhukhuneland.	No	Unlikely

7.3 BEETLES OF PARTICULAR CONSERVATION PRIORITY

Table 4.23 Fruit chafer species (Coleoptera: Scarabaeidae: Cetoninae) of the Limpopo Province which are of known high conservation priority.

Species	Red Listed Status	Recorded at site during survey	Residential status at the site: Confirmed, Highly likely, Likely, Medium possibility, Unlikely, Highly unlikely
<i>Ichnestoma stobbiai</i>	Taxonomic status of some populations uncertain	No	Highly unlikely
<i>Tmesorhina viridicyanea</i>	Uncertain/ rare	No	Unlikely
<i>Trichocephala brincki</i>	Uncertain	No	Highly unlikely

7.4 SCORPIONS OF PARTICULAR CONSERVATION IMPORTANCE

Table 4.24 Highly endemic and/ or habitat specific rock scorpion species of Limpopo and Mpumalanga Provinces combined. Main source: Prendini (2001)

Species	Distribution	Conservation Status	Residential status at the site: Confirmed, Highly likely, Likely, Medium possibility, Unlikely, Highly unlikely
<i>Hadogenes bicolor</i>	Endemic to South Africa (Mpumalanga and Limpopo)	Uncertain. Habitat specialist.	Unlikely
<i>Hadogenes longimanus</i> "Steelpoort specimens"	Specimens from Steelpoort have some different characteristics and may be a different taxon pending further investigations (See Prendini, 2001).	Data deficient. Habitat specialist	Unlikely at proposed footprints and study area
<i>Hadogenes newlandsi</i>	Endemic to South Africa (Limpopo Province).	Uncertain: Habitat specialist	Unlikely

<i>Hadogenes troglodytes</i>	Not threatened but regarded as sensitive species with high habitat specificity.	Not threatened (pers. obs.) but clearly lithophilous (rocky habitat specialist)	Likely
-------------------------------------	---	---	--------

7.5 BABOON SPIDERS OF PARTICULAR CONSERVATION IMPORTANCE

Table 4.25 Baboon spiders (Arachnida: Theraphosidae) species that are of known high conservation priority in the Limpopo Province. See De Wet & Schoeman (1991), Dippenaar-Schoeman (2002) and Foord, Dippenaar-Schoeman & van der Merwe (2002) for more information on the present known distributions of species.

Species	Red List Status	Recorded at site during survey	Residential status at the site: Confirmed, Highly likely, Likely, Medium possibility, Unlikely, Highly unlikely
<i>Ceratogyrus bechuanicus</i>	Not threatened: All <i>Ceratogyrus</i> species are on TOPS list.	No	Likely (but not necessarily at each footprint)
<i>Ceratogyrus brachycephalus</i>	Not threatened/ Uncertain: All <i>Ceratogyrus</i> species are on TOPS list.	No	Possibly
<i>Pterinochilus</i> species (<i>Pterinochilus junodi</i> , <i>P. pluridentatis</i>)	Not threatened: All <i>Pterinochilus</i> species are on TOPS list.	No	Likely

8 DISCUSSION

8.1 HABITAT AND VEGETATION CHARACTERISTICS

An outline of the overall habitat and vegetation characteristics is given in Table 4.1.

8.2 PLANT SPECIES

Assessment of threatened or other high conservation priority plant species

Threatened (critically endangered, endangered and vulnerable), near threatened, critically rare, rare and data deficient plant species in the Limpopo Province are listed in Tables 4.2 to 4.9 (extracted from Raimondo *et al.* 2009 and updates that followed).

Protected plant species

Indigenous tree species which are not threatened but which are protected, *Adansonia digitata* (Baobab), *Boscia albitrunca* (Shepherd's Tree), *Combretum imberbe* (Leadwood), *Philenopetra violaceae* (Apple-leaf) and *Sclerocarya birrea* (Marula Tree), have been found at the study area. Protected tree species under the National Forests Act No. 84 of 1998 are listed in Table 4.9. In terms of a part of section 15(1) of Act No. 84 of 1998, no person may cut, disturb, damage or destroy any protected tree or possess, collect, remove, transport, export, purchase, sell, donate or in any other manner acquire or dispose of any protected tree, except under a license granted by the Minister.

8.3 VERTEBRATES

8.3.1 Mammals

Assessment of threatened or other high conservation priority mammal species

Tables 4.10, 4.11 and 4.12 list the possible presence or absence of threatened, near threatened and data deficient mammal species respectively. Literature sources used are Skinner & Chimimba (2005) and Friedman & Daly (2004). With mammal species which normally needs a large range their residential status does not always imply that they are exclusively dependent on the site or use the site as important shelter or for reproduction.

Because the study area is west of the northern parts of Kruger National Park, only separated from Zimbabwe by the Limpopo River that allows for thoroughthrough of some animals and also consists of a large area with natural vegetation, large animals such as African elephant (*Loxodonta africana*) and large carnivores such a Spotted Hyaena (*Crocuta crocuta*) travel through the study area or could also be considered as resident. Signs of large animals such as Elephant has been seen at the site as well as tracks of large carnivores such as Spotted Hyaena. IUCN mammal species that are listed as threatened according to the IUCN that occur at the site are African Elephant (*Loxodonta africana*), Vulnerable and Leopard (*Panthera pardus*) Vulnerable. Lions could possibly also present at the study area from time to time (no tracks were found during the recent surveys).

8.3.2 Birds

Assessment of threatened or other high conservation priority bird species

Table 4.13 lists the possible presence or absence of threatened bird species at the site and Table 4.14 lists the possible occurrence or not of near threatened birds. With bird species which often have a large distributional range, their presence does not imply that they are particularly dependent on a site as breeding location. Literature sources used include Barnes (2000), Hockey, Dean & Ryan, P.G. (2005) and Chittenden (2007). For the threatened (vulnerable, endangered, critically endangered) bird species or any other bird species of particular conservation priority (near threatened, data deficient) the site does not appear to form part of any habitat of particular importance.

The study area is located to the west of the northern parts of the Kruger National Park. Study area is also a large area with diverse indigenous vegetation, rocky ridges, riparian zones and active channels including the Limpopo River. Threatened vulture species such as *Gyps africanus* (White-backed Vulture) listed Nationally as Critically Endangered and *Necrosyrtes monachus* (Hooded Vulture) listed as Critically Endangered could be regular visitors/ residents. Of particular interest for the riparian zones along the Limpopo River is the likely presence of *Scotopelia peli* (Pel's Fishing Owl) which is, in South Africa, dependent on subtropical riparian habitats at the extreme northeastern and eastern parts of the country. The Vulnerable *Terathopius ecaudatus* (Bateleur) has been seen at the study area during April 2018 survey. Near Threatened bird species such as *Alcedo semitorquata* (Half-collared Kingfisher) along riparian zones, *Cirithagra citrinipectus* (Lemon-breasted Canary) and *Leptoptilos crumeniferus* (Marabou Stork) would be likely residents at the study area, the latter two species also dependent on conservation areas in extreme northeastern parts of South Africa.

8.3.3 Reptiles

Assessment of threatened or other high conservation priority reptile species

Table 4.15 lists the possible presence or absence of threatened reptile species and near threatened reptile species at the site. Main source of compiling the list in Table 4.15 is Bates, Branch, Bauer, Burger, Marais, Alexander & De Villiers (2014), that is the Atlas and Red List of the Reptiles of South Africa, Lesotho and Swaziland (South African National Biodiversity Institute, Pretoria). A diversity of reptile species are likely to occur at the study area because there are numerous rupicolous habitats. *Crocodylus niloticus* (Nile Crocodile) is currently listed by the IUCN as Least Concern and not is not regarded as Vulnerable anymore. *Homopholis mulleri* (Muller's Velvet Gecko) is only known from Mopane veld around Soutpansberg. Possible occurrence at Limpopo Valley should be kept in mind during surveys in the study area.

8.3.4 Amphibians

Assessment of threatened or other high conservation priority reptile species

The only frog species from the Limpopo Province which is listed as a threatened species, in this case vulnerable, according to Minter, Burger, Harrison, Braack, Bishop and Kloepfer (2004) as well as Du Preez and Carruthers (2009) is *Breviceps sylvestris*, the northern forest rain frog. Two subspecies of *Breviceps sylvestris* are recognised and both occur in afro-montane forest or northeastern mountain grassland (Du Preez & Carruthers, 2009). Table 4.16 lists *Pyxicephalus adspersus* (Giant Bullfrog) as near threatened (Minter, Burger, Harrison, Braack, Bishop & Kloepfer, 2004; Du Preez & Carruthers, 2009). No threatened frog species or any other frog species of particular conservation priority appear to be present at the site.

8.4 INVERTEBRATES

8.4.1 Butterflies

Assessment of threatened butterfly species

In terms of conservation status of invertebrates in South Africa butterflies represents the most well studied group and many of the present extinction risk assessments are relatively well refined. Three “red data assessments” have already been conducted on South African butterflies notably that of Henning & Henning (1989), Henning, Terblanche & Ball (2009) and the most recent assessment Mecenero *et al.* (2013), the latter also comprising a butterfly atlas. Studies about the vegetation and habitat of threatened butterfly species in South Africa showed that ecosystems with a unique combination of features are selected by these often localised threatened butterfly species (Deutschländer and Bredenkamp 1999; Edge 2002, 2005; Terblanche, Morgenthal & Cilliers 2003; Lubke, Hoare, Victor & Ketelaar 2003). Threatened butterfly species in South Africa can then be regarded as bio-indicators of rare ecosystems.

Because the habitat specificity of invertebrates are often less well known and because of recent updates of information, the expected presence or absence of butterfly species of high conservation priority that are listed in Tables 4.17 – 4.21 is outlined beneath.

Threatened: Critically Endangered (global)

***Alaena margaritacea* (Wolkberg Zulu)**

The proposed global red list status for *Alaena margaritacea* according to the most recent IUCN criteria and categories is Critically Endangered (Mecenero *et al.* 2013). *Alaena margaritacea* is only known from one restricted area in the vicinity of Haenertsburg in the Wolkberg. The secluded colony is found on steep grassy slopes in the Wolkberg with where lichen covered rocks are a crucial part of the habitat (Henning, Terblanche & Ball 2009). Recently a second locality of this butterfly species has been found, also at high altitude at the Wolkberg mountains (A. Coetzer pers. comm.). Presence of this species at site is highly unlikely owing to lack of habitat requirements.

***Anthene crawshayi juanitae* (Juanita’s Ciliated Blue)**

The proposed global red list status for *Anthene crawshayi juanitae* according to the most recent IUCN criteria and categories is Critically Endangered (Mecenero *et al.*, 2013). *Anthene juanitae* has only recently been rediscovered after for two decades being known from only six specimens from riverine vegetation on the banks of the Olifants River at Manoutsa Park where the butterfly was discovered in 1990 (Henning, Terblanche & Ball 2009). Recently in 2011 and 2012 the butterfly was rediscovered at Manoutsa Park and also at a new locality at the Lekgalameetse Nature Reserve. Presence of this species at site is highly unlikely owing to lack of habitat requirements.

***Erikssonina edgei* (Waterberg Copper)**

Erikssonina edgei was previously referred to as the Waterberg population of *Erikssonina acraeina* before it was described as a new species from South Africa by Gardiner & Terblanche (2010). The proposed global red list status for *Erikssonina edgei* (hitherto known as the South African population of *Erikssonina acraeina*) according to the most recent IUCN criteria and categories is Critically Endangered (Possibly extinct) (Mecenero *et al.*, 2013). *Erikssonina edgei* is only known from one restricted area in the vicinity of Rankin’s Pass on deep sands

of the Waterberg (Gardiner & Terblanche, 2010). Presence of this species at site is highly unlikely owing to lack of habitat requirements.

Threatened: Critically Endangered (regionally: South Africa)

Acada biseriata (Axehead Orange)

Acada biseriata is listed as regionally Critically Endangered in South Africa (Mecenero *et al.*, 2013). In South Africa *Acada biseriata* is only recorded from Gundani northeast of Thohoyandou in the Limpopo Province (Mecenero *et al.* In press.). *Acada biseriata* only occurs at the VhaVenda Miombo vegetation type (Mucina & Rutherford 2006) in South Africa. Presence of this species at site is possible if *Brachystegia* trees would be present.

Charaxes guderiana guderiana (Blue-spangled Charaxes)

Charaxes guderiana guderiana is listed as regionally Critically Endangered in South Africa (Mecenero *et al.*, 2013). Only one population of this butterfly is known in South Africa in the Soutpansberg near Thohoyandou which is removed from the nearest main population in Zimbabwe by more than 500 km (Mecenero *et al.*, 2013). *Charaxes guderiana guderiana* only occurs at the VhaVenda Miombo vegetation type (Mucina & Rutherford 2006) in South Africa. Presence of this species at site is possible if *Brachystegia* trees would be present.

Threatened: Endangered (global)

Aloeides stevensoni (Stevenson's Copper)

The proposed global red list status for *Aloeides stevensoni* according to the most recent IUCN criteria and categories is Endangered (Mecenero *et al.*, 2013). *Aloeides stevensoni* colonies are found on south facing, high-altitude grassy slopes of the Wolkberg (Henning, Terblanche & Ball 2009). *Aloeides stevensoni* is endemic to the Limpopo Province near Serala and Haenertsburg and up to date only found in the Woodbush Granite Grassland vegetation type (Mecenero *et al.*, 2013, Mucina & Rutherford 2006). Presence of this species at site is highly unlikely owing to lack of habitat requirements.

Dingana clara (Wolkberg Widow)

The proposed global red list status for *Dingana clara* according to the most recent IUCN criteria and categories is Endangered (Mecenero *et al.*, 2013). Historically *Dingana clara* has been listed as Vulnerable by Henning, Terblanche & Ball (2009) so that the most recent assessment reflects an increase in the extinction risk. *Dingana clara* is endemic to South Africa and confined to the Wolkberg at Lekgalameetse Nature Reserve near Tzaneen in the south to just south of Haenertsburg in the north (Mecenero *et al.*, 2013). Adults are found on steep, rock-strewn, grassy slopes as high elevations among proteas (Henning, Ball & Terblanche, 2009). Presence of this species at site is highly unlikely owing to lack of habitat requirements.

Lepidochrysops lotana (Lotana Blue)

The proposed global red list status for *Lepidochrysops lotana* according to the most recent IUCN criteria and categories is Endangered (Mecenero *et al.*, 2013). The type locality where the butterfly was first discovered is on the farm Rietvlei 30km south of Polokwane. Another locality is known on the Wolkberg east of Polokwane

and very recently the butterfly was found in the Legalemeetse Nature Reserve (Mecenero *et al.*, 2013). The butterfly is present where the larval host plant *Ocimum obovatum* occurs on grassy slopes (Henning, Terblanche & Ball, 2009). Note that the distribution of the butterfly is much more restricted than the distribution of the host plant. Presence of this species at site is highly unlikely owing to lack of habitat requirements.

Telchinia induna salmontana (Soutpansberg Acraea)

The proposed global red list status for *Telchinia induna salmontana* according to the most recent IUCN criteria and categories is Endangered (Mecenero *et al.*, 2013). Historically *Telchinia induna salmontana* has been listed as Vulnerable by Henning, Terblanche & Ball (2009) so that the most recent assessment reflects an increase in the extinction risk. *Telchinia induna salmontana* is found in Soutpansberg Summit Sourveld (Mucina & Rutherford 2006) on the higher peaks in the Soutpansberg Mountains. Adults fly along exposed high rocky ridges where the food plant of the larva, *Aeschynomene nodulosa*, grows (Henning, Ball & Terblanche 2009). Presence of this species at site is highly unlikely owing to lack of habitat requirements.

Extremely Rare or Rare species (National categories)

Anthene minima minima (Little Cilated Blue/ Little Hairtail)

Anthene minima minima is listed as Rare (Low density) by Mecenero *et al.* (2013). *Anthene minima minima* is found in a few selected spots in South Africa in KwaZulu-Natal, Limpopo, and Mpumalanga and also Botswana and Swaziland. *Anthene minima minima* has been recorded from relatively dry savanna but its habitat requirements are still poorly understood. It is possible that this taxon is present at the study area.

Charaxes druceanus solitarius (Blouberg Silver-barred Charaxes)

Charaxes druceanus solitarius is listed as Rare (Restricted Range) by Mecenero *et al.* (2013). *Charaxes druceanus solitarius* is endemic to South Africa and limited to the Blouberg inselberg near Poleni in the Limpopo Province (Mecenero *et al.* In press.). *Charaxes druceanus solitarius* has only been found at the Northern Mistbelt Forest vegetation type (Mucina & Rutherford 2006). Presence of this species as resident at site is highly unlikely owing to lack of habitat requirements.

Charaxes xiphares stauderi (Blouberg Forest-king Charaxes)

Charaxes xiphares stauderi is listed as Rare (Restricted Range) by Mecenero *et al.* (2013). *Charaxes xiphares stauderi* is endemic to South Africa and limited to the Blouberg inselberg near Poleni in the Limpopo Province (Mecenero *et al.*, 2013). *Charaxes xiphares stauderi* has only been found at the Northern Mistbelt Forest vegetation type (Mucina & Rutherford 2006). Presence of this species as resident at site is highly unlikely owing to lack of habitat requirements.

Colotis celimene amina (Lilac tip)

Colotis celimene amina is listed as Rare (Low density) by Mecenero *et al.* (2013). In South Africa *Colotis celimene amina* is present from Pietermaritzburg in the south and northwards into parts of Kwa-Zulu Natal, Gauteng, Limpopo, Mpumalanga and the North West Provinces (Mecenero *et al.* In press.). Reasons for its rarity are poorly understood apart from that the butterfly species occurs at some places where *Boscia*

albitrunca is present (but clearly not at all places where *Boscia albitrunca* is present) (Terblanche, In prep.). *Colotis celimene amina* has been observed at the study area during April 2018 and its presence is confirmed.

Dingana jerinae (Kransberg Widow)

Dingana jerinae is listed as Rare (Range Restricted) by Mecenero *et al.* (2013). Historically the conservation status of *Dingana jerinae* was proposed to be Vulnerable (Henning, Terblanche & Ball 2009), however during the most recent assessment it was concluded that the habitat is currently under no immediate threat. *Dingana jerinae* is only known from the Kransberg part of the Waterberg where one of its localities extends into the Marekele National Park. Adults fly on steep slopes, below high cliffs, among fallen rocks as well as in rocky terrain on the summits (Henning, Terblanche & Ball 2009). *Dingana jerinae* is endemic to South Africa and limited to the Waterberg near Thabazimbi in the Limpopo Province (Mecenero *et al.*, 2013). Presence of this species as resident at site is highly unlikely owing to lack of habitat requirements.

Dira swanepoeli isolata (Blouberg Widow)

Dira swanepoeli isolata is listed as Rare (Restricted Range) by Mecenero *et al.* (2013). *Dira swanepoeli isolata* is endemic to South Africa and is only found at the southern slopes of the Blouberg in the Limpopo Province (Mecenero *et al.*, 2013). *Dira swanepoeli isolata* has only been found at montane grassy slopes of its single known locality (Mecenero *et al.*, 2013). Presence of this species as resident at site is highly unlikely owing to lack of habitat requirements.

Metisella meninx (Marsh Sylph)

Henning and Henning (1989) in the first South African Red Data Book of butterflies listed *Metisella meninx* as threatened under the former IUCN category Indeterminate. Even earlier in the 20th century Swanepoel (1953) raised concern about vanishing wetlands leading to habitat loss and loss of populations of *Metisella meninx*. According to the second South African Red Data Book of butterflies (Henning, Terblanche & Ball, 2009) the proposed global red list status of *Metisella meninx* has been Vulnerable. During a recent large scale atlas project the *Conservation Assessment of Butterflies of South Africa, Lesotho and Swaziland: Red List and Atlas* (Mecenero *et al.*, In press.) it was found that more *Metisella meninx* populations are present than thought before. Based on this valid new information, the conservation status of *Metisella meninx* has been changed to least concern Rare (Habitat specialist) (Mecenero *et al.*, 2103). Though *Metisella meninx* is more widespread and less threatened than perceived before, it should be regarded as a localised rare habitat specialist of conservation priority, which is dependent on wetlands with suitable patches of grass at wetlands (Terblanche *In prep.*). Another important factor to keep in mind for the conservation of *Metisella meninx* is that based on very recent discoveries of new taxa in the group the present *Metisella meninx* is species complex consisting of at least three taxa (Terblanche *In prep.*, Terblanche & Henning *In prep.*). The ideal habitat of *Metisella meninx* is treeless marshy areas where *Leersia hexandra* (rice grass) is abundant (Terblanche *In prep.*). The larval host plant of *Metisella meninx* is wild rice grass, *Leersia hexandra* (G.A. Henning & Roos, 2001). Presence of this species as resident at site is highly unlikely owing to lack of habitat requirements.

Orachrysops regalis (Royal Blue)

Orachrysops regalis is listed as Rare (Habitat specialist) (Mecenero *et al.*, 2013). *Orachrysops regalis* is endemic to the Limpopo Province and found from the Strydpoortberg mountain range near Haenertsburg in the south to Soutpansberg in the north (Mecenero *et al.*, 2013). Presence of this species as resident at site is highly unlikely owing to lack of habitat requirements.

Papilio ophidicephalus entabeni (Entabeni Emperor Swallowtail)

Papilio ophidicephalus entabeni is listed as Rare (Habitat specialist) by Mecenero *et al.* (2013). *Papilio ophidicephalus entabeni* is endemic to the Limpopo Province and limited to the forests of the Blouberg and Soutpansberg. *Papilio ophidicephalus entabeni* has only been found at the Northern Mistbelt Forest vegetation type (Mucina & Rutherford 2006). Presence of this species as resident at site is highly unlikely owing to lack of habitat requirements.

Papilio ophidicephalus transvaalensis (Woodbush Emperor Swallowtail)

Papilio ophidicephalus transvaalensis is listed as Rare (Habitat specialist) by Mecenero *et al.* (In press.). *Papilio ophidicephalus transvaalensis* is endemic to the Limpopo Province and limited to the forests from near Polokwane in the west to Ofcolaco in the east (Mecenero *et al.*, 2013). *Papilio ophidicephalus transvaalensis* has only been found at the Northern Mistbelt Forest vegetation type (Mucina & Rutherford 2006). Presence of this species as resident at site is highly unlikely owing to lack of habitat requirements and distributional barriers.

Data deficient

Coenyropsis natalii poetulodes

Coenyropsis natalii poetulodes is listed as Data Deficient by Mecenero *et al.* (2013). *Coenyropsis natalii poetulodes* is endemic to South Africa and limited to the western Wolkberg near Chuniespoort (Mecenero *et al.*, 2013). *Coenyropsis natalii poetulodes* has only been found at rank grassy slopes at an altitude of 1000 m to 1500 m in mixed savanna/ grassland of the western parts of the Wolkberg (Mecenero *et al.*, 2013). Presence of this species as resident at site is highly unlikely owing to lack of habitat requirements.

Pseudonympha swanepoeli

Pseudonympha swanepoeli is listed as Data Deficient by Mecenero *et al.* (2013). The population at the type locality near Houtbosdorp (“Woodbush Village”) where the butterfly was originally found may be extinct. If this population at high elevation in the Wolkberg is unique then the red list status would be Critically Endangered (Henning, Terblanche & Ball 2009). *Pseudonympha swanepoeli* is only known from one restricted marshy area near Houtbosdorp in the Wolkberg mountains. Previously known localities of the butterfly in the vicinity of Houtbosdorp have been destroyed (Henning, Terblanche & Ball 2009). Taxonomic uncertainty is a real problem for conservation in this case because all the *Pseudonympha swanepoeli* populations known today are clearly part of more than one taxon. Some of these taxa which are obscured by the present taxonomic predicament may be under a very high extinction risk. All *Pseudonympha swanepoeli* populations should be regarded as sensitive as a pre-cautionary principle. Presence of this species as resident at site is highly unlikely owing to lack of habitat requirements.

8.4.2 Cicadas

Assessment of high conservation priority cicada species

In general much progress has been made recently in South Africa to improve the taxonomy and ecological knowledge of cicadas in South Africa. However, in terms of conservation status many species and subspecies are still poorly known and extinction risk assessments are limited. Here only one species which are better known to the extent that some indication of their conservation priority could be listed (Table 4.22).

***Pycna (Platypleura) sylvia* (Giant cicada)**

Pycna sylvia, the largest endemic cicada species in South Africa, was recorded from the Mpumalanga Province in South Africa at Sekhukhuneland. *Pycna sylvia*, hitherto thought to be extinct, was rediscovered in 2001 after 95 years in the Groot Dwars River Valley, Mpumalanga during a faunal survey for Anglo Platinum (Malherbe, Burger & Stephen, 2004). The only known host plant of *Pycna sylvia* is the tree *Vitex obovata* subsp. *wilmsii*. Apparently *Pycna sylvia* is mostly found at or in the vicinity of dense stands of the host plant (Malherbe, Burger & Stephen, 2004). Based on present information it is unlikely that *Pycna sylvia* (confined to Sekhukhuneland) is to be found at the site.

8.4.3 Fruit chafer beetles

Assessment of threatened or other high conservation priority fruit chafer beetle species

Table 4.23 lists the fruit chafer beetle species (Coleoptera: Scarabaeidae: Cetoniinae) that are of known high conservation priority in the Limpopo Province. Some of the rare Cetoniinae is rather data deficient and more information is necessary for the extinction risk assessments. No fruit chafer beetles of particular conservation priority are expected to be resident at the site.

8.4.4 Scorpions

Table 4.24 lists rock scorpion species (Scorpiones: Ischnuridae) that are of known high conservation priority in the Limpopo and Mpumalanga Provinces combined. Rock scorpions could be present at the site owing to suitable rocky habitat at rocky ridges in the study area.

8.4.5 Baboon spiders

In the South African context baboon spider species (Table 4.25) belonging to the genus *Ceratogyrus* has a particular presence in the Limpopo Province. *Ceratogyrus* (“horned baboon spiders”) is also of importance to the pet trade and appears on the TOPS list with other baboon spider genera *Harpactira* and *Pterinochilus*.

Ceratogyrus bechuanicus and *Ceratogyrus brachycephalus* appear to be only found to occur in small colonies of a few burrows scattered over wide area at each locality (De Wet & Dippenaar-Schoeman 1991). This is in contrast to other baboon spider species such as *Pterinochilus* which is found in much larger colonies. Distribution of *Ceratogyrus bechuanicus* ranges from Botswana, Central Namibia, Zimbabwe (widespread), Mozambique to the northern parts of South Africa (Limpopo Province) (Dippenaar-Schoeman 2002). *Ceratogyrus bechuanicus* has also been recorded from the western Soutpansberg (Foord, Dippenaar-Schoeman & Van der Merwe 2002). In contrast to the more widespread species mentioned above, *Ceratogyrus brachycephalus* has a much more restricted distribution, being confined to localities in central Botswana, southern Zimbabwe and the extreme northern Limpopo (De Wet & Dippenaar-Schoeman 1991; Dippenaar-Schoeman 2002).

Burrows of *Ceratogyrus* can be found in different types of soils, ranging from sandy to very hard, compacted soils in areas sparsely covered with grass (De Wet & Dippenaar-Schoeman 1991). Most burrows are J-shaped (De Wet & Dippenaar-Schoeman 1991). In arid regions the burrow of baboon spiders (Theraphosidae) are usually deep to provide protection from high temperatures (Smith 1990). Adult males are usually not found in burrows and actively seeking females, freely wandering at night, and may also be shorter-lived than the females (De Wet & Dippenaar-Schoeman 1991; De Wet & Schoonbee 1991). Pitfall traps are found to be unsuccessful, as the males of *Ceratogyrus* are not easily captured in this manner (De Wet & Schoonbee 1991).

Ceratogyrus bechuanicus is well-represented in the Kruger National Park, Musina, D'nyala and Atherstone Nature Reserves as well as in the Klaserie and Sabi Sand private nature reserves (De Wet & Schoonbee 1991). *Ceratogyrus brachycephala* has only been found in the Messina Provincial Nature Reserve whilst its historic distribution includes the Langjan Nature Reserve (De Wet & Schoonbee 1991). *Ceratogyrus brachycephala* with its much smaller distribution has a higher conservation priority than *Ceratogyrus bechuanicus*. Since *Ceratogyrus* species are found in areas sparsely covered with grass, a balanced utilisation of habitat must be prescribed, and for management purposes the complete ecosystem must thus be taken into account (De Wet & Schoonbee 1991). Though De Wet & Schoonbee (1991) recommended determination of veld condition boundaries of habitats where colonies of *Ceratogyrus* occur, no detailed habitat study could be tracked in an extensive literature survey for this study. *Ceratogyrus bechuanicus* could be present at the study area.

Presence of notable populations of those baboon spider species of particular conservation concern are possible at the proposed footprint.

9 IMPACT ASSESSMENT AND MITIGATION MEASURES

The primary cause of loss of biological diversity is habitat degradation and loss (IUCN, 2004; Primack, 2006). Habitats of threatened plants are in danger most often due to urban developments such as is the case for the Gauteng Province (Pfab & Victor, 2002). Habitat conservation is the key to the conservation of invertebrates such as threatened butterflies (Deutschländer and Bredenkamp 1999; Edge 2002, 2005; Terblanche, Morgenthal & Cilliers 2003; Lubke, Hoare, Victor & Ketelaar 2003; Edge, Cilliers & Terblanche, 2008). Though human impacts in few cases have improved the habitat for mammalian species such as greater cane rats, that prosper in sugar cane and maize fields (Apps 2000), for many mammalian habitat specialist species, human impacts has lead to habitat loss. Some mammal species, especially many of the larger species, could adapt to a wide range of habitat types, but then need a large range. Some animals and plants are rare and occupy only one or a few specialised habitats (Primack 2006). Habitat conservation, either as large available land or as specialised habitats is therefore key to the conservation of many threatened plant species and animal species or any other species of high conservation priority (i.e. rare, near threatened species). In addition corridors and linkages may play a significant role in conservation of fauna.

Corridors are important to link ecosystems of high conservation priority. Such corridors or linkages are there to improve the chances of survival of otherwise isolated populations (Samways, 2005). How wide should corridors be? The answer to this question depends on the conservation goal and the focal species (Samways, 2005). Corridors for mammalian species are especially important for migratory species (Mwalyosi, 1991, Pullin 2002). For an African butterfly assemblage this is about 250m when the corridor is for movement as well as being a habitat source (Pryke and Samways 2003). Hill (1995) found a figure of 200m for dung beetles in tropical Australian forest. In the agricultural context, and at least for some common insects, even small corridors can play a valuable role (Samways, 2005). Much more research remains to be done to find refined answers to the width of grassland corridors in South Africa. The width of corridors will also depend on the type of development, for instance the effects of the shade of multiple story buildings will be quite different from that of small houses. Corridors have a number of advantages related to dispersal and gene flow by avoiding isolation of ecological patches. However, corridors could also have potential drawbacks, for example creating gene flow where none has occurred naturally in the past and also as reservoirs for pathogens or introduced species (Pullin, 2002). Perhault and Lomolino (2000) studied corridors and mammal community structure in an old-growth forest landscape in the United States of America and their data suggest that each corridor should be valued individually. A lot of research remains to be conducted to have a better idea of the value of corridors, but in general corridors would be of considerable value. It appears that a network of wetland corridors and rocky ridges is highly likely to be of considerable benefit in environmental management and planning. Though proper management plans for habitats are not in place, setting aside special ecosystems is in line with the recent Biodiversity Act (2004) of the Republic of South Africa.

To summarise: In practice, as far as any developments are concerned, the key would be to prioritise and plan according to sensitive species and special ecosystems.

The following potential impacts and mitigation measures with a view to the proposed developments apply:

9.1 ANTICIPATED RISKS OR IMPACTS TO THE LOSS OF HABITAT

The following impacts on the loss of habitat apply at the site.

Potential impacts on the available habitat will be of local extent, of permanent duration of medium intensity and high probability. The significance of loss of habitat is expected to be high without mitigation and moderate with mitigation.

Impact summary matrix:

Phase	Significance of Impact				
	None	Low	Moderate	High	With mitigation
Operational			X		Low

Mitigation measures:

- Exotic and invasive plant species should not be allowed to establish, if the development is approved.
- If the development is approved, every effort should be made to confine the footprint to the narrow strip allocated for development and have the least possible edge effects on the ecosystem.
- Wetlands and riparian zones with their buffer zones of 50 m should be upheld as a no-go zone for any prospecting and fenced off with appropriate material during the prospecting phase if nearby.

9.2 ANTICIPATED RISKS OR IMPACTS TO THE LOSS OF SENSITIVE SPECIES

Sensitive species are regarded here as those listed in section 5 and constitutes the flora and fauna that are threatened or of other particular high conservation importance. The eastern section of the study area is poorly explored and could be home to threatened or localised species. Indigenous tree species which are not threatened but which are protected, *Adansonia digitata* (Baobab), *Boscia albitrunca* (Shepherd's Tree), *Combretum imberbe* (Leadwood), *Philenopetra violaceae* (Apple-leaf) and *Sclerocarya birrea* (Marula Tree), have been found at the study area. Protected tree species under the National Forests Act No. 84 of 1998 are listed in Table 4.9. In terms of a part of section 15(1) of Act No. 84 of 1998, no person may cut, disturb, damage or destroy any protected tree or possess, collect, remove, transport, export, purchase, sell, donate or in any other manner acquire or dispose of any protected tree, except under a license granted by the Minister.

Mitigation measures for threatened, near threatened, declining or rare animal and plant species:

- Footprints where developments are approved should be kept to a minimum so that larger threatened mammals could roam undisturbed in the study area and around areas where developments are approved. Necessary caution should be adhered to at all times because dangerous large animals are present in the study area and unnecessary conflict between human activities and these dangerous animals could lead to unnecessary casualties of individuals of these threatened species: These pre-cautions apply to the large animals such

as African elephant (*Loxodonta africana*) and large carnivores such as Leopard (*Panthera pardus*) Vulnerable and Lion (*Panthera leo*).

- Each prospecting site should be inspected for nests of birds in trees in particular any large nests of raptors or vultures of which a number are threatened. In particular should nests of threatened vulture species such as *Gyps africanus* (White-backed Vulture) listed Nationally as Critically Endangered and *Necrosyrtes monachus* (Hooded Vulture) listed as Critically Endangered could be regular visitors/ residents be avoided. Threatened raptor species include the Vulnerable *Terathopius ecaudatus* (Bateleur) has been seen at the study area during April 2018 survey. If at all possible and practical, in the case of any removal of birds nests, this should be done by a qualified ornithologist/ bird specialist.
- If the development is approved, each prospecting site should be inspected for the presence of baboon spiders in particular “horned-baboon spiders” of the genus *Ceratogyrus* which has a particular presence in the Limpopo Province. *Ceratogyrus* (“horned baboon spiders”) is also of importance to the pet trade and appears on the TOPS list with other baboon spider genera *Harpactira* and *Pterinochilus*. If there are clearly burrows and resident baboon spiders in an area where prospecting will take place, these should be removed and translocated by a specialist.
- The eastern section of the site should be viewed as a no-go for developments because of a high likelihood of unique habitats, including wetlands and possible forests, that could host smaller threatened plant and animal species, also wetlands that could be suitable habitat for rare wetland animal and plant species, or aquatic habitats which could contain rare localized fish species, such as Killifish (*Nothobranchius*).

Mitigation measures for protected tree species:

- A permit at the relevant authorities should be applied for in case of any damage or removal of individual trees of *Adansonia digitata* (Baobab), *Boscia albitrunca* (Shepherd’s Tree), *Combretum imberbe* (Leadwood), *Philenopetra violaceae* (Apple-leaf) and *Sclerocarya birrea* (Marula Tree), if the development is approved.
- If permits for removal or damage to protected tree species are gained it would be necessary at each prospecting site to consider avoidance of damage to protected tree species first, avoidance of large individuals of any of the protected tree species at any prospecting site is strongly recommended.

9.3 ANTICIPATED RISKS OR IMPACTS TO HABITAT CONNECTIVITY AND OPEN SPACE

Potential impacts on connectivity will be of local extent, of permanent duration of medium intensity and low probability. The significance of the impacts on loss of connectivity is expected to be moderate without mitigation and low with mitigation.

Impact summary matrix: habitat connectivity

Phase	Significance of Impact				
	None	Low	Moderate	High	With mitigation
Construction			X		Low
Operational			X		Low

Mitigation measures:

- Exotic and invasive plant species should not be allowed to establish, if the development is approved, so that the quality and functionality of the conservation corridors are enhanced.
- Rubble or waste that could accompany the prospecting site, if the development is approved, should be removed during and after construction.
- If the development is approved, every effort should be made to confine the footprint to the narrow strip allocated for development and have the least possible edge effects on the ecosystem.
- If developments are approved, wetlands and riparian zones with their buffer zones of 50 m should be upheld as a no-go zone for any prospecting and fenced off with appropriate material during the prospecting phase if nearby.
- Rocky ridges form either as part of stepping-stone corridors or linked corridors, networks of particular conservation concern. Developments at rocky ridges should be avoided. If avoidance is not possible, footprints should be limited to a minimum in rocky ridges.

9.4 ANTICIPATED RISKS OR IMPACTS ASSOCIATED WITH CONSTRUCTION (PROSPECTING) ACTIVITIES

Overall construction activities associated with the development if approved will be of local extent, of medium duration, of low intensity and high probability. During the construction phase, the significance of the impacts associated with the construction phase is likely to be moderate without and low with mitigation.

Impact summary matrix:

Phase	Significance of Impact				
	None	Low	Moderate	High	With mitigation
Operational			X		Low

Mitigation measures:

- Contractors must ensure that no mammalian species are disturbed, trapped, hunted or killed during the construction phase.
- If the development is approved, every effort should be made to confine the footprint to the narrow strip allocated for the development and have the least possible edge effects on the surrounding area. the development is approved, measures should be taken to avoid any spills and infiltration of petroleum fuels or any chemical pollutants into the soil during construction phase.
- Wetlands and riparian zones with their buffer zones of 50 m should be upheld as a no-go zone for any prospecting and fenced of with appropriate material during the prospecting phase if nearby.

10 CONCLUSION

- Savanna vegetation in a pristine condition which contains a conspicuous diversity of indigenous plant species is present at most of the study area. Rocky ridges and sandy riverbeds provide a noticeable microhabitat diversity for a variety of plant species to exist. There are some areas that have been ecologically disturbed historically for example at and around the Old Gumbu Graphite Mine where diggings were made, homesteads were built and large pipeline for water from the Limpopo River had been built. Only ruins of buildings and pipelines are present today.
- The study area is located in the Savanna Biome which is for the greater part of the proposed footprints, i.e. Gumbu PT 2-6 and Gumbu PT8-21, represented by the Limpopo Ridge Bushveld (SVcb 27) with a single restricted area, Gumbu PT 7, at the Musina Mopane Bushveld (SVmp 1) and a single restricted area, Gumbu PT 1, at the Subtropical Alluvial Vegetation (AZa 7) vegetation types (Mucina & Rutherford 2006).
- Vegetation types listed above for the study area, i.e. Limpopo Ridge Bushveld (SVcb 27), Musina Mopane Bushveld (SVmp 1) and Subtropical Alluvial Vegetation (AZa 7) are not listed as threatened ecosystems according to the List of National Threatened Ecosystems (2011).
- The application area is a declared Nature Reserve according to NEMPAA of 2003 (Declared in 1983 and proclaimed in Governmental Gazette, 1992).
- The South African National Defence Force (SANDF) manages the area as conservation area and military training zone.
- Area applied for is located in Vhembe Biosphere Reserve which is also delineated as potential area for expansion of Kruger National Park (Vhembe District Bioregional Plan, 2017)
- Site is part of a Fish Sanctuary and Fish Support Area & associated sub-quaternary catchment in the Levuvhu and Letaba Water Management Area (WMA 2). Fish Sanctuaries are rivers that are essential for protecting Threatened or Near Threatened freshwater fish that are indigenous to South Africa (WMA 2) (Nel *et al.*, 2011a, 2011b).
- Ramsar site Makuleke Wetland is found outside and east of the study area. Note that watercourses and wetlands at the eastern section of the site feed into the adjacent Makuleke Wetlands (and another possible unmapped wetland), these should remain in pristine condition for the Makuleke Wetlands to function as a Ramsar site and important conservation area.
- A number of important conservation corridors exist in the study area. Rocky ridges are either as stepping-stone corridors or as directly linked corridors of conservation importance in the larger area. Streambeds and tributaries of the Limpopo River forms a vital conservation corridor network in the larger area. Limpopo river is a conservation corridor of major and fundamental importance.

- Key issues with regard to conservation of plant species of particular conservation concern in the study area:
 - Indigenous tree species which are not threatened but which are protected, *Adansonia digitata* (Baobab), *Boscia albitrunca* (Shepherd's Tree), *Combretum imberbe* (Leadwood), *Philenopetra violaceae* (Apple-leaf) and *Sclerocarya birrea* (Marula Tree), have been found at the study area. Protected tree species under the National Forests Act No. 84 of 1998 are listed in Table 4.9. In terms of a part of section 15(1) of Act No. 84 of 1998, no person may cut, disturb, damage or destroy any protected tree or possess, collect, remove, transport, export, purchase, sell, donate or in any other manner acquire or dispose of any protected tree, except under a license granted by the Minister. The presence or absence of these trees, in particular large individuals of *Adansonia digitata* (Baobab) should be verified at each proposed footprint.
- Key issues with regard the conservation of groups of animals at the study area:
 - Mammalian fauna. Because the study area is west of the northern parts of Kruger National Park, only separated from Zimbabwe by the Limpopo River that allows for moving through of some and also consists of a large area with natural vegetation, large animals such as African elephant (*Loxodonta africana*) and large carnivores such a Spotted Hyaena (*Crocuta crocuta*) travel through the study area or could also be considered as resident. Signs of large animals such as Elephant has been seen at the site as well as tracks of large carnivores such as Spotted Hyaena. IUCN mammal species that are listed as threatened according to the IUCN that occur at the site are African Elephant (*Loxodonta africana*), Vulnerable and Leopard (*Panthera pardus*) Vulnerable. Lions (*Panthera leo*), Vulnerable, could be present at the study area from time to time though no tracks were found at the Gumbu valley at the time of the survey. Elephant (*Loxodonta africana*) could also be more abundant at the site during the winter months of June – August.
 - Avian fauna. The study area is located to the west of the northern parts of the Kruger National Park. Study area is also a large area with diverse indigenous vegetation, rocky ridges, riparian zones and active channels including the Limpopo River. Threatened vulture species such as *Gyps africanus* (White-backed Vulture) listed Nationally as Critically Endangered and *Necrosyrtes monachus* (Hooded Vulture) listed as Critically Endangered could be regular visitors/ residents. Of particular interest for the riparian zones along the Limpopo River is the likely presence of *Scotopelia peli* (Pel's Fishing Owl) which is, in South Africa, dependent on subtropical riparian habitats at the extreme northeastern and eastern parts of the country. The Vulnerable *Terathopius ecaudatus* (Bateleur) has been seen at the study area during April 2018 survey. Near Threatened bird species such as *Alcedo semitorquata* (Half-collared Kingfisher) along riparian zones, *Cirithagra citrinipectus* (Lemon-breasted Canary) and

Leptoptilos crumeniferus (Marabou Stork) would be likely residents at the study area, the latter two species also dependent on conservation areas in extreme northeastern parts of South Africa.

- Reptiles. A diversity of reptile species is likely to occur at the study area because there are numerous rupicolous habitats. *Crocodylus niloticus* (Nile Crocodile) is currently listed by the IUCN as Least Concern and not is not regarded as Vulnerable anymore. *Homopholis mulleri* (Muller's Velvet Gecko) is only known from Mopane veld around Soutpansberg. Possible occurrence at Limpopo Valley should be kept in mind during surveys in the study area.
- Amphibians. No threatened frog species or any other frog species of particular conservation priority appear to be present at the site.
- Fish. The eastern section of the site contains poorly explored aquatic habitats which could harbour rare localized fish species, such as Killifish (*Nothobranchius*).
- Invertebrates. Most invertebrate groups are data deficient in terms of their conservation status, mainly because of a taxonomic impediment and a lack of data about their biogeography. Groups such as butterflies that are better known and could be assessed.
- Invertebrates: Butterflies. *Colotis celimene amina* is listed as Rare (Low density) by Mecenero *et al.* (2013) in South Africa and is found at the site. Reasons for its rarity are poorly understood apart from that the butterfly species occurs at some places where *Boscia albitrunca* is present (but clearly not at all places where *Boscia albitrunca* is present) (Terblanche, In prep.). *Colotis celimene amina* has been observed at the study area during April 2018 and its presence is confirmed.
- Invertebrates: Rock Scorpions. Rock scorpions of the genus *Hadogenes* are likely to be present at the site owing to suitable rocky habitat at rocky ridges in the study area.
- Invertebrates: Baboon spiders. If the development is approved, each prospecting site should be inspected for the presence of baboon spiders in particular "horned-baboon spiders" of the genus *Ceratogyrus* which has a particular presence in the Limpopo Province. *Ceratogyrus* ("horned baboon spiders") is also of importance to the pet trade and appears on the TOPS list with other baboon spider genera *Harpactira* and *Pterinochilus*. If there are clearly burrows and resident baboon spiders in an area where prospecting will take place, these should be removed and translocated by a specialist.

10.1 ECOLOGICAL SENSITIVITY

A preliminary indication of ecological sensitivity has been drawn up for this report. This synthesis is limited by the inaccessibility of the larger area. Also it appears from literature that in particular for smaller animals, wetland and forest plants, that the north-eastern section of the site could be an area which has been poorly explored in the past.

- In general, even based on limited knowledge, it appears ecological sensitivity increases from west to east at the site and from south to north. Northeastern part of the study area is ecologically the most sensitive (Figures 3-6). These findings could be refined by more studies.

For the present time being it is strongly recommended that Gumbu PT 1 (at the eastern section) and Gumbu PT 21 in the riparian zone of the Limpopo River regarded as no-go zones until at least a proper site inspection at the point is conducted. For the remainder of the proposed prospecting sites at the point of impact, the likely absence of protected trees, absence of localised plant species, absence of nests of threatened raptors or vultures and absence of baboon spider colonies should be confirmed.

- Of considerable concern is the lack of knowledge at the eastern parts of the site. There, judging from the Google images are unmapped wetlands and possibly forests. It is in particular at the eastern parts of the study area that visits to proposed footprints are imperative.

10.2 SENSITIVITY MAPS

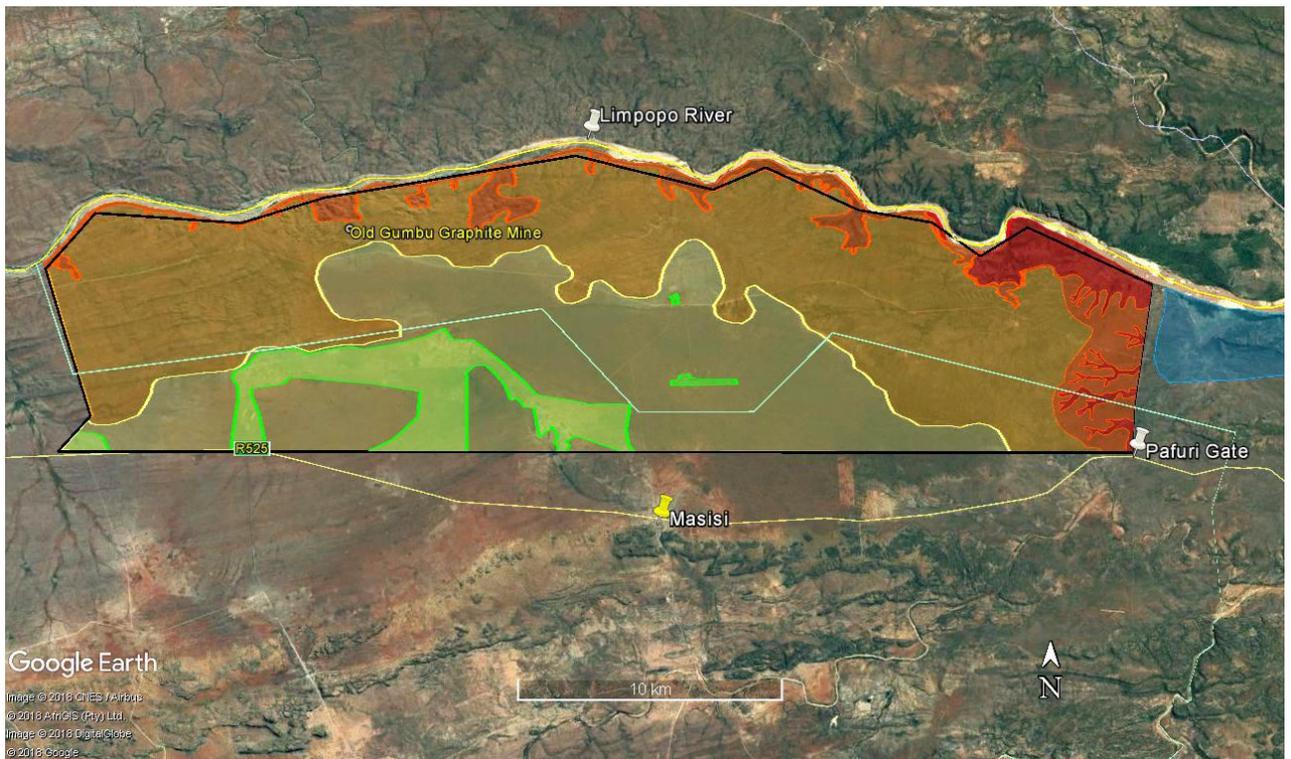


Figure 3 Indications of ecological sensitivity at the entire study area. Note: smaller drainage lines which are of high sensitivity in lower sensitivity areas are not indicated on the map. The map gives indications of the larger scale key sensitive ecological areas.

	Black outline	Boundaries of study area
	Red outline and shading	Very high sensitivity
	Orange-brown outline and shading	High-very high sensitivity
	Yellow-brown outline and shading	High sensitivity
	Light yellow outline and shading	Medium sensitivity
	Green outline and shading	Low sensitivity
	Light blue outline and shading	Makuleke Wetland Area (Ramsar site)

Grid references and altitudes were taken at site with a GPS Garmin E-trex 20 © instrument.

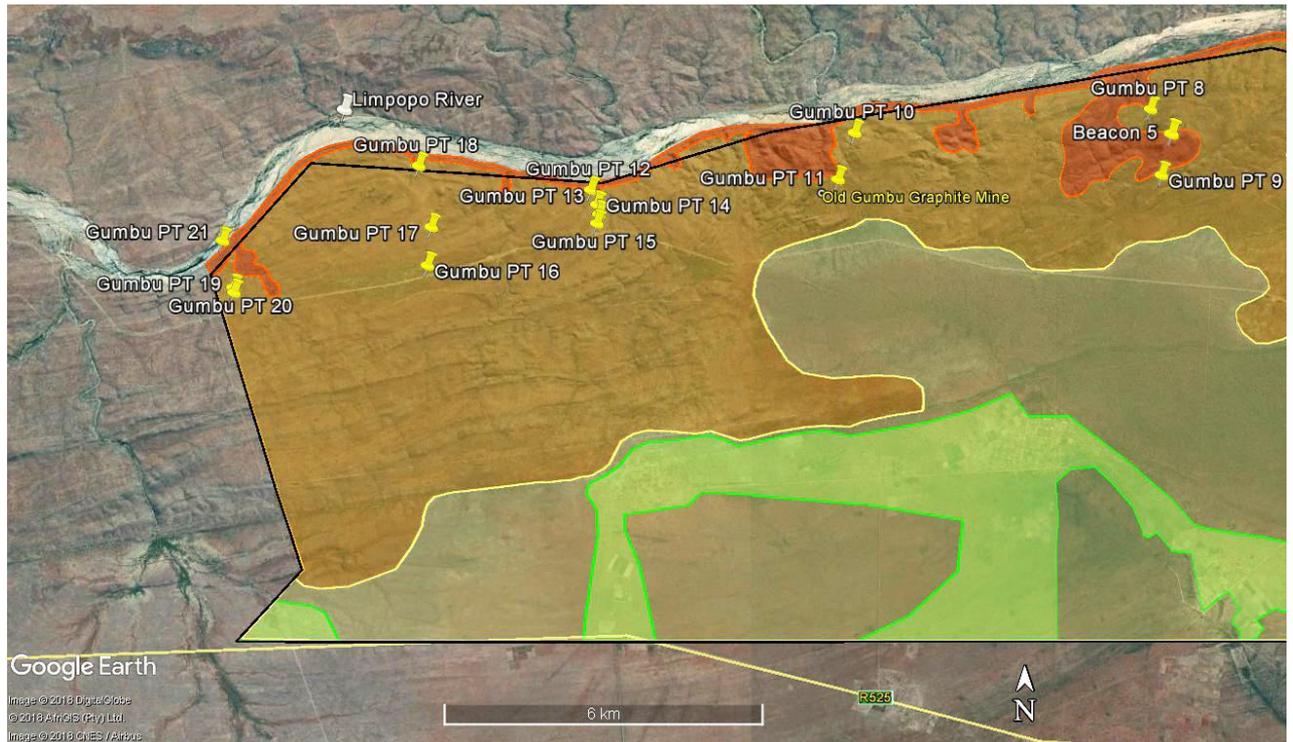


Figure 4 Indications of ecological sensitivity at the western parts of the study area. Note: smaller drainage lines which are of high sensitivity in lower sensitivity areas are not indicated on the map. The map gives indications of the larger scale key sensitive ecological areas.

—	Black outline	Boundaries of study area
—	Red outline and shading	Very high sensitivity
—	Orange-brown outline and shading	High-very high sensitivity
—	Yellow-brown outline and shading	High sensitivity
—	Light yellow outline and shading	Medium sensitivity
—	Green outline and shading	Low sensitivity

Grid references and altitudes were taken at site with a GPS Garmin E-trex 20 © instrument.

Map information were analysed and depicted on Google images with the aid of Google Earth Pro (US Dept. of State Geographer, MapLink/ Tele Atlas, Google, 2018).

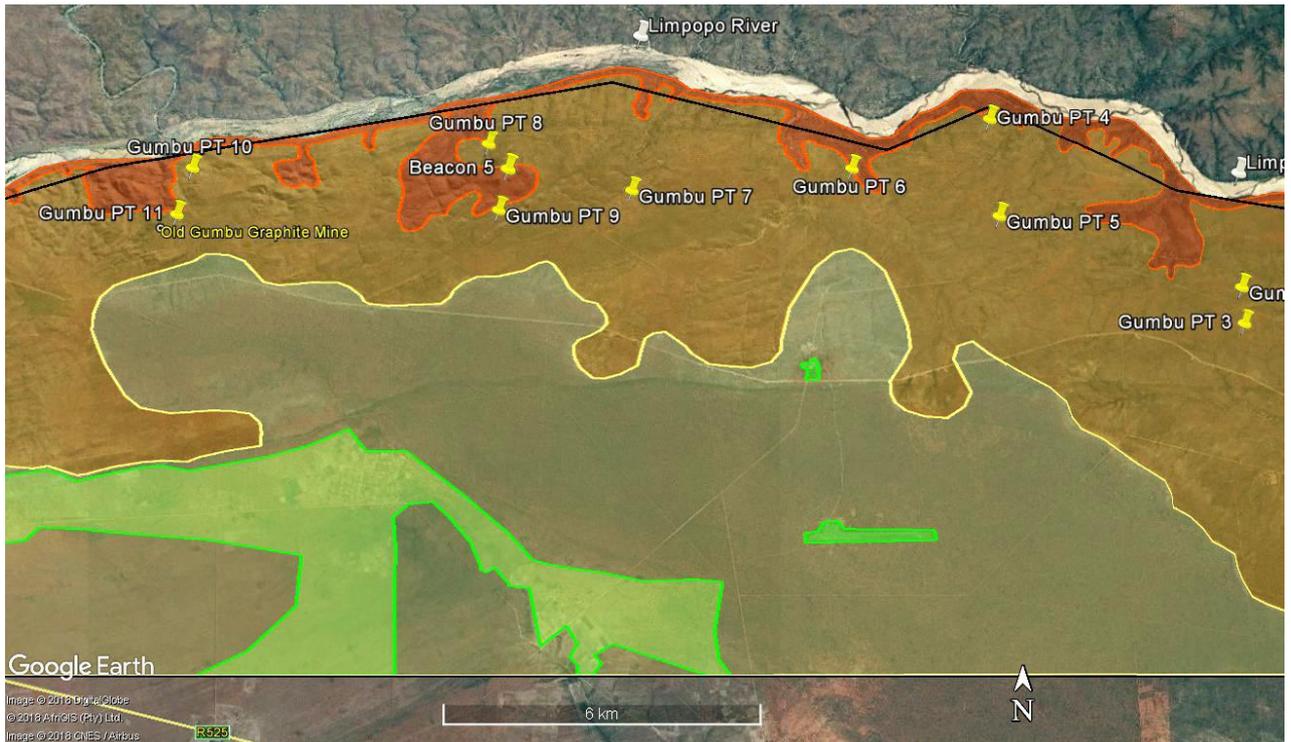


Figure 5 Indications of ecological sensitivity at the central parts of the study area. Note: smaller drainage lines which are of high sensitivity in lower sensitivity areas are not indicated on the map. The map gives indications of the larger scale key sensitive ecological areas.

—	Black outline	Boundaries of study area
—	Red outline and shading	Very high sensitivity
—	Orange-brown outline and shading	High-very high sensitivity
—	Yellow-brown outline and shading	High sensitivity
—	Light yellow outline and shading	Medium sensitivity
—	Green outline and shading	Low sensitivity

Grid references and altitudes were taken at site with a GPS Garmin E-trex 20 © instrument.

Map information were analysed and depicted on Google images with the aid of Google Earth Pro (US Dept. of State Geographer, MapLink/ Tele Atlas, Google, 2018).

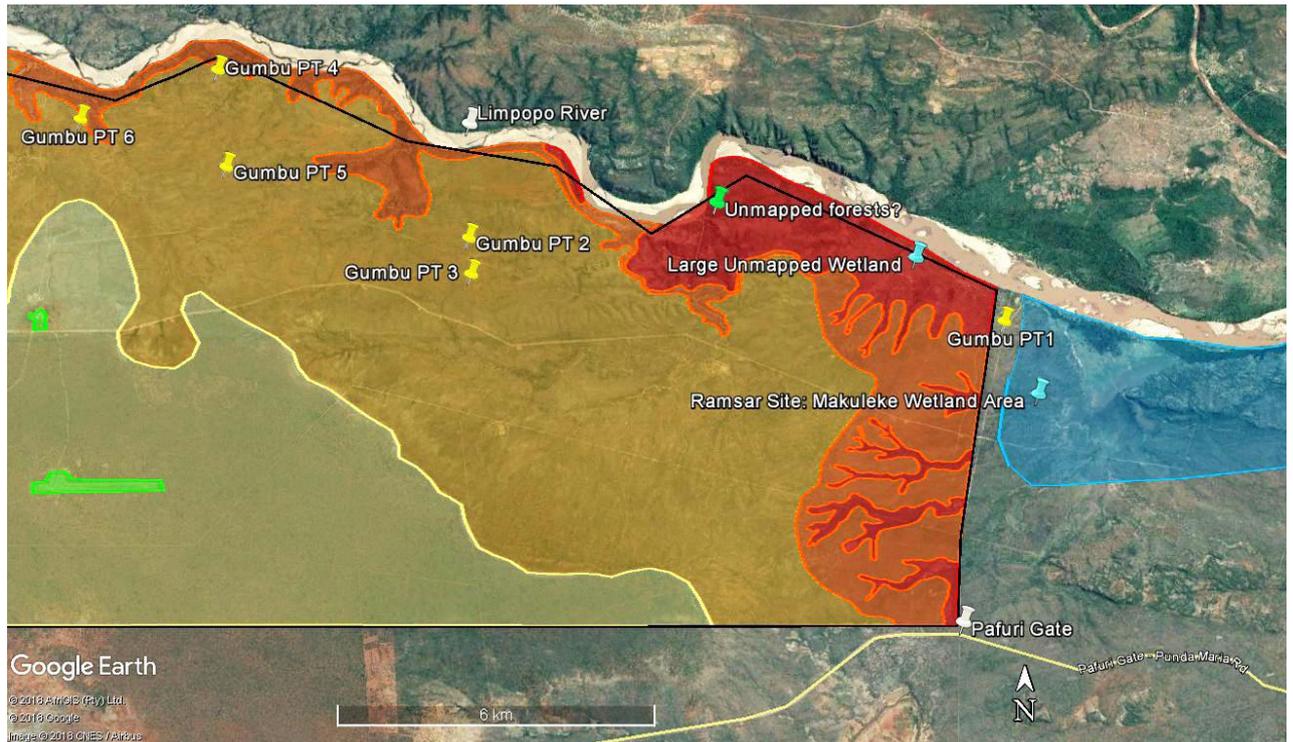


Figure 6 Indications of ecological sensitivity at the western parts of the study area. Note: smaller drainage lines which are of high sensitivity in lower sensitivity areas are not indicated on the map. The map gives indications of the larger scale key sensitive ecological areas.

	Black outline	Boundaries of study area
	Red outline and shading	Very high sensitivity
	Orange-brown outline and shading	High-very high sensitivity
	Yellow-brown outline and shading	High sensitivity
	Light yellow outline and shading	Medium sensitivity
	Green outline and shading	Low sensitivity
	Light blue outline and shading	Makuleke Wetland Area (Ramsar site)

Grid references and altitudes were taken at site with a GPS Garmin E-trex 20 © instrument.

Map information were analysed and depicted on Google images with the aid of Google Earth Pro (US Dept. of State Geographer, MapLink/ Tele Atlas, Google, 2018).

Ecological Sensitivity Rationale:

Note: smaller drainage lines which are of high sensitivity in lower sensitivity areas are not indicated on the map. The map gives indications of the larger scale key sensitive ecological areas.

Table 5.1 Rationale for different areas of ecological sensitivity at the study area.

 Very high sensitivity	There appear to be unmapped/ poorly investigated/ data deficient large wetland (also smaller wetlands) and possible forests in the north eastern parts of the site. Lower parts of a number of active channels and riparian zones which feed into the Makuleke wetlands adjacent to the study area have also been marked. In terms of smaller animals and plant species these areas are poorly known but these areas are likely to contain unique habitats and host threatened or rare species.
 High-very high sensitivity	Limpopo Riparian Zone, larger confluences with Limpopo River and areas adjacent to places with very high sensitivity. Limpopo River is corridor of major conservation concern and its riparian zone also hosts plant species and animal species which tend to be rare elsewhere in South Africa.
 High sensitivity	Rugged and varied landscape with prominent rocky ridges, valleys and riparian zones. Most of Limpopo Ridge Bushveld SVmp 2 ascribed to this zone. A number of plant and animal species which are widespread north of South Africa, but in South Africa confined to its northeastern extreme are found in this zone.
 Medium sensitivity	Landscape is less varied and likely to contain mostly widespread species and few/no rare localized species. Riverbeds in these areas should still be regarded as highly sensitive. There may be on closer inspection more sensitive parts but in general these areas appear less sensitive.
 Low sensitivity	Areas of low sensitivity are characterised by less varied landscapes and considerable ecological disturbances or high degree of transformation.

11 REFERENCES

Alexander, G. & Marais, J. 2007. A guide to the reptiles of Southern Africa. Cape Town: Struik.

Anderson, M.D. 2001. The effectiveness of two different marking devices to reduce large terrestrial bird collisions with overhead electricity cables in the eastern Karoo, South Africa. Draft report to Eskom Resources and Strategy Division. Johannesburg: South Africa.

Apps, P. 2000. Smither's mammals of southern Africa: a field guide. Cape Town: Struik.

Armstrong, A.J. 1991. On the biology of the marsh owl, and some comparisons with the grass owl. *Honeyguide* 37:148-159.

Barnes, K.N. ed. 2000. The Eskom Red Data Book of birds of South Africa, Lesotho and Swaziland. Johannesburg: BirdLife South Africa. 169 p.

Bates, M.F., Branch, W.R., Bauer, A.M., Burger, M., Marais, J., Alexander, G.J. & De Villiers, M.S. (eds.). 2014. Atlas and Red List of the Reptiles of South Africa, Lesotho and Swaziland. *Suricata* 1. South African National Biodiversity Institute, Pretoria.

Branch, B. 1998. Field guide to snakes and other reptiles of southern Africa. 3rd ed. Cape Town: Struik. 399 p.

Branch, W.R., Tolley, K.A., Cunningham, M., Bauer, A.M., Alexander, G., Harrison, J.A., Turner, A.A. & Bates, M.F. eds. 2006. A plan for phylogenetic studies of southern African reptiles: proceedings of a workshop held at Kirstenbosch, February 2006. Biodiversity Series 5. Pretoria: South African National Biodiversity Institute. 48 p.

Bromilow, C. 2001. Problem Plants of South Africa. Pretoria: Briza Publications.

Carruthers, V. 2001. Frogs and frogging in southern Africa. Cape Town: Struik.

Chittenden, H. 2007. Roberts Bird Guide. Cape Town: John Voelcker Book Fund.

- Cillié, B., Oberprieler, U. & Joubert, C. 2004. Animals of Pilanesberg: an identification guide. Pretoria: Game Parks Publishing.
- Cilliers, S.S., Müller, N. & Drewes, E. 2004. Overview on urban nature conservation: situation in the western-grassland biome of South Africa. *Urban forestry and urban greening* 3: 49-62.
- Conradie, W., Du Preez, L.H., Smith, K. & Weldon, C. 2006. Field guide to the frogs and toads of the Vredefort Dome World Heritage Site. Potchefstroom: School of Environmental Sciences and Development, Gauteng University. 53 p.
- Dippenaar-Schoeman, A.S. 2002. Baboon and trapdoor spiders in southern Africa: an identification manual. Plant Protection Research Institute Handbook No. 13. Pretoria: Agricultural Research Council.
- Deutschländer, M.S. & Bredenkamp, C.J. 1999. Importance of vegetation analysis in the conservation management of the endangered butterfly *Aloeides dentatis* subsp. *dentatis* (Swierstra) (Lepidoptera: Lycaenidae). *Koedoe* 42(2): 1-12.
- Dippenaar-Schoeman, A.S. & Jocqué, R. 1997. African spiders: an identification manual. Plant Protection Research Institute Handbook No. 9. Pretoria: Agricultural Research Council.
- Du Preez, L.H. 1996. Field guide and key to the frogs and toads of the Free State. Bloemfontein: Department of Zoology and Entomology, University of the Orange Free State.
- Du Preez, L.H. & Carruthers, V. 2009. A complete guide to the frogs of southern Africa. Struik Nature, Cape Town. 488p. CD with calls included.
- Edge, D.A. 2002. Some ecological factors influencing the breeding success of the Brenton Blue butterfly, *Orachrysops niobe* (Trimen) (Lepidoptera: Lycaenidae). *Koedoe*, 45(2): 19-34.
- Edge, D.A. 2005. Ecological factors influencing the survival of the Brenton Blue butterfly, *Orachrysops niobe* (Trimen) (Lepidoptera: Lycaenidae). North-West University, Potchefstroom, South Africa (Thesis - D.Phil.).
- Edge, D.A., Cilliers, S.S. & Terblanche, R.F. 2008. Vegetation associated with the occurrence of the Brenton blue butterfly. *South African Journal of Science* 104: 505 - 510.

Filmer, M.R. 1991. Southern African spiders: an identification guide. Cape Town: Struik.

Gardiner, A.J. & Terblanche, R.F. 2010. Taxonomy, biology, biogeography, evolution and conservation of the genus *Erikssonia* Trimen (Lepidoptera: Lycaenidae). *African Entomology* 18(1): 171 – 191.

Germishuizen, G. 2003. Illustrated guide to the wildflowers of northern South Africa. Briza, Pretoria. 224 p.

Germishuizen, G., Meyer, N.L. & Steenkamp (eds) 2006. A checklist of South African plants. Southern African Botanical Diversity Network Report No. 41. SABONET, Pretoria.

Goldblatt, P. 1986. The *Moraeas* of Southern Africa. Annals of Kirstenbosch Botanic Gardens, Volume 14. National Botanic Gardens, Cape Town. 224 p.

Goldblatt, P. & Manning, J. 1998. *Gladiolus* in Southern Africa. 320 p.

Henderson, L. Alien weeds and alien invasive plants: a complete guide to the declared weeds and invaders in South Africa. Plant Protection Research Institute Handbook No. 12. Pretoria: ARC: Plant Protection Research Institute.

Henning, G.A. & Roos, P.S. 2001. Threatened butterflies of South African wetlands. *Metamorphosis* 12(1): 26-33.

Henning, G.A., Terblanche, R.F. & Ball, J.B. (eds) 2009. South African Red Data Book: butterflies. SANBI *Biodiversity Series No 13*. South African National Biodiversity Institute, Pretoria. 158 p.

Henning, S.F. 1983. Biological groups within the Lycaenidae (Lepidoptera). *Journal of the Entomological Society of Southern Africa* 46(1): 65-85.

Henning, S.F. 1987. Outline of Lepidoptera conservation with special reference to ant associated Lycaenidae. *Proceedings of the first Lepidoptera conservation Symposium, Roodepoort: Lepidopterists' Society of southern Africa*: 5-7.

- Henning, S.F. & Henning, G.A. 1989. South African Red Data Book: butterflies. *South African National Scientific Programmes Report No. 158*. Pretoria: CSIR.
- Hill, C.J. 1995. Conservation corridors and rainforest insects. (*In* Watt, A.D., Stork, N.E. & Hunter, M.D. (eds.), *Forests and Insects*. London: Chapman & Hall. p. 381-393.)
- Hockey, P.A.R., Dean, W.J.R. & Ryan, P.G. (eds.). 2005. *Roberts Birds of Southern Africa*. Cape Town: John Voelcker Bird Book Fund.
- Holm, E. & Marais, E. 1992. *Fruit chafers of southern Africa*. Hartebeespoort: Ekogilde.
- IUCN. 2001. *IUCN Red List Categories and Criteria: Version 3.1*. IUCN Species Survival Commission. IUCN, Gland, Switzerland and Cambridge, UK.
- Jacobsen, W.B.G. 1983. *The ferns and fern allies of Southern Africa*. Butterworths, Durban. 542 p.
- Kudrna, O. 1995. Conservation of butterflies in central Europe. (*In* Pullin, A. S. ed. *Ecology and conservation of butterflies*. London: Chapman & Hall. p. 248-257.)
- Larsen, T.B. 1995. Butterfly biodiversity and conservation in the Afrotropical region. (*In* Pullin, A.S. ed. *Ecology and conservation of butterflies*. London: Chapman & Hall. p. 290-303.)
- Liebenberg, L. 1990. *A field guide to the animal tracks of Southern Africa*. Cape Town: David Philip Publishers.
- Leeming, J. 2003. *Scorpions of southern Africa*. Cape Town: Struik.
- Leroy, A. & Leroy, J. 2003. *Spiders of southern Africa*. Cape Town: Struik.
- Low, A.B. & Rebelo, A.G. (Eds.) 1996. *Vegetation of South Africa, Lesotho and Swaziland*. Pretoria: Department of Environmental Affairs and Tourism.

- Lubke, R.A., Hoare, D., Victor, J. & Ketelaar, R. 2003. The vegetation of the habitat of the Brenton Blue Butterfly, *Orachrysops niobe* (Trimen), in the Western Cape, South Africa. *South African Journal of Science* 99: 201-206.
- Manning, J. 2003. Photographic guide to the wild flowers of South Africa. Briza, Pretoria.
- Manning, J. 2009. Field guide to the wild flowers of South Africa. Struik, Cape Town.
- McMurtry, D., Grobler, L., Grobler, J. & Burns, S. 2008. Field guide to the orchids of northern South Africa and Swaziland. Umdaus Press, Hatfield.
- Mecenero, S., Ball, J.B., Edge, D.A., Hamer, M.L., Henning, G.A., Krüger, M, Pringle, E.L., Terblanche, R.F. & Williams, M.C. 2013. *Conservation Assessment of Butterflies of South Africa, Lesotho and Swaziland: Red List and Atlas*. Safronics (Pty) Ltd., Johannesburg & Animal Demography Unit, Cape Town.
- Minter, L.R., Burger, M., Harrison, J.A., Braack, H.H., Bishop, P.J. & Kloepfer, D. eds. 2004. Atlas and Red Data Book of the Frogs of South Africa, Lesotho and Swaziland. SI/MAB series 9. Washington, DC: Smithsonian Institution.
- Mucina, L. & Rutherford, M.C. eds. 2006. The vegetation of South Africa, Lesotho and Swaziland. *Strelitzia* 19. Pretoria: South African National Biodiversity Institute.
- Mucina, L., Rutherford, M.C., and Powrie, L.W. eds. 2005. Vegetation map of South Africa, Lesotho and Swaziland, 1:1 000 000 scale sheet maps. Pretoria: South African National Biodiversity Institute.
- Munguira, M.L. 1995. Conservation of butterfly habitats and diversity in European Mediterranean countries. (*In* Pullin, A.S. ed. Ecology and conservation of butterflies. London: Chapman & Hall. p. 277- 289.)
- New, T.R. 1993. ed. Conservation biology of *Lycaenidae* (butterflies). *Occasional paper of the IUCN Species Survival Commission* No. 8. 173 p.
- New, T.R. 1995. Butterfly conservation in Australasia – an emerging awareness and an increasing need. (*In* Pullin, A.S. ed. Ecology and conservation of butterflies. London: Chapman & Hall. p. 304 – 315.)
- Oates, M.R. 1995. Butterfly conservation within the management of grassland habitats. (*In* Pullin, A.S. ed. Ecology and conservation of butterflies. London: Chapman & Hall. (p. 98-112.)

- Opler, P.A. 1995. Conservation and management of butterfly diversity in North America. (In Pullin, A.S. ed. Ecology and conservation of butterflies. London: Chapman & Hall. p. 316-324.)
- Pfab, M.F. 2002. Priority ranking scheme for Red Data plants in Gauteng, South Africa. *South African Journal of Botany* (68): 299-303.
- Pfab, M.F. & Victor, J.E. 2002. Threatened plants of Gauteng, South Africa. *South African Journal of Botany* (68): 370-375.
- Picker, M., Griffiths, C. & Weaving, A. 2004. Field guide to insects of South Africa. 2nd ed. Cape Town: Struik.
- Pooley, E. 1998. A field guide to wild flowers of KwaZulu-Natal and the eastern region. Natal Flora Publications Trust, Durban. 630 p.
- Pringle, E.L., Henning, G.A. & Ball, J.B. eds. 1994. Pennington's Butterflies of Southern Africa. Cape Town: Struik Winchester.
- Pryke, S.R. & Samways, M.J. 2001. Width of grassland linkages for the conservation of butterflies in South African afforested areas. *Biological Conservation* 101: 85-96.
- Pullin, A.S. ed. 1995. Ecology and conservation of butterflies. London: Chapman & Hall. 363 p.
- Rautenbach, I.L. 1982. The mammals of the Transvaal. *Ecoplan monograph* 1: 1-211.
- Retief, E. & Herman, P.P.J. 1997. Plants of the northern provinces of South Africa: keys and diagnostic characteristics. *Strelitzia* 6. Pretoria: National Botanical Institute.
- Rutherford, M.C. & Westfall, R.H. 1994. Biomes of southern Africa: An objective categorisation, 2nd ed. *Memiors of the Botanical Survey of South Africa*, Vol. 63, pp. 1-94. Pretoria: National Botanical Institute.
- Ryan, P. 2001. Practical Birding: A guide to birdwatching in southern Africa. Cape Town: Struik.
- Samways, M.J. 2005. Insect diversity conservation. Cambridge: Cambridge University Press. 342

- Skinner, J.D. & Chimimba, C.T. 2005. The mammals of the southern African subregion. Cape Town: Cambridge University Press.
- Smit, N. 2008. Field guide to the Acacias of South Africa. Briza, Pretoria.
- Smithers, R.H.N. 1986. South African Red Data Book: Terrestrial mammals. *South African National Scientific Programmes Report No. 125*. Pretoria: CSIR.
- South Africa. 2004. National Environmental Management: Biodiversity Act No. 10 of 2004. Pretoria: Government Printer.
- Stuart, C. & Stuart, T. 2000. A field guide to the tracks and signs of Southern and East Africa. Cape Town: Struik. 310 p.
- Tarboton, W. & Erasmus, R. 1998. Owls and owling in southern Africa. Struik, Cape Town.
- Terblanche, R.F., Morgenthal, T.L. & Cilliers, S.S. 2003. The vegetation of three localities of the threatened butterfly species *Chrysoritis aureus* (Lepidoptera: Lycaenidae). *Koedoe* 46(1): 73-90.
- Terblanche, R.F. & Van Hamburg, H. 2003. The taxonomy, biogeography and conservation of the myrmecophilous *Chrysoritis* butterflies (Lepidoptera: Lycaenidae) in South Africa. *Koedoe* 46(2): 65-81.
- Terblanche, R.F. & Van Hamburg, H. 2004. The application of life history information to the conservation management of *Chrysoritis* butterflies (Lepidoptera: Lycaenidae) in South Africa. *Koedoe* 47(1): 55-65.
- Terblanche, R.F. & Edge, D.A. 2007. The first record of an *Orachrysops* in Gauteng. *Metamorphosis* 18(4): 131-141.
- Thomas, C.D. 1995. Ecology and conservation of butterfly metapopulations in the fragmented British landscape. (*In* Pullin, A.S. ed. Ecology and conservation of butterflies. London: Chapman & Hall. p. 46-64.)
- Van Jaarsveld, E.J. 2006. The Southern African *Plectranthus* and the art of turning shade to glade.

Van Oudtshoorn, F. 1999. Guide to grasses of southern Africa. Pretoria: Briza.

Van Rooyen, C.S. 2004. The Management of Wildlife Interactions with overhead lines. In: The fundamentals and practice of Overhead Line Maintenance (132kV and above), 217-245. Eskom Technology Services International, Johannesburg.

Van Wyk, B. 2000. A photographic guide to wild flowers of South Africa. Struik, Cape Town.

Van Wyk, B. & Malan, S. 1998. Field Guide to the Wild Flowers of the Highveld. Cape Town:Struik.

Van Wyk, B.E. & Smith, G.F. 2003. Guide to the aloes of South Africa. 2nd ed.
Pretoria: Briza Publications.

Van Wyk, B. & Van Wyk, P. 1997. Field guide to trees of southern Africa. Cape Town: Struik.

Walker, C. 1996. Signs of the Wild. 5th ed. Cape Town: Struik.

Warren, M.S. 1995. Managing local microclimates for the high brown fritillary, *Argynnis adipe*. (In Pullin, A.S. ed. Ecology and conservation of butterflies. London: Chapman & Hall.)

Watt, A.D., Stork, N.E. & Hunter, M.D. (eds.), Forests and Insects. London: Chapman & Hall. (p. 381-393.)