REPORT TO:

NORTHAM BOOYSENDAL MINE /
THE BUTTONSHOPE TRUST

BY:

CLEAN STREAM BIOLOGICAL SERVICES

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BASELINE BIODIVERSITY MANAGEMENT PLAN (BMP):

DE BERG PRIVATE NATURE RESERVE 2022

BASELINE BIODIVERSITY MANAGEMENT PLAN
DE BERG PRIVATE NATURE RESERVE
2022

EXECUTIVE SUMMARY

The National Environmental Management Biodiversity Act compels certain landowners and responsible entities to develop Biodiversity Management Plans that provide for the long-term survival of all forms of naturally occurring living organisms in the wild. The Biodiversity Act sets out a framework for planning the conservation and sustainable use of biological diversity within a broader framework of planning for sustainable development. The preparation of bioregional conservation plans, that embody the ecosystem approach of conservation in the context of climatic and geographical characteristics and interaction, is provided for as well as other conservation plans addressing specific components of biodiversity requiring special conservation attention.

The following primary conclusions were drawn from this study:

- All parts of the DBPNR comprise one of two **Threatened terrestrial ecosystems** listed in the 2011 Schedule of the NEMBA as **Endangered** under Criterion F ('priority areas for meeting biodiversity targets'), namely Sekhukhune Mountainlands (MP9) and Dullstroom Plateau Grasslands (MP4). The 2 127 ha DBPNR also falls entirely within one of **two centres of plant endemism**, namely the Sekhukhuneland Centre of Plant Endemism (SCPE) and the Lydenburg Centre of Plant Endemism (LCPE). The study area also falls within the recently described **Limpopo-Mpumalanga-Eswatini Escarpment (LMEE) centre of plant endemism**, an orographic entity some 53 594 km^2 in extent which encompasses both the SCPE and LCPE. The rugged DBPNR study area **remains in a largely pristine or near-pristine** state and only 2.1% (or ca. 46 ha) of the habitats and vegetation study area has been transformed by the planting of, and invasion by, alien trees, historical cultivation, the damming of wetlands and the establishment of infrastructure such as farm homesteads, a labourer's dwelling and a communications tower complex.
- The 2 127 ha DBPNR falls within the Mpumalanga Province and its biodiversity conservation importance is mapped in the Mpumalanga Biodiversity Sector Plan Version 3 (MBSP 2014). Most (59.6%) of the 2 127 ha DBPNR is categorised in the MBSP 2014 as '**Protected Areas'**. The portion of the DBPNR mapped as 'Protected Areas' comprises the entire extent of the farms De Berg and Triangle as they comprise the previous Davel Nature Reserve which was proclaimed in 1965 and is now included in the Northam Booysendal Mine's larger De Berg Private Nature Reserve. Areas mapped as '**CBA-Irreplaceable'** comprise 9.9% of the DBPNR and areas mapped as '**CBA-Optimal'** comprise 27.3% of the DBPNR. Areas mapped as 'Protected Areas', 'CBA-Irreplaceable' or 'CBA-Optimal', thus together comprise 96.8% of the DBPNR, which is regarded as an accurate reflection of the extreme conservation importance of the DBPNR.
- For the purposes of this study, the study area has been divided into **10 broad-scale vegetation units and land use classes** that was used as **Biodiversity Management Units (BMU's).** Of the ten identified BMU's, six comprise untransformed (and largely pristine or near-pristine) habitats (BMU 1: Sekhukhune Mountain Bushveld; BMU 2: Sekhukhune Montane Grassland; BMU 3: Steenkampsberg Montane Grassland; BMU 4: Northern Afrotemperate Forest; BMU 5: Valley-bottom wetlands and seeps; BMU 7: Mountain streams) and four comprise transformed habitats where the vegetation is secondary or has been cleared (BMU 9: Secondary vegetation - historical cultivation; BMU 10: Alien trees; BMU 11: Dams; BMU 13: Infrastructure). The untransformed BMU's together comprise 97.9% (or ca. 2 081 ha) of the study area.

- According to SANBI's online BODATSA database records, the quarter degree grid square within which the study area is situated, namely 2530AA, has been poorly explored botanically, and the database contains herbarium records for less than 533 plant species and infraspecific taxa collected within this grid of 50 000 ha. A total of **930 plant species and infraspecific taxa were recorded within the DBPNR** during the current study, **878 of which are indigenous** taxa and 52 (or 5.6%) of which are naturalised alien species. **Fourteen** of the 52 recorded alien species are listed as **declared invasive species** in the AIS Regulations. The total of 878 indigenous plant species and infraspecific taxa recorded during the current botanical survey of the 2 127 ha DBPNR alludes to the **exceptionally high plant species richness** (α-diversity) of the study area. This species richness is attributable to the fact that the study area lies within the **ecotone (transition zone) between four vegetation types**, **two Biomes** (the Savanna Biome and the Grassland Biome) and **two centres of plant endemism** (the SCPE and the LCPE) and is also situated within the recently identified LMEE centre of endemism which encompasses both the SCPE and LCPE. Furthermore, the **dramatic differences in elevation** within the study area create "**Ecological Diversity Gradients"** which add further to variability in available habitat and species richness.
- The DBPNR study confirmed the presence of **15 plant taxa that are endemic or near endemic to the SCPE** and **17 that are endemic or near endemic to the LCPE** within the 2 127 ha DBPNR. The study also confirmed the **presence of a minimum of 52 LMEE endemics** within the DBPNR.
- The DBPNR study confirmed the presence of **42 plant SCC within the 2 127 ha DBPNR** study area, 17 of which were recorded within the study area for the first time during the current study. The 42 SCC thus far recorded within the study area comprise **19 Threatened plant species** (EN or VU), **11 Near Threatened plant species**, **seven Rare plant species, and five Declining plant species** and it is considered highly probable that additional plant SCC are present. The 30 Threatened and Near Threatened plant taxa thus far recorded within the DBPNR comprise 15% of the 200 Threatened and Near Threatened species known to occur within the Mpumalanga Province in 2017 (MTPA database), a remarkable figure considering that the Mpumalanga Province covers an area of approximately 7 649 460 ha and the 2 127 ha DBPNR therefore comprises less than 0.03% of the province. The high-altitude Steenkampsberg Montane Grassland (BMU 3.1) and the valley-bottom and seep wetlands embedded within them (BMU 5), including various large peat wetlands (mires), were identified as the most important habitats for the conservation of plant SCC within the DBPNR. Ninety of the species recorded within the study area are Protected under either the National Forest Act (NFA), the National Environmental Management: Biodiversity Act (NEM:BA), or the Mpumalanga Nature Conservation Act (MNCA).
- The biodiversity conservation importance of the DBPNR is emphasised by the fact that the 5 981 ha **Verloren Vallei Nature Reserve**, which is consistently ranked as one of the three most important biodiversity conservation areas in Mpumalanga in internal assessments conducted by the MTPA (M. Lötter, pers. comm.) and borders directly on the southern boundary of the DBPNR, is known to contain 20 plant SCC whereas 42 plant SCC have thus far been recorded from the far smaller 2 127 ha DBPNR. The formalisation of the DBPNR as a formally legislated Protected Area is strongly supported by the findings of the current study.
- The DBPNR study recorded a strong **correlation between elevation and richness of Threatened, Near Threatened, and Rare plant species** within the DBPNR. The grasslands (BMU 3.1) and wetlands (BMU's 5 and 7) overlying metamorphic or sedimentary geology at elevations of above ca. 2 100 m.a.s.l. contain, by a large margin, the highest diversity of Threatened, Near Threatened, and Rare plant species within the DBPNR and it is considered probable that this pattern is repeated throughout

the Mpumalanga Province. The approximately 980 ha of habitat situated above 2 100 m.a.s.l. and with metamorphic or sedimentary geology within the DBPNR comprises approximately 7.3% of all such habitat occurring in the Mpumalanga Province. The exceptional conservation importance of BMU 3.1 is further emphasised by the fact that the DBPNR forms part of the Steenkampsberg 'plateau' which includes by far the largest area of contiguous sandstone and arenite lithology situated above 2 100 m.a.s.l. within the Mpumalanga Province, and therefore is likely to comprise the most important high elevation 'ecological refuge' or 'terrestrial island' within Mpumalanga.

- The DBPNR is not only of exceptionally high biodiversity value and conservation importance, but also an area of **great scenic beauty and tourism potential**. The DBPNR therefore holds great potential as a venue for conservation-compatible, income generating activities such as hiking, birdwatching, wildlife, and wildflower tourism. The development of this tourism potential will greatly enhance the long-term viability and sustainability of the DBPNR as a critical biodiversity conservation area. The linking of the DBPNR with the Verloren Vallei Nature Reserve will not only enhance the conservation value of both reserves but will also strengthen the economic viability and sustainability of both conservation areas.
- Based on faunal distribution data and habitats available within the study area, it is estimated that approximately **641 terrestrial vertebrate animal** species including frogs, reptiles, birds, and mammals can be expected in the study area.
- **Ten of the 18 expected frog species were encountered** in the DBPNR project area as part of the DBPNR study. In terms of frog SCC, two (possibly three) endemic frog species are expected while no red data listed species are estimated to occur in DBPNR.
- **Sixteen of the 71 expected reptile species were encountered** in DBPNR during the DBPNR study. **Twelve endemic reptile species** are expected to be found in the study area, **five** of which were confirmed during the DBPNR study. **One Threatened reptile species** (Southern African python) is also **expected to occur in the area** (including MTPA conservation status).
- The presence of **127 of an estimated 432 species of birds** that could potentially utilize the different biotopes of the DBPNR study area, was confirmed during the DBPNR study. **Forty-two bird 'species of conservation concern'** are likely to utilize the DBPNR study area, with eight of these confirmed to be present during the current study.
- Of all the mammal species that have distribution ranges in the region, 129 coincide with the DBPNR project area while approximately **120 medium to small mammal species** are expected to occur. During the DBPNR study signs and/or sights of 23 mammal species were recorded. **Twenty-five of the mammal species** expected in the study area are 'species of conservation concern' (SCC), with seven of these confirmed during the current study.
- The DBPNR provides **near-pristine montane habitat** for several faunal SCC, including viable subpopulations of Southern Mountain Reedbuck (EN) and Grey Rhebuck (NT) which move freely between the DBPNR and suitable habitat in surrounding private farmland and the largely untransformed Northam Booysendal property. The DBPNR and its immediate surrounds comprise one of the very few areas in Mpumalanga where fauna can disperse over large areas of highly varied untransformed habitats, representing two Biomes (Bushveld and Grassland) and varying in elevation from ca. 1 100 m.a.s.l. to 2 332 m.a.s.l. without any significant barriers for dispersal such as roads, game fencing, security fencing, and human settlements.
- The current study concluded that the DBPNR study area contains areas of **high to very high aquatic biodiversity conservation importance**. The present ecological status of most of the aquatic ecosystems falling within the DBPNR study area is **largely natural to slightly modified (ecological category A to B)** with **high to very high**

ecological importance and sensitivity. The Groot Dwars River reaches within the study area is furthermore classified as a **National Freshwater Ecosystem Priority Area (NFEPA)** which elevates their conservation importance. The National Environmental Screening Tool indicated that the aquatic **biodiversity sensitivity** of the majority of the DBPNR study area was ***Very High***.

- The study also confirmed the **absence of fish** from all rivers and streams (**Groot Dwars River, Everest tributary,** and **Klip River tributary**) within the original DBPNR study area (farms De Berg, Triangle, and Sterkfontein). The absence of indigenous fish from these upper catchment streams inside DBPNR is thought to be a natural phenomenon as a result of the abundance of natural migration barriers (waterfalls, cascades, large boulders) that occurs within the mountain stream (BMU 7) zone. It was promising that no alien fish species were present in the two dams on the farm De Berg. Limited fish sampling and visual observations performed at selected sites of the new section (farm Goedehoop) confirmed the presence of **one indigenous fish species**, namely *Enteromius cf. anoplus/motebensis* within the **Potspruit** river system on this farm. The presence of the **alien Rainbow trout** (*Oncorhynchus mykiss*) was also confirmed (visual observation) in the larger dam on the property. The barb (*E. cf. anoplus/motebensis*) requires further verification (genus currently under review in RSA) and, until verified, it will be considered as potentially being a **fish 'species of conservation concern'** (due to *E. motebensis* (IUCN) listing as Near Threatened (NT)).
- The current study also confirmed a **high aquatic macroinvertebrate diversity** present within the DBPNR. At least **one species** of aquatic macroinvertebrate of **conservation concern** could be expected within the DBPNR study area, namely, *Pseudagrion newtoni* (VU: Vulnerable) *(Damselfly:* Harlequin sprite). The presence of various **rare, endemic, or range-restricted macroinvertebrate taxa** were also confirmed. A total of **forty-seven (47) macroinvertebrate families** were also sampled within the DBPNR.
- **Fifty-nine (59) diatom species** were identified at the five sampling sites assessed in DBPNR during February 2022. Four of the five sites were characterised by **high biological water quality** reflecting near pristine conditions, while the remaining site was rated as having moderate biological water quality. **Endemic species** with a preference for high biological water quality were observed.
- During the field surveys conducted as part of the DBPNR study, it was noted that **35 dung beetle taxa** were present, with four taxa (*Neosisyphus cf. barbarossa* - confined to BM3, *Odontoloma cf. obscurum* – BMU 1 and BMU 2, *Sarophorus cf. "carinatus*" - BMU4 and *Sisyphus cf. "brown*" - BMU 2 and BMU 3) being highland endemics that were restricted to the Afrotropical Highlands region. It is likely that these taxa, including *Onthophagus cf. "pilosus group*" may represent **undescribed cryptic taxa**.
- Approximately **55 butterfly taxa** were recorded from the DBPNR, the highest number of species were recorded from BMU 7 (Mountain streams) and BMU 2 (Sekhukhune Montane Grassland). None of the observed butterfly species was Threatened or Near Threatened, although *Chrysoritis aethon* and *Dingana alticola* are endemic to the Lydenburg region.
- A total of **21 Odonata species** were observed on the DBPNR, with the highest number of species recorded from BMU7 (Mountain streams). None of the observed Odonata species was Threatened or Near Threatened, although *Chlorolestes fasciatus* and *Pinheyschna subpupillata* are endemic to the Drakensberg escarpment and sensitive to flow modifications and sedimentation.

Some **impacts** were identified as potentially posing a risk to the biodiversity of the study area. It is strongly recommended that the management actions as stated in the report should be incorporated into the reserve's biodiversity action plan. Various management actions are recommended with the most important being as follows:

- It is recommended that the proposed **management guidelines be implemented** with focus on **maintaining ecological connectivity** between the respective natural BMU's and to adopt a dynamic **grazing and burning management plan** that will benefit invertebrate diversity. The reserve management staff who have access the DBPNR should be trained on how to manage the grazing potential of the study area in an appropriate manner in conjunction with maintaining conservative stocking rates which will benefit the dung beetle richness of the area, but also preserve current butterfly and dragonfly/damselfly activity patterns.
- The main focus of biodiversity management should be on the **untransformed BMU's** with high to very high biodiversity conservation value.
- Aim to include the relevant **BMU-specific, species/group-specific, and general biodiversity management recommendations into a biodiversity action plan** for the proposed DBPNR.
- Implement an integrated **alien plant control program** (as per the AIS Regulations), with details being outlined in De Castro and Brits (2021b and 2022a).
- Biodiversity-related **follow-up studies and a monitoring programme** should be conducted.
- A programme should be developed to **promote the sustainable utilisation of natural resources** to benefit the local community.
- Engage and assist appropriate local government institutions and non-governmental organisations (NGOs) in developing and implementing an '**Environmental Education Programme'** that is tailored to address environmental issues that are of relevance within the DBPNR study area.
- It is recommended that **capacity building** amongst relevant personnel and landowners and informal tenants (e.g. people utilising the land on the study area), with respect to understanding biodiversity management in the study area, should take place. It is also emphasised that the relevant personnel responsible for biodiversity management, should have access to outside specialist input and support on an ongoing basis.

South Africa is rightly very proud of its rich biodiversity. However, our biodiversity is under threat from climate change, pollution, the excessive use of resources, and invasive plant and animal species. Developers are now under pressure to reduce and report on the impacts on biodiversity. Many of these developers have the opportunity to contribute to biodiversity conservation and management through gaining a better understanding of the ecosystems on their sites, and often through small changes to the way land is managed. Northam Booysendal is fortunate to be in control of the proposed DBPNR, an area that is richly endowed with exciting plant and animal species that needs protection. Declaring protected areas (PAs) (such as the proposed De Berg Private Nature Reserve) stands out as one of the main conservation strategies worldwide and there are clear commitments to expand their extent under the auspices of the Convention on Biological Diversity.

Summarized biodiversity conservation value of the various Biodiversity Management Units (BMU's) of the DBPNR study area:

BIODIVERSITY MANAGEMENT UNIT	BIODIVERSITY CONSERVATION VALUE			
	Botanical (vegetation)	Fauna (animals)*	OVERALL	COMMENTS
BMU 1: Sekhukhune Mountain Bushveld 	**Very high**	**Very high**	**VERY HIGH**	Mean plant species richness measured 33/100m^2. A total of 176 plant species recorded, 26 (or 14.8%) of which were recorded only within this unit. Four of the 42 plant SCC recorded within the DBPNR were recorded, including two taxa categorised as Threatened (VU) and two categorised as Near Threatened. Twelve of the 90 Protected plant species recorded within the DBPNR were recorded within this BMU. This BMU is representative of the Sekhukhuneland Mountain Bushveld vegetation type which is categorised as Least Threatened. However, this BMU is situated within the 'Sekhukhune Mountainlands' Threatened ecosystem which is categorised as Endangered. This BMU is also almost entirely mapped as either 'CBA-Optimal' or 'CBA-Irreplaceable' in the MBSP 2014. The entire extent of BMU 1 also falls within the SCPE and many of the 15 SCPE endemics recorded within the DBPNR occur within this BMU. BMU1 includes habitat characteristics that meet the requirements of 441 vertebrate animal species, consisting of 14 frog species, 61 reptile species, 272 bird species, and 94 mammal species. The presence of nine reptile species, 43 bird species, and six mammal species has been confirmed in this BMU during the 2021 to 2022 surveys. In terms of animal SCC, this BMU provides suitable habitats for an estimated two frog species, 10 reptile species, 12 bird species, and 15 mammal species. No terrestrial invertebrate SCC were predicted although this is due to very limited knowledge of the invertebrate fauna of the area. A moderate species richness of dung beetle (12) was recorded while 23 butterfly species were observed in this BMU.
BMU 2: Sekhukhune Montane Grassland	**Very high**	**Very high**	**VERY HIGH**	Mean plant species richness measured 47.2/100m^2, which is a markedly higher species richness than that measured in any other BMU. A total of 514 plant species were recorded, 144 (or 28.0%) of which were recorded only within this unit. Eleven of the 42 plant SCC recorded, including four taxa categorised as Threatened (EN or VU), four that are categorised as Near Threatened, and three that are categorised as Declining. Forty-eight of the 90 Protected plant species recorded within the DBPNR were recorded within this BMU.

BIODIVERSITY MANAGEMENT UNIT	BIODIVERSITY CONSERVATION VALUE			
	Botanical (vegetation)	**Fauna (animals)***	**OVERALL**	**COMMENTS**
				This BMU is representative of the Sekhukhuneland Montane Grassland vegetation type which is categorised as Least Threatened. However, this BMU is situated within the 'Sekhukhune Mountainlands' Threatened ecosystem which is categorised as Endangered. The vast majority of this BMU is also mapped as either 'CBA-Irreplaceable', 'CBA-Optimal' or 'Protected Area' in the MBSP 2014. The extent of BMU 2 falls mostly within the SCPE and most of the 15 SCPE endemics recorded within the study area occur within this BMU. BMU2 includes habitat characteristics that meet the requirements of 428 vertebrate animal species, consisting of 14 frog species, 50 reptile species, 270 bird species, and 94 mammal species. The presence of two frog species, eight reptile species, 82 bird species, and nine mammal species has been confirmed in this BMU during the 2021 to 2022 surveys. In terms of animal SCC, this BMU provides suitable habitats for an estimated two frog species, nine reptile species, 82 bird species, and nine mammal species. From a terrestrial invertebrate perspective, BMU2 contained the highest richness as well as the highest number of dung beetle individuals (average species richness of 18). Twenty-six butterfly species were observed. A potentially undescribed millipede species or aberrant form of *Doratogonus cf. flavifilis* was observed.
BMU 3: Steenkampsberg Montane Grassland 	**Very high**	**Very high**	**VERY HIGH**	Mean plant species richness measured 37.5/100m^2, which is the second highest species recorded for the BMU's. A total of 362 plant taxa were recorded, 87 (or 24.0%) of which were recorded only within this unit. This BMU is also likely to provide habitat for as yet undescribed taxa. BMU3 contains an exceptionally high concentration of plant SCC. Seventeen of the 46 plant SCC recorded within the study area were recorded within BMU3, including nine taxa categorised as Threatened (EN or VU), two categorised as Near Threatened, five that are categorised as Rare, and one categorised as Declining. Twenty-nine of the 90 Protected plant species recorded within the study area were also recorded within this BMU. This BMU is representative of the Steenkampsberg Montane Grassland vegetation type which is currently categorised as Least Concern. However, the vast majority of BMU is entirely situated within the

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				'Dullstroom Plateau Grasslands' Threatened ecosystem which is categorised as Endangered. The entire extent of BMU is mapped as 'Protected' (previous Davel Private Nature Reserve comprising the farms De Berg and Triangle), 'CBA-Irreplaceable' or 'CBA-Optimal' in the MBSP 2014. BMU3 also falls within the Steenkampsberg sub-centre of the LCPE and all of the 17 LCPE endemics recorded within the DBPNR occur either within BMU3 or within wetlands (BMU5) embedded within this unit. BMU3 includes habitat characteristics that meet the requirements of 171 vertebrate fauna species, consisting of 14 frog species, 27 reptile species, 108 bird species, and 22 mammal species. The presence of five reptile species, 61 bird species, and 12 mammal species has been confirmed in this BMU during the 2021 to 2022 surveys. In terms of animal SCC, this BMU provides suitable habitats for an estimated two frog species, nine reptile species, 22 bird species, and nine mammal species. Grassland BMU's contained the highest dung beetle species richness (average 14.74) as well as the highest number of beetle individuals when compared to the other terrestrial BMU's. Twenty-four butterfly species were also recorded from this BMU.
BMU 4: Northern Afrotemperate Forest 	**Very high**	**Very high**	**VERY HIGH**	Plant species richness is moderate as is typical of such relict forest patches in this region of Mpumalanga. Many of the occurring species are within the study area largely or entirely restricted to such Afrotemperate Forest patches. A total of 90 plant taxa were recorded within this BMU, 23 (or 25.6%) of which were recorded only within this unit. Four of the 42 plant SCC recorded within the study area were recorded within BMU4, including two taxa categorised as Threatened (EN or VU), one that is categorised as Near Threatened and one that is categorised as Declining. Twelve of the 90 Protected plant species recorded within the study area were also recorded within this BMU. This BMU is representative of the Northern Afrotemperate Forest vegetation type which is categorised as Least Concern or Least Threatened. However, this BMU is entirely situated within one of two Threatened ecosystems, namely 'Sekhukhune Mountainlands' and 'Dullstroom Plateau Grasslands', which are both categorised as Endangered. Almost all the forest patches comprising this BMU fall

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	Botanical (vegetation)	Fauna (animals)*	OVERALL	COMMENTS
				within areas mapped as either 'CBA-Optimal' or 'Protected Area' in the MBSP 2014. All of the forest patches comprising BMU4 fall within either the SCPE or the LCPE. BMU4 includes habitat characteristics that meet the requirements of 104 terrestrial fauna species, consisting of eight frog species, 10 reptile species, 73 bird species, and 13 mammal species. The presence of 22 bird species has been confirmed in this BMU during the 2021 to 2022 surveys. In terms of animal species of SCC, this BMU provides suitable habitats for an estimated two frog species, one reptile species, five bird species, and one mammal species. Invertebrate diversity is predicted to be lower when compared to the other BMU's, but could contain undescribed forest-interior species (e.g. millipedes). The Northern Afrotemperate Forest habitat (BMU4) sustained low numbers of dung beetles. Seven butterfly species and one dragon/damselfly species were recorded during the current study. Millipede taxa was mainly restricted to BMU4. A potentially undescribed species of the genus cf. *Gnomeskelus* (a keeled millipede) was sampled.
BMU 5: Valley-bottom wetlands and seeps 	**Very high**	**Very high**	**VERY HIGH**	Average plant species richness measured 18.9/100m^2, which is regarded as fairly typical species richness for wetlands in this region of Mpumalanga. Species richness vary markedly between wetland types and between lateral zones within a single wetland. This unit contains an exceptionally high concentration of plant SCC and as yet undescribed taxa and provides unique habitat for numerous spatially restricted habitat specialists, particularly those associated with mires and sheetrock wetlands, many of which are entirely restricted to such habitat. A total of 261 plant taxa were recorded within this BMU, and the fact that 99 (or 37.9%) of these species were recorded only within this BMU illustrates the uniqueness on the habitats comprising this unit and their botanical biodiversity conservation importance. The 261 plant taxa recorded within this unit, which comprises only ca. 6.4% of the DBPNR, comprise 28.1% of all the plant taxa recorded within the study area. This unit is also likely to contain a high number of undescribed taxa and three confirmed undescribed taxa were recorded from this BMU during 2020 to 2022 study and are in the process of being formally described and published. Sixteen of the 42

BIODIVERSITY MANAGEMENT UNIT	BIODIVERSITY CONSERVATION VALUE			
	Botanical (vegetation)	Fauna (animals)*	OVERALL	COMMENTS
				plant SCC recorded within the study area were recorded within BMU5, including nine taxa categorised as Threatened (CR, EN, or VU), three categorised as Near Threatened, two that are categorised as Rare, and two categorised as Declining. Twenty-four of the 90 Protected plant species recorded within the study area were also recorded within this BMU. The wetlands comprising BMU5 are entirely situated within one of two Threatened ecosystems, namely 'Sekhukhune Mountainlands' and 'Dullstroom Plateau Grasslands', which are both categorised as Endangered. All of the wetlands fall within either the SCPE or the LCPE. The vast majority of the wetlands of the study area, fall within areas mapped as either 'Protected Area', 'CBA-Irreplaceable' or 'CBA-Optimal' in the MBSP 2014. The wetlands of the farm De Berg, and in particular the large mires (peat wetlands) form the source of the Groot Dwars River and their preservation is therefore crucial in terms of maintaining the hydrological regimes and water quality, and hence ecosystem functioning and biodiversity levels, of the Groot Dwars River. BMU5 also provides crucial or exclusive habitat for various species of fauna. BMU5 includes habitat characteristics that meet the requirements of 132 animal species, consisting of 13 frog species, 12 reptile species, 89 bird species, and 18 mammal species. The presence of three frog species and 15 bird species has been confirmed in this BMU during the 2021 to 2022 surveys. In terms of animal SCC, this BMU provides suitable habitats for an estimated two frog species, four reptile species, eight bird species, and eight mammal species. The aquatic fauna biodiversity of this BMU is limited due to the limited availability of a water column. The current study confirmed that fish was absent from this BMU. Limited sampling confirmed the presence of various algae and moss species and at least 18 macroinvertebrate families. Diatom analyses confirmed that some sections of this BMU can be classified within an ecological category A (natural) and that biological water quality was excellent. This BMU is relatively widespread on De Berg, whereby the waterlogged conditions may limit the terrestrial invertebrate diversity. Twelve butterfly species and seven dragon/damselfly species were recorded during the current study.

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BMU 7: Mountain streams 	**Very high**	**Very high**	**VERY HIGH**	Plant species richness is moderate at lower altitudes and increases to high at higher altitudes and comprises various species and plant communities that are largely or entirely restricted to the riparian habitats of mountain streams. A total of 164 plant taxa were recorded within this BMU, 36 (or 22.0%) of which were recorded only within BMU7. Though this unit comprises only 2.5% of the DBPNR, nine of the 42 plant SCC recorded within the study area were recorded within BMU7, including three taxa categorised as Threatened, two that are categorised as Near Threatened, one that is categorised as Rare, and three that are categorised as Declining. Additional plant SCC are considered likely to be present. Fourteen of the 90 Protected plant species recorded within the study area was also recorded within this BMU. The mountain streams comprising BMU7 are entirely situated within one of two Threatened ecosystems, namely 'Sekhukhune Mountainlands' and 'Dullstroom Plateau Grasslands', which are both categorised as Endangered. All of the streams comprising BMU7 fall within either the SCPE or the LCPE. The streams of the study area, flow almost entirely through areas mapped as 'Protected Area', 'CBA-Irreplaceable' or 'CBA-Optimal' in the MBSP 2014. The mountain streams comprising BMU7 include all the tributaries of the source catchment (uppermost catchment) of the Groot Dwars River and their preservation is therefore crucial in terms of maintaining the hydrological regimes and water quality, and hence ecosystem functioning and biodiversity levels, of the Groot Dwars River. This unit has high functional value and provides crucial habitat for various species of fauna. BMU7 includes habitat characteristics that meet the requirements of 129 animal species, consisting of 15 frog species, 10 reptile species, 80 bird species, and 24 mammal species. The presence of four bird species and one mammal species has been confirmed in this BMU during the 2021 to 2022 surveys. In terms of animal SCC, this BMU provides suitable habitats for an estimated two frog species, three reptile species, four bird species, and nine mammal species. It is an important habitat for many Odonata species, of which many have Highveld/high-altitude affinities. Twenty-seven butterfly species and eleven dragon/damselfly species were recorded

BIODIVERSITY MANAGEMENT UNIT	BIODIVERSITY CONSERVATION VALUE			
	Botanical (vegetation)	**Fauna (animals)***	**OVERALL**	**COMMENTS**
				during the current study. The current study indicated that fish was absent from the most upper reaches of the mountain streams within the original DBPNR study area. It is estimated that the absence of fish from these areas may be a natural phenomenon as a result of various natural migration barriers (waterfalls, cascades) within these high gradient river reaches. One indigenous fish species (*Enteromius cf. anoplus/motebensis*) and one alien fish species (O. mykiss) was confirmed from the Potspruit section on the farm Goedehoop (new section of DBPNR). *Enteromius cf. anoplus/motobensis* requires further verification but currently it should be viewed as potentially being a fish SCC. The current study furthermore confirmed the presence of a highly diverse aquatic macroinvertebrate taxa richness with 47 macroinvertebrate families recently (2020 to 2022) sampled. Diatom analyses indicate excellent (ecological category A) biological water quality prevailing in many streams within DBPNR (many endemic diatom species with a preference for high biological water quality were also confirmed).
BMU 9: Secondary vegetation 	**Low to moderate**	**Moderate**	**MODERATE**	Mean plant species richness measured 17.7/100m^2, which is lower than that measured in any of the six BMU's comprising untransformed vegetation. A total of 70 plant taxa were recorded from this BMU, the vast majority of which are pioneer species and increaser species indicative of disturbance, and a high percentage of the recorded species are aliens. Species richness of indigenous plant species is likely to increase with elapsed time since rehabilitation, as secondary succession progresses. Secondary succession in Highveld and mountain grassland of Mpumalanga is known to be extremely slow (usually many decades) and often stalls to produce a more or less stable 'disclimax' plant community, which is not representative of natural 'climax' or 'steady state' vegetation. Furthermore, this BMU does not include potentially suitable habitat for any plant SCC or any of the 90 Protected plant species recorded within the study area. The few patches of secondary vegetation comprising this BMU are, however, embedded within one of two Threatened ecosystems, namely 'Sekhukhune Mountainlands' and 'Dullstroom Plateau

BIODIVERSITY MANAGEMENT UNIT	BIODIVERSITY CONSERVATION VALUE			
	Botanical (vegetation)	Fauna (animals)*	OVERALL	COMMENTS
				Grasslands', both of which are categorised as Endangered, and the majority of these patches of secondary vegetation are situated within areas mapped as either 'CBA-Optimal' or 'Protected Area' the MBSP 2014. BMU9 includes habitat characteristics that meet the requirements of 89 animal species, consisting of two frog species, 17 reptile species, 57 bird species, and 13 mammal species. The presence of three bird species has been confirmed in this BMU during the 2021 to 2022 surveys. In terms of animal SCC, this BMU provides suitable habitats for an estimated three reptile species, 10 bird species, and three mammal species.
BMU 10: Alien trees 	**Low**	**Low**	**LOW**	This BMU comprises habitats transformed through the planting and invasion of alien trees. The secondary vegetation of this unit has very low to negligible species richness in terms of indigenous species. A total of 31 plant taxa were recorded from this BMU, the majority of which are alien species. Furthermore, this BMU does not include potentially suitable habitat for any plant SCC or Protected plant species. Complete rehabilitation (i.e., return to species rich indigenous grassland which may eventually return to primary grassland) of these areas after the removal of the trees is often extremely difficult or impossible, as soil characteristics are often irreversibly altered. BMU10 includes habitat characteristics that meet the requirements of 43 terrestrial animal species, consisting of two reptile species, 35 bird species, and six mammal species. The presence of 11 bird species has been confirmed in this BMU during the 2021 to 2022 surveys. In terms of animal SCC this BMU provides suitable habitat for two mammal species.
BMU 11: Dams	**Low to moderate**	**Moderate**	**LOW**	BMU11 exists as six man-made dams that include five earth-walled farm dams and one old quarry excavation that contains water. BMU11 can be described as secondary wetland plant communities of the littoral and eulittoral zones of artificial wetlands. Vegetation is dominated by hygrophytic and hydrophytic grasses and sedges. Artificial wetland habitat provided by dams are unlikely to provide significant habitat for unique plant communities or plant SCC. They are furthermore regarded as impacts that affect the ecological

BIODIVERSITY MANAGEMENT UNIT	BIODIVERSITY CONSERVATION VALUE			
	Botanical (vegetation)	Fauna (animals)*	OVERALL	COMMENTS
				condition of natural watercourses (BMU's 5 and 7) by submerging indigenous wetland and riparian vegetation, permanently modifying hydrological processes, and causing erosion downstream of spillways. BMU11 includes habitat characteristics that meet the requirements of 82 animal species, consisting of 13 frog species, one reptile species, 65 bird species, and three mammal species. The presence of five frog species and 10 bird species has been confirmed in this BMU during the 2021 to 2022 surveys. In terms of animal SCC, this BMU provides suitable habitats for an estimated one frog species, one reptile species, two bird species, and two mammal species. Fish sampling in the dams on the farm De Berg (DB Dam 1 and 2) confirmed that there is currently no fish present in these dams. Limited fish sampling and visual observations confirmed the presence of one indigenous fish species, namely *Enteromius cf. anoplus/motebensis* and the alien Rainbow trout (*Oncorhynchus mykiss*) in the dams on the farm Goedehoop (site GH Dam 1 and 2). Limited aquatic macroinvertebrate sampling performed on De Berg Dam 1 indicated a moderate diversity of macroinvertebrates, with 17 taxa recorded in and around the dam. From a terrestrial invertebrate perspective, dams provide similar habitat to that of natural lakes or ponds, but where these are lacking may encourage establishment of populations of dragonflies and other species with aquatic nymphs that might not otherwise occur in an area. Five butterfly species and eight dragon/damselfly species were recorded from this BMU during the current study.
BMU13: Infrastructure	**Negligible**	**Negligible**	**Negligible**	The little vegetation occurring within this unit is entirely secondary in nature and has very low species richness in terms of indigenous species. A total of 34 plant taxa were recorded from this BMU and a high percentage of the species are alien. Furthermore, this unit does not contain potentially suitable habitat for any plant SCC or Protected plant species. BMU13 includes habitat characteristics that meet the requirements of 33 terrestrial fauna species, consisting of three frog species, five reptile species, 23 bird species and two mammal species. The presence of one frog species, one reptile species, five bird species, and two mammal species has been confirmed in this

BIODIVERSITY MANAGEMENT UNIT	BIODIVERSITY CONSERVATION VALUE			
	Botanical (vegetation)	Fauna (animals)*	OVERALL	COMMENTS
				BMU during the 2021 and 2022 surveys. In terms of animal SCC, this BMU provides suitable habitats for one frog species.

***Based on biodiversity conservation value of three groups, namely (1) terrestrial vertebrates (mammals, birds, reptiles, frogs), (2) terrestrial invertebrates and (3) aquatic fauna (fish and macroinvertebrates).**

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Addendum D: CLEAN STREAM BIOLOGICAL SERVICES (CSBS) (2022). Northam Booysendal Platinum/Buttonshope Trust: Aquatic Biodiversity Study (compiled as part of Baseline BMP study for the proposed De Berg Private Nature Reserve). Report number: CSBS/DBPNR/2022/A. Authored by Dr. Piet Kotze.

Addendum E: DE CASTRO AND BRITS (2022c): Management Plan with focus on Invertebrates for the De Berg Private Nature Reserve near Lydenburg, Mpumalanga. Authored by L. Niemand.

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ABBREVIATIONS

AIS	Alien and Invasive Species
ADU	Animal Demographic Unit
BMP	Biodiversity Management Plan
BMU	Biodiversity Management Unit
CBA	Critical Biodiversity Areas
CBD	Convention on Biological Diversity
CBMA	Core Biodiversity Management Areas
CSBS	Clean Stream Biological Services
°C	Degrees Celsius
CE	Centre of Endemism

CPE	Centre of Plant Endemism
DBPNR	De Berg Private Nature Reserve
DEA	Department of Environmental Affairs
DD	Data Deficient, according to IUCN Red List Criteria
DWS	Department of Water and Sanitation
EA	Environmental Authorisation
EI	Ecological Importance
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
EN	Endangered
EOO	Extent of Occurrence
ES	Ecological Sensitivity
ESA	Ecological Support Area
EST	Environmental Screening Tool
FEPA's	Freshwater Ecosystem Priority Areas
GIS	Geographic Information System
GPS	Global Positioning System
IBA	Important Birding Areas
IHI	Index of Habitat Integrity
IUCN	International Union for Conservation of Nature
LCPE	Lydenburg Centre of Plant Endemism
LC	Limpopo Conservation Plan 2013
LEDET	Limpopo Department of Economic Development Environment and Tourism
LMEE	Limpopo-Mpumalanga-Eswatini Escarpment 'centre of endemism'
MBSP	Mpumalanga Biodiversity Sector Plan
MTPA	Mpumalanga Department of Tourism, Parks and Agriculture.
NBSAP	National Biodiversity Strategy and Action Plan
NEMA	National Environmental Management Act
NEM:BA	National Environmental Management: Biodiversity Act
NEM:PAA	National Environmental Management: Protected Areas Act
NPAES	National Protected Area Expansion Strategy
NSAIDs	Non-steroidal anti-inflammatory drugs
NT	Near Threatened
PES	Present Ecological Status

POSA	Plants of Southern Africa database (http://newposa.sanbi.org)
PS	Protected Species
ROD	Record of decision
SANBI	South African National Biodiversity Institute
SARCA	South African Reptile Conservation Assessment
SCPE	Sekhukhuneland Centre of Plant Endemism
SCC	Species of Conservation Concern
SCC-u	Undescribed species treated as a SCC under the Precautionary Principle
SWSA	Strategic Water Source Area
SEAG	Species Environmental Assessment Guideline
sp. nov.	Species *nova* (Latin, *nova* = new)
TASP	Terrestrial Animal Species Protocol
TOPS	Threatened or Protected Species
VU	Vulnerable
WUL	Water Use Licence

1. INTRODUCTION

Northam Booysendal Mine is located some 17 km east of Roossenekal and 29 km west of Lydenburg and includes a surface rights area of nearly 13 000 ha with approximately two thirds situated within the Mpumalanga Province, while the northern portion falls within the Limpopo Province. The vast majority of this property comprises untransformed grassland and bushveld vegetation grazed by wildlife and domestic livestock, much of which is still in a near-pristine state with mining activities that have transformed portions of the central parts of the northern half of the area. In order to compensate for any negative impacts on biodiversity related to the development of the Booysendal mine, Booysendal/Buttonshope Conservation Trust purchased four properties in 2019 that are adjacent to the existing Booysendal mine property. This was done to offset any negative environmental impact that may be caused in the footprints of the mine and is in accordance with a biodiversity offset agreement between Booysendal Platinum, Mpumalanga Tourism and Parks Agency (MTPA), and the Buttonshope Conservation Trust. In this biodiversity offset agreement the offset was agreed on as 30:1. The goal is for the offset properties to be rehabilitated and managed by the Land Management Department of Booysendal as a conservation area. The properties that were purchased were De Berg 71JT portion 2, the remaining extent of De Berg 71JT, Triangle 72JT, and Sterkfontein 52JT portion 3. Apart from Sterkfontein, all the other properties were part of an existing private nature reserve; the so called "Davel Private Nature Reserve" that was proclaimed in 1965. The offset agreement furthermore stipulated that Sterkfontein 52JT portion 3 also needs to be proclaimed as a nature reserve. It was therefore decided to add Sterkfontein 52JT portion 3 to the Davel Private Nature and reproclaim it as the "De Berg Private Nature Reserve (DBPNR)" to form one large protected area. In April 2022 the Buttonshope Trust also purchased another property, Goedehoop 79JT portion 6. This property (Goedehoop farm) is extremely important as it borders on the MTPA Verloren Vallei Nature Reserve and forms a link that connects Verloren Vallei with the proposed DBPNR.

Clean Stream Biological Services (CSBS) was appointed by Northam Platinum Booysendal Mine to compile a first-phase biodiversity management plan (BMP) for the total surface rights area (12 950 ha) of the mine during the 2020/21 period. This first-phase study indicated that the Northam Booysendal surface rights area, and especially the proposed De Berg Private Nature Reserve (DBPNR) section, contains many plant and animal species and habitats of special conservation concern. Due to the critical biodiversity conservation importance of the proposed De Berg Private Nature Reserve area and the requirements for the establishment of the area as a private nature reserve, follow-up biodiversity assessments were conducted during 2021 and 2022 that specifically focused on this area of biodiversity conservation importance. The specialist information gathered as part of all work performed in this area during phase one and two (2020 to 2022) were used to compile this Biodiversity Management Plan (BMP) specifically for the proposed DBPNR.

Global, regional, or local biodiversity collapse may trigger the loss of natural ecosystem services such as pollination, oxygen generation, nutrient storage, water purification, pest control, soil formation, and disease prevention. There is an immense variety of life on earth that is necessary for the maintenance of these complex ecosystems. These ecosystems include all life forms such as fungi, micro-organisms, plants, animals, insects, fish, and algae that should be in balance to maintain ecosystem services. The loss of ecosystem services will precipitate the loss of human livelihoods, unpredictable weather, global spread of infectious diseases, increased wildfires, water shortages, and reduced food security. These changes will have major financial implications, precipitate societal changes such as mass migrations, and adversely affect the overall wellbeing of the human population or even its ultimate survival.

Biodiversity loss due to worldwide over-exploitation of natural resources has become the focus of attention during recent years. The Convention on Biological Diversity (CBD) set a goal to achieve significant reductions in biodiversity loss by 2010 (Hui *et al.,* 2008). A total of 143 countries including South Africa ratified the Convention on Biological Diversity at the 1992 Earth Summit in Rio de Janeiro. With the CBD that entered into force in 1993, the conservation of biodiversity was recognized for the first time in international law as "a common concern of humankind" and almost the entire world committed to it. Conserving biodiversity, however, is far from being an easy task, as shown by the difficulties to reach the conservation targets articulated in the strategic plans connected to the CBD. The failure of the 2010 biodiversity target to "achieve by 2010 a significant reduction of current rate of biodiversity loss at global, regional and national level" has been explicitly recognized (Casetta *et al.*, 2019).

South Africa has exceptional biodiversity that is characterised by a wide variety of ecosystem types, high species richness, and high levels of endemism. South Africa's biodiversity provides an array of benefits to the economy, society, and human wellbeing. These benefits that nature provides are dependent on intact ecosystems, healthy species populations and genetic diversity (SANBI, 2019). In South Africa, the National Environmental Management Biodiversity Act sets out a framework for planning the conservation and sustainable use of biological diversity within a broader framework of planning for sustainable development. It provides for the development, monitoring and review of a national biodiversity framework, which will be a National Biodiversity Strategy and Action Plan (NBSAP) giving effect to the objectives of the Convention on Biological Diversity (CBD). The preparation of bioregional conservation plans, that embody the ecosystem approach of conservation in the context of climatic and geographical characteristics and interaction, is provided for as well as other conservation plans addressing specific components of biodiversity requiring special conservation attention. It is therefore required that property owners should manage their own biodiversity effectively and contribute to the integrated management thereof on a regional and national context. According to Hermoso *et al. (*2016), declaring protected areas (PAs) (such as the proposed De Berg Private Nature Reserve) stands out as one of the main conservation strategies worldwide and there are clear commitments to expand their extent under the auspices of the Convention on Biological Diversity. The DBPNR as a proposed future protected area can therefore play an integral part in biodiversity conservation on various levels.

The main objective of this study was to utilise all available information, supplemented with focussed specialist assessments for the compilation of a baseline Biodiversity Management Plan for the proposed DBPNR section. The primary sources of information utilised were focussed specialist studies on vegetation (Addendum A: De Castro & Brits, 2022a, authored by T. de Castro), wetlands (Addendum B: De Castro and Brits, 2022, authored by R. Grobler), terrestrial fauna (Addendum C: Deacon, 2022), aquatic fauna (Addendum D: CSBS, 2022, authored by Kotze, Palmer & Koekemoer), and terrestrial invertebrates (Addendum E: De Castro & Brits, 2022c, authored by L. Niemand) conducted during 2020 to 2022, as well as relevant information contained in previous studies conducted in the area. The current study therefore enabled relatively high confidence analyses of the present status of the site-specific biodiversity of the DBPNR study area. This baseline management plan can serve as the foundation of the biodiversity management actions for the study area.

The current report (baseline Biodiversity Management Plan) therefore provides an overview and integration of the important biodiversity-related aspects identified during the biodiversity assessments for the study area. A primary objective of the current study was to delineate the

study area into different broad-scale biodiversity management units (BMU's), with distinct biodiversity aspects and management requirements. It furthermore describes the status of different biodiversity components (e.g. vegetation, frogs, reptiles, birds, mammals, fish, invertebrates) within the study area and presents management actions that could be implemented to conserve the biodiversity of the area. An additional deliverable of this investigation is a GIS application that aims to provide a spatial presentation of the important biodiversity aspects of the study area.

The proposed DBPNR presently contains a large natural area with very high biodiversity conservation value. Detailed assessments of site-specific ecosystems and the development of a management and monitoring strategy for biodiversity will enable the land-owner to manage its biodiversity effectively and to facilitate the integrated management thereof in a regional and national context. In this sense, management and conservation refers to the conservation of biological diversity, rehabilitation of disturbed areas, as well as the sustainable use of its biodiversity components. This biodiversity management plan aims to provide the primary information that is required to compile a site-specific Biodiversity Action Plan for the biodiversity management of the DBPNR study area to ensure compliance with applicable legislation.

NB: Purpose of this report
It must be emphasised that the aim of this BMP (current report) is not to provide all the detail regarding the different biodiversity aspects of the study area, but rather to delineate the DBPNR into "areas with specific biodiversity aspects and management requirements" (Biodiversity Management Units: BMU's), highlight the most important biodiversity aspects of the study area and provide management options to be considered. Throughout the report, recommended biodiversity management actions are **highlighted**. The detail regarding the different biodiversity components (vegetation, fauna) is provided in the separate specialist reports (addenda to this report). The Biodiversity Management Plan is furthermore supported by a GIS application that enables the presentation of spatial biodiversity information and to enable the overlay of different biodiversity aspects on aerial views of the mining area. These include aspects such as maps showing the biodiversity management units (BMU's) with hyperlinks to detailed descriptions of each BMU, locations of areas or species of conservation concern, national and regional conservation sector plans, etc.

2. OBJECTIVE

The main objective of this project was to compile a baseline site-specific biodiversity management plan for the proposed De Berg Private Nature Reserve (DBPNR) (approximately 2 127ha). Information on the relevant biodiversity aspects should provide data to facilitate integrated decision-making for the day-to-day management of the area. Management considerations can therefore be assessed jointly for aspects such as vegetation, terrestrial fauna (reptiles, amphibians, birds, small mammals), and aquatic biota (macroinvertebrates and fish) with existing or new developments. The land-owners should also be able to utilise this information to identify the potential direct impacts of their current and future activities on biodiversity, assess the risks, and take action to minimize negative and maximize positive effects through the implementation of biodiversity management actions. The biodiversity management plan should evolve and be updated over time as more information becomes available during follow-up specialist studies and a biodiversity monitoring programme. The current baseline BMP should therefore provide a starting point of a long-term initiative and it is important that the land-owner utilizes these findings to define achievable management objectives concerning the identified biodiversity aspects.

3. APPROACH

The following approach was utilised during this study:

- Verification and, where necessary, refinement of the existing mapping of Biodiversity Management Units (BMU's) for the DBPNR.
- Further specialist floral and faunal investigations were conducted to gather information regarding species composition and biodiversity aspects of each BMU.
- The ecological importance of habitats and associated species per BMU was done.
- The occurrence, or possible occurrence, of Threatened, sensitive, and important species and habitats within each BMU was investigated.
- The expected present human-related impact or risks to the botanical and faunal biodiversity aspects of each BMU was assessed.
- Specific management actions were recommended that can be taken to protect the biodiversity aspects of concern within each BMU.
- A GIS application was populated with maps indicating important biodiversity layers and BMU's that are linked to documents indicating their important biodiversity aspects and proposed management measures.
- Recommendations were made for future biodiversity related work and biodiversity monitoring requirements.

4. BACKGROUND ON BIODIVERSITY

The National Environmental Biodiversity Act of 2004 and Mining and Biodiversity Guidelines (DEA *et al.*, 2013) defines biological diversity as "the variability among living organisms from all sources including inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part including diversity within genes, species and between species (plant and animals), ecosystems, land-/seascapes, as well as ecological and evolutionary processes that allows these elements of biodiversity to persist over time". Biodiversity ensures the proper functioning of ecosystems, by ensuring that all the biological elements of the ecosystem are present, and therefore support the ecosystem's ability to provide value to humans and other organisms (ecosystem services) (COMSA, 2009; DEA *et al.,* 2013).

The Millennium Ecosystem Assessment of 2005 states that, over the past 50 years, humans have changed ecosystems more rapidly and extensively than in any comparable period of time in human history, largely to meet rapidly growing demands for food, fresh water, timber, fibre, and fuel. This has resulted in a substantial, and largely irreversible, loss in the diversity of life on earth. The changes that have been made to ecosystems have contributed to substantial nett gains in human well-being and economic development, but these gains have been achieved at growing costs in the form of degradation of many ecosystem services, increased risk of nonlinear changes, and the exacerbation of poverty for some groups of people. These problems, unless addressed, will substantially diminish the benefits that future generations obtain from ecosystems (Blignaut and Aronson, 2005).

South Africa ranks as the third most biologically diverse country in the world and contains three of the world's 34 biodiversity hotspots. As such, South Africa is of major global importance for biodiversity management and conservation (DEA *et al.,* 2013). Mining can be viewed as a sector of the South African industry that does not depend upon the direct, consumptive use of biodiversity, but may depend upon the maintenance of biodiversity, or may inadvertently have considerable negative impacts on biodiversity. Some of the potential negative impacts mentioned include habitat degradation, loss and fragmentation, the overexploitation of species, the pollution

of soil, air and water, the invasion of harmful alien organisms, and climatic change. A concern that arises with the use of land for mining is that the level of biodiversity in the region is normally diminished as a result. This concern can be addressed through proper planning, responsible mining with concurrent rehabilitation, as well as through special measures to conserve resident species. Ecosystems support all life in a variety of ways: directly, through oxygen production by plants, recycling and redistribution of nutrients and minerals; or indirectly through provision for waste disposal. These natural systems provide for basic human needs such as food and water.

Legislative framework

Sustainable development is enshrined in South Africa's Constitution and laws. Section 24 of the Constitution states that "everyone has the right (a) to an environment that is not harmful to their health or well-being; and (b) to have the environment protected, for the benefit of present and future generations, through reasonable legislative and other measures that: prevent pollution and ecological degradation; promote conservation; and secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development."

Historically, biodiversity in South Africa was not regulated by means of National Legislation. The National Environmental Management: Biodiversity Act (no. 10 of 2004) now sets out a framework for planning the conservation and sustainable use of biological diversity in South Africa. Landowners are now legally obliged to manage the biodiversity on their properties. The following two acts specifically aim to regulate biodiversity management:

1. National Environmental Management: Biodiversity Act No. 10 of 2004

The National Environmental Management: Biodiversity Act (NEM:BA) No. 10 of 2004 sets out a framework for planning the conservation and sustainable use of biological diversity within a broader framework of planning for sustainable development. It provides for the development, monitoring, and review of a national biodiversity framework, which shall be a National Biodiversity Strategy and Action Plan (NBSAP), giving effect to the objectives of the Convention on Biological Diversity (CBD). The preparation of bioregional conservation plans, that embody the ecosystem approach of conservation in the context of climatic and geographical characteristics and interaction, is provided for as well as other conservation plans addressing specific components of biodiversity requiring special conservation attention. Some of the sections relevant to the current study are as follows:

- Section 52-53: Your operation should be aware that in terms of Section 52, the Minister or the MEC of a province might, by notice in the Government Gazette, publish a list of ecosystems, which are Threatened, and in need of protection. Your operation should be aware that in terms of Section 53, the Minister may, by notice in the Government Gazette, identify any process or activity in an ecosystem listed as Threatened and in need of protection, as a threatening process, which requires prior authorisation from the Minister or MEC.
- Section 65-69: The Biodiversity Act defines "restricted activity" in relation to an alien species or listed invasive species as including having in possession or growing such species.
- Section 75: In terms of Section 75, your operation must control and eradicate listed invasive species by means of the prescribed methods.

2. The National Environmental Management Act (NEMA) (Act No. 107 of 1998)

The NEMA principles apply throughout South Africa to the actions of all organs of state that may significantly affect the environment, and thus to decision-making on mining applications. These principles require that impacts on biodiversity and ecological integrity are avoided, and if they cannot altogether be avoided, are minimised and remedied. They also specify that the costs of remedying pollution, environmental degradation, and consequent adverse health effects and of preventing, controlling or minimising further pollution, environmental damage, or adverse health effects must be paid for by those responsible for harming the environment. Moreover, the responsibility for the environmental health and safety consequences of a policy, programme, project, product, process, service, or activity exists throughout its life cycle.

NEMA principles of particular relevance to biodiversity (DEA *et al.*, 2013) include the following:

- Section 2(4)(a)(i): the disturbance of ecosystems and loss of biological diversity are avoided, or, where they cannot be altogether avoided, are minimised and remedied.
- Section 2(4)(a)(ii): pollution and degradation of the environment are avoided, or, where they cannot be altogether avoided, are minimised and remedied.
- Section 2(4)(a)(vi): the development, use and exploitation of renewable resources and the ecosystems of which they are part do not exceed the level beyond which their integrity is jeopardised.
- Section 2(4)(a)(vii): a risk-averse and cautious approach is applied, which takes into account the limits of current knowledge about the consequences of decisions and actions.
- Section 2(4)(e): responsibility for the environmental health and safety consequences of a policy, programme, project, product, process, service or activity exists throughout its life cycle.
- Section 2(4)(o): The environment is held in public trust for the people, the beneficial use of environmental resources must serve the public interest and the environment must be protected as the people's common heritage.
- Section 2(4)(p): The costs of remedying pollution, environmental degradation and consequent adverse health effects and of preventing, controlling or minimising further pollution, environmental damage or adverse health effects must be paid for by those responsible for harming the environment.
- Section 2(4)(r): Sensitive, vulnerable, highly dynamic or stressed ecosystems, such as coastal habitats including dunes, beaches and estuaries, reefs, wetlands, and similar ecosystems require specific attention in management and planning procedures, especially where they are subject to significant human resource usage and development pressure.

3. The National Environmental Management: Protected Areas Act 57 of 2003

Some of the relevant sections in this act pertaining to mining are as follows:

- Your operation should be aware that in terms of Section 9, the following kinds of protected areas are identified in the Act: special nature reserves (including wilderness areas) and protected environments; specially protected forest areas, forest nature reserves and forest wilderness areas declared in terms of the National Forests Act 84 of 1998 and mountain catchment areas declared in terms of the Mountain Catchment Areas Act 63 of 1970.
- Section 84: Your operation may not conduct commercial prospecting or mining activities in a protected environment without the written permission of the Minister and Cabinet member responsible for minerals and energy. Your operation should be aware that the Minister may review prescribed conditions with regard to any mining activities being conducted on any of these areas prior to 1 November 2004.

Other legal obligations and acts addressing the protection of biodiversity in South Africa include (COMSA, 2009):

- The Constitution of South Africa (Act No. 108 of 1996)
- National Water Act (Act No. 36 of 1998)
- Conservation of Agricultural Resources Act (Act No. 43 of 1983)
- Mineral and Petroleum Resources Development Act (MPRDA) (Act 28 of 2002).
- National Forest Act (Act 84 of 1998)
- National Environmental Management: Integrated Coastal Management Act (Act 24 of 2008).
- Convention on Biological Diversity
- Conventions on Wetlands (Ramsar Convention)
- World Heritage Convention (WHC) and World Heritage Convention Act (Act 49 of 1999)
- Convention of Migratory Species of Wild Animals.

The National Biodiversity Assessment 2018 (SANBI, 2019)

The National Biodiversity Assessment (NBA) is the primary tool for monitoring and reporting on the state of biodiversity in South Africa and informs policies, strategic objectives, and activities for managing and conserving biodiversity more effectively. The NBA is especially important for informing the National Biodiversity Strategy and Action Plan (NBSAP), the National Biodiversity Framework (NBF), and the National Protected Area Expansion Strategy (NPAES), and also informs other national strategies and frameworks across a range of sectors, such as the National Spatial Development Framework, the National Water and Sanitation Master Plan, and the National Biodiversity Economy Strategy. The NBA 2018 key messages are grouped into three clusters: a) South Africa's biodiversity provides benefits to people; b) South Africa's biodiversity is under pressure, but solutions are at hand; and c) the NBA stimulates work to address knowledge gaps. The NBA (2018) especially reiterates that water security is essential for human wellbeing and socio-economic development. Aquatic ecosystems provide the quantity and quality of water that people require to live and prosper, and also play a crucial role in buffering us through drought periods and long-term climate variation. Biodiversity management plans, such as compiled during the current study, can provide valuable information to be used as part of the National Biodiversity Assessment process.

Goods and Services of Biodiversity

Biodiversity matters to human beings in a variety of ways. There are important aesthetical dimensions, but part of our existence depends on direct use of biodiversity. Some of the cultural contributions include the provision of food, water, shelter, building material, fuel, medicine, aesthetic value, spiritual value, educational purpose, and recreation. It furthermore contributes to biotic and abiotic processes such as adding oxygen to air, enrichment of soils, soil formation, supporting of nutrient cycle, provision of habitat for fauna and flora, limiting storm damage, and regulation of floods and climate.

Biodiversity also serves human society as an indicator of ecological change. A few years ago, herpetologists studying amphibians, particularly frogs, began to compare incidental notes and realized that there was a major decline in populations of frogs throughout the world in patterns that are hard to understand and explain. Something is happening that appears to affect frog populations, and it would be extremely valuable to identify these vectors of change before they affect humans directly.

According to DEA *et al.,* (2013), ecosystem services can be classified into four categories:

- Provisioning services are the harvestable goods or products obtained from ecosystems such as food, timber, fibre, medicine, and fresh water.
- Cultural services are the non-material benefits such as heritage landscapes and seascapes, recreation, ecotourism, spiritual values, and aesthetic enjoyment.
- Regulating services are the benefits obtained from an ecosystem's control of natural processes, such as climate, disease, erosion, water flows, and pollination, as well as protection from natural hazards.
- Supporting services are the natural processes such as nutrient cycling, soil formation, and primary production that maintain the other services.

Factors reducing biodiversity

The overexploitation of natural resources by our species is a frequently recognised factor responsible for the loss of biodiversity (Casetta *et al*., 2019). Diamond (1989) refers to the "Evil Quartet" or "the four horsemen of the apocalypse" as habitat loss and fragmentation, overharvesting, introduced predators and competitors, and secondary extinction, while Wilson (2002) expresses similar concerns by characterizing the HIPPO (i.e. Habitat destruction, Invasive species, Pollution, (human) Population growth and Overharvesting). By far the biggest problem in protecting the world's biodiversity is habitat destruction. The numbers of loss can be staggering when considering the rapidly declining habitats, especially in the tropics.

Another outcome of habitat destruction is that the available habitat is broken up into pieces. A very disturbing picture appears when we begin to look at what this means for biodiversity. The fragmentation of habitats leaves remnants no longer connected to a larger wilderness and hence species are lost over time. This has serious implications for conservation and the use of landscapes. The good news is that if riparian habitats (vegetation along watercourses) are restored the landscape has more connectivity, eliminating some of the fragmentation problems.

Stress in the biological community reduces biodiversity. Stress can be a result of a number of factors including air pollution, high loads of fertilizer, introduced species, overgrazing, over utilisation, etc. Exotic fauna represent a very severe problem all over the world in this regard.

An additional and ultimate concern is global climatic change due to increasing levels of greenhouse gasses. Most of these gasses come from the burning of fossil fuels that represent carbon reservoirs that have been stored for thousands of millions of years, but which now are being oxidised and released into the atmosphere in a very short geological time. Biodiversity is dependent on an intricate web of factors that can be upset by rapid climatic change.

Beyond the immediate causes that threaten biodiversity, there are ultimate causes, such as human population growth – which adds roughly 100 million new people to the human population every year – and the massive impact of associated economic activities. In addition to these activities and the per-capita consumption in the industrial world, there is an enormously complex web of interactions. When a product is purchased, there may be a long chain between that product and some other part of this country or some other part of the world, which often goes unnoticed.

Biodiversity, Mining and Sustainable development

On the question "Why mining companies should consider biodiversity", the "Good Practice Guidance for Mining and Metals" (International Council on Mining and Metals, 2006) states that setting aside any ethical or moral considerations, which are increasingly the subject of corporate policies, it is important for companies to address biodiversity for a variety of sound business reasons. Many mining companies have adopted an increasingly sophisticated approach to managing biodiversity as part of their commitments to establishing and maintaining a social or functional 'licence to operate'. For example, adopting responsible practices with respect to biodiversity management is increasingly viewed as important with respect to:

- access to land, both at the initial stages of project development and for ongoing exploration to extend the lifetime of existing projects;
- reputation, which links to 'licence to operate', an intangible but significant benefit to business, and which can profoundly influence the perceptions of communities, NGOs, and other stakeholders of existing or proposed mining operations; and
- access to capital, particularly where project finance is to be obtained from one of the investment banks that are signatories to the Equator Principles, which apply the Biodiversity Performance Standard of the International Finance Corporation (IFC) to all investments in excess of $10 million (recognizing that strengthened commitments to biodiversity assessment and management are likely to be adopted).

Although the legacy of the mining industry is not always good when it comes to social and environmental impacts, opportunities exist at every stage of the mining life cycle to reduce the impacts of mining on land use, greenhouse gas emissions, water, and biodiversity, and increase the benefits to nearby communities (DEA *et al,* 2013). Biodiversity and mines need to coexist and find common ground. Biodiversity issues are very real and present a real crisis due to increased consumption and populations. It has also become evident that the biosphere cannot tolerate the current mode of economic growth. Massive changes in behaviour are required in all sectors to achieve sustainable development. Mainstreaming biodiversity involves integrating the values and goals of biodiversity conservation into the economy. The aim of mines today is to be good stewards of the environment and strive to leave the communities in which they work better than they found them (Godsell, 2005). Mines have huge conservation potential, as they own large areas of land and only utilize a small area for mining operations. It is therefore at the local level that we can get mining and conservation integration right (Godsell, 2005). It is important to build into the mining decision framework the understanding that not all biodiversity can be restored, and this should influence mining decision-making. An ecosystem approach should be followed for planning and conservation, which should include a holistic biodiversity and livelihoods assessment (Coombes, 2005).

Sound biodiversity management is more than an ethical and moral imperative; it also makes good business sense (COMSA, 2009). The fundamental principle that is flouted by applying conventional national income accounting to depletable resources is the separation that must be maintained between income and capital (Blignaut and Aronson, 2005). This principle tells us that if you liquidate your assets and use the proceeds for consumption, you are living beyond your means, and in doing so you are undermining your ability to create future income. Three basic rules to sustainability include: for renewable resources, the sustainable rate of use can be no greater than the rate of regeneration; for non-renewable resources, the sustainable rate of use can be no greater than the rate at which renewable resources, used sustainably, can be substituted for them; and for pollutants, the sustainable rate of emissions or effluent can be no greater than the rate at which a given pollutant can be recycled, absorbed or rendered harmless by the environment (Blignaut and Aronson, 2005).

According to COMSA (2009), two of the common reasons for mining companies to manage biodiversity impacts are legislative compliance and risk management. In addition, a greater involvement in biodiversity management adds to the improved image awarded to a company which is seen to be carrying out positive measures towards biodiversity conservation and sustainable development. Failure to adequately manage biodiversity issues can lead to:

- Prosecution and increased liabilities.
- Increased rehabilitation, remediation and closure costs.
- Local community, civil society, and shareholders' objections and mobilisation.
- Restricted access to raw materials such as access to land and water resources.
- Compromised access to finance and insurance.

The consideration of biodiversity conservation and protection throughout the phases of a mining project can also reduce the social, economic, and environmental risks, and have the following benefits (COMSA, 2009):

- Less contentious authorisation periods, as a result of better relationships with regulatory agencies and stakeholders, and thus fewer objections and appeals.
- Reduced risks and liabilities.
- Improved local community relations and partnerships.
- Improved employee loyalty and motivation.

If we can bring about a more integrated approach to living within our ecosystems, we are much more likely to save the fundamental structure of biodiversity. Positive contributions can be made even on a small scale such as within the De Berg Private Nature Reserve or even just in a single garden. All stakeholders, such as business, government, and environmental groups need to be involved to avoid a staggering loss of biodiversity in the decades and centuries ahead. A good start in the local context of DBPNR is to organize the knowledge of existing biodiversity. Practicable management principles could then be incorporated into the reserve's management plan. It is just good basic biological housekeeping to try to find out what we have and where it is. In turn, biodiversity can be enjoyed and used in a variety of ways and we can learn even more about it and thus help ourselves achieve sustainable development.

Mining and biodiversity guidelines

In 2013, guidelines on mining and biodiversity were published that focuses on guidance to the mining sector on how to address biodiversity issues in the South African context. It aims to provide the mining sector with a practical, user-friendly manual for integrating biodiversity considerations into planning processes and managing biodiversity during the development and operational phases of a mine, from exploration through to closure. It is, however, emphasised that the guideline does not exempt the user from complying with the relevant pieces of legislation (DEA *et al*., 2013). Although the proposed DBPNR is not earmarked for mining as it is an offset area for current Northam Booysendal mining impacts, this information remains of importance should mining be considered in future within DBPNR or the surrounding area.

The guideline document again highlights the fact that the mining industry plays a vital role in the growth and development of South Africa and its economy and the rich endowment of mineral resources has been a key driver of social and economic development. However, it also emphasises that on par with this mineral wealth are exceptional endowments of biodiversity and ecosystems. Sustaining the goods and services that flow from our ecosystems, and the benefits

that these provide over the long term, will require limits in mining and other activities in certain areas (DEA *et al.*, 2013).

The Guideline (DEA *et al.,* 2013) is founded on **six principles** that should be applied when addressing biodiversity issues and impacts in a mining context:

- Apply the law (as a minimum)
- Use the best available biodiversity information
- Engage relevant stakeholders thoroughly
- Use best practice in environmental impact assessment (EIA) to identify, assess, and evaluate impacts on biodiversity
- Apply the mitigation hierarchy when planning any mining-related activities and develop robust environmental management programmes (EMP)
- Ensure effective implementation of EMPs, including adaptive management

The **principal impacts** of mining on biodiversity comprise (DEA *et al.*, 2013):

- The loss and/or degradation or conversion of land, marine and other aquatic habitats (removal of natural vegetation and destruction of habitat) and associated loss of species.
- Significant alteration of ecological processes, sometimes irreversibly (e.g. the breaching of aquitards, changes in the water table, disruption of species movement patterns, disruption of the local hydrological cycle, and permanent alteration of flow).
- Pollution (including noise and light pollution) and migration of pollutants in air, soils, surface water, groundwater, or the ocean.
- Introduction of invasive alien species.
- Changes in demand for, or consumption of, natural resources (either directly or through indirect or induced changes as a consequence of mining activities).

The **mitigation** of negative impacts on biodiversity and ecosystem services is a legal requirement for authorisation purposes and must take on different forms depending on the significance of the impact and the area being affected. A mitigation hierarchy is provided that strive to first avoid disturbance of ecosystems and loss of biodiversity, and where this cannot be avoided altogether, to minimise, rehabilitate, and then finally offset any remaining significant residual negative impacts on biodiversity.

Biodiversity priority areas are areas in the landscape or seascape that are important for conserving a representative sample of ecosystems and species, for maintaining ecological processes, or for the provision of ecosystem services and include the following categories:

- Protected areas (PA's)
- World Heritage Sites and their legally proclaimed buffers
- Critically endangered and endangered ecosystems
- Critical Biodiversity Areas
- River and wetland Freshwater Ecosystem Priority Areas (FEPAs), and 1km buffer of river and wetland FEPAs
- Ramsar Sites
- Protected area buffers
- Transfrontier Conservation Areas (remaining areas outside of formally proclaimed PAs)
- High water yield areas
- Coastal Protection Zone
- Estuarine functional zones

- Ecological support areas
- Vulnerable ecosystems
- Focus areas for land-based protected area expansion and focus areas or offshore protection.

Minimising impacts of mining is a mitigation measure that applies to the environment in general. In areas where the biodiversity to be affected is of conservation value or importance, then every effort should be made to minimise those impacts that cannot be avoided or prevented. Mining companies should strive to minimise impacts on biodiversity by (DEA *et al*., 2013):

- Minimising land clearing by using technologies and mining practices that minimise habitat disturbance and delineating working zones.
- Using proven pollution prevention, control, and treatment measures (e.g. treatment of acid mine drainage or leachate from mine waste/dumps).
- Implementing appropriate measures to prevent or manage the introduction and spread of potential invasive species.
- Using effective erosion control measures.
- Avoiding road building wherever possible (during the early stages of the mining life cycle in particular) or existing; and if roads are to be constructed, using existing corridors and building away from steep slopes or waterways.
- Using lighter and more energy efficient equipment to reduce impacts on biodiversity.
- Positioning drill holes and trenches away from sensitive biodiversity features where possible.
- Capping or plugging of drill holes to prevent animals becoming trapped or injured.
- Removing and rehabilitating roads and tracks that are no longer needed.
- Avoiding fouling or discharge of pollutants into aquatic/marine ecosystems.
- Avoiding the introduction of alien species.
- Using indigenous vegetation to revegetate land on an ongoing basis as part of rehabilitation measures.

It should be noted that in some cases, where the habitat of highly threatened or local endemic species will be negatively impacted, 'search, rescue and relocation' measures are over-emphasised as a means of 'minimising' impact. This measure is not an acceptable form of mitigation. These measures are no substitute for *in situ* conservation and, although they may appear to be effective in the short term, they have a net effect of shrinking the distribution of the species and increasing their vulnerability to extinction through loss of habitat. In areas where the biodiversity (or ecosystem services) to be affected are of conservation value or importance, such as in biodiversity priority areas, it is especially important that mitigation should not stop at minimising impacts; implementing measures to remedy remaining impacts through rehabilitation/restoration and/or biodiversity offsets should become an imperative as reflected in the national environmental management principles (Section 2 of NEMA). **[Refer to section 6 in this report for mining and biodiversity guidelines mapping and categories of concern for the DBPNR study area].**

5. STUDY AREA: DE BERG PRIVATE NATURE RESERVE (DBPNR)

The 2 127 ha DBPNR comprises the farms De Berg 71JT, Triangle 72JT, Sterkfontein 52JT Portion 3, and Goedehoop 79JT Portion 6 and is situated in the northern parts of the Mpumalanga Province between Roossenekal and Lydenburg and directly to the north of the Verloren Vallei Nature Reserve (Figure 1). The farms De Berg and Triangle are included in the Davel Private Nature Reserve which was proclaimed in 1965 (Government Gazette No. 3134, 27 January 1965). The current study area focussed on the area earmarked to offset any negative environmental impact that may be caused in the footprints of Northam Booysendal Platinum mine and is in accordance with a biodiversity offset agreement between Booysendal Platinum, Mpumalanga Tourism and Parks Agency (MTPA), and the Buttonshope Conservation Trust. The land-owners also aim to link the proposed DBPNR with the existing MTPA Verloren Vallei Nature Reserve (through the Goedehoop 79JT portion 6), thereby creating a larger conservation area (Figure 1).

Almost the entire study area comprises untransformed grassland and, to a lesser extent, bushveld vegetation grazed and browsed by wildlife (Figure 1), including introduced Blesbok and naturally occurring Southern Mountain Reedbuck, Grey Rhebok, Common Duiker, Klipspringer, Bushbuck (confined to the Groot Dwars River valley), Bushpig, Porcupine, Rock Hyrax, Scrub Hare, and Jameson's Red Rock Rabbit. The vegetation of the study area shows no signs of overgrazing and is almost entirely in a pristine to near-pristine state. A few, small patches of secondary grassland of historically cultivated areas, are present on the farms Sterkfontein and Goedehoop, but these secondary grasslands cover only ca. 7 ha within the DBPNR.

Infrastructure covers a total of 6 ha within the DBPNR and includes a farm labourer's dwelling on the southern boundary of the farm Sterkfontein, a communications tower complex on the summit of De Berg peak, an old homestead on the farm De Berg which now serves as the DBPNR management offices, a tourist cottage on the farm Goedehoop, and a regional dirt road which cuts through the western parts of the farm Goedehoop. An abandoned and unusable mining exploration track is present on the farm Sterkfontein on the steep slopes above the Groot Dwars River. Numerous, small invasive stands of alien trees occur in the northern parts of the farm De Berg and on the farm Triangle, and two small plantations (each less than 8 ha) of Eucalyptus trees are present on the farms De Berg and Goedehoop. A total of four small farm dams (none larger than 1.3 ha) and one small, inundated quarry are present on the farms De Berg and Goedehoop.

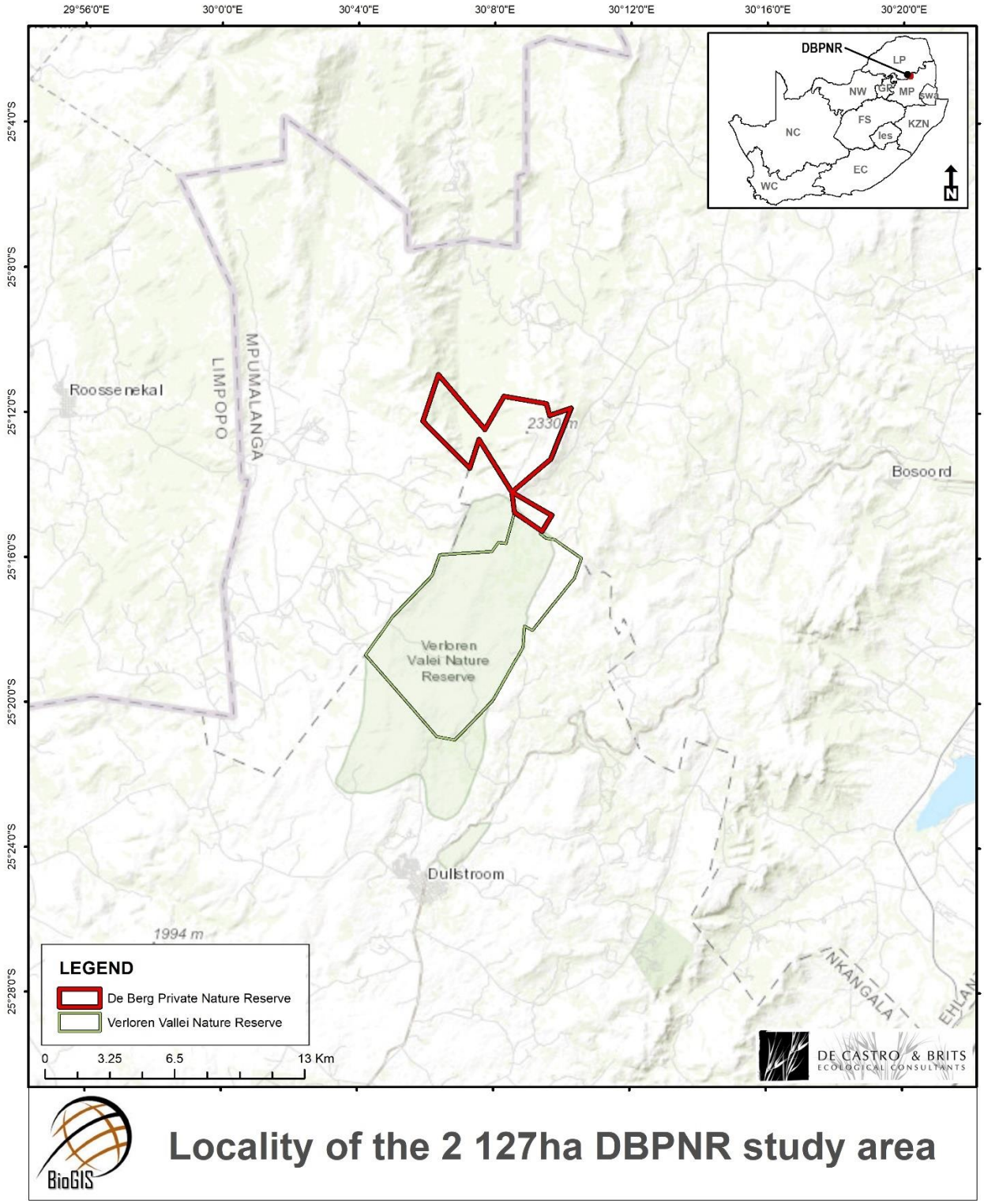


Figure 1: Locality map of DBPNR study area.

Physical habitat and climate

Elevation within the 2 127 ha DBPNR study area varies dramatically from 1 372 m.a.s.l. at the point where the upper Groot Dwars River flows out of the DBPNR on the northern boundary of the farm Sterkfontein to 2 332 m.a.s.l. on the summit of the De Berg peak situated on the farm De Berg. The prominent topographical features of the study area are the deep valley of the Groot Dwars River, the rocky (igneous), north-south orientated ridge of the Dwarsberge that reaches an elevation of ca. 1 977 m.a.s.l. on the western boundary of the DBPNR, and the De Berg peak (2 332 m.a.s.l.) which is the highest point within the Steenkampsberg Mountains and the Mpumalanga Province. The vegetation of the study area shows strong correlation with geology, but also with altitudinal gradients which have a pronounced impact on climatic conditions (e.g. temperature, rainfall, and humidity) and various aspects of vegetation structure (*sensu* Kent & Coker, 1992) such as physiognomy, life-form composition, species composition, and species dominance. In the hotter, drier valley habitat on the lower slopes of the Groot Dwars River valley the vegetation is representative of bushveld, which grades to wooded grassland and then grassland on the cooler, more moist upper slopes, crests, and plateaus of the Dwarsberge and Steenkampsberg. Many of the plant species occurring within the DBPNR are restricted to well defined altitudinal ranges (e.g., the endemic tree *Lydenburgia cassinoides* occurs only below 1 600 m.a.s.l. and various plant SCC occur only at elevations of above 2 100 m.a.s.l. on the Steenkampsberg).

In accordance with the VEGMAP 2018 (Mucina & Rutherford, 2006 and Dayaram *et al*., 2017), the Steenkampsberg Montane Grassland vegetation type, which comprises approximately two thirds of the study area, experiences a similar climate to the adjacent Sekhukhune Montane Grassland but features moderately higher rainfall and cooler temperatures with occasional snow falls during winter at higher altitudes. According to the VegMap 2018, mean annual precipitation within this vegetation type is 798 mm, mean annual temperature is 14.1°C and mean frost days is 23 (Dayaram *et al.,* 2017 Dayaram *et al.,* 2019).

The Sekhukhune Montane Grassland vegetation type, which comprises approximately one fifth of the study area, experiences a similar climate to the adjacent Steenkampsberg Montane Grassland. This region features a summer rainfall regime with annual precipitation varying from 600 mm in the west to 720 mm in the east of where the study area is situated (Mucina & Rutherford, 2006). Annual rainfall recently measured at the Booysendal Mine's Department of Land Management offices situated some 10 km north-north-east of the DBPNR on the farm Pietersburg at an elevation of ca. 1 940 m.a.s.l., was 772 mm in 2018, 724 mm in 2019, and 1095 mm in 2020 (Marius Kruger, pers. comm.). Much of the rainfall occurs during thunderstorms between November and January. Mean daily temperature ranges from a minimum of 2.8°C in winter to a maximum of 24.9°C in summer (Mucina & Rutherford, 2006) and vary considerably with altitudinal gradients.

The Sekhukhune Mountain Bushveld vegetation type, which comprises approximately 7% of the DBPNR, features summer rainfall with very dry winters. Annual precipitation is 500-700 mm, but local topography influences rainfall patterns over short distances (Mucina & Rutherford, 2006). Mean annual rainfall measured at Booysendal Mine, situated some 8 km to the north of the DBPNR, was approximately 688 mm in 2017 (Booysendal Mine unpubl. data). Daily temperatures vary considerably at different localities in accordance with the rugged topography, with highest temperatures in lower-lying areas and lowest temperatures on southern aspects of mountains. Temperatures below freezing point rarely occur in the region, even at higher altitudes (Siebert *et al.*, 2003).

Geology and soils

In accordance with the 1:250 000 geological map of 2530 Barberton (Council for Geoscience, 2001), the main geological features on which the DBPNR study area is situated are the Bushveld Igneous Complex and the Transvaal Sequence. The geology of approximately 31% of the study area consists of well exposed ultramafic rocks of the Rustenburg Layered Suite of the Bushveld Igneous Complex which has been described in detail by Siebert (Siebert *et al*., 2002c). These areas of ultramafic igneous rock occur mainly on the farms Sterkfontein Portion 3 and Triangle, but smaller areas with this geology are also present in the northern parts of the farm De Berg. The areas of ultramafic igneous rock of the farms Triangle and De Berg are isolated as a result of lava flowing over quarzitic geology of the older Transvaal Sequence and subsequent erosion or as a result of magma extrusions. These ultramafic rocks comprise norite, gabbro, anorthosite, and pyroxenite of the Dwars River and Dsjate Subsuites of the Rustenburg Layered Suite (Siebert *et al*., 2002c), but within the study area surface geology seems to comprise very largely of norite and quartz-norite (norite with a higher silica content). High concentrations of heavy metals (e.g. chromium, cobalt, iron and nickel) occur in metalliferous or serpentiniferous soils derived from ultramafic rock, and the norite, anorthosite, and pyroxenite ultramafic substrates show a significant positive correlation with percentage plant endemism in the Sekhukhuneland Centre of Plant Endemism (Siebert *et al.* 2001 & Siebert 2002c). Soil types of Sekhukhuneland are mainly red or black montmorillonitic clays and are rich in ions such as Calcium, Potassium, Sodium and Magnesium (Siebert *et al.*, 2001). Within the study area, the soils overlying ultramafic geology are predominantly shallow, rocky, and clayey. Glenrosa and Mispah soil forms are common. Rocky areas without soil (exposed sheetrock or rock 'balds') are common on steep slopes.

The Dwars River Valley is characterised by prismacutanic horizons with melanic structured diagnostic horizons (Mucina & Rutherford, 2006). Deeper soils are largely restricted to the alluvial deposits on the narrow, active- and paleo-floodplains of the extreme upper reach of the Groot Dwars River (BMU7 in the current report) situated within the study area, as well as some areas of deeper soils deposited by hillwash on adjacent foot slopes. Erosion is severe in places, as is evident along abandoned, severely eroded mining exploration tracks on steep slopes and in areas of natural erosion such as the large, 'slip-slope' terrace at Site xc76 on the farm Triangle.

The geology of approximately 70% of the study area forms part of the Transvaal Sequence. More specifically, the geology comprises mainly quartzites, arenite and minor shale of the Steenkampsberg Formation of the Pretoria Group (Lötter, 2019 and www.agis.agric.za, accessed June 2020), but no surface shale was recorded within the study area during the current or previous surveys by the author (De Castro & Brits, 2021a, 2022a). The geology of the Transvaal Sequence comprises approximately 69% of the farm Sterkfontein Portion 3, over half of the farm Triangle, the vast majority of De Berg and Goedehoop (some exposed diabase dykes form linear ridges on the farm Goedehoop). The landscape is characterised by extensive outcrops of quartzitic rock interspersed with short grassland on deeper soils comprising colluvial sediments of Quaternary origin. An exposed diabase dyke forms a narrow band of boulder strewn rocky habitat with an extent of approximately 13 ha on the farm Goedehoop. The soils of the parts of the study area that are situated on the Transvaal Sequence are largely freely drained, dystrophic, sandy soils or sandy loams. Peat substrates are present in valley-bottom wetlands and in hillslope seeps, predominantly on the high-lying plateau of the farm De Berg at elevations of over 2 000 m.a.s.l., but also at a few sites on the farm Triangle and a single site in the north-eastern corner of the farm Sterkfontein Portion 3.

6. REGIONAL BIODIVERSITY CONSERVATION CONTEXT

6.1 Threatened ecosystems

All parts of the DBPNR comprise one of two threatened terrestrial ecosystems as listed in the 2011 Schedule (Notice 1002 of Government Gazette No. 3489, 9 December 2011) of the National Environmental Management: Biodiversity Act (Act 10 of 2004), which provides a 'National List of Ecosystems that are threatened and in need of protection', in one of four categories: Critically endangered (CR), Endangered (EN), Vulnerable (VU), or Protected. The two threatened ecosystems comprising the study area are Sekhukhune Mountainlands (MP9) and Dullstroom Plateau Grasslands (MP4). Both ecosystems are listed as **Endangered** under Criterion F ('priority areas for meeting biodiversity targets'). The stated purpose of listing 'threatened ecosystems', is primarily to reduce the rate of ecosystem and species extinction. This includes preventing further degradation and loss of structure, function, and composition of threatened ecosystems.

The **Sekhukhune Mountainlands Threatened (Endangered) ecosystem** straddles the border of the Mpumalanga and Limpopo provinces and is situated predominantly on the high-lying norite mountains between Roossenekal, De Berg, and Steelpoort, within the Sekhukhuneland Centre of Plant Endemism described by Siebert (Siebert, 1998; Van Wyk & Smith, 2001) which is currently thought to include approximately 100 endemic and near-endemic plant taxa. In accordance with NEMBA 'National List of Ecosystems that are threatened and in need of protection', the portion of the DBPNR situated to the east of the Groot Dwars River is included in the Sekhukhune Mountainlands Threatened ecosystem.

The **Dullstroom Plateau Grasslands Threatened (Endangered) ecosystem** is confined to Mpumalanga and comprises high-altitude plateau grasslands of the Steenkampsberg between De Berg in the north and Belfast in the south. This threatened ecosystem coincides largely with the Lydenburg Centre of Plant Endemism which is currently thought to include approximately 100 endemic and near-endemic plant taxa (Lötter, 2019) as well as crucial breeding and feeding habitat for various fauna including the Critically Endangered bird species Wattled Crane and Rudd's Lark. In accordance with NEMBA 'National List of Ecosystems that are threatened and in need of protection', the portion of the DBPNR situated to the west of the Groot Dwars River is included in the Dullstroom Plateau Grasslands Threatened ecosystem.

6.2 Centres of plant endemism

The 2 127 ha DBPNR falls entirely within one of two centres of plant endemism, namely the **Sekhukhuneland Centre of Plant Endemism (SCPE)** (Siebert, 1998; Van Wyk & Smith, 2001) and the **Lydenburg Centre of Plant Endemism (LCPE)** (Lötter, 2019). The SCPE is situated on the ca. 4 000 km^2 of well exposed ultramafic rocks of the eastern Rustenburg Layered Suite which straddles the border of the Mpumalanga and Limpopo Provinces between Stoffberg in the south and the Potlake Nature Reserve in the North (Siebert *et al.*, 2001). The LCPE is entirely situated within Mpumalanga where it occurs on the Timeball Hill and Steenkampsberg Geological Formations of the Pretoria group between Carolina in the south and Pilgrims Rest in the north and the geology comprises predominantly of shale and quartzite with small quantities of andesite and diabase intrusions (Lötter, 2019).

Approximately 31.4% of the study area has an igneous geology (mostly norites) and falls within the SCPE (Siebert, 1998; Van Wyk & Smith, 2001). The portions of the study area included in

the SCPE (BMU's 1 and 2) fall mostly within the Roossenekal Sub-centre of the SCPE which is defined as the grassland areas in and adjacent to the quarter degree grid 2529 BB (Siebert, 1998). Siebert *et al.* (2001) identified 30 endemic and 50 near-endemic plant species for the SCPE, but various additional endemic species have subsequently been identified or newly described and no more recent, definitive list of endemics and near-endemics has been published. Lötter (2019) stated that the SCPE has a species richness of approximately 2 200 species, approximately 100 of which are endemic or near-endemic to the SCPE. The distribution of the endemics of the SCPE is positively correlated with the occurrence of ultramafic rocks (Siebert *et al.*, 2001). There is only one provincial nature reserve (Potlake Nature Reserve) in the SCPE and it is considered poorly protected and vulnerable to disturbance through mining developments.

Approximately 68.6% of the DBPNR, comprising mostly of the eastern and central parts on the farms De Berg and Triangle as well as the upper (southern) part of the Groot Dwars River valley, falls within the Steenkampsberg Sub-Centre of the LCPE (Lötter, 2019) and has a geology comprising mostly of quartzites and arenites. Lötter (2019) stated that the LCPE has a species richness of approximately 2 200 species, 80 of which are endemic to the LCPE, including 28 taxa that are endemic to the Steenkampsberg sub-centre of the LCPE within which the central and eastern parts of the DBPNR are situated. The flora of the LCPE is Afromontane with links to the Zimbabwean Highlands and the southern Drakensberg. The LCPE encompasses 46% of the Mpumalanga Province's flora in only 9.3% of its surface area (Lötter, 2019). Only 3.6% of the LCPE and 1.7% of the Steenkampsberg sub-centre of the LCPE is currently included within a legislated, state-owned Nature Reserve.

The recently described Limpopo-Mpumalanga-Eswatini Escarpment (LMEE) is a 'centre of endemism' comprising an orographic entity some 53 594 km^2 in extent that forms part of southern Africa's Great Escarpment and extends from Pongola River in the south, Woodbush in the north, the Highveld in the west and the Lowveld in the east (Clark *et al*., 2022). The LMEE therefore comprises a large area that encompasses both the SCPE and LCPE. A total of 496 endemic plant taxa have thus far been identified for the LMEE (Clark *et al*., 2022) and an initial screening indicated that a minimum of 52 LMEE endemics are present in the DBPNR (see Addendum A).

6.3 Mining and Biodiversity Guidelines

Based on the national mining and biodiversity guideline (DEA *et al.*, 2013) biodiversity priority areas map, the entire DBPNR study area falls within category (B) Highest biodiversity importance. More detail regarding the risk and implications for mining of these areas are provided in Table 1.

Table 1: Categories of biodiversity priority areas in relation to their biodiversity importance and implication for mining applicable to the DBPNR study area.

Category	Biodiversity priority areas	Risk for mining	Implications for mining
B. Highest biodiversity importance	• Critically endangered and endangered ecosystems • Critical Biodiversity Areas (or equivalent areas) from provincial spatial biodiversity plans • River and wetland Freshwater Ecosystem Priority Areas (FEPAs), and a 1km buffer around these FEPAs • Ramsar Sites	Highest risk for mining	Environmental screening, EIAs and their associated specialist studies should focus on confirming the presence and significance of these biodiversity features, and to provide site-specific basis on which to apply the mitigation hierarchy to inform regulatory decision-making for mining, water use licences, and environmental authorisations. If they are confirmed, the likelihood of a fatal flaw for new mining projects is very high because of the significance of the biodiversity features in these areas and the associated ecosystem services. These areas are viewed as necessary to ensure protection of biodiversity, environmental sustainability, and human well-being. An environmental impact assessment should include the strategic assessment of optimum, sustainable land use for a particular area and will determine the significance of the impact on biodiversity. This assessment should fully take into account the environmental sensitivity of the area, the overall environmental and socio-economic costs and benefits of mining, as well as the potential strategic importance of the minerals to the country. Authorisations may well not be granted. If granted, the authorisation may set limits on allowed activities and impacts, and may specify biodiversity offsets that would be written into licence agreements and/or authorisations.

6.4 Mpumalanga Biodiversity Sector Plans

The Mpumalanga Biodiversity Sector Plans (MBSPs) are spatial tools that form part of a broader set of national biodiversity planning tools and initiatives that are provided for in national legislation and policy. It comprises a set of maps of biodiversity priority areas accompanied by contextual information and land-use guidelines that make the most recent and best quality biodiversity information available for use in land-use and development planning, environmental assessment and regulation, and natural resource management. It must, however, be emphasised that the MBSP and LCP mapping was produced at a very broad-scale, over a number of years, and for an entire province, and their habitat and land-cover mapping is of necessity not as accurate as the vegetation, land-cover type, and sensitivity mapping provided in the current report.

Terrestrial Ecosystems

The 2 127 ha DBPNR falls within the Mpumalanga Province and its biodiversity conservation importance is mapped in the Mpumalanga Biodiversity Sector Plan Version 3 (MBSP 2014) (Lötter *et al*., 2014) (Figure 2). Most (59.6%) of the 2 127 ha DBPNR is categorised in the MBSP 2014 as 'Protected Areas'. The portion of the DBPNR mapped as 'Protected Areas' comprises the entire extent of the farms De Berg and Triangle as they comprise the previous Davel Nature Reserve which was proclaimed in 1965 and is now included in the Northam Booysendal Mine's larger De Berg Private Nature Reserve which has yet to be officially proclaimed. Areas mapped as 'CBA-Irreplaceable' comprise 9.9% of the DBPNR and areas mapped as 'CBA-Optimal' comprise 27.3% of the DBPNR. Areas mapped as 'Protected Areas', 'CBA-Irreplaceable', or 'CBA-Optimal' thus together comprise 96.8% of the DBPNR, which is regarded as an accurate reflection of the extremely high conservation importance of the DBPNR. The remaining 3.2% of the DBPNR comprises of the categories 'Other Natural Areas' (2.3%), 'Moderately modified-old lands' (0.4%) and 'Heavily modified' (0.4%) and 'ESA Landscape corridor' 0.1%.

The 49 ha (or 2.3% of the DBPNR) area mapped as 'Other Natural Areas' is situated in the south-eastern parts of the farm Sterkfontein and comprises almost entirely of near-pristine Sekhukhune Montane Grassland, two of the largest patches of well-developed Northern Afrotemperate Forest occurring in the study area and a large area of exposed norite bedrock which includes a large 'sheetrock seep wetland'. Various localities for plant SCC were recorded within the area mapped as 'Other Natural Areas' during the current study, including various localities for *Aloe barbera-jeppeaeae* (NT) and the type locality for *Ledebouria* sp. nov. '*noritica*' (Endangered), the latter being located on the sheetrock seep wetland. The 49 ha area mapped as 'Other Natural Areas' should be reallocated to 'CBA-Irreplaceable' category. Though the MBSP 2014 mapping was used to check for the presence of protected areas and potentially sensitive and conservation worthy areas prior to the conduction of field surveys, it must be emphasised that the MBSP mapping was produced at a very broad-scale, over a number of years, and for an entire province, and the MBSP habitat and land-cover mapping is of necessity not as accurate as the vegetation, land-cover type, and sensitivity mapping provided in the current report.

Table 2: Mpumalanga Biodiversity Sector Plan 2014 (Lötter *et al*., 2014) categories and land-use guideline.

MBSP biodiversity category	**Description of what is included** (ecosystems, species and processes)	**Primary objective of the Biodiversity Category**	**Permissible land-uses that are unlikely to compromise the biodiversity objective**
Protected Areas – National Parks & Nature Reserves	Protected Areas are formally protected by law and recognised in terms of the Protected Areas Act, including contract protected areas declared through the biodiversity stewardship programme. 'National Parks and Nature Reserves' is one of three subcategories and includes formally proclaimed national parks, nature reserves, special nature reserves, and forest nature Reserves.	Areas that are meeting biodiversity targets and therefore must be kept in a natural state, with a management plan focused on maintaining or improving the state of biodiversity.	All operational aspects of managing these areas must be subject to their main purpose, which is to protect and maintain biodiversity and ecological integrity and should be governed by a formally approved management plan and land use activities that support the primary function of these areas as primary sites for biodiversity conservation. The management plan must identify allowable activities, which should be consistent at least with the CBA-Irreplaceable category.
CBA-Irreplaceable	Areas that are 80-100% irreplaceable for meeting biodiversity conservation targets; or Critical Linkages; or Critically Endangered ecosystems.	Maintain in a natural state with no loss of ecosystems, functionality or species; no flexibility in land use options.	- Conservation/stewardship.
CBA-Optimal	Areas that are optimally located as part of the most efficient solution to meet biodiversity targets.	Maintain in a natural state with no loss of ecosystems, functionality or species; some flexibility in land use options.	- Conservation/stewardship. - Low impact tourism.
Other Natural Areas	Natural areas which are not identified as CBA's or ESA's, but which provide a range of ecosystem services from their ecological infrastructure.	Minimise habitat and species loss through strategic landscape planning and ensure basic ecosystem functionality.	All land-uses are either 'Permissible', or 'Permissible under certain conditions'.
Heavily Modified	Transformed areas, where biodiversity and ecological function have been lost to the point that they are not worth considering for conservation at all.	Manage the land use in a biodiversity-friendly manner aiming to maximise ecological functionality.	Almost all land-uses are 'Permissible', with the exception of quarrying/open cast mining and underground mining, which are either 'Permissible', or 'Permissible under certain conditions'.
Moderately Modified – old lands	Areas which were modified within the last 80 years but now abandoned, including old mines and old cultivated lands.	Stabilise and manage to restore ecological functionality, particularly soil carbon and water-related functionality.	Almost all land-uses are 'Permissible', with the exception of quarrying/open cast mining and underground mining, which are either 'Permissible', or 'Permissible under certain conditions'.

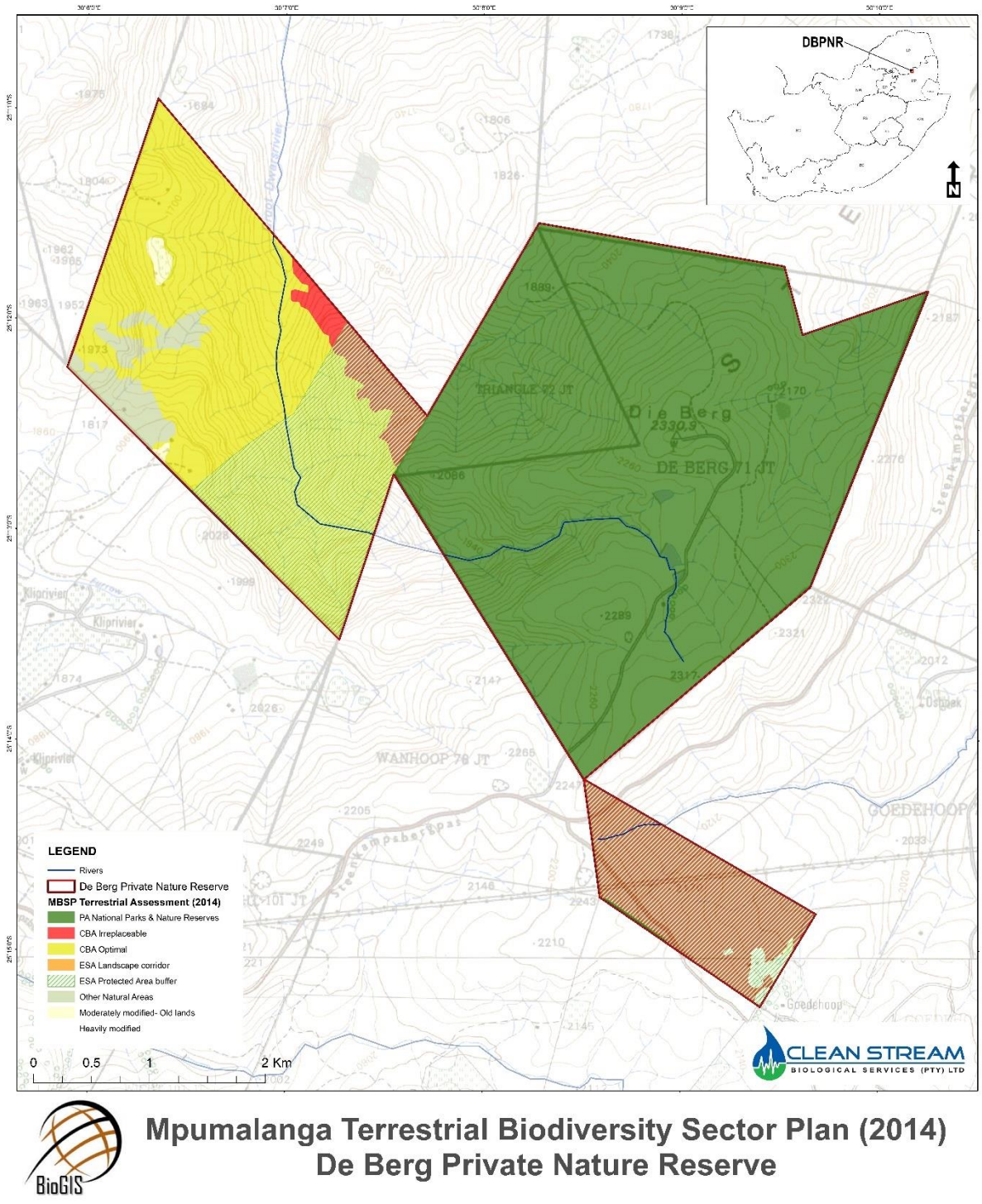


Figure 2: Mpumalanga Biodiversity Sector Plan Version 3 (MBSP 2014) map for the DBPNR study area (terrestrial ecosystems).

Aquatic / Freshwater ecosystems

In terms of aquatic ecosystems, the study area falls within the Olifants (B) Water Management Area (WMA) and specifically quaternary catchments B41G (Groot Dwars River and Everest tributary), B41C (Klip River), and B42F (Potspruit). The DBPNR study area is primarily drained by the upper (source streams) of the Groot Dwars River (sub-quaternary reach B41G-721), the most upper reaches of the Everest tributary that leaves the DBPNR to later flow into the Groot Dwars River outside of the current study area (before the inflow into Der Brochen Dam), and the upper Potspruit (on the farm Goedehoop) (Figure 3). The Groot Dwars Rivers (including the Everest tributary) confluence with the Klein Dwars River downstream of the study area to become the Dwars River that flows into the Steelpoort River (close to the town of Steelpoort), which is one of the primary tributaries of the Olifants River. The Klip River also flows into the Steelpoort River within the inundated section of the Goedehoop Dam. The Potspruit flows into the Waterval River (that includes the Buffelskloof Dam) and later joins the Spekboom River that also confluence with the Steelpoort River close to the town of Burgersfort. For the purpose of this aquatic fauna assessment, emphasis is placed on the Groot Dwars River (SQ reach B41G-721) and its tributaries (Everest tributary and various other small unnamed tributaries), the upper Klip River (B41C), as well as the upper reaches of the Potspruit (SQ reach B42F-812) (Figure 3).

The Groot-Dwars River (sub-quaternary reach B41G-721) is considered by the Mpumalanga Biodiversity Conservation Plan to be **"Critical Biodiversity Areas"** (FEPA River), while the various tributaries draining these sub-catchments (Everest Tributary, etc.) are classified as "**Ecological Support Areas: Important sub-catchments"** (FEPA sub-catchments) (Figure 3,Table 3).

Table 3: Summary of map categories shown in the freshwater/aquatic CBA map for Mpumalanga, and their meanings (MBSP 2014) (Lötter *et al.*, 2014).

Map category	Description	Subcategory	Description
Critical Biodiversity Areas (CBA)	All areas required to meet biodiversity pattern and process targets; Critically Endangered ecosystems, critical linkages (corridor pinch-points) to maintain connectivity; CBA's are areas of high biodiversity value that must be maintained in a natural state.	CBA: Rivers	Rivers, with a 100 m buffer, that need to be maintained in a good ecological condition in order to meet biodiversity targets for freshwater ecosystems. This category includes FEPA rivers and all FEPA free-flowing rivers. The FEPA rivers include those required to meet biodiversity targets for threatened fish species.
		CBA: Wetlands	Wetlands that are important for meeting biodiversity targets for freshwater ecosystems; the ecological condition of these wetlands needs to be maintained or improved, and their loss or deterioration must be avoided. This category includes FEPA wetlands.
		CBA: Aquatic Species	Areas considered critical for meeting the habitat requirements for selected aquatic invertebrate species (dragonflies, damselflies, crabs). These species are known to occur only at one or a few localities and are at high risk of extinction if their habitat is lost. Fish species are included under the CBA River category.
Ecological Support Areas (ESA)	Areas that are not essential for meeting targets, but that play an important role in supporting the functioning of CBA's	ESA: Wetland Clusters	Clusters of wetlands embedded within a largely natural landscape to allow for the migration of fauna and flora between wetlands.
		ESA: Wetlands	All non-FEPA wetlands. Although not classed as FEPAs, these wetlands support the hydrological functioning of rivers, water tables and freshwater

Map category	Description	Subcategory	Description
	and that deliver important ecosystem services.		biodiversity, as well as providing a host of ecosystem services through the ecological infrastructure that they provide.
		ESA: Important Sub-catchments	Sub-catchments that either contain river FEPAs and/or Fish Support Areas.
		ESA: Fish Support Area	Sub-catchments that harbour fish populations of conservation concern, based on FEPA data augmented with regional data sets.
		ESA: Strategic Water Source Areas	High rainfall areas that produce 50% of Mpumalanga's runoff in only 10% of the surface area, thus supporting biodiversity and underpinning regional water security.
Other Natural Areas (ONA)	Areas that have not been identified as a priority in the current systematic biodiversity plan but retain most of their natural character and perform a range of biodiversity and ecological infrastructural functions.		
Heavily Modified Areas	Areas in which significant or complete loss of natural habitat and ecological function has taken place due to activities such as ploughing, hardening of surfaces, open-cast mining, cultivation and so on.	Heavily Modified	Heavily Modified: All areas currently modified to such an extent that any valuable biodiversity and ecological function has been lost.
		Heavily Modified: Dams	Artificial water bodies that have impacted on wetland or river ecosystems. These areas may still have a recharge effect on wetlands, groundwater and river systems and may support river- or water-dependent fauna and flora, such as water birds and wetland vegetation.

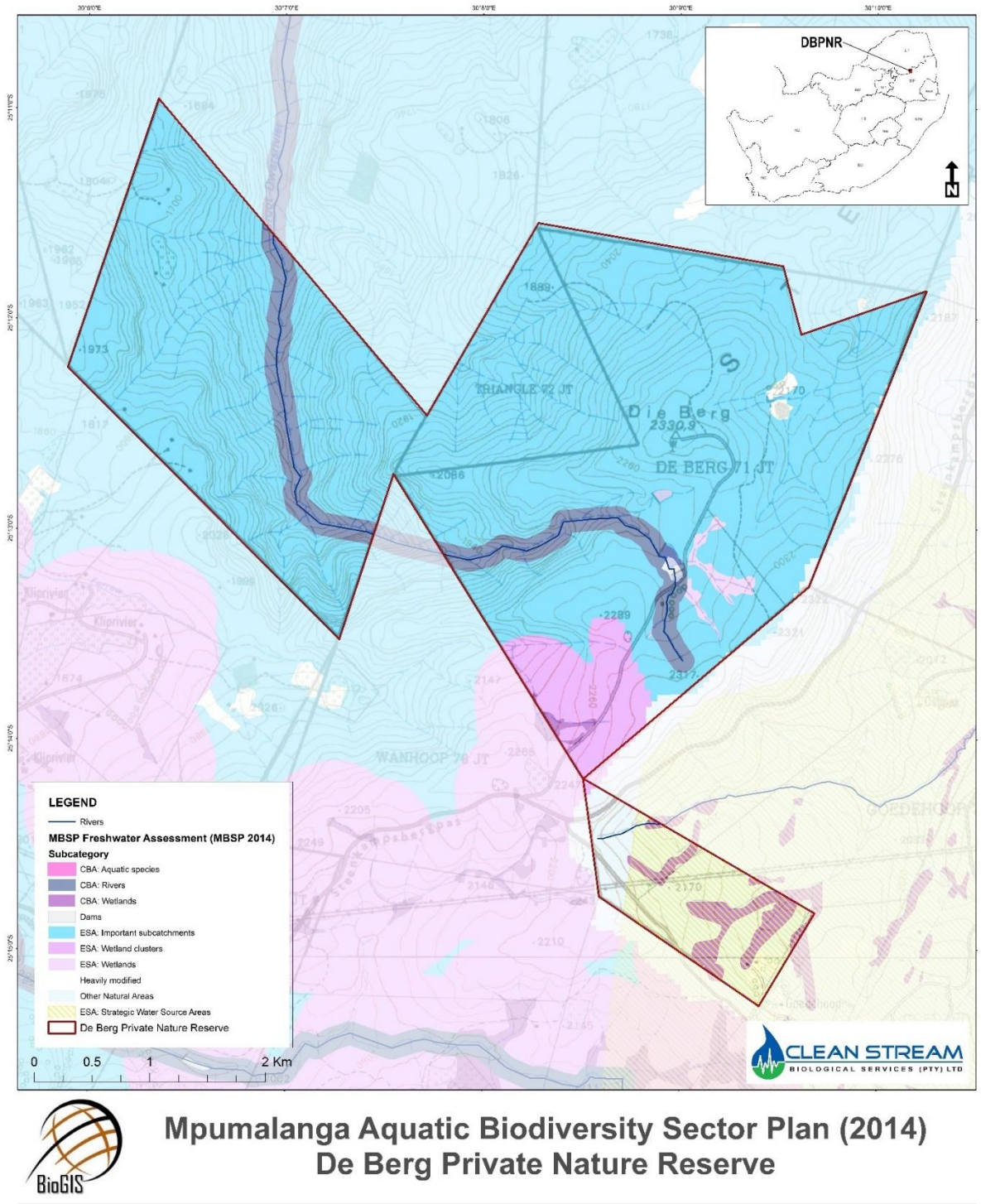


Figure 3: The location of DBPNR relative to the classification of aquatic biodiversity sub-catchments in the Mpumalanga Biodiversity Conservation Plan (2014).

6.5 National Freshwater Ecosystem Priority Area (NFEPA)

NFEPAs are rivers, together with their associated catchment, that are currently in a good to pristine state and are important in terms of maintaining Threatened or Near Threatened fish species. NFEPA Rivers should be maintained in a high level of biotic integrity in order to contribute to national biodiversity goals (Nel *et al.*, 2011). The river and its surrounding catchment, including tributaries, need to be managed in a way that maintains the good condition of the receiving river (A or B ecological category) (Nel *et al*., 2011).

The FEPA assessment indicated that the **Groot Dwars River** (SQ reach B41G-721) is **classified as a National Freshwater Ecosystem Priority Area** (Fish) (Figure 4). The fish species of conservation concern listed for this reach is *Opsaridium peringueyi*. This species is unlikely to occur within the Northam Booysendal study area (located upstream of the Der Brochen Dam) under present and, potentially, also under reference conditions. This species is relatively abundant in the Steelpoort River and will also frequent the lower section of the Dwars River (outside the study area). The presence of another fish species of conservation concern, namely *Enteromius cf. motebensis* in the study area, however, confirms the importance of the Groot Dwars River as a priority area and hence further support the classification of this sub-quaternary reach as a NFEPA river. The Groot-Dwars River furthermore flows towards the Dwars River and Steelpoort River where *Opsaridium peringueyi* occurs. The NFEPA classification of the Groot Dwars River also indicated the presence of the following FEPA River Ecosystem types: Permanent/Seasonal - Eastern Bankenveld - Upper foothill and Lower foothill.

The **Potspruit** (SQ reach B41F-812) is **not classified as a NFEPA river** reach (fish). This sub-quaternary reach, however, includes FEPA wetland clusters, stating the following wetland ecosystem types to be present: Mesic Highveld Grassland Group 6_Channelled valley-bottom wetland, Mesic Highveld Grassland Group 6_Flat, and Mesic Highveld Grassland Group 6_Seep.

The Mining and Biodiversity Guideline (DEA *et al.* (2013) recommends a buffer of 1 km from a FEPA River, while the Draft National Biodiversity Policy (2017) recommends an offset ration of 1:20 for FEPA rivers.

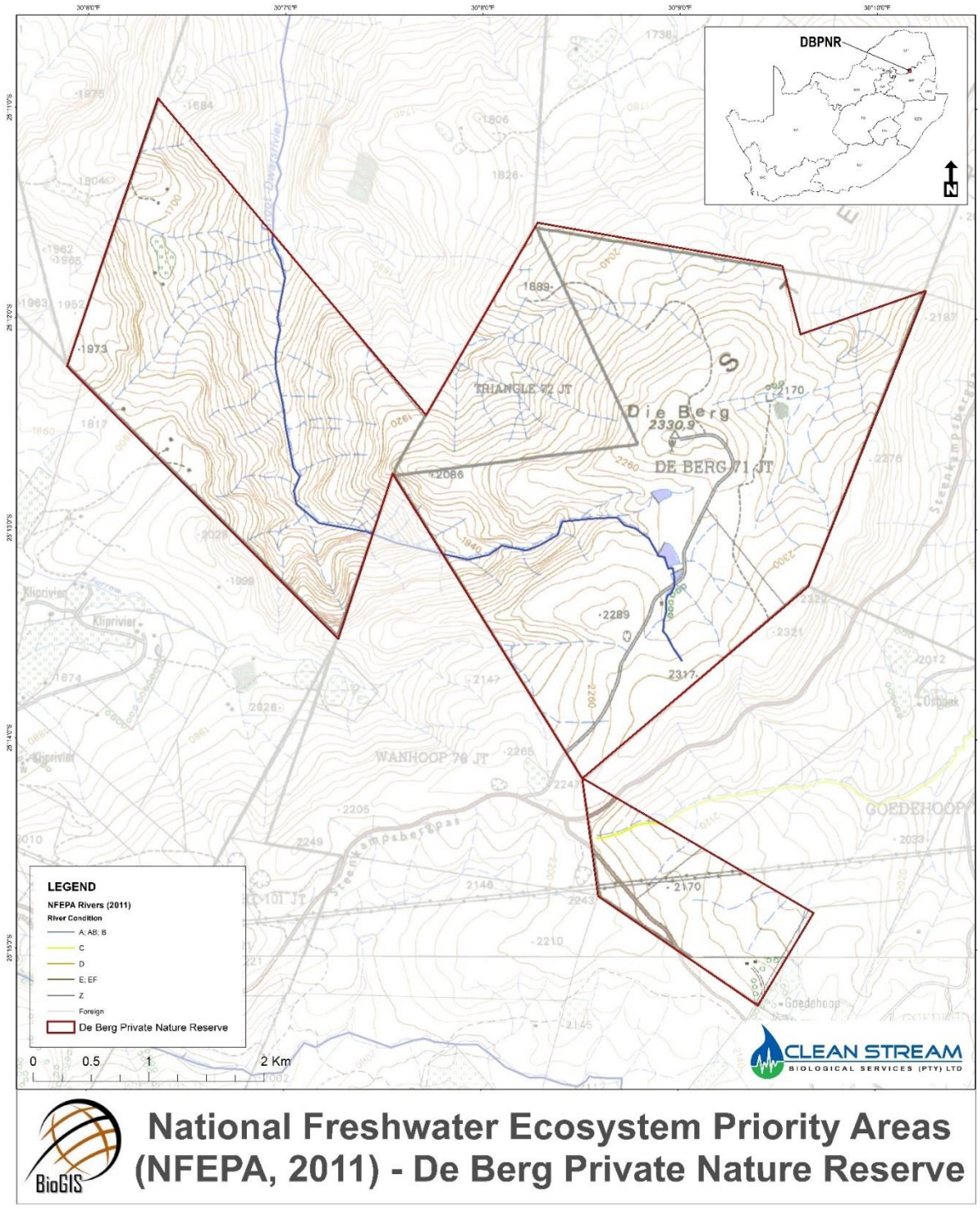


Figure 4: Position of DBPNR study area relative to NFEPAs.

6.6 Aquatic Biodiversity Sensitivity

The National Environmental Screening Tool indicated that the aquatic biodiversity sensitivity of the majority of the DBPNR study area was ***Very High*** (Figure 5). The reasons given for the very high classification were:

- Critical Biodiversity Areas (CBA's) for aquatic ecosystems
- wetland features; and
- freshwater priority areas.

A section of the study area (new Goedehoop farm section) falls with the ***low sensitivity*** zone (Figure 5).

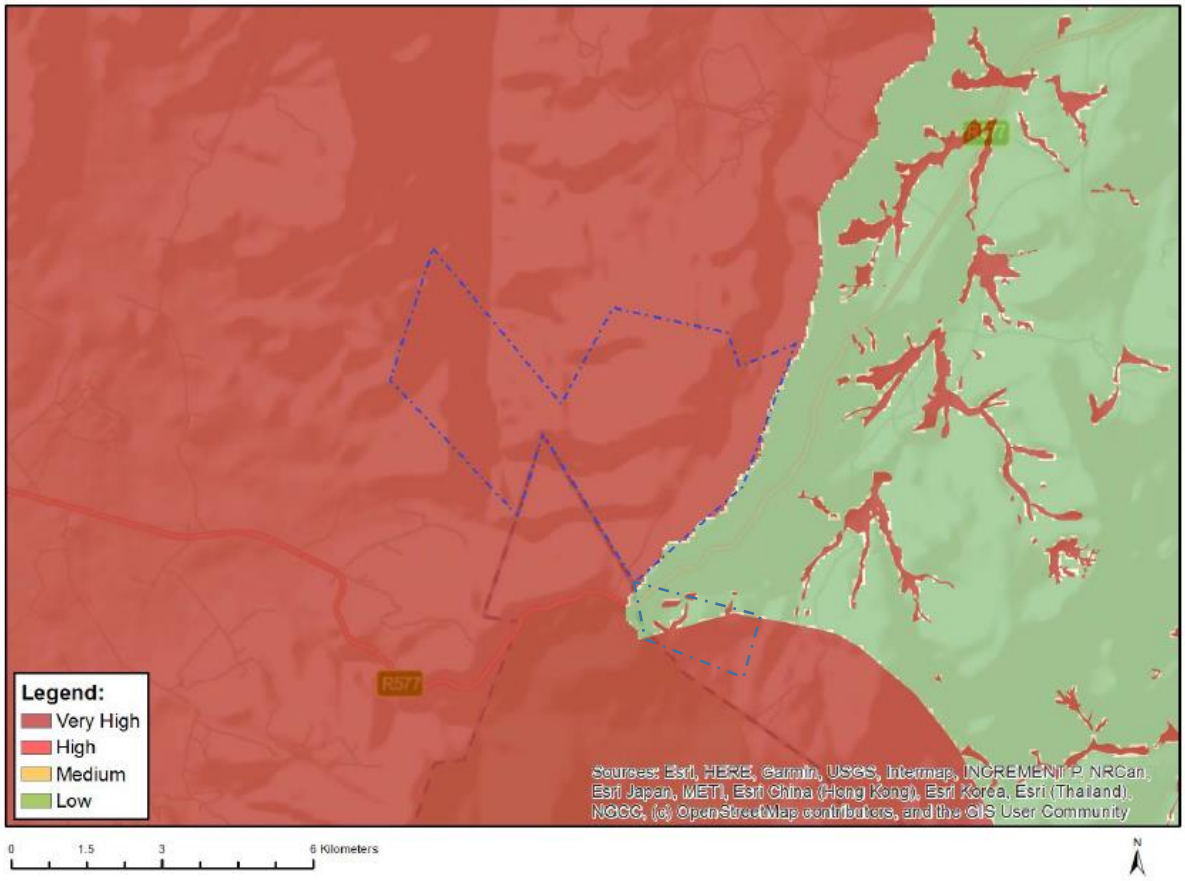


Figure 5: Aquatic Biodiversity Theme Sensitivity

[Source: Environmental Screening Tool (https://screening.environment.gov.za).]

7. BIODIVERSITY MANAGEMENT UNITS (BMU's) OF DBPNR STUDY AREA

There are three levels at which biodiversity can be approached, namely the genetic, the species and the ecosystem levels. **Genetic diversity** refers to the variation of genes within species. **Species diversity** refers to the variety and abundance of species within a geographic area. **Ecosystem diversity** refers to the variety of ecosystems within a certain political or geographical boundary (National Environmental Management Biodiversity Act, 2004). The current biodiversity assessment focused on the description of ecosystem- and species-related biodiversity. It can be expected that if ecosystem diversity is managed effectively, localised species and genetic diversity should also be protected. Emphasis was therefore firstly placed on the ecosystem diversity (landscape/habitat types/BMU's) within the Booysendal study area with reference to species expected and observed to utilise these habitats (with a strong focus on species of conservation concern). The current section (section 7) therefore aims to specifically describe the ecosystem diversity of the study area, while more detail regarding the different species of concern is provided in section 8 and the various supporting specialist reports (Addenda).

As part of the baseline Biodiversity Management Plan compiled for the entire Northam Booysendal study area (surface rights area) (that included the majority of the DBPNR) conducted in 2020/21, the area was divided into thirteen (13) biodiversity management units (BMU's). A total of ten of these BMU's (six untransformed and four transformed), were identified within the current DBPNR study area (numbering kept consistent)(Figure 6). The aim of defining biodiversity management units is to identify homogenous and discernible areas/landscapes within DBPNR, each with distinctive biodiversity composition and management requirements. The broad-scale vegetation and land-use units provide a basis for the determination of different areas with homogenous characteristics, which in general also reflects discernible different faunal biotopes and are also visually identifiable within the study area. For these reasons, the vegetation/land-use units therefore formed the basis for the determination of the Biodiversity Management Units (BMU's). The following biodiversity management units were therefore identified within the DBPNR study area:

- BMU 1: Sekhukhune Mountain Bushveld
- BMU 2: Sekhukhune Montane Grassland
- BMU 3: Steenkampsberg Montane Grassland
- BMU 4: Northern Afrotemperate Forest
- BMU 5: Valley-bottom wetlands and seeps
- BMU 7: Mountain streams
- BMU 9: Secondary vegetation (historical cultivation)
- BMU 10: Alien trees
- BMU 11: Dams
- BMU 13: Infrastructure

The following BMU's occurred within the greater Northam Booysendal study area (2020/21) but falls outside (extralimital) of the proposed DBPNR:

- BMU 6: Pan wetlands
- BMU 8: Rivers
- BMU 12: Current cultivation

Each BMU is described and an overview provided of its botanical and faunal biodiversity aspects in the current section (Section 7). More detail regarding the specific botanical and faunal diversity is provided in Section 8. Priority biodiversity management recommendations are also provided for each BMU in the current section, while general biodiversity management recommendations are provided in Section 9 and the various specialist reports (Addenda).

The relative biodiversity conservation value of each BMU was also estimated based on various criteria used for each specialist component (see specialist reports in addenda for detail). Some of the primary criteria considered in evaluating the importance of biodiversity of each BMU include the following:

- Ecological status of the vegetation unit/BMU [i.e. untransformed (primary) or transformed (secondary)].
- Provincial (Mpumalanga and Limpopo) biodiversity sector plan categories.
- Conservation status of vegetation type or terrestrial ecosystem represented by each BMU.
- Relative indigenous plant and animal species richness of the BMU's.
- Confirmed presence or habitat-derived probability of occurrence of plant or animal species of conservation concern.
- Is the BMU a water resource? (All water resources are sensitive and require protection).
- Presence of special (unique or restricted) habitats.
- Presence of invasive alien species.
- Any other significant biodiversity features of the BMU that may contribute to its conservation value.

Based on the above considerations, each BMU was given a conservation value (importance or sensitivity) of very high, high, moderate, low or negligible:

- A BMU with **high to very high** biodiversity conservation value is generally one that comprises untransformed biotopes where the presence of species of conservation concern have been confirmed or where there is a high probability of such a species occurring. These BMU's often consist of primary vegetation, rivers, streams, and wetlands and are considered important even if they are disturbed. Mining and development should be limited and prevented as far as possible in these BMU's and priority should be given to any potential impacts or risks identified.
- BMU's with a **moderate** biodiversity conservation value are generally areas with some disturbance, but not as severe as for areas with a low sensitivity / importance. These are generally transformed habitats with good habitat potential or deteriorated untransformed habitats. The relative species richness of these units may also be lower than in those with high conservation value. Although the presence of species of conservation concern may not have been confirmed in these units yet, there is still a moderate possibility that these species may utilise these BMU's. Future alterations of these BMU's should be limited, but development in these areas is preferred above the areas with high to very high conservation value.
- The BMU's with a **low** biodiversity conservation value are generally disturbed or transformed biotopes with little conservation value. The diversity of indigenous species is relatively low (compared to the natural untransformed habitats of the site) and the units are unlikely to support threatened/protected species. Future developments should, where possible, be planned within these areas, rather than in the moderate or high conservation areas.
- The BMU's that have been more or less irreversibly transformed from their natural state have **negligible** value in terms of biodiversity conservation.

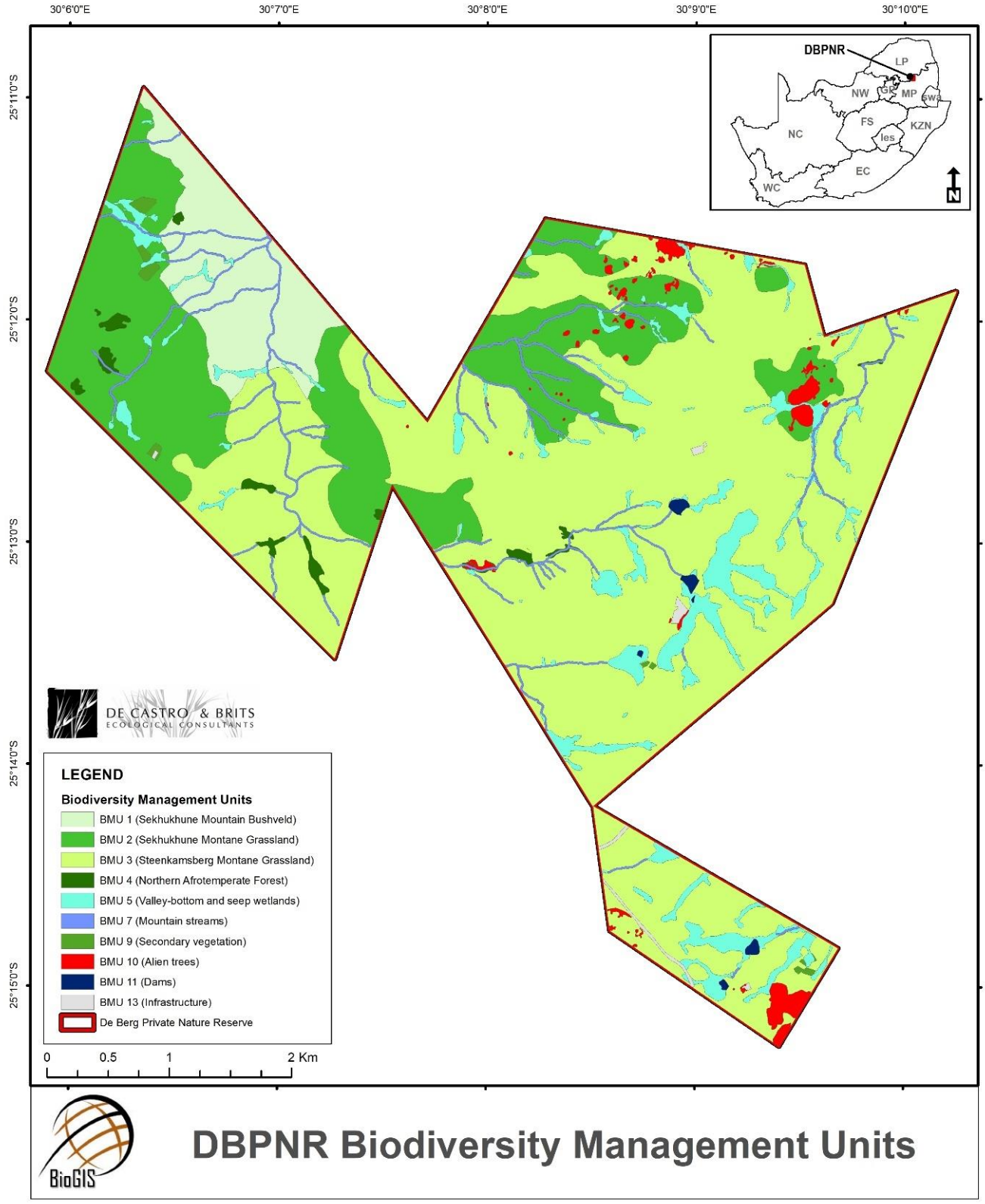


Figure 6: Biodiversity Management Units of the DBPNR study area.

BMU1: Sekhukhune Mountain Bushveld

BMU1: *Senegalia caffra* open woodland. Farm Sterkfontein.

BMU1: Groot Dwars River valley near northern boundary of the farm Sterkfontein.

BMU1 (Sekhukhune Mountain Bushveld) covers an area of approximately 153 ha (or 7.2% of the study area), which is the third largest surface area covered by any of the BMU's identified for the study area. The plant communities comprising this unit are representative of Sekhukhune Mountain Bushveld (Mucina & Rutherford, 2006) which is situated at the upper limit of its elevational distribution where it grades into Sekhukhune Montane Grassland. This BMU occurs on ultramafic rocks (seemingly mostly norite within the study area) of steep, rocky lower- and mid-slopes of the Groot Dwars River valley on the farm Sterkspruit, at altitudes that vary from ca. 1 372 m.a.s.l. at the point where the Groot Dwars River exits the study area on its northern boundary to ca. 1 650 m.a.s.l. The vegetation is predominantly short/low open woodland with small areas of closed woodland, and dense thicket on steep, rocky slopes below cliffs and large boulders. The vegetation comprising this BMU can be regarded as transitional (ecotone) between '*Combretum hereroense-Grewia vernicosa* Open Mountain Bushveld' and '*Themeda triandra-Senecio microglossus* Cool Moist Grasslands' (Siebert *et al*., 2002b).

Mean plant species richness measured in quadrats placed within this BMU was 33 (n = 2) species per 100 m^2. A total of 176 plant species were recorded from this BMU, 26 (or 14.8%) of which were recorded only within this unit. However, it must be emphasised that this unit was comparatively under-sampled during the current study. Four of the 42 plant SCC (*sensu* Raimondo *et al*., 2009; http://redlist.sanbi.org) recorded within the DBPNR were recorded within BMU1, including two taxa categorised as Threatened (VU) and two that are categorised as Near Threatened. Twelve of the 90 Protected plant species recorded within the DBPNR were recorded within this BMU. This BMU is representative of the Sekhukhuneland Mountain Bushveld vegetation type which is categorised as Least Threatened (Mucina & Rutherford, 2006; Skowno, 2019). However, this BMU is situated within the 'Sekhukhune Mountainlands' Threatened ecosystem (Schedule 11 of NEMBA, 2011) which is categorised as Endangered. This BMU is also almost entirely mapped as either or 'CBA-Optimal' or 'CBA-Irreplaceable' in the MBSP 2014 (Lötter *et al.,* 2014). The entire extent of BMU1 also falls within the SCPE (Van Wyk & Smith, 2001) and many of the 15 SCPE endemics recorded within the DBPNR occur within this BMU. This BMU is therefore considered to be of **Very High botanical biodiversity conservation value**.

BMU1 includes habitat characteristics that meet the requirements of 441 terrestrial vertebrate fauna species, consisting of 14 frog species, 61 reptile species, 272 bird species, and 94 mammal species. The presence of nine reptile species, 43 bird species, and six mammal species has been confirmed in this BMU during the 2021 to 2022 surveys. In terms of animal species of high conservation importance (red data listed, NEMBA protected, etc.), this BMU provides suitable habitats for an estimated two frog species, 10 reptile species, 12 bird species, and 15 mammal species. This BMU is considered to be of **Very High terrestrial vertebrate fauna conservation value**.

BMU1 is very diverse in floristic richness and micro-habitat types. It is likely to support a high diversity of invertebrate species which may show a high specificity to this BMU. No terrestrial invertebrate SCC were predicted although this is due to very limited knowledge of the invertebrate fauna pertaining to the vegetation type. A moderate species richness of dung beetle (12) was recorded from the bushveld-dominated habitat. A total of 23 butterfly species were observed during the current study within this BMU. This BMU is considered to be of **Very High terrestrial invertebrate conservation value**.

The overall biodiversity conservation value of BMU1 (Sekhukhune Mountain Bushveld) is considered to be VERY HIGH, justifying priority in biodiversity conservation management.

BMU1-specific biodiversity management recommendations:

- Implement the existing integrated alien plant control plan developed for the 12 950 ha Northam Booysendal property (which includes the DBPNR) (De Castro & Brits, 2021b). Alien invasive trees such as *Acacia dealbata** are invading BMU1 along the 'corridors of disturbance' created by abandoned and badly eroded graded exploration roads in the Groot Dwars valley slopes on the farm Sterkfontein (e.g. Site 87) and these expanding stands of invasive trees should be controlled as a matter of urgency.
- Graded exploration roads on the farm Sterkfontein that were abandoned without any rehabilitation are now badly eroded and must either be repaired and maintained to prevent erosion and sedimentation of surrounding habitats (in particular BMU's 7 & 8) or, if no longer required, must be closed, stabilised, and revegetated to prevent ongoing erosion and sedimentation.
- Frequent fires set by Khat (*Catha edulis*) poachers in the Groot Dwars River valley directly north of the study area throughout the year may spread into the DBPNR and are likely to lead to long-term ecosystem degradation and biodiversity loss within BMU1. The reserve management should seek to control such fires by implementing measures such as establishing fire breaks along the northern boundary of the Sterkfontein portion of the DBPNR.
- Ensure that beneficial grazing occurs by applying conservative wildlife stocking rates and preventing overgrazing.
- Develop and implement an appropriate 'burning plan' and prevent unplanned human induced fires (e.g. establish firebreaks).
- Implement a simple monitoring programme to evaluate the ecological condition (due to temporal changes in the graminoid and forb composition) based on the presence/absence surveys of important (typical) and key invertebrate taxa (Addendum E: De Castro & Brits, 2022c).
- The following potential impacts/risk to terrestrial fauna were identified and management measures recommended (refer to Addendum C: Deacon, 2022 for detail):
    - Trampling vegetation cover and compacting soil: The two most common methods for alleviating compaction are soil ripping (also called subsoiling or tilling) and addition of organic matter.
    - Utilising natural resources/products: Refrain from utilising natural resources or products on the DBPNR (for building, firewood, etc.); a rule to be communicated and adhered to by all employees or guests.
    - Hunting and poaching: With the increased presence of security in the DBPNR and the improvement of the fences around the area, the incidents of poaching have diminished, but continued anti-poaching efforts are required.

BMU2: Sekhukhune Montane Grassland

BMU2: Rocky grassland at ca. 1 900 m.a.s.l. on the farm Sterkfontein Portion 3.

BMU2 (Sekhukhune Montane Grassland) covers an area of approximately 450 ha (or 21.2% of the study area), which is the second largest surface area covered by any of the BMU's identified for the study area. The plant communities comprising this unit are representative of Sekhukhuneland Montane Grassland (Mucina & Rutherford, 2006). This BMU comprises areas with igneous ultramafic geology (mostly norite and silica norite, but possibly also gabbro) and mostly at elevations of between ca. 1 650–2 100 m.a.s.l. (small areas representative of this unit do occur at elevations as high as 2 280 m.a.s.l). The topography comprises the crests, plateaus, and rocky upper- and mid-slopes of a tall ridge of the Dwarsberge, and the parts of the west- and north-facing slopes of the De Berg peak of the Steenkampsberg. Outcrops of large norite boulders, sheetrock, and cliffs occur in the parts of this BMU situated on the farm Sterkfontein. The vegetation is grassland with lone trees and thicket clumps restricted to boulder outcrops that act as 'fire collars'. Larger patches of thicket which often grade into the patches of Afrotemperate Forest (BMU4) occur on steep rocky slopes and the bases of cliffs which act as 'fire collars'.

This BMU also includes large areas of open *Protea* woodland, which can be termed 'wooded grassland' as few or no other tree species occur at significant densities. The vegetation of this BMU conforms well to the '*Themeda triandra-Senecio microglossus* Cool Moist Grasslands' vegetation type described for the SCPE by Siebert *et al*. (2002b), but in some areas at lower elevations within this BMU the vegetation can be regarded as transitional between '*Themeda triandra-Senecio microglossus* Cool Moist Grasslands' and '*Combretum hereroense-Grewia vernicosa* Open Mountain Bushveld' (Siebert *et al*., 2002b). The vegetation of this unit situated at high elevations (above ca. 1 100 m.a.s.l.) grades into Steenkampsberg Montane Grassland (BMU3) and lacks many of the SCPE endemics characteristic of Sekhukhune Montane Grassland. The vegetation structure (including physiognomy, canopy cover, species composition and dominance) of the grassland of this

BMU varies in accordance to habitat characteristics such as altitude, slope, aspect, rock cover, and soil type and depth.

Mean plant species richness measured in quadrats placed within this BMU was 47.2 (n = 10) species per 100 m^2, which is markedly higher species richness than that measured in any other BMU. A total of 514 plant species were recorded from this BMU, 144 (or 28.0%) of which were recorded only within this unit. Eleven of the 42 plant SCC (*sensu* Raimondo *et al*., 2009; http://redlist.sanbi.org) recorded within the study area were recorded within BMU2, including four taxa categorised as Threatened (EN or VU), four that are categorised as Near Threatened and three that are categorised as Declining. Forty-eight of the 90 Protected plant species recorded within the DBPNR were recorded within this BMU. This BMU is representative of the Sekhukhuneland Montane Grassland vegetation type which is categorised as Least Threatened (Skowno *et al*., 2019; Schedule 11 of NEMBA). However, this BMU is situated within the 'Sekhukhune Mountainlands' Threatened ecosystem (Schedule 11 of NEMBA, 2011) which is categorised as Endangered. The vast majority of this BMU is also mapped as either 'CBA-Irreplaceable', 'CBA-Optimal' or 'Protected Area' in the MBSP 2014 (Lötter *et al.*, 2014). The extent of BMU2 falls mostly within the SCPE (Van Wyk & Smith, 2001) and most of the 15 SCPE endemics recorded within the study area occur within this BMU. This BMU is therefore considered to be of **Very High botanical biodiversity conservation value**.

BMU2 includes habitat characteristics that meet the requirements of 428 terrestrial fauna species, consisting of 14 frog species, 50 reptile species, 270 bird species, and 94 mammal species. The presence of two frog species, eight reptile species, 82 bird species, and nine mammal species has been confirmed in this BMU during the 2021 to 2022 surveys. In terms of animal species of high conservation importance (red data listed, NEMBA protected, etc.), this BMU provides suitable habitats for an estimated two frog species, nine reptile species, 82 bird species, and nine mammal species. This BMU is considered to be of **Very High terrestrial vertebrate fauna conservation value**.

From a terrestrial invertebrate perspective, BMU2 occurs at a higher altitude than BMU1, although it is likely to contain invertebrate species that are restricted to high altitude grassland. It appears that grassland BMU's contained the highest richness as well as the highest number of dung beetle individuals when compared to the other terrestrial BMU's. BMU2 had an average dung beetle species richness of 18. Twenty-six butterfly species were observed in this BMU during the current study. A potentially undescribed millipede species or aberrant form of *Doratogonus cf. flavifilis* was observed from the Sekhukhuneland Montane Grassland. This BMU is considered to be of **Very High terrestrial invertebrate conservation value**.

The overall biodiversity conservation value of BMU2 (Sekhukhune Montane Grassland) is considered to be VERY HIGH.

BMU2-specific biodiversity management recommendations:

- Implement the existing integrated alien plant control plan developed for the 12 950 ha Northam Booysendal property (which includes the DBPNR) (De Castro & Brits, 2021). Very little alien plant invasion is present within BMU2 on the farm Sterkfontein, but *Acacia dealbata** and *Acacia mearnsii** are established invaders in portions of BMU2 situated on the highly inaccessible west-facing slopes of the farm Triangle. These expanding stands of invasive trees should be controlled as a matter of urgency.
- Frequent fires set by Khat poachers in the Groot Dwars River valley directly north of the study area throughout the year may spread into the DBPNR and are likely to lead to long-term ecosystem degradation and biodiversity loss. The reserve management should seek to control such fires by implementing measures such as establishing fire breaks along the northern boundary of the Sterkfontein portion of the DBPNR.

- Ensure that beneficial grazing occurs by applying conservative wildlife stocking rates and preventing overgrazing.
- Develop and implement an appropriate ‘burning plan’ and prevent unplanned human induced fires (e.g. establish firebreaks).
- Most butterfly species (especially the Lycaenidae - "blues") engage daily between 09h00 - 14h00 in "hilltopping" which involves individuals ascending hills to reach the highest point where males establish territories, and where males and females of the same species find opportunities to mate. Therefore, "hilltopping" is an essential behaviour for butterfly species to maintain populations. Burning plans/programmes should acknowledge the "hilltopping" behaviour of butterflies, and corridors (along an altitudinal gradient) should be left unburned (especially in the late dry season) to allow butterfly individual access to the highest points on hills and ridges.
- Maintain conservative stocking rates during game introductions to prevent overgrazing or trampling of steep slopes which may become prone towards erosion.
- All *Protea*-dominated grassland should be maintained in a "viable" condition by implementing "best-practice" veld management and burning regimes. The *Protea* stands are an important host plant for the butterfly *Capys alpheus extentus,* which shows a disjointed distribution range in South Africa and most of the population being fragmented.
- Implement a simple monitoring programme to evaluate the ecological condition (due to temporal changes in the graminoid and forb composition) based on the presence/absence surveys of important (typical) and key invertebrate taxa (see Addendum E: De Castro & Brits, 2022c).
- The following potential impacts/risk to terrestrial fauna groups were identified and management measures recommended (refer to Addendum C: Deacon, 2022 for detail):
    - Overgrazing: Assess and compile best practice grassland management guidelines for high altitude areas in southern Africa. By reducing overgrazing, ground cover will be retained and therefore sustain natural prey diversity of the medium- and small mammal predators.
    - Uncontrolled burning: Conservation managers should assess and implement best practice grassland management guidelines for high altitude areas in southern Africa. Not only the frequency, but also the method of burning should be determined by management objectives.
    - Trampling vegetation cover and compacting soil: The two most common methods for alleviating compaction are soil ripping (also called subsoiling or tilling) and addition of organic matter.
    - Utilising natural resources/products: Refrain from utilising natural resources or products on the DBPNR (for building, fire wood, etc.); a rule to be communicated and adhered to by all employees or guests.
    - Hunting and poaching: With the increased presence of security in the DBPNR and the improvement of the fences around the area, the incidents of poaching have diminished, but continued anti-poaching efforts are required.

BMU3: Steenkampsberg Montane Grassland

BMU3.1: *Rendlia altera* plateau grassland on deeper, sandy soils of colluvial origin at ca. 2 300 m.a.s.l. on the farm De Berg.

BMU3.1: Rocky grassland on skeletal soils overlying quartzite at ca. 2 300 m.a.s.l. on the farm De Berg.

BMU3.1: Rocky, quartzitic ridge at ca. 2 300 m.a.s.l. on the farm De Berg.

BMU3.1: *Passerina montana* shrubland at ca. 2 300 m.a.s.l. on the farm De Berg.

BMU3.1: Transition between BMU3.1 and BMU3.2 at ca. 2 100 m.a.s.l. showing a patch of *Protea roupelliae* woodland (below 2 100 m.a.s.l.) and a mountain stream (BMU7).

BMU3.2: Grassland with scattered *Protea roupelliae* trees and *Acacia dealbata** invasive stands at ca. 2 000 m.a.s.l. on the farm Triangle.

BMU3.2: *Protea roupelliae* wooded grassland (right) and *Protea caffra* wooded grassland (left).

BMU3.2: *Syncolostemon eriocephalus* open shrubland on rocky (arenite) north-west facing slope.

BMU3 (Steenkampsberg Montane Grassland) covers an area of approximately 1 273 ha (or 59.8% of the study area), which is the largest surface area covered by any of the BMU's identified for the study area. The vegetation of most of this unit is representative of Steenkampsberg Montane Grassland (Dayaram *et al.*, 2017). The Steenkampsberg Montane Grassland of the study area falls within the Steenkampsberg Sub-centre of the Lydenburg CPE, is species rich, and has high levels of plant endemicity. Largely restricted to the farms De Berg and Triangle, but also extends into the Groot Dwars River valley on the farm Sterkfontein Portion 3. This unit occurs on quartzites (and probable arenites) of the Pretoria Group at elevations ranging from 1 498 m.a.s.l. in the Groot Dwars River valley to 2 332 m.a.s.l. at the summit of the De Berg peak. Numerous invasive stands of *Acacia dealbata** and *Acacia mearnsii** are present in the northern parts of this BMU, mostly at elevations below 2 100 m, but theses invaders have thus far transformed only a small percentage of the largely pristine grasslands comprising this BMU. Numerous 1st, 2nd, and 3rd order drainage lines (BMU7) flow through this unit and many wetlands (BMU5) are embedded in the grassland and 'wooded grassland' comprising this unit. These wetlands and mountain streams comprise the entire source catchment of the Groot Dwars River. Bloem *et al*. (1993) provided a detailed description of grasslands of the Steenkampsberg Montane Grassland of the Verloren Vallei Nature Reserve situated less than 1 km to the south of the study area.

The vegetation structure (including physiognomy, canopy cover, species composition and dominance) of the grassland of this BMU varies markedly in accordance to habitat characteristics such as elevation, slope, aspect, rock cover, and soil type and depth. BMU3 was divided into three sub-units, each with distinct vegetation, on the basis of observed 'elevational diversity gradients' (EDG) (Figure 7). Each of the three identified BMU3 sub-units (BMU's 3.1, 3.2, and 3.3) is briefly described below.

BMU3.1 – Steenkampsberg Montane Grassland – high altitude

This sub-unit covers an area of ca. 878 ha and therefore comprises approximately 69% of BMU3. Includes short grassland of the undulating plateau and crests of Steenkampsberg at elevations above 2 100 m.a.s.l. on dystrophic, skeletal soils of rocky quartzitic outcrops (possibly also arenites) as well as moderately deep soils comprising colluvial sediments of Quaternary origin which were deposited above the quartzitic lithology. 'Wooded grassland' is absent other than for a few small, isolated patches of *Passerina montana* shrubland on rocky (quartzite) ridge summits. This unit is of exceptional importance in terms of the conservation of plant SCC. The vegetation comprises a mosaic of two major plant communities, namely the short, dense grassland on largely dystrophic, moderately deep colluvial soils with little to no rock cover and sparse, low grassland, herb land and shrubland, rich in prostrate woody shrubs, on shallow to skeletal soils of large areas of exposed quartzitic bedrock, boulder outcrops and low cliffs. Sixteen of the 17 plant SCC recorded within BMU3 were recorded within BMU3.1. Rocky, quartzitic habitat within this unit comprises the exclusive or most important habitat for eleven of the sixteen plant SCC recorded within BMU3.1.

The short, dense grassland on deeper soils comprising colluvial sediments with little or no rock cover is dominated by grasses in terms of cover, but has high species richness in terms of forbs, many of which are LCPE endemics. The vegetation of the rocky (quartzitic) habitats with shallow to skeletal soils is highly variable and can vary from sparse grassland to what can be termed low shrubland comprising prostrate (procumbent or decumbent) shrubs.

BMU3.2 – Steenkampsberg Montane Grassland – mid-altitude

This sub-unit covers an area of ca. 345 ha and therefore comprises approximately 27% of BMU3. Includes the moderately tall dense grassland with patches of *Protea* open to closed woodland on steep, rocky slopes at lower elevations between 1 650–2 100 m on the farms De

Berg, Triangle, and adjacent areas of Sterkfontein 52 Portions 3. The *Protea caffra* and *Protea roupelliae* low open to low closed woodland (*sensu* Edwards, 1983), can more accurately be termed 'wooded grassland' as few or no other tree species occur at significant densities and the herbaceous layer does not differ significantly from that of the surrounding grassland. Areas of 'wooded grassland' also include three small patches of *Syncolostemon eriocephalus* tall open shrubland and a single patch of *Passerina montana* tall open shrubland at high elevations in the north-eastern part of the farm De Berg. Three of the 17 plant SCC recorded within BMU3 were recorded within BMU3.2.

The moderately tall, dense grassland with patches of *Protea* 'wooded grassland' has high species richness and is dominated by grasses. In areas of Protea wooded grassland, few or no other tree species occur at significant densities and the dominant tree is either *Protea roupelliae* (between ca. 1 900 m.a.s.l. and 2 100 m.a.s.l.) or *Protea caffra* (between ca. 1 650 m.a.s.l. and 1 950 m.a.s.l.)

BMU3.3 – Steenkampsberg Montane Grassland – low altitude

Comprises short to moderately tall, dense grassland and sparse to open woodland on the rocky lower slopes of the upper Groot Dwars River valley on the Farm Sterkspruit. Elevation ranges from 1 498–1 650 m.a.s.l. This unit is regarded as an ecotone between the Grassland and Savanna Biomes as well as the Sekhukhune Mountain Bushveld and Steenkampsberg Montane Grassland vegetation types. None of the 17 plant SCC recorded within BMU3 were recorded within BMU3.3, and though this sub-unit was under-sampled, few SCC are likely to occur.

Mean plant species richness measured in quadrats placed within **BMU3 (3.1, 3.2 and 3.3)** was 37.5 (n = 21) species per 100 m^2, which is the second highest species richness recorded for the 10 BMU's. A total of 362 plant taxa were recorded within this BMU, 87 (or 24.0%) of which were recorded only within this unit. This BMU is also likely to provide habitat for as yet undescribed taxa. BMU3 contains an exceptionally high concentration of plant SCC. Seventeen of the 46 plant SCC (*sensu* Raimondo *et al*., 2009; http://redlist.sanbi.org) recorded within the study area were recorded within BMU3, including nine taxa categorised as Threatened (EN or VU), two categorised as Near Threatened, five that are categorised as Rare and one categorised as Declining. Twenty-nine of the 90 Protected plant species recorded within the study area were also recorded within this BMU. This BMU is representative of the Steenkampsberg Montane Grassland vegetation type which is currently categorised as Least Concern (Skowno *et al*., 2019). However, the vast majority of BMU3 is entirely situated within the 'Dullstroom Plateau Grasslands' Threatened ecosystem (Schedule 11 of NEMBA, 2011) which is categorised as Endangered. The entire extent of the BMU is mapped as 'Protected' (previous Davel Private Nature Reserve comprising the farms De Berg and Triangle), 'CBA-Irreplaceable' or 'CBA-Optimal' in the MBSP 2014 (Lötter *et al.*, 2014). BMU3 also falls within the Steenkampsberg sub-centre of the LCPE (Lötter, 2019) and all of the 17 LCPE endemics recorded within the DBPNR occur within either within BMU3 or within wetlands (BMU5) embedded within this unit. BMU3 is therefore considered to be of **Very High botanical biodiversity conservation value**. The exceptional botanical biodiversity conservation value of BMU3 is attached predominantly to BMU3.1.

BMU3 includes habitat characteristics that meet the requirements of 171 terrestrial fauna species, consisting of 14 frog species, 27 reptile species, 108 bird species, and 22 mammal species. The presence of five reptile species, 61 bird species, and 12 mammal species has been confirmed in this BMU during the 2021 to 2022 surveys. This BMU is considered to be of **Very High terrestrial fauna conservation value**.

From a **terrestrial invertebrate** perspective, this unit is widespread in the study area and forms the dominant high-altitude grassland unit. It provides several micro-habitat types and may contain several high-altitude specialist taxa. Grassland BMU's contained the highest dung beetle species richness (average 14.74) as well as the highest number of beetle individuals when compared to the other terrestrial BMU's. Twenty-four butterfly species were recorded from this BMU during the current study. This BMU is considered to be of **Very High terrestrial invertebrate conservation value**.

The overall biodiversity conservation value of BMU3 (Steenkampsberg Montane Grassland) is considered to be VERY HIGH.

BMU3-specific biodiversity management recommendations:

- Implement the existing integrated alien plant control plan developed for the 12 950 ha Northam Booysendal property (which includes the DBPNR) (De Castro & Brits, 2021b). Emphasis should be placed on controlling the many invasive stands of *Acacia dealbata** occurring in the northern parts of the farms De Berg and Triangle as this species is the most important habitat transformer within BMU3. The removal of the ca. 7 ha Eucalyptus plantation near Site 98 on the farm De Berg is also regarded as a priority and is currently in progress.
- Ensure that beneficial grazing occurs by applying very conservative wildlife stocking rates and preventing overgrazing. No ungulates that are not indigenous to the Steenkampsberg should be introduced into the DBPNR.
- Develop and implement an appropriate 'burning plan' and prevent unplanned human induced fires (e.g., establish firebreaks).
- Encourage botanical interest groups associated with the MTPA and SANBI [e.g. the 'Plant Specialist Group (PSG)] to conduct field trips to the reserve on a regular basis to search for plant SCC and new, undescribed taxa.
- Most butterfly species (especially the Lycaenidae - "blues") engage daily between 09h00 - 14h00 in "hilltopping" which involves individuals ascending hills to reach the highest point where males establishes territories, and where males and females of the same species find opportunities to mate. Therefore, "hilltopping" is an essential behaviour for butterfly species to maintain populations. Burning plans/programmes should acknowledge the "hilltopping" behaviour of butterflies, and corridors (along an altitudinal gradient) should be left unburned (especially in the late dry season) to allow butterfly individuals access to the highest points on hills and ridges.
- Maintain conservative stocking rates during game introductions to prevent overgrazing or trampling of steep slopes which may become prone towards erosion.
- All *Protea*-dominated grassland should be maintained in a "viable" condition by implementing "best-practice" veld management and burning regimes. The *Protea* stands are an important host plant for the butterfly *Capys alpheus extentus,* which shows a disjointed distribution range in South Africa with most of the population being fragmented.
- Implement a simple monitoring programme to evaluate the ecological condition (due to temporal changes in the graminoid and forb composition) based on the presence/absence surveys of important (typical) and key invertebrate taxa (see Addendum E: De Castro & Brits, 2022c).
- Potential impacts/risk to terrestrial fauna groups were identified and management measures recommended (refer to Addendum C: Deacon, 2022 for detail).

BMU4: Northern Afrotemperate Forest

BMU4: Northern Afrotemperate Forest patch embedded in Sekhukhune Montane Grassland (BMU2) on a south-east facing slope.

BMU4: A patch of Northern Afrotemperate Forest embedded in Steenkampsberg Montane Grassland (BMU3) on a south-facing slope in the deep valley of the mountain stream (BMU7) that forms the uppermost reach of the Groot Dwars on the farm De Berg.

BMU4: Northern Afrotemperate Forest in a narrow ravine (slot canyon on the farm De Berg).

BMU4 (Northern Afrotemperate Forest) covers an area of approximately 16 ha (or 0.8% of the study area). The forest communities comprising this unit are representative of Northern Afrotemperate Forest (Mucina & Rutherford, 2006). Based on an analysis of Google Earth Pro imagery and fairly extensive ground-truthing, 15 patches of Northern Afrotemperate Forest (most less than 1 ha and none larger than 3 ha) occur within the DBPNR. These forest patches occur at elevations ranging from ca. 1 600 m.a.s.l. to 2 200 m.a.s.l. and cover a total of ca. 0.8% of the DBPNR. All of these forest patches occur on steep, rocky, east- or south-facing slopes or in narrow gorges (slot canyons), which provide protection from fire (act as 'fire collars'). Forest patches occur embedded in Sekhukhune Montane Grassland (BMU2) or in the ecotone between this vegetation type and Sekhukhune Mountain Bushveld (BMU1), as well as within Steenkampsberg Montane Grassland (BMU3) along mountain streams in narrow valleys and gorges of the upper Groot Dwars River catchment. The vegetation comprises low forest (*sensu* Edwards, 1983) with moderate species richness. The Northern Afrotemperate Forest patches of the study area comprise short forest (i.e., canopy generally less than 10 m) with emergents reaching up to ca. 15 m. Dominance varies somewhat between forest patches in accordance with habitat characteristics (e.g. aspect, slope, elevation, and moisture). The alien invasive trees *Acacia dealbata*, Acacia melanoxylon**, and *Pinus patula** have invaded some of these forest patches that occur along streams and pose an elevated risk in term of habitat transformation.

No sampling quadrats were placed within this BMU, but **plant species richness** is moderate as is typical of such relict forest patches in this region of Mpumalanga. Many of the occurring species are, however, within the study area, largely or entirely restricted to such Afrotemperate Forest patches. A total of 90 plant taxa were recorded within this BMU, 23 (or 25.6%) of which were recorded only within this unit. Four of the 42 plant SCC (*sensu* Raimondo *et al*., 2009; http://redlist.sanbi.org) recorded within the study area were recorded within BMU4, including two taxa categorised as Threatened (EN or VU), one that is categorised as Near Threatened, and one that is categorised as Declining. Twelve of the 90 Protected plant species recorded

within the study area were also recorded within this BMU. This BMU is representative of the Northern Afrotemperate Forest vegetation type which is categorised as Least Concern or Least Threatened (Skowno *et al*., 2019; Schedule 11 of NEMBA). However, this BMU is entirely situated within one of two threatened ecosystems (Schedule 11 of NEMBA, 2011), namely 'Sekhukhune Mountainlands' and 'Dullstroom Plateau Grasslands', which are both categorised as Endangered. Almost all of the forest patches comprising this BMU fall within areas mapped as either 'CBA-Optimal' or 'Protected Area' in the MBSP 2014 (Lötter *et al.*, 2014). All of the forest patches comprising BMU4 fall within either the SCPE or the LCPE. This BMU is therefore considered to be of **Very High botanical biodiversity conservation value**.

BMU4 includes habitat characteristics that meet the requirements of 104 **vertebrate fauna** species, consisting of eight frog species, 10 reptile species, 73 bird species, and 13 mammal species. The presence of 22 bird species has been confirmed in this BMU during the 2021 to 2022 surveys. In terms of animal species of high conservation importance (red data listed, NEMBA protected, etc.), this BMU provides suitable habitats for an estimated two frog species, one reptile species, five bird species, and one mammal species. This BMU is considered to be of **High terrestrial fauna conservation value**.

From a **terrestrial invertebrate** perspective this unit is represented by isolated patches of forest habitat and may contain a distinct invertebrate fauna that is restricted to cool, moist, and closed-canopy habitat. Invertebrate diversity is predicted to be lower when compared to the other BMU's, but could contain undescribed forest-interior species (e.g. millipedes). The Northern Afrotemperate Forest habitat (BMU4) sustained low numbers of dung beetles, with only two species captured during the survey conducted as part of the current study. Seven butterfly species and one dragon/damselfly species were recorded from this BMU during the current study. Millipede taxa was mainly restricted to BMU4 with three taxa confined to the moist, humus rich soils of certain forest enclaves. Searching in some of the forest enclaves did not detect any millipede taxa, which was ominously absent for no apparent reason. A potentially undescribed species of the genus cf. *Gnomeskelus* (a keeled millipede) was sampled from an Afrotemperate forest patch on the farm Sterkspruit, as well as two species pertaining to the genus *Sphaerotherium.* This BMU is considered to be of **Very High terrestrial invertebrate conservation value**.

The overall biodiversity conservation value of BMU4 (Northern Afrotemperate Forest) is considered to be VERY HIGH.

BMU4-specific biodiversity management recommendations:

- Implement the existing integrated alien plant control plan developed for the 12 950 ha Northam Booysendal property (which includes the DBPNR) (De Castro & Brits, 2021b). Most Afrotemperate Forest patches are free of alien invasive species that are habitat transformers, the exceptions being those forest patches situated in the deep narrow valley of the Groot Dwars River near where it exits the eastern boundary of the farm De Berg, where *Acacia dealbata** and *Pinus patula** are established invaders that pose a significant risk of habitat transformation. Felling of large alien trees in forests can damage or destroy large specimens of very old indigenous forest trees and should be avoided in preference for ringbarking [see alien plant control programme (De Castro & Brits, 2021b) for details].
- A buffer zone of at least 50 m should be allocated from the edge of BMU4 forests to protect the forest edge from veld fires (especially in the late dry season) where BMU4 is located within BMU2 and BMU3. For example, it was evident that fires (grassland patches that borders onto forest patches) at Karkloof (KZN), can significantly "dry" out forest edges in such a way that the soil moisture regime is affected and subsequently also limit the availability of soil moisture for millipedes and other terrestrial soil invertebrates such as earthworms. The forest edge (the first 10-20 m from the edge towards the interior of the

forest) is regarded as an important habitat for forest soil invertebrates such as earthworms and millipedes. However, the buffer area may be reduced during "cool" burns when sufficient moist/high humidity is present (e.g. after a rainfall event in spring).

- Implement a simple monitoring programme to evaluate the ecological condition (due to temporal changes in the graminoid and forb composition) based on the presence/absence surveys of important (typical) and key invertebrate taxa (see Addendum E: De Castro & Brits, 2022c).
- Potential impacts/risk to terrestrial fauna groups were identified and management measures recommended (refer to Addendum C: Deacon, 2022 for detail).

BMU5: Valley-bottom wetlands and seeps

BMU5: Valley-bottom wetland on De Berg. Wetland is a mire, a type of peatland.

BMU5: Sheetrock wetland on norites at 1 900 m.a.s.l. on Sterkfontein Portion 3.

BMU5: Valley-bottom wetlands and seeps.

BMU5 (Valley-bottom wetlands and seeps) covers an area of approximately 136 ha (or 6.4% of the study area). All of the streams comprising this BMU form part of the most upper catchments (source zones) of the Groot Dwars River and its tributaries (including Everest Stream), Klip River tributary, and Potspruit. These catchments are classified as Critical Biodiversity Areas or Ecological Support Areas (MBSP 2014) (Lötter *et al.*, 2014) and the Groot Dwars River (SQ reach B41G-721) within this BMU are also classified as a National Freshwater Ecosystem Priority Area (NFEPAs). BMU5 includes the hygrophytic and hydrophytic grass and sedge dominated wetland plant communities on hydromorphic soils and peat substrates of channelled and unchanneled valley-bottom wetlands and seeps which usually show strong lateral zonation of vegetation (including physiognomy, dominance and species richness) in accordance with moisture gradients (including frequency and duration of saturated soil conditions and inundation). The wetlands comprising this unit also have exceptionally high functional value and form the entire source of the Groot Dwars River.

The wetlands of the DBPNR occur on a wide variety of substrates at altitudes which vary dramatically from 1 372 m.a.s.l. to 2 332 m.a.s.l. The wetland vegetation structure varies markedly in accordance with these dramatic variations in key habitat characteristics. Substrates vary from various types of hydromorphic soils that experience conditions of temporary, seasonal, or permanent saturation to organically enriched soils (including soils with an organic topsoil horizon) and true peat substrates, to skeletal soils of sheetrock seep wetlands (De Castro & Brits, 2022b).

The soils of the vast majority of the wetlands situated at elevations of above approximately 1 950 m.a.s.l. on the farms De Berg and, to a far lesser extent, the farm Triangle, are either organically enriched (including soils with an organic topsoil horizon) or comprise **true peat wetlands** (De Castro & Brits, 2022b). Actively forming peat wetlands (mires) are situated within valley-bottom wetlands and seeps on hillslopes and adjacent to mountain stream channels. The extensive mires at high elevations on the farms De Berg and Triangle form part of the Central Highlands Peatland Ecoregion (Grundling *et al*., 2017) and are of a group of peatlands associated with the Steenkampsberg Plateau wetlands (De Castro & Brits, 2022b). A single mire was also recorded on a terrace in the north-eastern corner of the farm Sterkfontein (between sites xc42 and xb9) on norite lithology at elevations of between 1 700–1 750 m.a.s.l.

The majority of **mires (peat wetlands),** including the largest mire wetlands, recorded within the DBPNR, are embedded within BMU3.1 on the farm De Berg. Mires are commonly defined internationally as peat wetlands which contain at least some peat to a thickness of at least 0.30 m and are dominated by living peat forming plants (Rydin and Jeglum, 2006). The mires of the farm De Berg form the source of the Groot Dwars River. In accordance to the National Peatland Database (Grundling *et al*., 2017), the mires recorded during the 2021-2022

wetlands (De Castro & Brits, 2022b) and current studies represent the first records of peat wetlands on the farms De Berg and Triangle, and the nearest previously known peat wetland is located approximately 3.3 km southeast of De Berg on the farm Wanhoop 78JT. The spatially restricted mire habitats of the farms De Berg and Triangle (which include mires in valley-bottom wetland setting as well as a few perched, dome-shaped mires on hillslopes) contribute disproportionately to the levels of plant endemism and the number of plant SCC occurring within the DBPNR. The vegetation of mires occurs on true peat and adjacent soils with an organic topsoil horizon and is distinct from other wetland communities and many of the constituent species are largely or entirely restricted to these habitats. Species dominance in mires differs with lateral zonation and type of mire (e.g. valley-bottom or dome-shaped perched mire). The mire recorded on a terrace in the north-eastern corner of the farm Sterkfontein (between sites xc42 and xb9) on norite lithology at elevations of between 1 700–1 750 m.a.s.l. is, in accordance to the National Peatland Database (Grundling *et al*., 2017), the first true peatland recorded on the Dwarsberge and Sekhukhuneland as a whole (De Castro & Brits, 2022b).

Sheetrock wetlands can be regarded as a type of seep that comprises areas of exposed bedrock (both norite and sandstone) located on mountain slopes or terraces, and which experience seasonal or occasionally semi-permanent surface flow of water. Patches of shallow or skeletal soils (usually sandy and humic) that experience periods of temporary, seasonal, or permanent saturation or elevated moisture conditions occur on the exposed bedrock and support unique communities of highly specialised plant species that are in many cases largely or entirely restricted to such habitat. The sparse vegetation includes high species richness of geophytes. These sheetrock wetlands provide habitat for numerous spatially restricted species of lithophytes and hygrophytes, including various plant SCC. Two new species of *Ledebouria* (*Ledebouria* sp. nov. '*purpurea'* and *Ledebouria* sp. nov. '*noritica'*) that are in the process of being described and scientifically published were recorded from sheetrock wetland habitats during the current survey. *Ledebouria* sp. nov. '*purpurea'* is known only from the DBPNR, while *Ledebouria* sp. nov. '*noritica'* is known only from one locality within the DBPNR and one locality situated some 15 km to the north-north-east of the DBPNR within the 12 950 ha Northam Booysendal property on the farm Hebron. *Ledebouria* sp. nov. '*purpurea'* has been recorded only from sheetrock and sheetrock wetlands on quartzites on the farm De Berg and *Ledebouria* sp. nov. '*noritica'* has been recorded only on sheetrock seeps on norite. The declared alien invasive trees *Acacia dealbata** and *Acacia mearnsii** have invaded and transformed small areas of seep wetland habitat on the northern boundary of the DBPNR on the farm De Berg at an elevation of about 2 040 m.a.s.l.

Average plant species richness measured in quadrats placed within this BMU was 18.9 (n = 7) species per 100 m^2, which is regarded as fairly typical species richness for wetlands in this region of Mpumalanga. Species richness does, however, vary markedly between wetland types and between lateral zones within a single wetland. This unit contains an exceptionally high concentration of plant SCC and as yet undescribed taxa and provides unique habitat for numerous spatially restricted habitat specialists, particularly those associated with mires and sheetrock wetlands, many of which are entirely restricted to such habitat. A total of 261 plant taxa were recorded within this BMU, and the fact that 99 (or 37.9%) of these species were recorded only within this BMU illustrates the uniqueness on the habitats comprising this unit and their botanical biodiversity conservation importance. The 261 plant taxa recorded within this unit, which comprises only ca. 6.4% of the DBPNR, comprise 28.1% of all the plant taxa recorded within the study area. This unit is also likely to contain a high number of undescribed taxa and three confirmed undescribed taxa were recorded from this BMU during the current survey and 2020-2021 survey (De Castro & Brits, 2022a) and are in the process of being formally described and published. Sixteen of the 42 plant SCC (*sensu* Raimondo *et al*., 2009; http://redlist.sanbi.org) recorded within the study area were recorded within BMU5, including nine taxa categorised as Threatened (CR, EN or VU), three categorised as Near Threatened,

two that are categorised as Rare and two categorised as Declining. Twenty-four of the 90 Protected plant species recorded within the study area were also recorded within this BMU.

The wetlands comprising BMU5 are entirely situated within one of two Threatened ecosystems (Schedule 11 of NEMBA, 2011), namely 'Sekhukhune Mountainlands' and 'Dullstroom Plateau Grasslands', which are both categorised as Endangered. All of the wetlands comprising BMU5 fall within either the SCPE or the LCPE. The vast majority of the wetlands of the study area, fall within areas mapped as either 'Protected Area', 'CBA-Irreplaceable' or 'CBA-Optimal' in the MBSP 2014 (Lötter *et al.*, 2014), but the sheetrock wetland of great conservation value situated at site xc37a on the south boundary of the farm Sterkfontein has erroneously been mapped as 'Other Natural Areas' in the MBSP 2014. The wetlands of the farm De Berg, and in particular the large mires (peat wetlands), form the source of the Groot Dwars River and their preservation is therefore crucial in terms of maintaining the hydrological regimes and water quality, and hence ecosystem functioning and biodiversity levels, of the Groot Dwars River. BMU5 also provides crucial or exclusive habitat for various species of fauna. This BMU is therefore considered to be of **Very High botanical biodiversity conservation value**.

BMU5 includes habitat characteristics that meet the requirements of **132 terrestrial fauna species**, consisting of 13 frog species, 12 reptile species, 89 bird species, and 18 mammal species. The presence of three frog species and 15 bird species has been confirmed in this BMU during the 2021 to 2022 surveys. In terms of animal species of high conservation importance (red data listed, NEMBA protected, etc.), this BMU provides suitable habitats for an estimated two frog species, four reptile species, eight bird species, and eight mammal species. This BMU is considered to be of **Very High terrestrial fauna conservation value**.

The **aquatic fauna biodiversity** of this BMU is limited due to the limited availability of a water column. The current study confirmed that fish was absent from this BMU as a result of the natural habitat limitation as well as the various natural migration barriers (waterfalls, cascades) preventing movement of fish into these upper reaches. Limited sampling confirmed the presence of various algae and moss species and at least 18 macroinvertebrate families (that includes many species). Diatom analyses confirmed that some sections of this BMU can be classified within an ecological category A (natural) and that biological water quality was excellent. These source zones play a critical role in sustaining the mountain streams (BMU7) and lower river reaches, and no activities should be allowed that may jeopardise the water quality and overall ecological integrity of these source zones. This BMU is considered to be of **high biodiversity conservation value in terms of aquatic biodiversity**.

This BMU is relatively widespread on De Berg, whereby the waterlogged conditions may limit the **terrestrial invertebrate diversity**. It is predicted to contain highly specialised taxa that can cope with waterlogged conditions and flooding. The vegetation along the marginal zone is an important food resource for many nectar-feeding invertebrates and the linear configuration of the BMU will facilitate invertebrate dispersal. Twelve butterfly species and seven dragon/damselfly species were recorded from this BMU during the current study. This BMU is considered to be of **Very High terrestrial invertebrate conservation value**.

The overall biodiversity conservation value of BMU5 (Valley-bottom wetlands and seeps) is considered to be VERY HIGH.

BMU5-specific biodiversity management recommendations:

- Development within 100 m of any area of BMU5 should be avoided and environmental authorisation should be sought for such a development where required by the NWA or NEMA legislation.
- Take into consideration requirements for authorisation from the DWS for all Section 21 (c) and (i) water use activities proposed in a 500 m radius from any wetland.

- The more detailed recommendations for the conservation management of the wetlands included in BMU5 provided in the specialist report on the wetlands of the DBPNR (Addendum B: De Castro & Brits, 2022b) should be implemented by the reserve management.
- Implement the existing integrated alien plant control plan developed for the 12 950 ha Northam Booysendal property (which includes the DBPNR) (De Castro, 2021b). The few wetlands currently significantly impacted by invasive stands and plantations of alien invasives are situated in the northern parts of the farm De Berg and the southern boundary of the farm Goedehoop. *Pinus* spp. and other alien trees planted in large windbreaks directly adjacent to the highly sensitive peat wetland (mire) at Site 71 on the farm De Berg were cleared by reserve management in late 2021.
- The removal of the illegal homestead near Site 27 on the farm Sterkfontein is seen as a biodiversity conservation priority due to the risk posed to the recently discovered plant *Ledebouria* sp. nov. '*noritica*' (EN). A sheetrock wetland situated some 200 m from the homestead is the type locality for this species which is known from only one other locality. The sheetrock seep habitat of this species is being significantly degraded by livestock trampling and the excavation of watering holes which has physically destroyed plants and causes severe disruption to the hydrological regimes which are a key habitat determinant for this species.
- Encourage botanical interest groups associated with the MTPA and SANBI [e.g. the 'Plant Specialist Group (PSG)] to conduct field trips to the reserve on a regular basis to search for plant SCC and new, undescribed taxa as the wetlands of the study area have exceptionally high richness of plant SCC and additional SCC as well undescribed taxa are likely to be present.
- The creation of vehicle tracks through any wetland should be avoided and no track crossing of a wetland should be graded or elevated by berm construction.
- No hydrocarbons (e.g. petrol, diesel, and oil), herbicides, or pesticides should be stored within 200 m of any peat wetland (mire) for any length of time as peat substrates have elevated sensitivity to hydrocarbon spills due to their ability to absorb and adsorb hydrocarbons (Moore *et al.*, 1997) which makes rehabilitation practically impossible.
- Control runoff of sediment laden stormwater into wetlands or streams.
- Prevent seepage and surface discharge of untreated effluents into wetlands or streams.
- Implement the integrated alien plant control plan for the study area developed by De Castro and Brits (2021b). Specific emphasis should be placed on controlling the following alien invasive species: *Acacia dealbata, A. mearnsii, Eucalyptus* spp., and *Populus* x *canescens.* Prioritise the initial removal of a plantation of *Eucalyptus* spp. of approximately 7.27 ha, with subsequent follow-up control events on Goedehoop, in accordance with the existing alien control plan. The plantation is causing a desiccation effect on downstream wetlands due to high water usage through evapotranspiration.
- Follow-up control to address coppicing of three *Eucalyptus* spp. plantations that were recently controlled adjacent to valley bottom and seep wetlands directly south of the site office at coordinates 25°13'20.82''S 30°8'55.63''E and further east upslope of a suspected peatland at coordinates 25°12'25.52''S 30°9'31.22''E. The suspected presence of peat in one of the wetlands bordering a former *Eucalyptus* spp. plantation makes complete and successful control a very high priority as their presence can result in the drying out (desiccation) of peat, which makes it susceptible to burning. Several active peat fires occur throughout South Africa and are of increasing concern as a threat to peatland wetlands.
- Monitor the migration (advancement) of an eroding headcut erosion feature by staking a painted metal peg next to the current headcut position, at coordinates 25°12'23.96"S 30° 9'47.13"E. The headcut is regarded as a natural erosion feature, but it has the potential to form a gully in a seep wetland. Based on available information (lack of anthropogenic

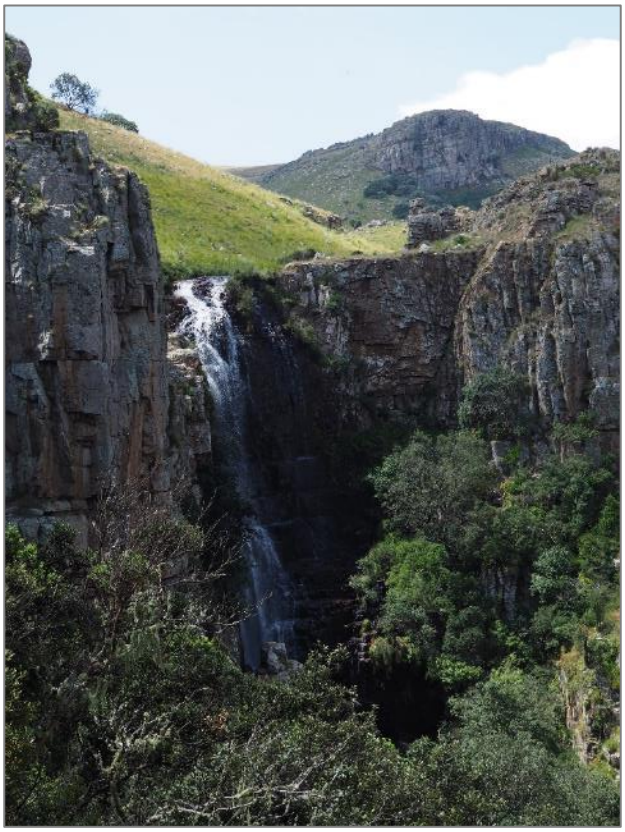
impacts), this is regarded as natural channel development within the drainage network and is not regarded as a serious threat that needs to be stabilised through rehabilitation intervention. Only monitoring is recommended at this stage. Shallow rock layers that are common in the area are expected to form a natural barrier that will halt erosion at an unknown distance upstream of the current headcut position.

- The creation of vehicle tracks through any wetland (BMU5) should be avoided as far as possible and no track crossing of a wetland should be graded. Any new road crossing in wetlands will require authorisation from regulatory authorities and will have to demonstrate that flows will remain unaltered in terms of direction, velocity, and volume, with mitigation measures that will help prevent scour erosion and the development of new channels caused by flow concentration.
- Control runoff of stormwater into streams and wetlands through watercourse sensitive stormwater management measures that incorporate energy dissipators and naturally vegetated buffers. Stormwater attenuation features should mimic natural water movement patterns, meaning that infiltration should be prioritised, and only disbursed flows should be allowed at outlets. Erosion control need to be put in place to ensure that erosion and sedimentation does not occur in the downstream watercourses.
- Delineated BMU5 boundaries should be used in future design planning phases to help avoid overlap and maintain a 100 m setback distance between wetlands and new developments that may be required for the proposed nature reserve, such as ablution facilities, sewage systems, and accommodation infrastructure. Additional studies, such as hydropedology studies may also be required by the DWS and other regulatory authorities.
- The use of *Pennisetum clandestinum* (Kikuyu grass) should be avoided for the establishment of lawns, for erosion control, or any other use within the study area. This alien invasive species easily encroaches into wetlands and streams and becomes very difficult to eradicate once established.
- Maintain conservative stocking rates during game introductions to prevent overgrazing and trampling wetlands, seeps, the edges of dams, and to prevent disturbances caused to obligatory wetland taxa such as *Harpendyreus noquasa, Telchinia rahira rahira, T. anacreon*, and potentially also *Metisella meninx*.
- It is advised against the **entire** burning of wetland and seep units and dam edges (the moist grassland surrounding artificial dams), but to rather only burn part thereof in view that burning of an entire wetland unit could potentially exterminate important obligate wetland invertebrate taxa. When only part of a particular wetland is burned, it will allow wetland invertebrate sub-populations to recover quickly and will facilitate re-colonisation thereof.
- Implement a simple monitoring programme to evaluate the ecological condition (due to temporal changes in the graminoid and forb composition) based on the presence/absence surveys of important (typical) and key invertebrate taxa.
- Potential impacts/risks to terrestrial fauna groups (refer to Addendum C: Deacon, 2022 for detail) and aquatic biota (Refer to Addendum D: CSBS, 2022) were identified and management measures recommended.

BMU7: Mountain streams

BMU7: 1st order stream embedded within BMU3.1 on the farm De Berg at ca. 2 150 m.a.s.l.

BMU7: Mountain stream that forms the uppermost reach of the Groot Dwars River on the farm De Berg. Stream flowing through BMU3.1 at ca. 2 150 m.a.s.l.



BMU7: 15 m high waterfall on Mountain Stream on the farm De Berg.

BMU7 (Mountain streams) covers an area of approximately 53 ha (or 2.5% of the study area) and includes the perennial and non-perennial mountain streams (mostly 1st and 2nd order streams) which occur on both igneous (mostly norite) and sedimentary (sandstone) geology. In terms of geomorphological zone classification (Rowntree & Wadeson, 1999), BMU7 comprises entirely of watercourse reaches categorized as Mountain streams (zone B) and Mountain headwater streams (zone A). Aquatic biotopes in this zone comprised bedrock, pools, runs, riffles, cascades, and waterfalls. All of the streams comprising this BMU form part of the most upper catchments of the Groot Dwars River and its tributaries (including Everest Stream), Klip River tributary, and very short stretches of the Potspruit on the farm Goedehoop. Many reaches of this unit are classified as Critical Biodiversity Areas or Ecological Support Areas (MBSP 2014) (Lötter *et al.*, 2014) and the Groot Dwars River (SQ reach B41G-721) within this BMU is also classified as a National Freshwater Ecosystem Priority Area (NFEPAs).

BMU7 includes the azonal riparian plant communities of perennial and non-perennial mountain streams (mostly 1st and 2nd and 3rd order streams) which flow over both igneous, ultramafic rocks (mostly norite and quartz-norite), quartzites, and arenite through all three major BMU's found within the study area, namely Sekhukhune Mountain Bushveld (BMU1), Sekhukhune Montane Grassland (BMU2) and Steenkampsberg Montane Grassland (BMU3). The largest and most important perennial streams comprising the source catchment of the Groot Dwars River all arise on the farms De Berg and Triangle, predominantly in areas of quartzitic lithology. The riparian vegetation of the steep, high-altitude, upper reaches of these streams comprise a narrow band (almost absent in the extreme upper reaches of 1st order streams) of herbaceous vegetation dominated by hygrophytic grasses and sedges, shrubland characterised by shrubs such as *Cliffortia* spp. or patches of *Leucosidea sericea* thicket, and Northern Afrotemperate Forest (see BMU4). The vegetation of the lower reaches of these streams usually comprises riparian woodland or thicket. The majority of the streams comprising this BMU form part of the catchment of the Groot Dwars River.

Along weakly perennial or non-perennial, 1st order streams flowing over bedrock at the highest elevations (mostly on the farms De Berg and Triangle), riparian vegetation is very poorly developed or absent, and terrestrial plant communities extend practically to the channels' edge. Along 2nd and 3rd order streams on De Berg, Triangle and, to a lesser extent, Sterkspruit, that are characterised by rapids, cascades, and waterfalls, the riparian plant communities form a narrow but distinct and well-developed band along the channels and the vegetation comprises herbaceous communities dominated by hygrophytic grasses and sedges with scattered rheophytic shrubs or patches of riparian shrubland. Many of the prominent grasses are C_3 metabolic pathway grasses typical of cool, high-altitude environments.

Riparian woodland and thicket interspersed with patches of herbaceous vegetation with scattered rheophytic shrubs is largely confined to streams (including the reach of the Groot Dwars situated within the farm Sterkfontein) at elevations below 1 650 m.a.s.l., but may occur as high as 1 750 m.a.s.l. Short, closed riparian woodland (*sensu* Edwards, 1983) on rocky, boulder strewn streambeds is often completely dominated by *Lydenburgia cassinoides* (SCPE endemic) at lower elevations along the Groot Dwars River to the north of the DBPNR, but this species is only present at elevations below ca. 1 600 m.a.s.l. where streams flow through Sekhukhune Mountain Bushveld (BMU1) and is not dominant within the study area. At elevations below ca. 1 800 m.a.s.l., no significant riparian habitat transformation has occurred as a result of alien invasive plant species. Above ca. 1 800 m.a.s.l., the riparian habitats of reaches of some mountain streams have been invaded by declared alien invasive trees such as *Acacia dealbata*, Acacia mearnsii**, and *Pinus patula**. Though the invasion of riparian habitats by alien trees at high elevations is currently highly localised, the aforementioned alien invasive species pose a serious risk in terms of widespread transformation of riparian habitats in the DBPNR, as well as the loss of the large number of plant SCC that are largely or entirely restricted to such habitats.

No vegetation sampling quadrats were surveyed within this BMU, but species richness is moderate at lower altitudes and increases to high at higher altitudes and comprises various species and plant communities that are largely or entirely restricted to the riparian habitats of mountain streams. A total of 164 plant taxa were recorded within this BMU, 36 (or 22.0%) of which were recorded only within BMU7. Though this unit comprises only 2.5% of the DBPNR, 9 of the 42 plant SCC (*sensu* Raimondo *et al*., 2009; http://redlist.sanbi.org) recorded within the study area were recorded within BMU7, including three taxa categorised as Threatened, two that are categorised as Near Threatened, one that is categorised as Rare and three that are categorised as Declining. Additional plant SCC are considered likely to be present. Fourteen of the 90 Protected plant species recorded within the study area was also recorded within this BMU. The mountain streams comprising BMU7 are entirely situated within one of two Threatened ecosystems (Schedule 11 of NEMBA, 2011), namely 'Sekhukhune Mountainlands' and 'Dullstroom Plateau Grasslands', which are both categorised as Endangered. All of the streams comprising BMU7 fall within either the SCPE or the LCPE. The streams of the study area flow almost entirely through areas mapped as 'Protected Area', 'CBA-Irreplaceable', or 'CBA-Optimal' in the MBSP 2014 (Lötter *et al.*, 2014). The mountain streams comprising BMU7 include all the tributaries of the source catchment (uppermost catchment) of the Groot Dwars River, and their preservation is therefore crucial in terms of maintaining the hydrological regimes and water quality, and hence ecosystem functioning and biodiversity levels, of the Groot Dwars River. This BMU is therefore considered to be of **Very High botanical biodiversity conservation value**.

BMU7 includes habitat characteristics that meet the requirements of 129 **terrestrial vertebrate fauna species,** consisting of 15 frog species, 10 reptile species, 80 bird species, and 24 mammal species. The presence of four bird species and one mammal species has been confirmed in this BMU during the 2021 to 2022 surveys. In terms of animal species of

high conservation importance (red data listed, NEMBA protected, etc.), this BMU provides suitable habitats for an estimated two frog species, three reptile species, four bird species, and nine mammal species. This BMU is considered to be of **Very High terrestrial vertebrate fauna conservation value**.

This BMU is scattered across the study site and consists of various perennial-running upland streams. It is an important habitat for many Odonata species, of which many have Highveld/high-altitude affinities. The vegetation along the marginal zone is an important food resource for many nectar-feeding invertebrates and the linear configuration of the BMU will facilitate invertebrate dispersal. Twenty-seven butterfly species and eleven dragon/damselfly species were recorded from this BMU during the current study. This BMU is considered to be of **Very High terrestrial invertebrate conservation value**.

The current study indicated that **fish was absent** from the most upper reaches of the mountain streams of the Groot Dwars River (farms De Berg and Sterkfontein Portion 3), Everest Tributary (on the farm De Berg), and Klip River tributary within the original DBPNR study area. It is estimated that the absence of fish from these areas may be a natural phenomenon as a result of various natural migration barriers (waterfalls, cascades) within these high gradient river reaches. One indigenous fish species (*Enteromius cf. anoplus/motebensis*) and one alien fish species (*Oncorhynchus mykiss*) was confirmed from the Potspruit section on the farm Goedehoop (new section of DBPNR). The identification of *E. cf. anoplus/motebensis* requires further verification but currently it should be viewed as a potential species of conservation concern since *E. motebensis* is currently listed as Near Threatened (NT) by the IUCN. The current study furthermore confirmed the presence a highly diverse aquatic macroinvertebrate taxa richness with 47 macroinvertebrate families (that includes a high number of species) recently (2020 to 2022) sampled in this BMU within DBPNR. The presence of various taxa with a high (five taxa) and moderate (11 taxa) requirement for unmodified water quality indicate that many of the mountain stream reaches in the study area is currently still in an excellent ecological condition. This was also confirmed by diatom analyses that indicate excellent (ecological category A) biological water quality prevailing in many streams within DBPNR (many endemic diatom species with a preference for high biological water quality were also confirmed). These upper catchment streams also play an important role in sustaining the lower river reaches (adequate flow and water quality through dilution of pollutants), and it is therefore strongly recommended that these mountain stream catchment areas (entire DBPNR) should be conserved, and no activities should be allowed that may jeopardise the water quality and overall ecological integrity of these source streams. This BMU is considered to be of **Very High biodiversity conservation value in terms of aquatic biodiversity**.

The overall biodiversity conservation value of BMU7 (Mountain streams) is considered to be VERY HIGH.

BMU7-specific biodiversity management recommendations:

- Development within 100 m of any area of BMU7 should be avoided, and environmental authorisation should be sought for such a development where required by the NWA or NEMA legislation.
- Implement the existing integrated alien plant control plan developed for the 12 950 ha Northam Booysendal property (which includes the DBPNR) (De Castro & Brits, 2021b). Emphasis should be placed on controlling alien invasive trees that are established habitat transformers within riparian habitats of mountain streams (e.g. *Acacia dealbata*, Acacia mearnsii*,* and *Pinus patula**) on the farms De Berg and Triangle.
- Control runoff of sediment laden stormwater into streams or wetlands.

- Prevent seepage and surface discharge of untreated effluents into streams or wetlands.
- The creation of vehicle tracks through any wetland (BMU7) should be avoided as far as possible and no track crossing of a stream should be graded. Any new road crossing in mountain streams will require authorisation from regulatory authorities and will have to demonstrate that flows will remain unaltered in terms of direction, velocity, and volume with mitigation measures that will help prevent scour erosion and sedimentation into downstream watercourses.
- Control runoff of stormwater into streams and wetlands through watercourse sensitive stormwater management measures that incorporate energy dissipaters and naturally vegetated buffers. Stormwater attenuation features should mimic natural water movement patterns, meaning that infiltration should be prioritised and only disbursed flows should be allowed at outlets. Erosion control need to be put in place to ensure that erosion and sedimentation does not occur in the downstream watercourses.
- Delineated BMU7 boundaries should be used in future design planning phases to help avoid overlap and maintain a 100 m setback distance between mountain streams and new developments that may be required for the proposed nature reserve, such as ablution facilities, sewage systems, and accommodation infrastructure. Additional studies may also be required by the DWS and other regulatory authorities.
- The use of *Pennisetum clandestinum* (Kikuyu grass) should be avoided for the establishment of lawns, for erosion control, or any other use within the study area. This alien invasive species easily encroaches into wetlands and streams, and becomes very difficult to eradicate once established.
- Implement the recommended ‘burning plan’ and prevent unplanned human induced fires (e.g., establish firebreaks).
- To maintain the current/extant Odonata richness (especially the presence of *Chlorolestes fasciatus*), it is crucial to control the growth of *Cliffortia* spp. along the mountain streams (by means of mechanical pruning or by controlled burning). A good balance between shady (closed canopy) and sunny (open canopy) positions along a particular mountain stream will benefit Odonata richness. However, a complete "shade-out" of potential resting perches and rocks, used by Odonata along the stream margin, by marginal vegetation (in particular by *Cliffortia* spp.) will markedly reduce the Odonata richness.
- Implement a simple monitoring programme to evaluate the ecological condition (due to temporal changes in the graminoid and forb composition) based on the presence/absence surveys of important (typical) and key invertebrate taxa (see Addendum E: De Castro & Brits, 2022c).
- Potential impacts/risk to terrestrial fauna groups (refer to Addendum C: Deacon, 2022 for detail) and aquatic biota (refer to Addendum D: CSBS, 2022) were identified and management measures recommended.

BMU9: Secondary vegetation

BMU9: Patch of Secondary Grassland within BMU3.1 completely dominated by the alien invasive grass *Pennisetum clandestinum** (Kikuyu) at ca. 2 150 m.a.s.l. on the farm De Berg.

BMU9 (Secondary vegetation: historical cultivation) covers an area of approximately 7 ha (or 0.3% of the DBPNR). This unit includes the secondary vegetation of historically cultivated, scoured, or heavily trampled and nutrient enriched soils (i.e. historic cattle feeding points). The largest areas ascribed to this BMU are embedded within BMU's 2 and 5 on the farm Sterkfontein, but a few, smaller areas are embedded within BMU's 3.1 and 5 in the north-eastern parts of the farm Goedehoop. The secondary vegetation comprising this BMU is in a relatively advanced state of secondary succession (last cultivated at least two decades ago) and the vegetation comprises secondary grassland dominated by perennial pioneer grasses. Vegetation structure (including dominance, species composition, physiognomy, etc.) varies in accordance with time elapsed since disturbance, successional stage, soil type, and moisture regimes. This secondary vegetation is typically species poor (low α-diversity) and comprise largely of pioneer species and increaser species indicative of disturbance.

Mean **plant species richness** measured in sampling quadrats placed within this BMU was 17.7 (n = 3) species per 100 m^2, which is lower than that measured in any of the six BMU's comprising untransformed vegetation. A total of 70 plant taxa were recorded from this BMU, the vast majority of which are pioneer species and increaser species indicative of disturbance, and a high percentage of the recorded species are aliens. Species richness of indigenous species is likely to increase with elapsed time since rehabilitation, as secondary succession progresses. Secondary succession in Highveld and mountain grassland of Mpumalanga is known to be extremely slow (usually many decades) and often stalls to produce a more or less stable 'disclimax' plant community, which is not representative of natural 'climax' or 'steady state' vegetation. Furthermore, this BMU does not include potentially suitable habitat for any plant SCC or any of the 90 Protected plant species recorded within the study area. The few patches of secondary vegetation comprising this BMU are, however, embedded within one of

two Threatened ecosystems (Schedule 11 of NEMBA, 2011), namely 'Sekhukhune Mountainlands' and 'Dullstroom Plateau Grasslands', both of which categorised as Endangered, and the majority of these patches of secondary vegetation are situated within areas mapped as either 'CBA-Optimal' or 'Protected Area' in the MBSP 2014 (Lötter *et al.*, 2014). This BMU is therefore considered to be of **Low to Moderate botanical biodiversity conservation value**.

BMU9 includes habitat characteristics that meet the requirements of 89 **terrestrial vertebrate fauna species**, consisting of two frog species, 17 reptile species, 57 bird species, and 13 mammal species. The presence of three bird species has been confirmed in this BMU during the 2021 to 2022 surveys. In terms of animal species of high conservation importance (red data listed, NEMBA protected, etc.), this BMU provides suitable habitats for an estimated three reptile species, 10 bird species, and three mammal species. This BMU is of **Moderate terrestrial vertebrate fauna conservation value**.

Previous disturbance is likely to affect habitat and soil structure and reduce microhabitat diversity. This BMU consists of areas where previous, mainly anthropogenic activities occurred, with the subsequent colonisation of pioneer and secondary species. Most of the taxa are predicted to be generalist species. This BMU was not surveyed in detail for terrestrial invertebrates as part of the current study. This BMU is considered to be of **Low to Moderate terrestrial invertebrate conservation value**.

The overall biodiversity conservation value of BMU9 (Secondary vegetation: historical cultivation) is considered to be MODERATE.

BMU9-specific biodiversity management recommendations:

- Implement the integrated alien plant control plan for the study area (De Castro and Brits, 2021b).
- Ensure that beneficial grazing occurs by applying conservative stocking rates and preventing overgrazing.
- Develop and implement an appropriate 'burning plan' and prevent unplanned human induced fires (e.g. establish firebreaks).
- Where possible, avoid the establishment of mining infrastructure on areas of this BMU that are continuous with untransformed habitats or act as corridors between untransformed habitats.
- Potential impacts/risk to terrestrial fauna groups were identified and management measures recommended (refer to Addendum C: Deacon, 2022 for detail).

BMU10: Alien trees

BMU10: Plantation of *Eucalyptus* spp. embedded in BMU3 on the farm De Berg. Clearing of the plantation was completed in June 2022.

BMU10 (Alien trees) covers an area of approximately 28 ha (or 1.3% of the DBPNR). Comprises mostly of two Eucalyptus plantations (each less than ca. 8 ha) and numerous invasive stands of alien trees that are habitat transformers (in particular *Acacia dealbata** and *Acacia mearnsii**). One of the Eucalyptus plantations is situated in the north-eastern parts of the farm De Berg (clearing of this plantation largely completed) and the other on the south-eastern boundary of the farm Goedehoop. The parts of the DBPNR most impacted by habitat transformation as a result of alien tree invasion are situated at elevations between ca. 1 800 m.a.s.l. and 2 100 m.a.s.l. within BMU2 and BMU3.2 on the farm Triangle and in the northern and north-eastern parts of the farm De Berg. A detailed alien plant baseline survey and control programme for the DBPNR, which identifies and maps concentration of alien invasive plant species, was completed in 2021 (De Castro & Brits, 2021b).

Based on the available literature, the authors experience in the region, as well as observations made during the current and previous surveys, the following alien invasive plant species pose the greatest threat to the untransformed habitats and indigenous vegetation of the study area and its immediate surrounds and should be regarded as priority species for alien plant control efforts: **Acacia dealbata, *Acacia mearnsii, *Acacia melanoxylon, *Eucalyptus* spp., **Pinus patula, *Pinus* cf. *elliotii,* and **Pennisetum clandestinum.* All of these species are aggressive invaders and habitat transformers or potential habitat transformers that pose a significant threat to the biodiversity of the DBPNR. With the exception of **Pennisetum clandestinum* (Kikuyu grass) all the aforementioned priority species are trees. The BMU's most susceptible to habitat transformation and biodiversity loss as a result of alien plant invasion are: Steenkampsberg Montane Grassland (in particular BMU3.2) and Sekhukhune Montane Grassland (BMU2, in particular patches of grassland at high elevations on the Farm Triangle) as well as patches of Northern Afrotemperate Forest (BMU4) and Mountain Streams (BMU7) embedded within the montane grassland areas. Little to no alien plant invasion is present at low elevations within Sekhukhune Mountain Bushveld (BMU1) and BMU3.3.

This BMU comprises habitats transformed through the planting and invasion of alien trees. The secondary vegetation of this unit has very low to negligible species richness in terms of indigenous species. A total of 31 plant taxa were recorded from this BMU, the majority of which are alien species. Furthermore, this BMU does not include potentially suitable habitat for any plant SCC or Protected plant species. Complete rehabilitation (i.e. return to species rich indigenous grassland which may eventually return to primary grassland) of these areas after the removal of the trees is often extremely difficult or impossible, as soil characteristics are often irreversibly altered (particularly in the case of areas infested with *Acacia dealbata** and *Acacia mearnsii**). This unit therefore has **Low value in terms of botanical biodiversity conservation**.

BMU10 includes habitat characteristics that meet the requirements of 43 **terrestrial vertebrate species**, consisting of two reptile species, 35 bird species, and six mammal species. The presence of 11 bird species has been confirmed in this BMU during the 2021 to 2022 surveys. In terms of animal species of high conservation importance (red data listed, NEMBA protected, etc.), this BMU provides suitable habitat for two mammal species. This BMU is considered to be of **Low terrestrial vertebrate fauna conservation value**.

This BMU includes exotic an alien tree species with a low expected **terrestrial invertebrate** richness. This BMU was not surveyed in detail. This BMU is considered to be of **Very low – negligible terrestrial invertebrate conservation value**.

The overall biodiversity conservation value of BMU10 (Alien trees) is considered to be LOW.

BMU10-specific biodiversity management recommendations:

- Implement the existing integrated alien plant control plan developed for the 12 950 ha Northam Booysendal property (which includes the DBPNR) (De Castro & Brits, 2021b).
- Implement a simple monitoring programme to evaluate the ecological condition (due to temporal changes in the graminoid and forb composition) based on the presence/absence surveys of important (typical) and key invertebrate taxa (see De Castro & Brits, 2022c).
- Tree trunks and large branches of trees cut down in plantations or large invasive stands should not be placed in piles which will burn at high temperature for long periods of time, as this will cause ‘hotspots’ with soils that are sterilised by heat and consequently remain unvegetated and exposed to erosion for many years. Such large tree trunks should be offered as timber or firewood to interested parties or removed to be used or sold as firewood, wherever possible.

BMU11: Dams

BMU11: Dam 1 (top) and Dam 2 (bottom) on the Farm De Berg.

BMU11 (Dams) covers an area of approximately 5 ha (or 0.2% of the DBPNR). This BMU comprises secondary wetland plant communities of the littoral and eulittoral zones of artificial wetlands created by four small farm dams (none larger than 1.3 ha) and one small, inundated quarry on the farms De Berg and Goedehoop. All of the farm dams are 'in–channel' earth-walled dams (Ollis *et al*. 2013). The vegetation of the margins of the dams are dominated by hygrophytic or hydrophytic grasses and sedges that are predominantly either pioneer species or aliens indicative of disturbance.

This unit comprises **secondary vegetation** of transformed riverine or wetland habitats and has low species richness in terms of indigenous species. A total of 34 plant taxa were recorded from this BMU, none of which are restricted to this BMU. Although this BMU does not include potentially suitable habitat for any plant SCC or Protected plant species, it does contain highly productive wetland plant communities that are usually dominated by indigenous species and have a similar vegetation structure to the plant communities of the wetland systems within which they are situated. These dams also provide highly productive habitat for a variety of animal species. This BMU is therefore considered to be of **Low to Moderate botanical biodiversity conservation value.**

BMU11 includes habitat characteristics that meet the requirements of 82 **terrestrial vertebrate fauna,** consisting of 13 frog species, one reptile species, 65 bird species, and three

mammal species. The presence of five frog species and 10 bird species has been confirmed in this BMU during the 2021 to 2022 surveys. In terms of animal species of high conservation importance (red data listed, NEMBA protected, etc.), this BMU provides suitable habitats for an estimated one frog species, one reptile species, two bird species, and two mammal species. This BMU is considered to be of **Low terrestrial vertebrate fauna conservation value**.

According to the wetland classification system of (Ollis *et al*. 2013), all of the farm dams are 'in–channel' earth-walled dams. BMU11 (dams) are artificially created aquatic habitats that transformed natural river reaches (mostly lotic ecosystems) into stagnant (lentic ecosystems). Although these dams created artificial habitats that are utilised by various aquatic fauna, they should be viewed as an impact/threat to the natural biodiversity of the study area. These dams often create migration barriers to the natural movement of fish and create suitable habitat for some (mostly unwanted) fish species, including alien fish. The dams furthermore also alter the natural aquatic biota composition in the rivers directly downstream of the dams due to flow and water quality changes. The current study indicated that functional feeding of macroinvertebrates at all sites surveyed was dominated by shredders, except downstream De Berg Dam 1, where there was a high abundance of filterers. The change in functional feeding downstream of the dam is attributed to the release of plankton from the dam. Seepage downstream of the dam was also characterised by dense growth of the protobacterium, *Leptothrix ochracea*, which clogged interstitial spaces and created conditions that were unsuitable for aquatic macroinvertebrates. *Leptothrix ochracea* is typically associated with oxidation of iron.

Fish sampling in the dams on the farm De Berg (DB Dam 1 and 2) confirmed that **there is currently no fish present in these dams**. The absence of indigenous fish from these dams (and the upper reaches of the Groot Dwars River) inside DBPNR is thought to be a natural phenomenon as a result of the abundance of natural migration barriers (waterfalls, cascades, large boulders) that occurs within the mountain stream (BMU7) zone of this river. It was promising that no alien fish is currently present within these dams since it was suggested by locals that these dams may have been historically stocked with Rainbow Trout (*Oncorhynchus mykiss*). The presence of any alien fish in these dams may have posed a serious threat to the natural indigenous biodiversity of this area as well as the downstream reaches that contains fish species of conservation concern. Limited fish sampling and visual observations confirmed the presence of one indigenous fish species, namely *Enteromius cf. anoplus/motebensis* and the alien Rainbow trout (*Oncorhynchus mykiss*) in the dams on the farm Goedehoop (site GH Dam 1 and 2). The presence of the aggressive predatory Rainbow trout is a threat to the indigenous fish of the system. It was, however, promising to note that the indigenous barb (*E. anoplus/motebensis*) also occurred in the marginal vegetation of this dam, and this species was abundant both upstream (GH Dam 1) and downstream (site PS1) at the time of sampling in March 2022. It therefore seems that the trout is not currently an immediate threat to the occurrence of this indigenous fish in the upper Potspruit system. Should the landowners decide to maintain the Rainbow Trout population within this dam, the status of the indigenous fish should be closely monitored and the necessary permission/permits acquired from MTPA. Limited aquatic macroinvertebrate sampling performed on De Berg Dam 1 indicated a moderate diversity of macroinvertebrates, with 17 taxa recorded in and around the dam.

From a **terrestrial invertebrate** perspective, dams provide similar habitat to that of natural lakes or ponds, but, where these are lacking, may encourage establishment of populations of dragonflies and other species with aquatic nymphs that might not otherwise occur in an area. These include small artificial impoundments which is often colonised by taxa that are predominantly found on lentic systems and will often displace lotic-specialist taxa. The invertebrate composition is expected to consist of widespread generalist taxa. Five butterfly

species and eight dragon/damselfly species were recorded from this BMU during the current study. This BMU is considered to be of **Moderate terrestrial invertebrate conservation value**.

The overall biodiversity conservation value of BMU11 (Dams) is considered to be LOW.

BMU11-specific biodiversity management recommendations:

- Implement the existing integrated alien plant control plan developed for the 12 950 ha Northam Booysendal property (which includes the DBPNR) (De Castro & Brits, 2021).
- The only dams where significant infestation of alien invasive habitat transformers have been recorded are the two dams situated on the farm Goedehoop, where the dam walls are completely overgrown with Kikuyu (*Pennisetum clandestinum**).
- Prevent seepage and surface discharge of untreated effluent from reserve offices, staff accommodation, and future tourist accommodation into dams.
- Prevent runoff of sediment laden stormwater from roads and tracks into dams.
- Repair the dam spillway at coordinates 25°13’8.89’’S 30°8’56.18’’E to prevent the erosion of the earthen dam wall and adjacent areas, thereby preventing sedimentation in the downstream watercourse. Also consider lowering the spillway to reduce the size of the impoundment behind the dam wall, which will allow indigenous wetland plant species to become re-established on the margins of the dam. This will also require alien control intervention.
- Control runoff of stormwater into streams and wetlands through watercourse sensitive stormwater management measures that incorporate energy dissipaters and naturally vegetated buffers. Stormwater attenuation features should mimic natural water movement patterns, meaning that infiltration should be prioritised, and only disbursed flows should be allowed at outlets. Erosion control need to be put in place to ensure that erosion and sedimentation does not occur in the downstream watercourses.
- DBPNR should aim to limit the construction of any additional instream dam walls and also remove any redundant dams from the river systems under their control.

BMU13: Infrastructure

BMU13 (Infrastructure) covers an area of approximately 6 ha (or 0.3% of the study area), which is the second smallest area covered by any of the four identified BMU's which comprise transformed habitats. Infrastructure includes a farm labourer's dwelling on the southern boundary of the farm Sterkfontein, a communications tower complex on the summit of the De Berg peak, an old homestead on the farm De Berg which now serves as the DBPNR management offices, a tourist cottage on the farm Goedehoop, and a regional dirt road which cuts through the western parts of the farm Goedehoop. The habitats of these infrastructure areas have been completely transformed and the natural vegetation cleared. The transformed habitats included in this unit are unvegetated or vegetated by alien ruderal weeds, lawns, planted alien ornamentals, windbreak trees (e.g. *Eucalyptus* spp.*), and indigenous pioneer species indicative of severe disturbance.

The little vegetation occurring within this unit is entirely secondary in nature and has very low species richness in terms of indigenous species. A total of **34 plant taxa** were recorded from this BMU, none of which are restricted to this BMU, and a high percentage of the species are alien species. Furthermore, this unit does not contain potentially suitable habitat for any plant SCC or Protected plant species. Untransformed vegetation in close proximity to these areas

is also often degraded as a result of various 'edge effects' emanating from these transformed habitats. The alien invasive plant species present at some homesteads (e.g. *Eucalyptus* spp.*, *Acacia dealbata**, and *Pennisetum clandestinum** at the Goedehoop homestead) act as sources of seeds and other propagules which can cause infestations of these alien invasive species in surrounding habitats. This unit therefore has **Negligible value in terms of botanical biodiversity conservation.**

BMU13 includes habitat characteristics that meet the requirements of 33 **terrestrial vertebrate fauna** species, consisting of three frog species, five reptile species, 23 bird species and two mammal species. The presence of one frog species, one reptile species, five bird species and two mammal species has been confirmed in this BMU during the December 2020 and February 2021 surveys. In terms of animal species of high conservation importance (red data listed, NEMBA protected, etc.), this BMU provides suitable habitats for one frog species. This BMU is considered to be of **Negligible terrestrial vertebrate fauna conservation value**.

The habitat is largely to completely transformed within this BMU. Negligible **diversity of invertebrates** can be expected with a few highly disturbance-tolerant indigenous species, as well as tramp and invasive alien species, are likely to inhabit structures and their immediate surrounds. Indigenous species attracted to lights at night may occur, but those that do not manage to return to their natural habitats will die within the areas of infrastructure. No terrestrial invertebrate SCC or Protected species (PS) are expected. This BMU is considered to be of **Negligible terrestrial invertebrate conservation value**.

The overall biodiversity conservation value of BMU13 (Infrastructure) is considered to be NEGLIGIBLE.

BMU13-specific biodiversity management recommendations:

- Implement the recommendations of the existing integrated alien plant control plan developed for the 12 950 ha Northam Booysendal property (which includes the study area) (De Castro & Brits, 2021b).
- Any future tourist or staff accommodation facilities should be constructed within existing infrastructure footprints (BMU13) or within the footprints of other historically transformed areas (BMU's 9 and 10).
- Disturbed, unvegetated areas must be revegetated immediately upon completion of activity.
- Implementation of stormwater management measures such as construction of stilling basins and energy dissipators, with particular emphasis on stormwater runoff from roads which discharges into wetlands and particularly into peat wetlands.
- During the construction of any tourism or management infrastructure development, reduction of water quality in surrounding wetland habitats must be prevented through the construction and maintenance of sediment traps and, where necessary, oil traps.
- Regular monitoring and maintenance of bunded areas around any hydrocarbon (oil, petrol, or diesel), herbicide, or pesticide storage facility.
- The planting of any alien plant species anywhere within the DBPNR should be prohibited. Only species indigenous to the study area should be planted for horticultural purposes (including the establishment of lawns) and the plants should be grown from seeds and other propagules obtained within the study area.

8. BIODIVERSITY OF NORTHAM BOOYSENDAL STUDY AREA

The current section provides a summary of **the plant and animal species diversity** of the DBPNR study area with special emphasis on **species of conservation concern (SCC).** This section aims to provide some detail of the species referred to in section 7 (landscape diversity/BMU's) as well as species-specific biodiversity management recommendations for all species/groups of conservation concern. Also refer to the addenda and references indicated in grey blocks below each section for more detail.

8.1 VEGETATION / BOTANICAL BIODIVERSITY (INCLUDING WETLANDS)

Vegetation is the basis of almost all life on earth and most other organisms depend on vegetation for survival (COMSA, 2009). Vegetation also plays a role in maintaining certain climatic conditions on earth, but vegetation is often the first to be destroyed for development and the last to be rehabilitated. Vegetation also provides the basis for many of the ecosystem values and services. It is imperative that the vegetation component of an area should be studied in detail, as it provides an important foundation for the management of biodiversity in an area.

National vegetation types

In accordance with the most recent national vegetation map for South Africa, Lesotho and Swaziland produced by SANBI (VEGMAP 2018), four vegetation types occur within the 12 950 ha Northam Booysendal property (initial baseline BMP compiled in 2021), namely Sekhukhune Mountain Bushveld (SVcb 18), Sekhukhune Montane Grassland (GM 19), Steenkampsberg Montane Grassland (GM 30), and Northern Afrotemperate Forest (FOz 2) (De Castro & Brits, 2021a). Though the VEGMAP 2018 only include Sekhukhune Montane Grassland, Steenkampsberg Montane Grassland, and a single patch of Northern Afrotemperate Forest within the DBPNR boundaries, Sekhukhune Mountain Bushveld is also present within the DBPNR (De Castro & Brits, 2021a). The four aforementioned vegetation types were used as the basis for the BMU's identified and mapped for the DBPNR during the 2021 botanical biodiversity assessment of the 12 950 ha Northam Booysendal property (De Castro & Brits, 2021a).

Broad-scale vegetation units

The pre-settlement vegetation of the 2 127ha DBPNR was entirely comprised of the Steenkampsberg Montane Grassland, Sekhukhune Montane Grassland, Sekhukhune Mountain Bushveld, and Northern Afrotemperate Forest vegetation types (Mucina & Rutherford, 2006; Dayaram *et al.*, 2019). The rugged DBPNR study area remains in a largely pristine or near-pristine state and only 2.1% (or ca. 46 ha) of the study area has been transformed by the planting of, and invasion by, alien trees, historical cultivation, the damming of wetlands, and the establishment of infrastructure such as farm homesteads, a labourer's dwelling, and a communications tower complex (see Table 4). The historical establishment of two Eucalyptus plantations (each less than 8 ha) and invasion by alien trees (in particular *Acacia dealbata**) have made the greatest contributions to habitat transformation, and such areas transformed by alien tree planting and invasion are situated mostly on the farm Triangle and the northern and north-eastern parts of the farm De Berg. The habitats and vegetation of the vast majority 97.9% (or ca. 2 081 ha) of the DBPNR remain in an untransformed and pristine or near-pristine state and very little degradation has occurred as a result of common anthropogenic impacts such as altered fire regimes, historical overgrazing or exclusion of grazing, alterations to hydrological patterns, and reduced water quality.

The broad-scale vegetation units and land use units described below were selected so as to form practical Biodiversity Management Units (BMU's) for the BMP of the DBPNR. The vegetation units/BMU's selected here have been derived based on structural and functional criteria. The term structure refers to various aspects of vegetation structure such as physiognomy, life-form composition, species composition, species dominance and stand structure (Kent & Coker, 1992). Functional criteria include aspects such a characteristic ecosystem processes, habitat characteristics, habitat suitability for plant SCC, and ecological status (e.g. primary vegetation of untransformed habitats versus secondary vegetation of transformed or severely degraded habitats).

The vast majority of the study area remains in an untransformed and pristine or near-pristine state. These areas of untransformed habitat and vegetation form part of one of **two centres of plant endemism** (the SCPE and the LCPE) and remain highly diverse and species rich (α-diversity), as is reflected by the fact that **878 indigenous plant species** and infraspecific taxa were recorded during the surveys (De Castro & Brits, 2021a, 2022a), which lacked complete seasonal coverage of all habitats present. The Beta diversity (β-diversity), which is the 'rate of change in species composition across habitats or among communities' is also exceptionally high and is a reflection of the high habitat diversity caused by rugged topography, highly varied geology, and a marked 'elevational diversity gradients'. The broad-scale vegetation units or BMU's are therefore simply practical management units that combine various plant communities which share structural and functional characteristics and have common management requirements.

A total of 10 BMU's, six of which comprise untransformed (primary) vegetation and four of which comprise transformed habitats with secondary vegetation or no vegetation (i.e. infrastructure), were identified within the study area (Figure 7). The extent of each BMU, proportion of the study area covered, average plant species richness, number of species recorded, and relative botanical biodiversity conservation value per BMU is provided in Table 4.

Table 4: Percentage of the 2 127 ha DBPNR occupied by each of the identified BMU's, number of sites surveyed in each unit, average species richness per 100 m², total number of taxa recorded and perceived biodiversity/conservation value of each unit.

BMU	Extent within 2 127 ha DBPNR	% of the study area	**Average Species richness per 100 m² (α-diversity)	Total number of taxa recorded in BMU	Number of taxa recorded exclusively in BMU	Botanical biodiversity conservation value
BMU1. Sekhukhune Mountain Bushveld	153 ha	7.2%	33 (n=2)	176	26 (14.8%)	Very High
BMU2. Sekhukhune Montane Grassland	450 ha	21.2%	47.2 (n=10)	514	144 (28.0%)	Very High
BMU3. **S**teenkampsberg Montane Grassland	1 27 3ha	59.8%	37.5 (n=21)	362	87 (24.0%)	Very High
BMU4. Northern Afrotemperate Forest	16 ha	0.8%	Moderate	90	23 (25.6%)	Very High
BMU5. Valley-bottom and seep wetlands	136 ha	6.4%	18.9 (n=7)	261	99 (37.9%)	Very High
BMU7. Mountain streams	53 ha	2.5%	Moderate to High	164	36 (22.0%)	Very High
BMU9. Secondary vegetation	7 ha	0.3%	17.7 (n=3)	70	1 (1.4%)	Low-Moderate
BMU10. Alien trees	28 ha	1.3%	Very low	31	1 (3.2%)	Low
BMU11. Dams	5 ha	0.2%	Low	34	0 (0.0%)	Low-Moderate
BMU13. Infrastructure	6 ha	0.3%	Negligible	34	0 (0.0%)	Negligible
TOTAL	**2 127 ha**	**100%**				

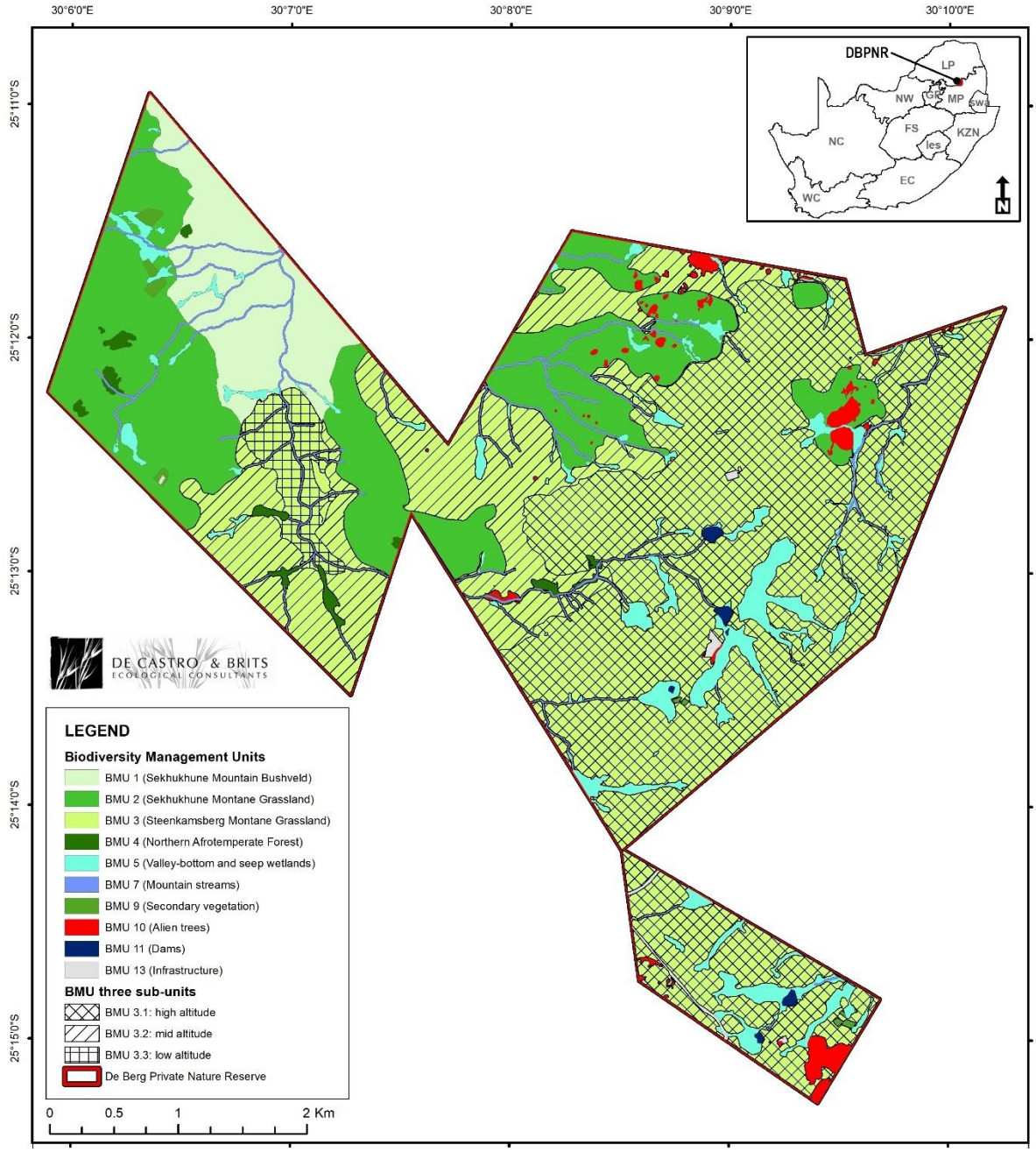


Figure 7: Map of study area indicating the broad scale vegetation units / biodiversity management units (BMU's) (including BMU3 sub-units).

Plant species list

According to the BODATSA database records (http://posa.sanbi.org, accessed in May 2022), the quarter degree grid square within which the study area is situated, namely 2530AA, as well as the grid immediately to the south which contains similar habitats (2530CC), have been poorly explored botanically. The BODATSA database contains herbarium records for less than 533 plant species and infraspecific taxa collected within the 2530AA grid square which, when it is considered that each grid is 50 000 ha in extent, reflects low levels of historical collecting effort and botanical exploration. During the current botanical biodiversity field surveys conducted in the 2021-2022 season for the 2 127 ha DBPNR (Addendum A: De Castro & Brits, 2022a), as well as field surveys conducted during the 2020-2021 season for the 12 950 ha Northam Booysendal property (De Castro & Brits, 2021a) which includes the DBPNR, **a total of 930 plant species and infraspecific taxa were recorded, including 878 indigenous taxa and 52 (5.6% of the total number of species) naturalised alien species**.

The initial species list compiled for the DBPNR as part of the 2020-2021 botanical biodiversity assessment of the 12 950 ha Northam Booysendal property (De Castro & Brits, 2021a) included a total of 667 plant species and infraspecific taxa. A total of 930 plant species and infraspecific taxa were confirmed to occur within the 2 127 ha DBPNR during the current study, of which 878 are indigenous taxa and 52 (5.6%) are naturalised aliens. It is, however, emphasised that the 52 alien species listed in the species list do not constitute a complete list of naturalised alien plants occurring within the study area; a comprehensive list of alien species is provided in the existing alien plant control program report (De Castro & Brits, 2021b). Of the 52 recorded alien species, 14 are listed as declared invasive species in the AIS Regulations. Based on the authors' experience the list of 878 indigenous plant species provided in this report probably includes approximately 85% to 90% of the indigenous species present within the DBPNR.

The **flowering plant families** most well represented in the flora of the DBPNR are (indigenous species richness in parenthesis): Poaceae (134), Asteraceae (120), Fabaceae (51), Cyperaceae (49), Iridaceae (26), Orchidaceae (26), Scrophulariaceae (26), Apocynaceae (25), Hyacinthaceae (21), and Lamiaceae (21). This is regarded as fairly typical for an area of grasslands and open woodlands in the Highveld and mountainous regions of Mpumalanga, though the contribution of the Iridaceae, Orchidaceae, Hyacinthaceae, and Lamiaceae to the total species richness is regarded as exceptionally high. The exceptionally high species richness in three of the four most well represented families, namely the Poaceae, Asteraceae, and Cyperaceae, is attributable largely to large numbers of obligate hygrophytes and hydrophytes recorded within high-altitude wetlands (BMU5), and in particular peatlands, over-lying quartzitic geology at elevations above ca. 2 100 m.a.s.l. The representation of plant families in the flora of the study area recorded during the current study corresponds fairly well to that reported by NSS (2017) in a ca. 800 ha portion of the 12 950 ha Northam Booysendal property surveyed for the purposes of the Booysendal South EIA in an area of igneous geology. NSS (2017) found that the most well represented families were Poaceae (59), Asteraceae (44), Fabaceae (20), and Cyperaceae (15).

The 2 127 ha DBPNR falls entirely within one of two CPEs, **namely Sekhukhuneland CPE** (Siebert, 1998; Van Wyk & Smith, 2001) **and Lydenburg CPE** (Lötter, 2019). According to Lötter (2019), some 100 endemic and near-endemic taxa are known for the SCPE and 80 are known for the LCPE (including 28 taxa that area endemic to the Steenkampsberg sub-centre of the LCPE). The DBPNR study confirmed the presence of 15 plant taxa that are endemic or near endemic to the SCPE and 17 that are endemic or near endemic to the LCPE (De Castro & Brits, 2022a). The SCPE endemics were recorded within Sekhukhune Mountain Bushveld (BMU1) and

Sekhukhune Montane Grassland (BMU2) as well as the patches of Northern Afrotemperate Forest (BMU4) embedded within these vegetation types. The LCPE endemics were recorded from Steenkampsberg Montane Grassland (BMU3), the high-altitude wetlands (BMU5), and the mountain streams (BMU7) embedded within it. Many of the endemic species thus far recorded within the DBPNR are common within the study area and/or its immediate surrounds and some are even dominant or sub-dominant in certain habitats (e.g. *Vitex obovata* subsp. *wilmsii*), and various other plant taxa that are endemic or near endemic to either the SCPE or LCPE undoubtedly occur within the study area.

The recently described **Limpopo-Mpumalanga-Eswatini Escarpment (LMEE) is a 'centre of endemism'** comprising an orographic entity some 53 594 km^2 in extent that forms part of southern Africa's Great Escarpment and extends from Pongola River in the south, Woodbush in the north, the Highveld in the west, and the Lowveld in the east (Clark *et al*., 2022). The LMEE therefore encompasses both the SCPE and LCPE. A total of 496 endemic plant taxa have thus far been identified for the LMEE (Clark *et al*., 2022) and an initial screening indicated that a minimum of **52 LMEE endemics are present in the DBPNR** (De Castro & Brits, 2022a), though it must be emphasised that far more LMEE endemics are likely to be present. It should be noted that many of the LMEE endemics identified by Clark and co-authors (2022) are as yet undescribed and unpublished taxa and the identification of such species is not possible in a brief study such as presented here. The current study therefore focused on the identification and management of plant 'species of conservation concern' (*sensu* Raimondo *et al.,* 2009) and their habitat rather than on endemic species.

Alien Plants

Based on the available literature, the authors' experience in the region, as well as observations made during the current and previous surveys, the following **alien invasive plant species** pose the greatest threat to the untransformed habitats and indigenous vegetation of the study area and its immediate surrounds and should be regarded as priority species for alien plant control efforts: **Acacia dealbata, *Acacia mearnsii, *Acacia melanoxylon, *Eucalyptus* spp., *Pinus patula, *Pinus* cf. *elliotii,* and *Pennisetum clandestinum.* All of these species are aggressive invaders and habitat transformers or potential habitat transformers that pose a significant threat to the biodiversity of the DBPNR. With the exception of **Pennisetum clandestinum* (Kikuyu grass) all the aforementioned priority species are trees. The parts of the study area most impacted by habitat transformers are situated at elevations between ca. 1 800 m.a.s.l. and 2 100 m.a.s.l. on the farms De Berg and Triangle. The largest plantations and invasive stands of alien trees (*Acacia dealbata** and *Eucalyptus* spp.*) occur in the north-eastern parts of the farm De Berg and on the eastern boundary of the farm Goedehoop. The BMU's most susceptible to habitat transformation and biodiversity loss as a result of alien plant invasion are Steenkampsberg Montane Grassland (in particular BMU3.2) and Sekhukhune Montane Grassland (BMU2, in particular patches of grassland at high elevations on the farm Triangle) as well as patches of Northern Afrotemperate Forest (BMU4) and Mountain Streams (BMU7) embedded within the montane grassland areas. Little to no alien plant invasion is present at low elevations within Sekhukhune Mountain Bushveld (BMU1) and BMU3.3.

The DBPNR management should develop and implement an integrated alien plant control program (as per the AIS Regulations), which identifies the species that pose the greatest threat, in terms of habitat transformation, within the study area, and considers all appropriate chemical, mechanical, biological, and cultural control methods for the alien species (De Castro & Brits, 2021b). Emphasis should be placed on controlling the declared alien invasive species listed in

De Castro and Brits (2021b), and in particular the following priority species: **Acacia dealbata, *Acacia mearnsii, *Acacia melanoxylon, *Eucalyptus* spp., *Pinus patula, *Pinus* cf. *elliotii,* and **Pennisetum clandestinum*. A comprehensive alien plant report that maps concentrations of alien species that are habitat transformers, and therefore pose a significant risk to biodiversity within the study area, and recommends a suitable approach and practical methods for the eradication or control of such species was completed for the 12 950 ha Northam Booysendal study area by De Castro and Brits (2021b). The implementation of a comprehensive alien plant control program is already being carried out by the mine's Department of Land Management, and this control program should be regarded as a biodiversity conservation management priority for the mine. Alien plant eradication efforts should be focused on the portions of the DBPNR which have both the highest diversity and concentrations of plant SCC and the highest levels of habitat transformation by alien plants, namely the farms De Berg and Triangle, but should initially target even small stands or individuals of aggressive habitat transformers recorded within any untransformed BMU and in particular within BMU's 2, 3.1, 3.2, 5, and 7.

Protected plants

Three pieces of legislation which grant protected status to selected indigenous plant species are of relevance to the study area, namely:

- National Forests Act (Act 84 of 1998, as amended on the 23rd of September 2010),
- National Environmental Management: Biodiversity Act (Act 10 of 2004, as amended on the 16th of April 2013), and
- Mpumalanga Nature Conservation Act (No.10 of 1998).

Schedule A of the National Forests Act (Act 84 of 1998) lists 47 tree species that are Protected in South Africa and may not be removed or damaged without the granting of a Permit by the National Department of Agriculture, Forestry and Fisheries. Though protected, most of these species have large distribution ranges, are common to abundant throughout much of their distribution ranges and are not threatened with extinction in any sense. Four species recorded within the study area are Protected in terms of the NFA (Table 5).

The National Environmental Management: Biodiversity Act (Act 10 of 2004, as amended in April 2013), provides a list of 'Threatened or Protected Species' (TOPS list) which includes plant and animal species that are directly threatened by utilisation and require protection. This Act assigns species threatened by utilisation to one of four categories, namely Critically Endangered, Endangered, Vulnerable, and Protected, but it must be emphasised that these categories are different from the rigorously defined IUCN Ver. 3.1 categories for Threatened plant species (IUCN, 2001) which are used by SANBI's Threatened Species Program to produce the National Red List (http://redlist.sanbi.org). The destruction, collection or trading of any species listed in the Act requires a permit which must be obtained from the MTPA permitting office. Three species listed in the Biodiversity Act were recorded within the study area during the current study, namely the medicinal plants *Alepidea cordifolia* [= *A. amatymbica*, in part.], *Dioscorea sylvatica,* and *Merwilla plumbea,* all three of which are categorised as Vulnerable in the TOPS list (Table 5). All three of the aforementioned species are also Threatened (*Alepidea cordifolia* and *Dioscorea sylvatica*) or Near Threatened (*Merwilla plumbea*) species (http://redlist.sanbi.org) and are discussed in more detail in the section on this report dealing with plant 'species of conservation concern' (*sensu* Raimondo *et al.*, 2009).

A number of plant species occurring in Mpumalanga Province are not considered to be Threatened or listed as being 'species of conservation concern' (*sensu* Raimondo *et al*., 2009), but are protected under Schedules 11 and 12 of the Mpumalanga Nature Conservation Act (No.10 of 1998). Eighty-five of the species recorded within the study area (Table 5) are protected plants for which, under Schedule 11 of the Mpumalanga Nature Conservation Act (Act no. 10 of 1998), a permit has to be obtained prior to their removal and transport. These 85 protected species are listed in Table 5 together with the BMU's in which they have been recorded.

Management recommendation: The damaging or destruction of plant species that are Protected in terms of the National Forest Act (Act 84 of 1998), NEM:BA (Act 10 of 2004, as amended on the 16th of April 2013), or the Mpumalanga Nature Conservation Act (No.10 of 1998) during any future development should be avoided wherever possible, and the need for a permit for the removal, transport or destruction of any such protected plant should be established with the provincial authorities (Permitting Office of the MTPA) prior to development. It is recommended that where untransformed natural habitats are to be affected by an authorised development, Protected plant species are rescued and placed in a nursery or donated to a research institute (e.g. SANBI botanical gardens) prior to development, rather than simply being destroyed. Where feasible, viable subpopulations of such species should also be translocated to transformed (including rehabilitation areas) or untransformed areas within the study area which provide potentially suitable habitats, but such translocations will have to be carried out in a manner that ensures that no ecological degradation of the host habitat occurs and will have to be evaluated by a botanist for each species and each potential translocation area. The aforementioned measures are not applicable to the 15 protected species that are also Threatened or Near Threatened species (see Table 5) and should therefore be conserved *in situ*.

Table 5: List of all 90 plant species thus far recorded within the DBPNR, protected under either the National Forest Act (NFA), the National Environmental Management: Biodiversity Act (NEMBA) or the Mpumalanga Nature Conservation Act (MNCA).

Species*	Family	MNCA	NEMBA (TOPS List)	NFA	BMU's where recorded
Agapanthus inapertus	Alliaceae	X			2
Alepidea cordifolia (EN)	Apiaceae		X		5 & 7
Aloe arborescens	Asphodelaceae	X			1 & 2
Aloe bergeriana	Asphodelaceae	X			2
Aloe barbara-jeppeae (NT)	Asphodelaceae	X			2 &1
Aloe challisii (VU)	Asphodelaceae	X			3
Aloe castanea	Asphodelaceae	X			2
Aloe chortolirioides var. *woolliana*	Asphodelaceae	X			3
Aloe cooperi (Declining)	Asphodelaceae	X			2, 5 & 7
Aloe ecklonis	Asphodelaceae	X			2
Aloe greatheadii var. davyana	Asphodelaceae	X			1 & 2
Aloe minima	Asphodelaceae	X			2
Aloe modesta (VU)	Asphodelaceae	X			3
Aloe pretoriensis	Asphodelaceae	X			1, 2 & 3
Aloe reitzii var. *reitzii* (NT)	Asphodelaceae	X			3 & 2
Alsophila dregei	Cyatheaceae	X			2, 3, 5 & 7

Species*	Family	MNCA	NEMBA (TOPS List)	NFA	BMU's where recorded
Berchemia zeyheri	Rhamnaceae	X			1
Brachystelma coddii	Apocynaceae	X			2
Brachystelma stellatum	Apocynaceae	X			3
Brunsvigia radulosa	Amaryllidaceae	X			2, 3 & 5
Corycium nigrescens	Orchidaceae	X			2, 3 & 5
Cyrtanthus cf. *bicolor*	Amaryllidaceae	X			5 & 7
Cyrtanthus breviflorus	Amaryllidaceae	X			5
Curtisia dentata (NT)	Cornaceae			X	4
Dioscorea cotinifolia	Dioscoreaceae	X			2 & 4
Dioscorea cf. dregeana	Dioscoreaceae	X			4
Dioscorea sylvatica (VU)	Dioscoreaceae	X	X		4 & 2
Disa acontitoides	Orchidaceae	X			2
Disa alticola (VU)	Orchidaceae	X			3 & 5
Disa maculomarronina	Orchidaceae	X			5
Disca patula var. *transvaalensis*	Orchidaceae	X			3
Disa versicolor	Orchidaceae	X			3
Disperis stenoplectron	Orchidaceae	X			5
Eucomis autumnalis (Declining)	Hyacinthaceae	X			2, 3 & 5
Eucomis vandermerwei (VU)	Hyacinthaceae	X			3
Eulophia bainesii	Orchidaceae	X			2 & 3
Eulophia ovalis	Orchidaceae	X			2
Eulophia nutans	Orchidaceae	X			1 & 2
Faurea galpinii	Proteaceae	X			3 & 7
Faurea saligna	Proteaceae	X			7
Gladiolus calcaratus (VU)	Iridaceae	X			5
Gladiolus crassifolius	Iridaceae	X			2, 5 & 6
Gladiolus dalenii	Iridaceae	X			3
Gladiolus densiflorus	Iridaceae	X			2
Gladiolus ecklonis	Iridaceae	X			2
Gladiolus longicollis subsp *platypetalus*	Iridaceae	X			2
Gladiolus papilio	Iridaceae	X			5
Gladiolus permeabilis	Iridaceae	X			3
Gladiolus varius	Iridaceae	X			3
Gladiolus woodii	Iridaceae	X			2 & 3
Habenaria barbertoni (NT)	Orchidaceae	X			2
Habenaria clavata	Orchidaceae	X			2
Habenaria cf. *dives*	Orchidaceae	X			1 & 2
Habenaria epipactidea	Orchidaceae	X			2
Habenaria falcicornis	Orchidaceae	X			2 & 5
Habenaria filicornis	Orchidaceae	X			5

Species*	Family	MNCA	NEMBA (TOPS List)	NFA	BMU's where recorded
Haemanthus humilis	Amaryllidaceae	X			2 & 3
Hesperantha coccinea	Iridaceae	X			5 & 7
Huernia stapelliodes	Apocynaceae	X			2
Huernia zebrina subsp. *insigniflora*	Apocynaceae	X			2
Kniphofia fluviatilis	Asphodelaceae	X			5 & 7
Kniphofia linearifolia	Asphodelaceae	X			5 & 7
Liparis bowkeri	Orchidaceae	X			4
Lydenburgia cassinoides (NT)	Celastraceae			X	1 & 7
Merwilla plumbea (NT)	Hyacinthaceae	X	X		2
Neobolusia tysonii	Orchidaceae	X			5
Olea capensis subsp. *enervis*	Oleaceae	X			2 & 7
Olea europaea subsp. *africana*	Oleaceae	X			2 & 4
Pittosporum viridiflorum	Pittosporaceae			X	1, 2, 3, 4 & 7
Polystachya ottonia	Orchidaceae	X			4
Protea caffra subsp. *caffra*	Proteaceae	X			2 & 3
Protea gauguedi	Proteaceae	X			3
Protea parvula (NT)	Proteaceae	X			2 & 7
Protea roupelliae subsp. *roupelliae*	Proteaceae	X			2 & 3
Protea welwitschii	Proteaceae	X			2
Pterygodium cooperi	Orchidaceae	X			7
Pterygodium magnum	Orchidaceae	X			5
Satyrium cristatum	Orchidaceae	X			5
Satyrium longicauda var. *longicauda*	Orchidaceae	X			5
Satyrium parviflorum	Orchidaceae	X			2 & 4
Scadoxus multiflorus	Amaryllidaceae	X			1, 2 & 4
Scadoxus puniceus	Amaryllidaceae	X			3 & 4
Schizocarpus nervosus	Hyacinthaceae	X			2 & 3
Schizochilus zeyheri	Orchidaceae	X			5
Sclerocarya birrea subsp. *caffra*	Anacardiaceae			X	1
Stenoglottis fimbriata	Orchidaceae	X			4
Watsonia bella	Iridaceae	X			5
Watsonia occulta	Iridaceae	X			3
Zantedeschia pentlandii (VU)	Araceae	X			1 & 2
Zantedeschia rehmannii	Araceae	X			2 & 3

* Conservation status categories provided in parenthesis are in accordance to SANBI (http://redlist.sanbi.org and the MTPA). CR = Critically Endangered, EN = Endangered, VU = Vulnerable, NT = Near Threatened.

Plant 'species of conservation concern' (SCC)

Prior to the conduction of the field surveys, available database information pertaining to the threatened plant species of the region of the Mpumalanga Province within which the study area is situated was obtained from the MTPA PlantDat database, as well as from SANBI's online Botanical Database of Southern Africa (BODATSA) (http://posa.sanbi.org, accessed in May 2022). The entire study area falls within the Mpumalanga Province and within the grid square 2530AA. All 'threatened species' categories, namely Critically Endangered (CR), Endangered (EN), and Vulnerable (VU) species, and other 'species of conservation concern', namely Near Threatened (NT), Declining, Critically Rare, and Rare species (Raimondo *et al*., 2009 and http://redlist.sanbi.org, accessed August 2020) historically recorded from the quarter degree grid square within which the 2 127 ha DBPNR study area is situated (2530AA), were extracted from the databases and are presented in De Castro and Brits (2022a). Selected species which occur in similar habitat in the adjacent grid square immediately to the south (2530AC) have also been included in the list of potentially occurring plant 'species of conservation concern', as have species recorded within these quarter degree grids for the first time during the DBPNR survey (De Castro & Brits, 2022a) or the 2020-2021 survey of the 12 950 ha Northam Booysendal property within which the DBPNR is situated (De Castro & Brits, 2021a). The annotated list of plant 'species of conservation concern' (SCC) potentially occurring or recorded in the study area include 70 species and infraspecific taxa. Emphasis was placed on searching for these plant species within potentially suitable habitat during the field surveys conducted as part of the current study.

The Red List of South African Plants (Raimondo *et al*., 2009; http://redlist.sanbi.org) provides an assessment of all South African plant taxa. The Red List therefore contains taxa that are currently regarded as being threatened with extinction (Critically Endangered, Endangered, and Vulnerable) or are close to being threatened with extinction (Near Threatened), as well as taxa that are currently not regarded as being threatened with extinction (Least Concern), in accordance with IUCN Version 3.1 criteria (IUCN, 2001). In addition to these IUCN categories, the South African Red List also includes unique, South African categories for species which do not currently qualify as Threatened or Near Threatened in accordance with IUCN criteria and are thus categorised as Least Concern by the IUCN, but which are of some conservation concern (Raimondo *et al*., 2009). These South African categories are Critically Rare, Rare, and Declining, and were developed specifically to highlight species that, though not Threatened with extinction or Near Threatened, require some conservation effort and monitoring. In terms of the recommended methodology provided by Raimondo *et al*. (2009), the term 'species of conservation concern' (SCC) includes the IUCN Threatened and Near Threatened categories as well as the non-IUCN South African Red List categories (i.e. Critically Rare, Rare, and Declining), and this approach is followed here.

The 70 plant SCC (*sensu* Raimondo *et al.,* 2009) for the DBPNR study area include **39 species or infraspecific taxa categorised as Threatened (Critically Endangered, Endangered or Vulnerable), 12 categorised as Near Threatened, 11 categorised as Rare and 8 categorised as Declining**, at either a national or provincial (Mpumalanga) level. The current study established the presence of **42 plant SCC within the 2 127 ha DBPNR, 17 of which are new records for the study area** (see Table 6). The SCC recorded within the study area comprise **19 Threatened species (CR, EN or VU) (Figure 8), 11 Near Threatened species (Figure 9), 7 Rare species and 5 Declining** species. It is considered highly probable that future surveys will reveal the presence of additional plant SCC within the DBPNR. These 42 recorded plant SCC are listed in Table 6 and Table 7 together with their conservation status, source of record, sites at which they were recorded, and the BMU's within which they are known to occur. All 42 of these SCC are

also included in the list of potentially occurring SCC, together with relevant information on their known habitat requirements (both within their Extent of Occurrence and within the study area), geographical distribution, flowering times, current conservation status, and potential or confirmed occurrence and distribution within the current study area (De Castro & Brits, 2022a).

A total of **30 Threatened and Near Threatened taxa** (19 Threatened and 11 Near Threatened) have therefore thus far been **recorded within the 2 127 ha DBPNR**, a figure which represents **15% of the 200 Threatened and Near Threatened species known for Mpumalanga** (MTPA). This is a remarkable figure when one considers that the Mpumalanga Province covers an area of approximately 7 649 460 ha and the 2 127 ha DBPNR therefore comprises less than 0.03% of the province.

Table 6: List of the 42 plant SCC (*sensu* Raimondo *et al*., 2009, http://redlist.sanbi.org) that have been recorded within the 2 127 ha DBPNR study area (including the recently acquired farm Goedehoop). These records are based on historical records included in the MTPA database, the species recorded during the botanical survey of the DBPNR (De Castro & Brits, 2022a) and the 2021 survey of the 12 950 ha Northam Booysendal study area (De Castro & Brits, 2021a), as well as previous surveys conducted by McCleland (2010) in the adjacent Hoogland area situated directly to the north of De Berg. Forty-two plant SCC have thus far been recorded within the DBPNR study area, including 19 Threatened, 11 Near Threatened taxa, 7 Rare and 5 Declining taxa. The 17 plant 'species of conservation concern' recorded within DBPNR study area for the first time during the DBPNR (De Castro & Brits, 2022a) or Northam Booysendal surveys (De Castro & Brits, 2021a) are highlighted in yellow.

Species	**Family**	**IUCN (version 3.1) Conservation Status Category***		**Source of records#**	**BMU's where recorded** (Listed in order of importance)
		National	**MTPA**		
Alepidea cordifolia	Apiaceae	EN	EN	MTPA ADC	BMU 5 BMU 7
Alepidea cf. *longeciliata*	Apiaceae	EN	EN	ADC	BMU 5
Aloe chalisii	Asphodelaceae	VU	VU	ADC	BMU 3
Aloe modesta	Asphodelaceae	VU	VU	ADC	BMU 3
Bulbine sp. nov. aff. *capitata* (ADC 1766)	Asphodelaceae	EN (provisional)	EN (provisional)	ADC	BMU 5
Crassula setulosa var. *deminuta*	Crassulaceae	VU	VU	MTPA WM, ADC	BMU 3
Dioscorea sylvatica	Dioscoreaceae	VU	VU	ADC	BMU 4 BMU 2
Disa alticola	Orchidaceae	VU	VU	MTPA ADC	BMU 5 BMU 3
Eucomis vandermerwei	Hyacinthaceae	VU	VU	MTPA WM, ADC	BMU 3
Gladiolus calcaratus	Iridaceae	LC	VU	MTPA ADC	BMU 5 BMU 3
Graderia linearifolia	Orobanchaceae	VU	VU	MTPA ADC	BMU 3
Ledebouria sp. nov. '*altipaludosus*' ined.	Hyacinthaceae	VU (provisional)	VU	ADC	BMU 5

Species	Family	IUCN (version 3.1) Conservation Status Category*		Source of records#	BMU's where recorded (Listed in order of importance)
		National	MTPA		
Ledebouria megaphylla [=*Resnova mesgaphylla*]	Hyacinthaceae	-	VU	WM, ADC	BMU 4 BMU 2 BMU 1
Ledebouria sp. nov. '*noritica*' ined.	Hyacinthaceae	EN (provisional)	EN	ADC	BMU 5 BMU 2
Ledebouria sp. nov. '*purpurea*' ined.	Hyacinthaceae	VU (provisional)	VU	MTPA ADC	BMU 3 BMU 5
Ledebouria sp. nov. '*steenkampsbergensis*' ined.	Hyacinthaceae	VU (provisional)	VU	MTPA ADC	BMU 3
Morella microbracteata	Myricaceae	EN	EN	ADC	BMU7
Wurmbea viridiflora	Colchicaceae	VU (provisional)	VU	MTPA ADC	BMU 5 BMU 7
Zantedeschia pentlandii (R. Whyte ex W. Watson) Wittm.	Araceae	VU	VU	MTPA WM, ADC	BMU 2 BMU 1
19 Threatened (CR, EN & VU)					
Alepidea attenuata	Apiaceae	NT	NT	POSA ADC	BMU 5
Aloe barbara-jeppeae	Asphodelaceae	NT	NT	MTPA ADC, NSS	BMU 2 BMU 1
Aloe reitzii var. reitzii	Asphodelaceae	NT	NT	ADC	BMU 3 BMU 2
Curtisia dentata	Cornaceae	NT	NT	WM, ADC	BMU 4
Disa maculomarronina	Orchidaceae	NT	NT	MTPA ADC	BMU 5
Habenaria barbertoni	Orchidaceae	NT	NT	ADC WM	BMU 2
Jamesbrittenia macrantha	Scrophulariaceae	NT	NT	ADC	BMU 1
Lydenburgia cassinoides	Celastraceae	NT	NT	ADC	BMU 7 BMU 1
Merwillea plumbea	Hyacinthaceae	NT	NT	WM, ADC	BMU 2 BMU 7
Protea parvula	Proteaceae	NT	NT	ADC	BMU 3 BMU 7
Watsonia bella	Iridaceae	LC	NT	MTPA ADC	BMU 5
11 Near Threatened					
Amauropelta oppositiformis	Thelypteridaceae	LC	Rare	MTPA	BMU 5 BMU 3
Brachystelma stellatum	Apocynaceae	Rare	Rare	MTPA	BMU 3
Helichrysum ephelos	Asteraceae	Rare	Rare	ADC	BMU 5
Khadia alticola	Aizoaceae	Rare	Rare	MTPA	BMU 3

Species	Family	IUCN (version 3.1) Conservation Status Category*		Source of records#	BMU's where recorded (Listed in order of importance)
		National	MTPA		
				ADC	
Pterygodium cooperi	Orchidaceae	LC	Rare	ADC	BMU 7
Streptocarpus latens	Gesneriaceae	Rare	Rare	MTPA ADC	BMU 3
Watsonia occulta	Iridaceae	LC	Rare	MTPA WM	BMU 3
7 Rare					
Aloe cooperi	Asphodelaceae	LC	Declining	ADC	BMU 2 BMU 7
Callilepis leptophylla	Asteraceae	LC	Declining	ADC	BMU 2
Eucomis autumnalis subsp. *clavata*	Hyacinthaceae	LC	Declining	ADC	BMU 2 BMU 5 BMU 3
Gunnera perpensa	Gunneraceae	LC	Declining	ADC	BMU 5
Ilex mitis	Aquifoliaceae	LC	Declining	ADC	BMU 4 BMU 7
5 Declining					

* Unless otherwise stated in parenthesis, conservation status is in accordance to the latest *Red List of South African Plants* (Raimondo *et al*., 2009), and the continuously updated online Red List of SANBI (http://redlist.sanbi.org, accessed August 2020. CR = Critically Endangered, EN = Endangered, VU = Vulnerable, NT = Near Threatened and LC = Least Concern).
# MTPA = Mpumalanga Parks & Tourism Agency, POSA = Plants of Southern Africa Database (http://newposa.sanbi.org), ADC = Antonio De Castro, WM = Warren McCleland and ML = Mervyn Lötter.

Table 7: Lists of plant 'species of conservation concern' (*sensu* Raimondo *et al*., 2009, http://redlist.sanbi.org) recorded within each of the 10 BMU's identified for 2 127 ha DBPNR study area. The 17 plant SCC recorded in the DBPNR for the first time during the DBPNR survey (De Castro & Brits, 2022a) or during the 2021 survey (De Castro & Brits, 2021a) of the 12 950 ha Booysendal study area, are highlighted in yellow.

BMU	Recorded plant 'species of conservation concern' (SCC)*				
	Threatened	Near Threatened	Rare	Declining	Total
1	**2** *Ledebouria megaphylla* (VU) *Zantedescia pentlandii* (VU)	**2** *Jamesbrittenia macrantha* *Lydenburgia cassinoides*	**-**	-	4
2	**4** *Dioscorea* cf. *sylvatica* (VU) *Ledebouria megaphylla* (VU) *Ledebouria* sp. nov. '*noritica*' (EN) *Zantedescia pentlandii* (VU)	**4** *Aloe barbara-jeppeae* *Aloe reitzii* var. *reitzii* *Habenaria barbertoni* *Merwillea plumbea*	-	**3** *Aloe cooperi* *Callilepis leptophylla* *Eucomis autumnalis*	11
3	**9**	**2**	**5**	**1**	17

BMU	Recorded plant 'species of conservation concern' (SCC)*				
	Threatened	Near Threatened	Rare	Declining	Total
	Aloe chalisii (VU) *Aloe modesta* (VU) *Crassula setulosa var. deminuta* (VU) *Disa alticola* (VU) *Eucomis vandermerwei* (VU) *Gladiolus calcaratus* (VU) *Graderia linearifolia* (VU) *Ledebouria* sp. nov. '*purpurea*' (VU) *Ledebouria* sp. nov. '*steenkampsbergensis*' (VU)	*Aloe reitzii* var. *reitzii* *Protea parvula*	*Amauropelta oppositiformis* *Brachystelma stellatum* *Khadia alticola* *Streptocarpus latens* *Watsonia occulta*	*Eucomis autumnalis* subsp. *clavata*	
4	**2** *Dioscorea* cf. *sylvatica* (VU) *Ledebouria megaphylla* (VU)	**1** *Curtisia dentata*	-	**1** *Ilex mitis*	4
5	**9** *Alepidea cordifolia* (EN) *Alepidea* cf. *longeciliata* (EN) *Bulbine* sp. nov. (ADC 1766) (EN) *Disa alticola* (VU) *Gladiolus calcaratus* (VU) *Ledebouria* sp. nov. '*altipaludosus*' (VU) *Ledebouria* sp. nov. '*noritica*' (EN) *Ledebouria* sp. nov. '*purpurea*' (VU) *Wurmbea viridflora* (VU)	**3** *Alepidea attenuata* *Disa maculomarronina* *Watsonia bella*	**2** *Amauropelta oppositiformis* *Helichrysum ephelos*	**2** *Eucomis autumnalis* *Gunnera perpensa*	16
7	**3** *Alepidea cordifolia* (EN) *Morella micribracteata* (EN) *Wurmbea viridflora* (VU)	**2** *Lydenburgia cassinoides* *Protea parvula*	**1** *Pterygodium cooperi*	**3** *Aloe cooperi* *Ilex mitis* *Gunnera perpensa*	9
9	-	-	-	-	0
10	-	-	-	-	0
11	-	-	-	-	0
13	-	-	-	-	0

* CR = Critically Endangered, EN = Endangered, VU = Vulnerable, NT = Near Threatened & LC = Least Concern.

Threatened species (CR, EN, and VU)

Placement of a taxon in one of the categories of threat indicates that it is at risk of extinction (Raimondo *et al.* 2009). Critically Endangered species can be defined in simple terms as taxa which face an extremely high risk of extinction, Endangered taxa are those facing a very high risk of extinction and Vulnerable taxa face a high risk of extinction (http://redlist.sanbi.org). According to the MTPA database (2017) a total of 159 Threatened species (CR, EN, and VU) were known from the Mpumalanga Province in 2017. The presence of **19 Threatened species** within the 2

127 ha DBPNR has been recorded during the latest study by De Castro and Brits (2022a) (Table 6, Figure 8). Remarkably, the study area flora therefore includes approximately 11.9% of all Threatened species known for the province in an area which comprises less than 0.03% of the province.

The **19 Threatened plant species** thus far recorded within the DBPNR include no taxa categorised as Critically Endangered, **five categorised as Endangered and 14 categorised as Vulnerable**. The occurrence of the 19 recorded Threatened plant species in each of the 10 BMU's identified for the study area is shown in Table 7. The BMU's within which the highest number of Threatened taxa were recorded are BMU5, which comprises only ca. 6.4% of the study area but contains nine Threatened species, BMU3, which comprises ca. 59.8% of the study area and contains nine Threatened species and BMU2, which comprises ca. 21.2% of the study area and contains four Threatened species. The wetlands of the study area (BMU5), and particularly the high-altitude wetlands embedded within Steenkampsberg Montane Grassland (BMU3), are therefore of great importance in terms of botanical biodiversity conservation within the DBPNR. Five of the nine recorded Threatened wetland species were recorded from peat wetlands (mires) within this unit, emphasising the extreme conservation importance of these peat wetlands.

Five of the 19 recorded Threatened plants were discovered recently (three during the 2021 De Castro & Brits survey of the 12 950 ha Northam Booysendal property) and are currently in the process of being described and published. The conservation status categories described below are therefore provisional and have been communicated to the MTPA, which together with the Threatened species Programme of SANBI will verify the provisional conservation status categories. It is regarded as highly probable that additional undescribed plant taxa occur within the DBPNR. Each of the **five new species recently found within the DBPNR** are briefly discussed below.

Bulbine sp. nov. aff. *capitata* (ADC 1766) (Plate 1)

This species was first identified as a potential new species by Mr. Tony de Castro during the 2020-2021 Northman Booysendal botanical biodiversity survey (De Castro & Brits, 2021a) and its status as an undescribed taxon will be confirmed during further field studies to be conducted by the author and Prof. Gideon Smit (Asphodelaceae taxonomist). The genus *Bulbine* was last revised over 40 years ago (Baijnath, 1977) and is regarded as probable that many taxa within this genus remain undescribed. The plants found at various sites in two large valley-bottom wetlands at the farm De Berg bare a superficial resemblance to *Bulbine capitate* but differ significantly from this species in terms of root, inflorescence, and flower morphology and are habitat specialists entirely restricted to true peat substrates of the central zones of high-altitude valley-bottom wetlands. It is therefore considered highly probable that the plants at farm De Berg represent an undescribed species.

The species is entirely restricted to high-altitude (over 2 225–2 243 m.a.s.l.) valley-bottom wetlands with peat substrates on the farm De Berg. It has only been recorded from shallower, seasonally saturated, true peat or peaty soils in the central or outer zones of the two large valley-bottom wetlands where thousands of plants are present and conspicuous when in flower during spring. Due to its highly specialised habitat requirements and extremely small known 'Extent of Occurrence' and 'Area of Occupancy', and the fact that significant habitat loss (ca. 1.8 ha) is likely to have occurred as a result of the historical construction of a tar road crossing and two dams, this wetland species has been provisionally categorised as Endangered by Mr. de Castro (conservation status to be confirmed by the MTPA and SANBI).

Plate 1: *Bulbine* sp. nov. aff*. capitata* (ADC 1766) (EN). Habitat in mire. Yellow flowers are *Bulbine* sp. nov.

Ledebouria sp. nov. '*altipaludosus*' ined. (ADC *s.n.*) (Plate 2)

This species was first identified as a potential new species by Mr. Tony de Castro during the 2020-2021 Northman Booysendal botanical biodiversity survey (De Castro & Brits, 2021a) and its status as a distinct new species has been confirmed by Andrew Hankey (*Ledebouria* taxonomist at SANBI) following a site visit to the recorded localities. Type specimens have been collected and illustrated and the species is in the process of being described and published by Hankey and De Castro. *Ledebouria altipaludosus* is currently known only from the 12 950 ha Northam Booysendal property, where it has been recorded at various sites on the farms De Berg, Triangle, Goedehoop, and Pietersburg. The species is entirely restricted to high-altitude (2 088 to 2 258 m.a.s.l.) valley-bottom and seep wetlands (BMU5) within Steenkampsberg Montane Grassland (BMU3) or, to a lesser extent, within Sekhukhune Montane Grassland (BMU2) where it is far less abundant. Wetlands where this species was recorded invariably have true peat or peaty soils overlying sandstone (at De Berg) or Norite (at Pietersburg), and these substrates are seasonally to permanently saturated. The plants are most abundant in the outer zones of actively forming peat wetlands (i.e. mires) at sites 70 and 18 on the farm De Berg where thousands of plants are present. Flowering was recorded in October and early November.

Due to its specialised habitat requirements and restricted 'Extent of Occurrence' and 'Area of Occupancy', and the fact that some historical habitat loss has undoubtedly occurred as a result of the construction of a tar road and two cement-walled dams at De Berg, this wetland species has been provisionally categorised as Vulnerable by Mr. de Castro (conservation status to be confirmed by the MTPA and SANBI).

	
Ledebouria sp. nov. *'altipaludosus'* ined. (VU) habitat in mire in valley-bottom wetland.	*Ledebouria* sp. nov. *'altipaludosus'* ined. (VU).

Plate 2*: Ledebouria* sp. nov. '*altipaludosus*' ined. (ADC s.n.)

Ledebouria sp. nov. '*noritica*' ined. (Plate 3)

This species was first identified as a potential new species by Mr. Tony de Castro during the 2020-2021 Northman Booysendal botanical biodiversity survey (De Castro & Brits, 2021a) and its status as a distinct new species has been confirmed by Andrew Hankey (*Ledebouria* taxonomist at SANBI) following a site visit to the recorded localities. Type specimens have been collected and illustrated and the species is in the process of being described and published by Hankey and De Castro. The species is currently known only from the 12 950 ha Northam Booysendal study area, where it has been recorded at four sites (all at single locality) on the farm Sterkfontein Portion 3 and at a single site 15 km to the north-north-east on the farm Hebron. Less than 100 plants were recorded at the dryer Hebron site, whereas a few thousand plants in dense colonies were recorded at the Sterkfontein Portion 3 locality. *Ledebouria noritica* is entirely restricted to seasonally or temporarily saturated shallow to skeletal, gravelly soils overlying norite (silica norite) sheetrock on moderately steep, west-facing slopes at altitudes from 1 760 m.a.s.l. to 1 920 m.a.s.l. within Sekhukhune Montane Grassland (BMU2). *Ledebouria noritica* is therefore endemic to the SCPE. The habitat can be described as norite sheetrock seeps, and plants are most abundant growing from beneath boulders on the margins of areas where seasonal to periodic surface flow occurs over the sheetrock. The bases of the plant are usually seasonally inundated by gently flowing water. The plants were recorded flowering in October and early November.

Due to its highly specialised habitat requirements and restricted 'Extent of Occurrence' and 'Area of Occupancy', and the fact that some historical and ongoing habitat loss and degradation has occurred as a result of the establishment of an illegal squatter's dwelling directly adjacent to site 25, this sheetrock wetland species has been provisionally categorised as Vulnerable by Mr. De Castro (conservation status to be confirmed by the MTPA and SANBI). The residents of the illegal dwelling have introduced livestock that has caused significant trampling of *Ledebouria noritica*

habitat and have also excavated various wells for the purposes of watering livestock which have not only led to the destruction of plants but is also likely to significantly impact the quality of the remaining habitat by altering the hydrological regimes of the sheetrock wetland.

	
Ledebouria sp. nov. '*noritica*' ined. (VU). Sheetrock wetland habitat on norite.	*Ledebouria* sp. nov. *'noritica'* ined. (EN).

Plate 3: *Ledebouria* sp. nov. '*noritica*' ined.

<u>*Ledebouria* sp. nov. '*purpurea*' ined. (Plate 4)</u>

This species was first identified as a new species by Andrew Hankey (*Ledebouria* taxonomist at SANBI) a few years ago and Type specimens have been collected and illustrated and the species is in the process of being described and published by Hankey and De Castro. Subsequent to its discovery by Hankey, *Ledebouria purpurea* has been recorded by the 'Mpumalanga Plant Specialist Group', Mervyn Lötter (MTPA) and Tony de Castro at various localities on the farms De Berg and Triangle and at one other locality on the nearby farm Wanhoop and is therefore endemic to the Steenkampsberg sub-centre of the LCPE. *Ledebouria purpurea* grows on shallow skeletal soils overlying quartzitic bedrock on gradual mountain slopes and terraces at elevations from 2 151–2 303 m.a.s.l., usually in areas which experience surface flow during high rainfall periods and where the soils are seasonally to temporarily saturated. Most abundant on pockets of soil on quartzitic bedrock which experiences surface flows during high rainfall events or periods, a habitat that can be termed 'sheetrock wetland'. Flowering recorded from late October to January. *Ledebouria purpurea* has highly specialised habitat requirements and highly restricted 'Extent of Occurrence' and 'Area of Occupancy' and has been categorised as Vulnerable by the MTPA.

Ledebouria sp. nov. '*purpurea*' ined. (VU). Sheetrock wetland habitat on quartzite.

Ledebouria sp. nov. '*purpurea*' ined. (VU).

Plate 4: *Ledebouria* sp. nov. '*purpurea*' ined.

Ledebouria sp. nov. '*steenkampsbergensis*' ined. (Plate 5)

This species was first identified as a new species by Andrew Hankey (*Ledebouria* taxonomist at SANBI) a few years ago and Type specimens have been collected and illustrated and the species is in the process of being described and published by Hankey and De Castro. Subsequent to its discovery by Hankey, *Ledebouria steenkampsbergensis* has been recorded by the 'Mpumalanga Plant Specialist Group', Mervyn Lötter (MTPA) and the De Castro at 17 sites on the farms De Berg and Triangle but is not known to occur elsewhere. This species is therefore endemic to the DBPNR and the Steenkampsberg sub-centre of the LCPE. *Ledebouria steenkampsbergensis* is restricted to very sparsely vegetated, shallow to skeletal, gravel soils overlying quartzitic bedrock and between rocks. All seventeen sites where this species has been recorded are situated at elevations of between 2 202 m.a.s.l. and 2 332 m.a.s.l. Flowering recorded from late October to January. *Ledebouria steenkampsbergensis* has highly specialised habitat requirements and highly restricted 'Extent of Occurrence' and 'Area of Occupancy' and has been categorised as Vulnerable by the MTPA.

Ledebouria sp. nov. '*steenkampsbergensis*' ined. (VU).

Ledebouria sp. nov. '*steenkampsbergensis*' ined. (VU). Habitats: skeletal, gravel covered soils on quartzite.

Plate 5: *Ledebouria sp. nov. 'steenkampsbergensis'* ined.

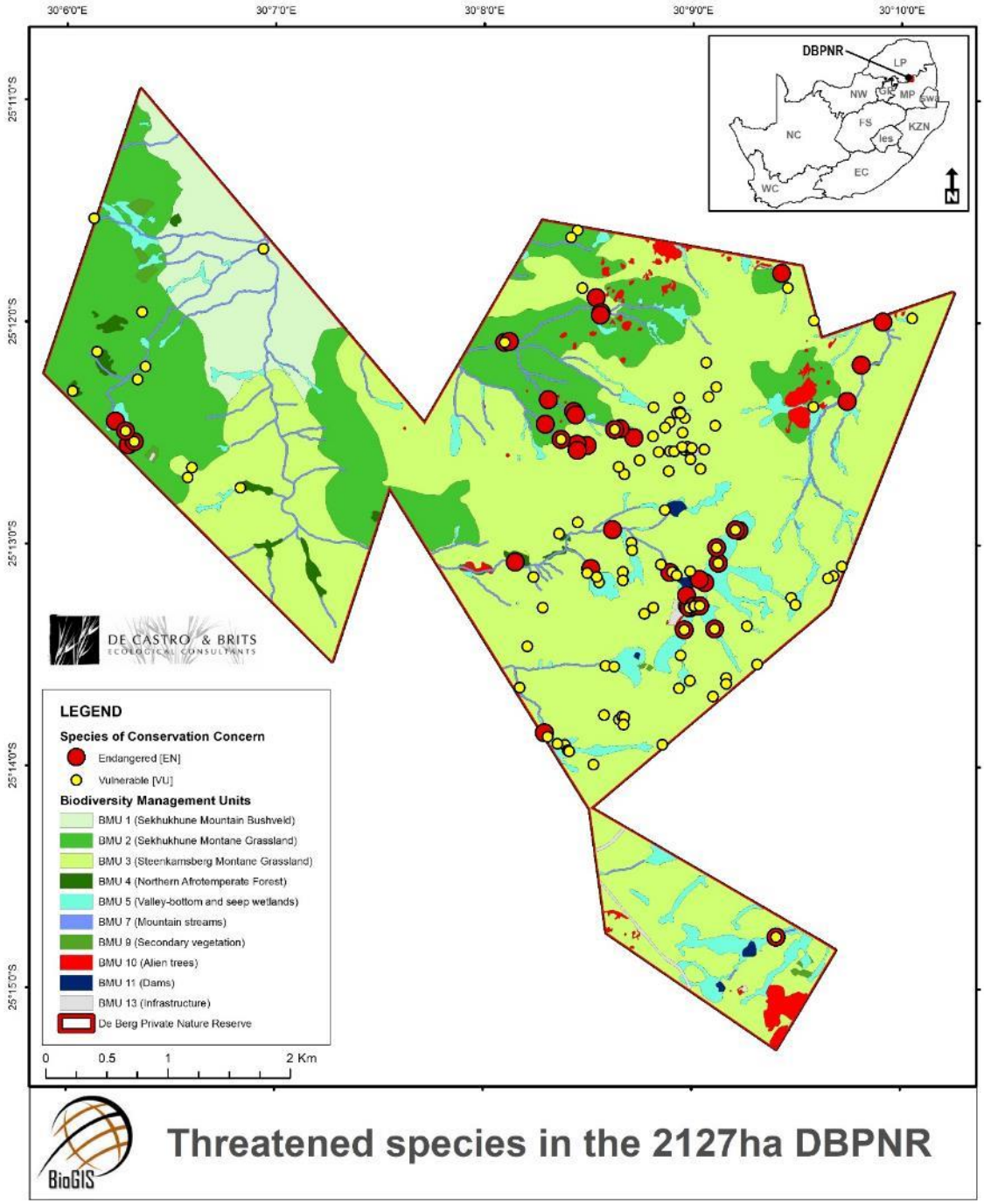


Figure 8: Threatened plant species localities within the DBPNR study area.

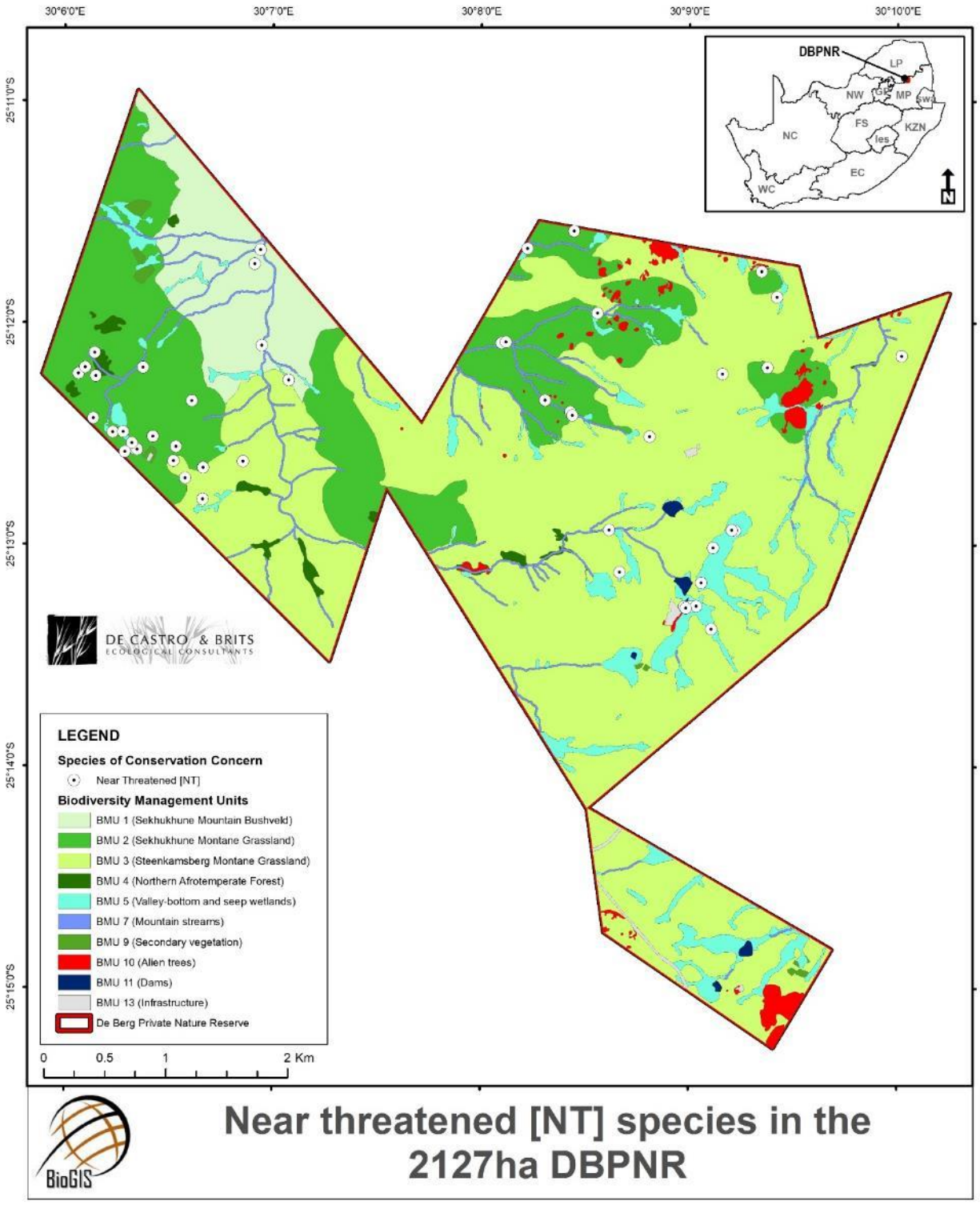


Figure 9: Near Threatened plant species localities within the DBPNR study area.

Near Threatened species

The category Near Threatened is applied to taxa that do not meet the criteria for the lowest category of Threatened species (Vulnerable) but are sufficiently close enough to qualifying that they may easily become in danger of extinction in the near future (Raimondo *et al*. 2009). According to the MTPA database (2017) a total of 41 Near Threatened species are known from the Mpumalanga Province. The presence of **11 Near Threatened species** within the 2 127 ha study area has been confirmed during the current study. Remarkably, the study area flora therefore includes approximately 26.8% of all Near Threatened species known for the province in an area which comprises less than 0.03% of the province.

The occurrence of the 11 recorded Near Threatened species in each of the 10 BMU's identified for the study area is shown in Table 6 and Figure 9. The BMU's within which the highest number of Near Threatened taxa were recorded are BMU2, which comprises ca. 21.2% of the DBPNR and contains four Near Threatened species, BMU5, which comprises ca. 6.4% of the DBPNR and contains three Near Threatened species, and BMU's 1, 3, and 7 which each contain two Near Threatened species. The wetlands of the study area (BMU5), and particularly the high-altitude wetlands embedded within Steenkampsberg Montane Grassland (BMU3) within the DBPNR, are therefore of great importance in terms of botanical biodiversity conservation within the study area. All three of the Near Threatened wetland species recorded within BMU5 were recorded from peat wetlands (mires) within this unit, emphasising the extreme conservation importance of these peat wetlands (De Castro & Brits, 2022a).

Rare species

A species qualifies for the South African category of 'Rare' when it meets at least one of four South African criteria for rarity, **but is not currently exposed to any direct or plausible potential threat and does not qualify for a category of threat according to one of the five IUCN criteria** (Raimondo *et al.* 2009). The four South African criteria are as follows:

- Restricted range: Extent of Occurrence (EOO) <500 km^2, OR
- Habitat specialist: Species is restricted to a specialised microhabitat so that it has a very small Area of Occupancy (AOO), typically smaller than 20 km^2, OR
- Low densities of individuals: Species always occurs as single individuals or very small subpopulations (typically fewer than 50 mature individuals) scattered over a wide area, OR
- Small global population: Less than 10 000 mature individuals.

According to the MTPA database (2017) a total of 96 Rare species are known from the Mpumalanga Province. The current study established the presence of **seven Rare species within the 2 127 ha DBPNR**. The DBPNR flora therefore includes approximately 7.3% of all Rare taxa known for the province in an area which comprises less than 0.03% of the province.

The occurrence of the seven recorded Rare species in each of the 10 BMU's identified for the study area is shown in Table 9. The BMU within which the highest number of Rare taxa were recorded is BMU3 (Steenkampsberg Montane Grassland), which comprises 59.8% of the study area and contains five Rare species. The only other BMU's within which Rare species were recorded were BMU5, where two rare species were recorded, and BMU7 where one Rare species was recorded. The Steenkampsberg Montane Grassland (BMU3), and the high-altitude wetlands (BMU5) embedded within it, which together comprise the majority of the DBPNR, are therefore of

the greatest importance in terms of in terms of the conservation of Rare species within the study area.

Declining species

Declining species are all categorised as Least Concern in terms of the IUCN criteria (Raimondo *et al*., 2009 and http://redlist.sanbi.org, accessed in July 2021), but are 'species of conservation concern' as defined by Raimondo *et al*. (2009). Declining is a South African Red List category reserved for species which are not Threatened or Near Threatened, but which are declining as a result of over-utilisation, and therefore merit monitoring and some conservation effort.

According to the MTPA database (2017) a total of 26 Declining species are known from the Mpumalanga Province. The current study confirmed the presence of **five Declining species within the 2 127 ha DBPNR**. The study area flora therefore includes approximately 19.2% of all Declining species known for the province in an area which comprises only 0.17% of the province. The occurrence of the five recorded Declining species in each of the 10 BMU's identified for the study area is shown in Table 6 and 7 and Figure 10. The BMU's within which the highest number of Declining taxa were recorded are BMU2 (Sekhukhune Montane Grassland), which comprises. 21.2% of the DBPNR and contains three Declining species and BMU7 (Mountain Streams), which comprises ca. 2.5% of the study area and also provides habitat for three Declining species.

With the exception of *Aloe cooperi*, which is a widespread species but is regarded as Declining due to habitat loss and degradation, all of the recorded Declining species are popular and heavily utilised medicinal plants that are subjected to destructive harvesting. *Ilex mitis* is subjected to bark harvesting and *Callilepis leptophylla, Eucomis autumnalis*, and *Gunnera perpensa* are subjected to the harvesting of underground structures. There are concerns that long-term over-utilisation of wild plants will lead to a decline in many of the subpopulations of these species. All of these species are also long-lived and slow-growing to very slow-growing geophytes or trees and are thus particularly vulnerable to over-exploitation. The localities for these species provide only an indication, but not a complete record, of the distribution of these species within the DBPNR.

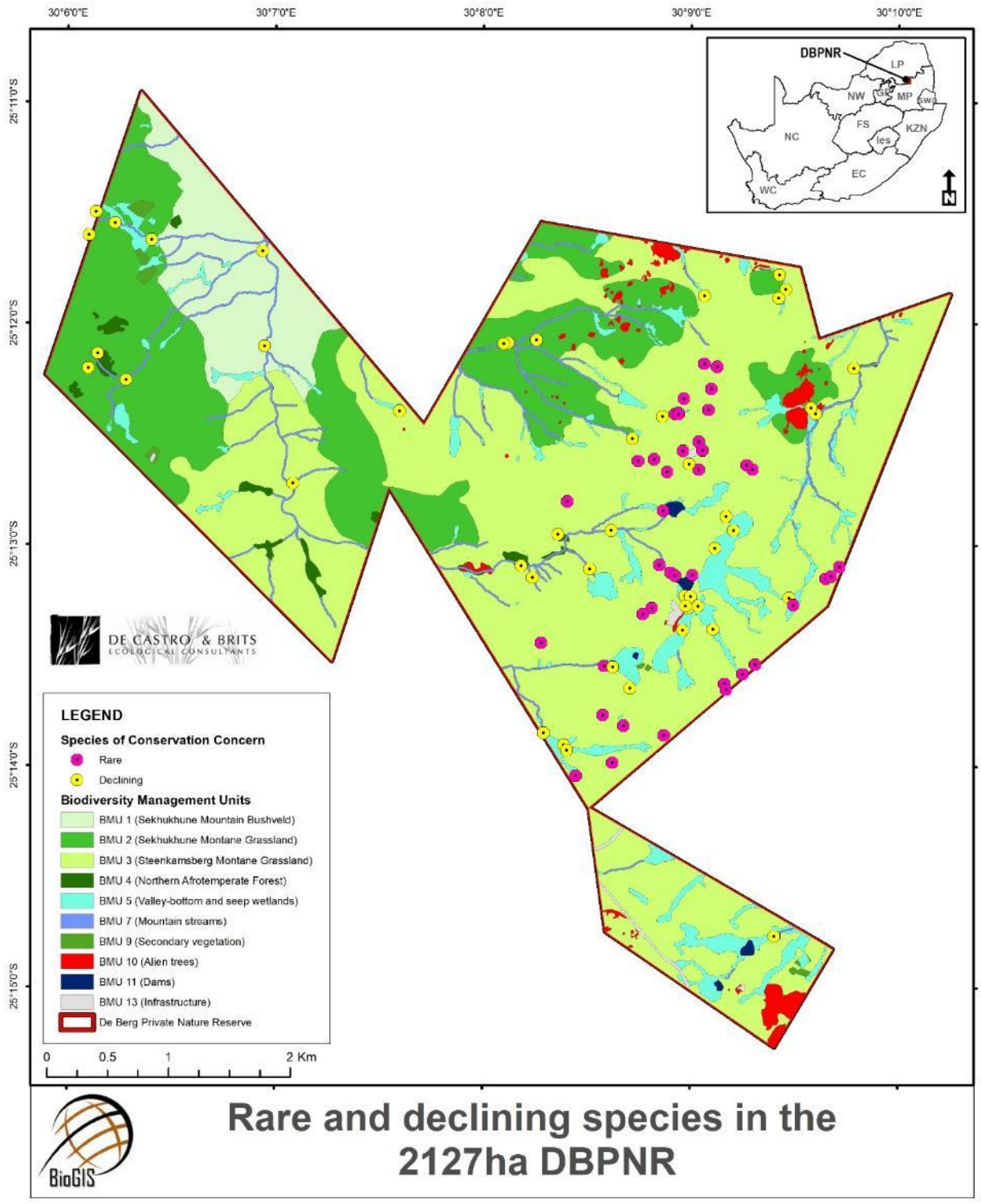


Figure 10: Rare and declining plant species localities within the DBPNR study area.

Potentially occurring plant 'species of conservation concern'

In addition to the 42 plant SCC recorded within the DBPNR during the current study, 28 additional SCC have historically been recorded within the grids 2530AA and 2530AC. Details regarding the habitat, flowering times, and probability of occurrence of these species are provided in De Castro and Brits (2022a). Ten of the aforementioned 28 SCC are considered to have a High probability of occurring within the DBPNR, namely *Asclepias* sp. nov. aff. *schlechteri* (CR), *Brownlea graminicola* (VU), *Crotalaria monophylla* (VU), *Delosperma delainthoides* (sphalmanthoides?) (VU), *Drimia altissima* (Declining), *Disa zuluensis* (EN), *Disa rungweensis* (Rare), *Gymnosporia sekhukhuniensis* (VU), *Monopsis koweyensis* (VU), and *Syncolostemon rugosifolius* (VU), and 12 are considered to have a Moderate probability of occurring within the DBPNR. Potentially suitable habitat for the 10 species for which there is a High probability of occurrence within the study area occurs mainly in terrestrial habitats within Steenkampsberg Montane Grassland (BMU3 and particularly within BMU 3.1) and Sekhukhune Montane Grassland (BMU2). All 10 of the aforementioned species for which there is a High probability of occurrence are inconspicuous and difficult to detect and identify when not in flower. Descriptions of the BMU's and microhabitats within which each of the aforementioned potentially occurring SCC are likely to be present are provided De Castro and Brits (2022a), as are the known flowering periods for each species.

It is emphasised that various new species, most of which are endemic and/or SCC, have been described from Sekhukhuneland since Siebert's publication on the endemic taxa of the SCPE (Siebert *et al*., 2001) and various new plant taxa are currently in the process of being described and published by plant taxonomists (Clark *et al*., 2022; S. Siebert, P. Bester and A. Hankey pers. comm., June 2020) from both the SCPE and the LCPE as well as the greater LMEE. Future botanical surveys within the study area should therefore have strong floristic rather than phytosociological emphasis and should prioritise the compilation of accurate species lists that include potential or confirmed new taxa.

In order to expand and verify the species list provided in De Castro and Brits (2022a) and to search for as yet unrecorded plant SCC such as *Asclepias* sp. nov. aff. *schlechteri* (CR), *Brownlea graminicola* (VU), *Crotalaria monophylla* (VU), *Delosperma delainthoides* (VU), *Drimia altissima* (Declining), *Disa zuluensis* (EN), *Disa rungweensis* (Rare), *Gymnosporia sekhukhuniensis* (VU), *Monopsis koweyensis* (VU), and *Syncolostemon rugosifolius* (VU) which have a High probability of occurrence*,* as well as other potentially occurring 'species of conservation concern' listed, it is recommended that additional botanical surveys should be conducted in future, ideally in October, December, late January, and March. These surveys will serve to increase the seasonal coverage of the floristic surveys already conducted for the study area. The surveys should focus on searching for the 10 aforementioned species in potentially suitable habitat within BMU's 2, 3 and 5, but should ideally also include brief searches of representative areas of all other untransformed BMU's recorded within the DBPNR in order to verify the presence/absence of other plant 'species of conservation concern'. The DBPNR management should also invite the MTPA (contact person: M. Lötter of MTPA Scientific Services) and their associated botanists to conduct site visits for the purposes of botanical exploration. In the event of any additional plant SCC being recorded during these follow-up surveys, appropriate *in situ* and/or *ex situ* conservation measures should be developed and implemented in conjunction with the MTPA Biodiversity Planning Division and SANBI's Threatened Species Programme where such species are Threatened by any activity or proposed development.

Recommendations for the conservation of plant 'species of conservation concern':

Threatened, Near Threatened, or Rare plant species

Due to the exceptionally high number of Threatened (CR, EN, and VU), Near Threatened, and Rare plant species recorded within the study area (37 in total), the fact that many of these species have been recorded from numerous sites and often share habitat with other plant SCC and the fact that many of these species will undoubtedly be discovered at additional sites during future surveys, the recommendation of species- and site-specific management measures is regarded as impractical. The recommended approach to the conservation management of Threatened, Near Threatened, and Rare species within the study area is a 'habitat conservation approach' where emphasis is placed on conserving BMU's and restricted habitats where such species are known to occur (Tables 6 and 7) or potentially occur.

Principles and practical recommendations pertaining to the conservation management of the 37 Threatened (CR, EN, and VU), Near Threatened, and Rare species thus far recorded within the DBPNR, are as follows:

- The **most important BMU's for the conservation** of Threatened, Near Threatened and Rare species are, in order of importance: BMU3 (comprises ca. 59.8% of the study area), BMU5 (comprises only ca. 6.4% of the study area), BMU2 (comprises ca. 21.2% of the study area) and BMU7 (comprises only ca. 2.5% of the study area). High-altitude peat wetlands (mires) situated at elevations above ca. 2 100 m.a.s.l. within BMU5, are regarded as the single most important habitat for Threatened and Near Threatened species within the DBPNR. BMU's 5, 3, and 2 should be the focus of efforts to conserve Threatened, Near Threatened, and Rare species and their habitat within the study area.
- The 2021 botanical baseline survey of the 12 950 ha Northam Booysendal property (De Castro & Brits, 2021a), which includes the DBPNR, established that the DBPNR contained 35 of the 46 plant SCC then known to occur within the Northam Booysendal property and therefore comprised the most important area for the conservation of Threatened, Near Threatened, and Rare plant species within the 12 950 ha property. The DBPNR is also regarded by the MTPA as one of the most important biodiversity conservation areas in the Mpumalanga Province (M. Lötter, pers. comm.) and the findings of the most recent survey (De Castro & Brits, 2022a) strongly support this view. The mine should seek to **formalise the DBPNR as a Protected Area** where the management priority should be the conservation of plant SCC and their habitats.
- ***In situ* conservation** is vital and should be the only option recommended in cases where the conservation of subpopulations of Threatened, Near Threatened, and Rare species is required (Raimondo *et al*., 2009). *Ex situ* conservation, a practice often termed 'search and rescue', is very rarely successful, expensive, and is considered an unacceptable conservation measure (Raimondo *et al*., 2009, Pfab, 2001b and GDARD, 2015). In accordance with the recommendations of Raimondo *et al.* (2009), the general principal to conservation management of Threatened, Near Threatened, and Rare species within the study area should be that no further loss of any subpopulations of such species should be permitted and any impacts to confirmed habitat for such species should be avoided wherever possible. Exceptions include species that qualify as Near Threatened under Criterion B of the IUCN criteria, such as *Lydenburgia cassinoides* which is widespread within BMU1 and along streams (BMU7) at elevations below 1 600 m.a.s.l. as well as throughout much of the SCPE. The loss of a few individuals or small areas of habitat for such species may in some cases be acceptable (Raimondo *et al*., 2009), but must be authorised by the MTPA based on a specialist assessment.

- Threatened, Near Threatened, or Rare species have been recorded within all six of the untransformed BMU's identified for the study area and **prior to any proposed development** or activity within BMU's 1, 2, 3, 4, 5, and 7, the proposed footprint of development should be subjected to a thorough search for such recorded species as well potentially occurring species. Particular emphasis should be placed on searching footprints within BMU2, BMU 3.1, and in particular BMU5.
- In cases where localities for Threatened, Near Threatened, or Rare species are considered to be at risk from proposed tourism or management infrastructure development (e.g. service tracks, low-water bridges, and tourist accommodation), a species-specific '**management and monitoring plan'** for the potentially affected species and its habitat must be developed by a specialist. Such a 'management and monitoring plan' must include the following aspects:
    - Determination of the 'Area of Occupancy' (AOO) and population size of the species potentially affected by the proposed development or activity.
    - Determination of the potential impacts of the proposed development or activity on the conservation of the affected species both at the scale of the study area and at a national scale or population level (where population refers to all known individuals of a species).
    - Determination of suitable mitigation measures.
    - Determination of suitable buffer zones for the protection of the species and its habitat (of particular importance in the case of wetland species).
    - The final monitoring and management programme for the species should be compiled with the input and approval of the MTPA (contact person: Mr Mervyn Lötter).
- In accordance with the general principles for the determination of buffer zones provided by GDARD (Pfab 2001b and GDARD 2015), recommended generic buffer zone widths for Threatened, Near Threatened, and Rare species potentially affected by proposed activities are **600 m for all Threatened** (CR, EN and VU) species and **300 m for all Near Threatened and Rare species**. These generic buffer zones should be refined and appropriately modified for each potentially affected species in accordance with aspects such as the autecology of the species, habitat characteristics, potential impacts of the proposed development or activity on the species and its habitat, and historical and current land use of the area surrounding the subpopulation.
- All species should be subjected to simple, ongoing informal **monitoring** by Field Rangers of the mine's Department of Land Management, with specialist input where necessary. Such personnel should receive basic training in the informal monitoring of Threatened, Near Threatened, and Rare species. Training should include identification of such species and areas which hold concentrations of such species, as well as frequency of monitoring and basic reporting format. Harvesting incidents and other observed threats to plant SCC and their habitats (e.g. erosion, sedimentation, or invasion by alien plants) should be reported immediately.
- The five Endangered species recorded within the DBPNR should be subjected to basic **monitoring** by a specialist at two-year intervals, or more frequently if deemed necessary by the reserve management (mine's Land Management Department). Such monitoring should consist of simply visiting the recorded localities for these species listed in Table 6, counting the number of plants present (where appropriate), noting any signs of harvesting

or threats to the plant habitat (e.g. overgrazing, erosion, or invasion by alien plants), and photographing the site.

- The reserve management should invite the MTPA (contact person: M. Lötter of MTPA Scientific Services) to conduct botanical exploration of the study area together with its research partners such as SANBI and the Plant Specialist Group (PSG). Emphasis should be placed on botanical exploration of the remote areas of the DBPNR situated in the Groot Dwars River valley which have thus far been relatively poorly sampled. Such a collaboration will greatly assist reserve management in terms of continually updating their records of the occurrence, distribution, and utilisation of plant SCC and sensitive habitats within the DBPNR and its immediate surrounds.

Declining species

Recommendations pertaining to the recorded Declining plant species are as follows:

- **Development** at sites where Declining plant species have been recorded **should be avoided** wherever possible.
- **Access to sites** where Declining plant species occur should be **controlled** in order to avoid illegal medicinal plant harvesting. This will benefit not only the medicinal plant species, but will also facilitate biodiversity conservation within the study area as a whole.
- The five recorded Declining plant species can be **used as indicators** of medicinal plant harvesting pressure within the study area, though it must be emphasised that no signs of medicinal plant harvesting were recorded within the DBPNR during the current survey. Declining species should be subjected to simple, ongoing informal monitoring by Field Rangers of the Department of Land Management and Environmental Officers of the SHEQ Department, with specialist input where necessary. Such personnel should receive basic training in the informal monitoring of Declining species, as well as other SCC and medicinal plants, which should include identification of such species, areas which hold concentrations of such species and should be regularly monitored, as well as reporting of harvesting incidents and other observed threats to plant SCC and their habitats (e.g. erosion, sedimentation, or invasion by alien plants).
- In the event of any Declining species being recorded within an approved development site, **permission for the removal** of such species should be obtained from the Permitting Office of the MTPA, and the appropriate *in situ* and/or *ex situ* conservation measures should be developed and implemented with the approval of the MTPA conservation authorities where necessary. Where feasible, the four recorded Declining species that are perennial herbs or geophytes (but not the tree *Ilex mitis*) can be translocated to transformed, degraded, or untransformed parts of the study area which provide potentially suitable habitat, but such translocations will have to be carried out in a manner that ensures no ecological degradation of the host habitat occurs, and will have to be briefly evaluated by an ecologist for each species and each potential translocation area. Alternatively, Declining species can be rescued and donated to appropriate conservation and research institutions such as the Walter Sisulu National Botanical Garden or the Pretoria National Botanical Garden of SANBI.

Notes on the observed elevational gradients with regards to the distribution of plant SCC

An 'elevational diversity gradient' (EDG) is an ecological pattern where biodiversity changes with elevation, and there is a growing appreciation of the utility of elevational gradients as tools to uncover the mechanisms that shape both patterns of biodiversity and the functioning of ecosystems (Rahbek *et al*., 2021). Most studies showed hump-shaped diversity gradients, with diversity (particularly species richness) peaking at mid-elevations in a defined environment such

as a single mountain (Carsten & Rahbek, 2012). A number of factors have been implicated as underlying causes of elevational diversity gradients, but some of the most obvious and frequently tested are climate and productivity (Rahbek, 1995).

Though species richness generally peaks at mid-altitude in a given environment, the number of endemic species (including a high proportion of Threatened, Near Threatened, and Rare species) often peaks at the highest elevations which provide unique and spatially restricted habitats at a regional level. It is well known that climatic, edaphic, and topographic differences between mountains and surrounding lowlands result in mountains acting as terrestrial islands with high levels of endemic biota. Mountains also act as refuges and buffers against climate change as the elevational gradients provide the opportunity for plants to shift distribution to higher elevation during periods of warming climate conditions. Elevations within the study area, vary from ca. 1372 m.a.s.l. at the lowest point where the Dwars River exits Sterkfontein, to ca. 2332 m.a.s.l. at the summit of the De Berg Mountain which is the highest point in Mpumalanga.

In the current brief study, EDGs in the distribution of Threated, Near Threatened, and Rare (*sensu* Raimondo *et al.*, 2009) plant species were used as a proxy for an important aspect of vegetation structure (*sensu* Kent & Coker, 1992) which is used in the identification of vegetation types and lower-level plant communities, namely species composition. Elevational gradients in the distribution of Threated, Near Threatened, and Rare species, were used together with quantitative data on species composition and dominance gathered in sampling quadrats and mapping of the distribution of wooded grassland (De Castro & Brits, 2022a) to distinguish three broad-scale sub-units within Steenkampsberg Montane Grassland (BMU3). These three sub-units are BMU 3.1 (at elevations of over ca. 2 100 m.a.s.l.), BMU 3.2 (at elevations of between 2 100 m.a.s.l. and 1 650 m.a.s.l.) and BMU 3.3 (at elevations of between 1 500 m.a.s.l. and 1650 m.a.s.l.). The BMU3 sub-units are mapped in Figure 7.

An analysis of the elevational distribution of all 37 Threated, Near Threatened and Rare species recorded within the DBPNR (De Castro & Brits, 2022a) indicated that, though less than ca. 50% of the DBPNR is situated at elevations of greater than 2100 m.a.s.l., 22 (or 59.5%) of the recorded Threatened, Near Threatened, and Rare taxa were recorded only at elevations of over 2 100 m.a.s.l. and 15 (or 40.5%) of the Threated, Near Threatened, and Rare taxa were recorded only at elevations of over 2 200 m.a.s.l.

In order to control for edaphic factors (principally geology) in the distribution patterns of the species analysed, the elevational distribution of the 27 Threatened, NT, and Rare plant taxa recorded in terrestrial and wetland habitats overlying quartzitic lithology within the DBPNR was also assessed. Within the DBPNR, areas with quartzitic lithology occur at elevations ranging from 1 498–2 332 m.a.s.l. Areas overlying quartzitic geology are all included within Steenkampsberg Montane Grassland (BMU3) and the Afrotemperate Forest patches (BMU4), Wetlands (BMU5), and Mountain Streams (BMU7) embedded, or flowing through, Steenkampsberg Montane Grassland. Twenty-one (or 78%) of the 27 Threatened, NT and Rare taxa recorded on habitats overlying quartzitic lithology were recorded only at elevations of 2 100 m.a.s.l. or more, and 14 of these 21 species were recorded only at elevations of over 2 200 m.a.s.l.

The area of Mpumalanga situated above 2 100 m.a.s.l. is 20 362 ha, comprising a total of 72 distinct areas or ‘polygons’ (Figure 11). The Mpumalanga Province covers a total area of 7 649 460 ha and areas above 2 100 m.a.s.l. therefore comprise approximately 0.27% of the province. The geology of approximately 66% of the 20 362 ha of habitat at elevations of above 2 100 m.a.s.l. in Mpumalanga comprises either metamorphic rock such as quartzites (ca. 51%)

or sedimentary rock including various arenites (ca. 15%), while the remainder (ca. 34%) has an igneous lithology. Habitat above 2 100 m.a.s.l. and with a metamorphic or sedimentary geology therefore covers an area of only ca. 13 363 ha within the Mpumalanga Province. The approximately 980 ha of habitat situated above 2 100 m.a.s.l. and with metamorphic or sedimentary geology within the DBPNR (Figure 11) therefore comprises approximately 7.3% of all such habitat occurring in the Mpumalanga Province. The exceptional conservation importance of BMU 3.1 is further emphasised by the fact that the DBPNR forms part of the Steenkampsberg 'plateau' which includes by far the largest area of contiguous sandstone and arenite lithology situated above 2 100 m.a.s.l. within the Mpumalanga Province, and therefore is likely to comprise the most important high elevation 'ecological refuge' within Mpumalanga.

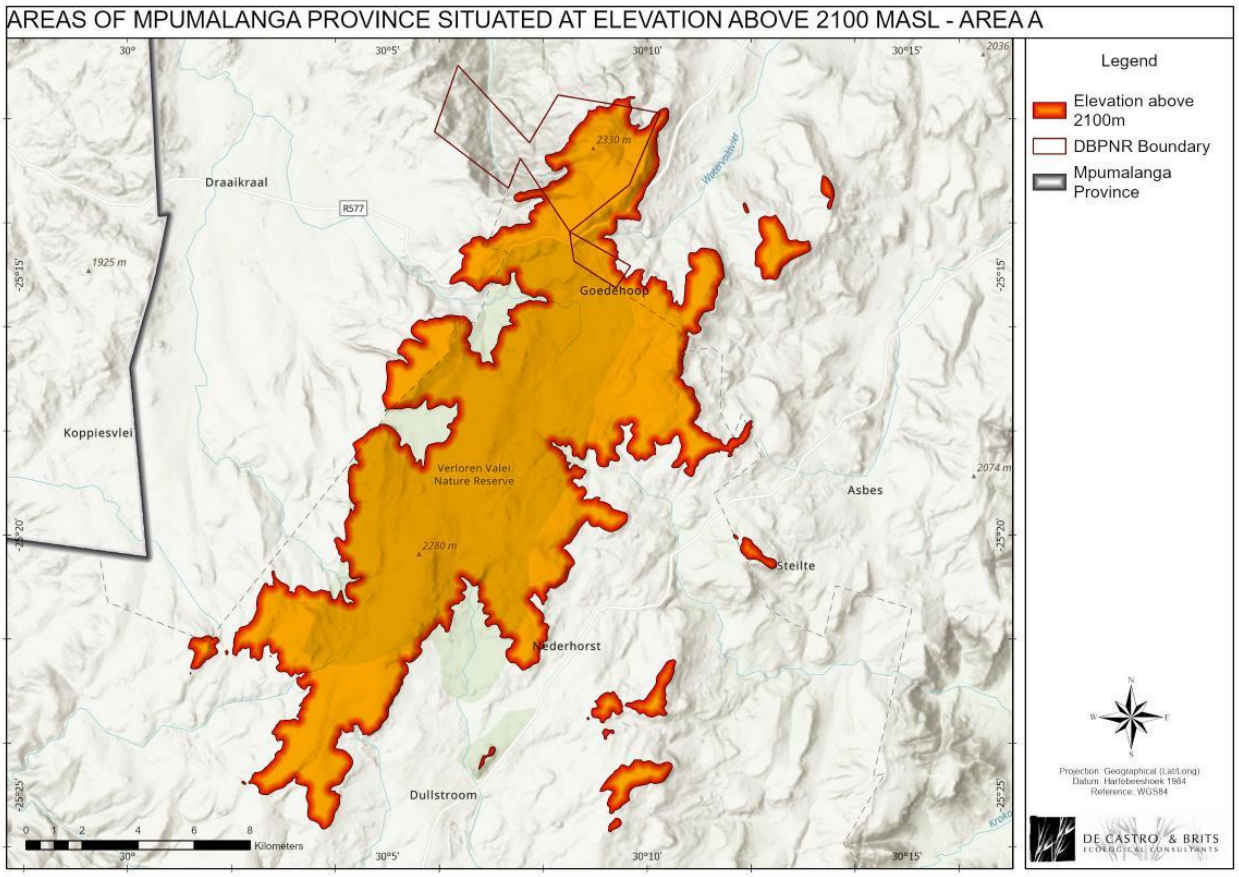


Figure 11: DBPNR in relation to the areas of Mpumalanga Province that is situated as elevation above 1200 m.a.s.l.

Wetlands

Valley bottom and seep wetlands in BMU5 and mountain streams in BMU7, represent some of the **most pristine and habitat diverse watercourses in the South African grassland biome**, based on Mr. Retief Grobler's more than 15 years of working experience as a specialist wetland consultant (De Castro & Brits, 2022b). From marginal sheetrock seep wetlands with shallow soils, lithophytes and hygrophytes, to permanently saturated peat wetlands (mires) with obligate hydrophytes that include forbs, grasses, mosses, and sedges. The uniqueness of these ecosystems in the study area is made abundantly clear by the **presence of no fewer than 21**

plant 'species of conservation concern' (SCC) (*sensu* Raimondo *et al*., 2009) that occur in BMU's 5 and 7. BMU's 5 and 7, which collectively form just under 9 % of the study area, provide habitat for close to 50 % of all recorded plant SCC in the study area; this value may change as the botanical study is still being finalised (De Castro & Brits, 2022a).

It is not only in terms of the presence of plant SCC that BMU's 5 and 7 are remarkable, but also in terms of their **ecological condition**. The Present Ecological State (PES) of a selection of different wetland types were all assessed as **natural/unmodified** (class A PES). Hydrological and geomorphological impacts were negligible in most cases, while vegetation also remains intact and pristine for the most part. The **ecological intactness of wetlands and mountain streams is the norm rather than the exception within the proposed DBPNR, which is not a common occurrence in wetland assessments**. The value of valley bottom and seep wetlands in terms of their **Ecological Importance and Sensitivity** (EIS) was consistently assessed as **Very high** (class A EIS) to **High** (class B EIS), while ecosystem functioning related to the supply and demand for **biodiversity maintenance** was identified as the **most important ecosystem service** consistently supplied by a range of different wetland types. **Peatlands** also scored very high for having the potential to **regulate stream flows, store carbon, and provide drinking water** for human consumption. Peatlands are spatially restricted wetlands with unique soils that have a high content of soil organic carbon (SOC), which is referred to as peat when it has dead soil organic matter (SOM) of more than 30 % (dry mass) or SOC of more than 20 % (Joosten & Clark, 2002; Soil Classification Working Group, 2018).

Prominent watercourse impacts are localised and include features such as six man-made dams with a combined surface area of 4.76 ha. No new dams are expected to be planned or required in the future, but the threat of other impacts will increase over time, specifically the encroachment of alien invasive plant species into BMU's 5 and 7.

In the early 2000s, it was estimated that close to 25% of peatlands in the Central Highlands Peatland Ecoregion had been altered by a range of impacts that include water abstraction, cultivation, afforestation, peat fires, agricultural drains, erosion, road infrastructure, and dams, including trout dams (Grundling & Grobler, 2005). More recently the risk of mining has increased in the surrounding area, which places wetlands and other watercourses at risk. Recorded peat wetlands in the study area, also referred to as peatlands and mires, form part of BMU5 and are particularly sensitive to disturbances in their catchment. These wetlands are highly dependent on water infiltration and groundwater flow patterns, which are needed to create saturated conditions for peat growth and preservation.

Grundling and Grobler (2005) highlight the importance of peatlands in Verloren Vallei Nature Reserve, which borders the study area to the south, as examples of peatlands that represent the characteristics of the area due to them being well preserved with limited external (i.e. catchment) impacts. The same holds true for the **seven confirmed peat wetlands in the proposed DBPNR**, as **these wetlands are not only pristine, but their catchments are also ecologically intact**. Peatland catchments are located entirely within the study area, except for the catchment of the peatland at Sterkfontein. The benefit of not only protecting peatlands, but also their catchments along with the catchments of the large majority of all BMU's 5 and 7 in the proposed new DBPNR, significantly increases the importance of the study area as a strategic conservation area with low risks for watercourse degradation in the future. The study area is therefore also considered as a strategic water resource area. This is confirmed by the south-eastern portion of Goedehoop overlapping with the Mpumalanga Drakensberg Strategic Water Source Area (SWSA), as indicated on the SWSAs of South Africa, Lesotho, and Swaziland spatial layer (Nel *et al*., 2013). The study area overlaps with a category 3 SWSA, which represents areas that supply ≥50 % of South Africa's water supply and are therefore regarded as national Strategic Water Sources Areas (Nel *et al*., 2013). Over half of the Mpumalanga Drakensberg SWSA have been modified from a

natural state and are particularly affected by plantation forestry, while only 9 % of this SWSA is protected (Nel *et al*., 2013). The proposed DBPNR will therefore not only conserve natural wetlands and streams (BMU's 5 and 7) and unique biodiversity but will also protect a national Strategic Water Source Area that is currently poorly protected.

Wetlands delineated and classified previously during the 2021 Booysendal botanical baseline study, included channelled valley bottom, unchannelled valley bottom, and seep wetlands which were all grouped into BMU5 (De Castro & Brits, 2021a). These same wetlands were found to be present within the DBPNR study area, meaning that BMU5 could be used in the same manner as in the 2021 study to incorporate wetland habitats in the latest study (De Castro & Brits, 2022a, b). BMU5 has the largest surface area of all three watercourse-associated BMU's, with a size of 132.29 ha. This is much larger than wetland habitat indicated in the study area through existing spatial datasets only, such as the National Wetlands Map 5 and the 2020 South African National Land Cover (SANLC) dataset.

All wetland habitat within BMU5 can be classified into hydrogeomorphic (HGM) types, based on the classification system developed by Ollis *et al*., (2013), entitled 'Classification System for Wetlands and other Aquatic Ecosystems in South Africa'. The HGM classification system is based on three key parameters pertaining to a wetland, namely the geomorphic setting of the wetland, the source of water inputs into the wetland, and its hydrodynamics (how water moves through the wetland). The three different HGM types applicable to BMU5, namely channelled valley bottom, unchannelled valley bottom and seep wetlands described by De Castro & Brits (2021a) and confirmed in the most recent study, are further described and illustrated in De Castro and Brits (2022b) (Addendum B). Seep wetlands are the most common type of wetland across the entire study area, while channelled and unchannelled valley bottom wetlands are restricted to areas with lower longitudinal slopes in De Berg and Goedehoop.

Wetlands are associated with prolonged periods of soil saturation, which can also include temporary to permanent inundation. This results in the creation of anaerobic conditions, which can result in specific soil signatures such as low chroma matrix colours, spots of iron depletion, or mottling, depending on the duration and frequency of anaerobic conditions. Mottling occurs near the soil surface (top 0.5 m) when there is a flux between wetting and drying cycles (anaerobic to aerobic conditions), with anaerobic condition lasting for at least a few weeks per year to produce these signatures over time (DWAF, 2005 and 2008). Organic matter also accumulates under anaerobic conditions where plants with unique adaptations can still actively grow. Wetlands are also associated with low energy environments, where water moves slowly through the landscape, often with a dispersed flow pattern and a strong reliance on interflow in the soil profile.

Bleached and light soil matrix colours were common in shallow soils that developed on weathered quartzite, which was not uniformly regarded as hydromorphic features caused by iron removal during anaerobic conditions. Light soil matrix colours can also be contributed to an expected low iron content in quartzite derived soils. In addition, these soils develop into a sandy texture with a comparatively lower clay content than most other soils, making leaching and water movement easier due to a higher hydrological conductivity. Pedogenesis on quartzite can therefore result in soils with a light/bleached colour that developed without the presence of wetland conditions. Areas identified as wetland habitat that contained dominant bleached/light colours in the topsoil profile, also had to contain other wetland indicators, such as mottling, hygrophytes and/or hydrophytes to be considered as wetland habitat.

It is important in a biodiversity management study to include descriptions of unique and spatially restricted wetland habitats, rather than only focussing on a wetland classification system based on HGM type. The HGM classification system is well suited to help assess the functionality of wetlands that have similar hydrological and geomorphological drivers (DWAF, 2007;

Kotze *et al*., 2020; MacFarlane *et al*., 2008), but it underemphasises the importance of unique wetland habitats for biodiversity. Two important wetland habitats that form part of BMU5 are highlighted as being of particular importance for biodiversity management, namely peat wetlands (mires) and sheetrock seep wetlands.

Peat wetlands (mires)

Organic matter can accumulate and undergo chemical changes if consistently favourably conditions last for long enough (decades to centuries rather than years) to form peat, which is the remains of plant litter that accumulated under very consistent water-saturated conditions through incomplete decomposition and chemical changes over time (Rydin & Jeglum, 2006). Peat is quantified by the amount of dead soil organic matter (SOM) that is present and is calculated from soil organic carbon (SOC) that is determined through procedures such as the Walkley-Black method or loss of ignition method. Once the SOC of a sample has been determined, it is converted to SOM by multiplying it with the conventional Van Bemmelen factor of 1.724 or the more recently revised factor of 2.0 as recommended by Pribyl (2010). Values of more than 30 % (dry mass) of dead SOM are regarded as peat internationally (Joosten & Clark, 2002). At a national level, the recently updated soil classification system for South Africa defines a peat topsoil horizon as follows (Soil Classification Working Group, 2018):

- *Contains more than 20 % organic carbon in environments associated with water inundation or at least water saturation for extended periods;*
- *Inundation, and/or water saturation must be recognised by the physical presence of water or inferred through lowland terrain positions capable of accumulating and storing water, or via wetland vegetation.*

South African SOC criteria for the presence of peat make it stricter (more difficult) for a soil to classify as peat. Both the conventional Van Bemmelen conversion factor of 1.724 and the more recent Pribyl (2010) factor of 2.0, result in SOM % cut off values for peat that are higher than the 30 % SOM international specification of Joosten and Clark (2002), with resultant values of 34.48 % and 40 % SOM respectively. This is unexpected, as South Africa is largely a semi-arid country with lower peat reserves compared to countries in the northern hemisphere with far larger peat reserves, such as Canada, Scandinavia, and Russia. Seven of the 10 analysed samples contained peat, while one of the remaining samples is a borderline case.

Recorded peat wetlands in the study area occur in the Central Highlands Peatland Ecoregion (Grundling *et al*., 2017) and form part of a group of peatlands associated with the Steenkampsberg Plateau. The majority of peatlands in the Central Highlands Peatland Ecoregion are concentrated within the Steenkampsberg Plateau, with artesian springs being common in some of these peatlands (Grundling & Grobler, 2005). Distinct signs of artesian springs were not observed within the study area, but recorded dome shaped peatlands may be associated with springs, which require further investigation in order to understand the hydrological drivers and processes of these peatlands better.

Grundling and Grobler (2005) refer to Lakenvlei Wetland Complex, located approximately 36 km south of the study area, as the largest and oldest known peatland in the Central Highlands Peatland Ecoregion, which was dated at 5 080 ± 50 years before present (BP) at a peat depth of 1.95 m. The peatland has subsequently been sampled to a depth of 4.2 m and this thickness can be used to infer a peat age of approximately 11 600 years, with an average peat accumulation of 0.36 mm/year (Grundling & Grobler, 2005). Using the same principle, it can be estimated that the mire at sample point P3a at De Berg, which has a peat thickness of close to 1 m, has an inferred peat age of approximately 2 500 years.

All seven confirmed peat sites contain a thickness that qualify as peatlands based on site observations. A peatland is defined internationally as a peat covered terrain with a thickness of 0.40–0.30 m (Rydin & Jeglum, 2006). Recorded peat wetlands also qualify as 'mires' which are defined as wetlands that contain at least some peat and are dominated by living peat forming plants, such as sedges and mosses (e.g. *Sphagnum* spp.) (Rydin & Jeglum, 2006).

Six of the seven wetlands with confirmed peat substrate within DBPNR are located above 2000 m.a.s.l., with only the wetland in Sterkfontein being the exception (sample SF17), occurring at an elevation of approximately 1740 m.a.s.l. based on the 10 m interval contour data. All seven peatlands are new records of peat wetlands within the Steenkampsberg Plateau, which incorporate the four new records described by De Castro and Brits (2021a). The nearest known wetland in the National Peatland Database is recorded less than 450 m southwest of the study area in Verloren Vallei Nature Reserve, located on the farm Wanhoop 78JT (Grundling, *et al*., 2017).

The confirmed peatland at Sterkfontein is, however, of high significance as it represents the first known peatland within the Sekhukhuneland Centre of Plant Endemism based on available records in the National Peatland Database (Grundling *et al*., 2017). Grundling and Grobler (2005) mention that only three records of peatlands are known to be present in Verloren Vallei Nature Reserve, while seven peat samples have been confirmed within the proposed De Berg Private Nature Reserve. However, more recent information indicate that 15 peat records have been listed in the National Peatland Dataset for Verloren Vallei Nature Reserve (Grundling *et al*., 2017), of which some are in the same wetland system.

De Castro and Brits (2021a) mentioned that identified mires in the study area form highly spatially restricted habitats that contribute disproportionately to the levels of plant endemism and the number of plant SCC occurring within the study area. Examples of SCC associated with peatlands include the Endangered *Bulbine* sp. nov. aff. *capitata*, the Vulnerable (provisional) *Ledebouria* sp. nov. '*altipaludosus*' ined., and the Near Threatened *Watsonia bella.* Mires also contain interesting obligate hydrophytes, such as a carnivorous *Drosera* sp. and *Urticularia* spp. that are adapted to grow and thrive in nutrient poor (oligotrophic) environments, which is common in undisturbed mires and peatlands (Rydin & Jeglum, 2006). A change in plant species composition in peatlands can therefore be expected should an influx of nutrients occurs, such as nitrogen and phosphate associated compounds transported by runoff from point and non-point pollution sources. It must be emphasised that these pollution sources are presently absent from the study area, but they remain risks that should be considered in the future for infrastructure planning that may be required, such as recreational ablution facilities. Mires and peat wetlands are also dependent on regular saturation in order to achieve a positive net rate of peat accumulation, or at least peat perseverance in a dry cycle. Mires and peat wetlands are consequently not only sensitive to water quality changes, but also to changes that may affect groundwater and soil water flow patterns and processes, which can include excavation and water abstraction activities.

Sheetrock seep wetlands

Sheetrock seeps wetlands (SRSWs) are inconspicuous and marginal wetland systems located on both noritic and quartzitic rock sheets that range from bare areas to pockets of deeper soil, often with signs of organic enrichment. Soils remain shallow (skeletal), and drainage is impeded by hard rock layers. Seepage is an important component that is present during the wet season, to create a mosaic of habitats with wetness, soil, and micro relief differences. This creates habitats that are suitable for both terrestrial and wetland plant species to co-occur. The uniqueness of the habitat is further reflected by the occurrence of several plant SCC in these areas, such as the Endangered *Disa alticola* and *Ledebouria* sp. nov. '*noritica*' ined., the

Vulnerable *Ledebouria* sp. nov. '*purpurea*' ined. and *Wurmbea viridiflora,* and the Rare *Amauropelta oppositiformis* (De Castro & Brits, 2022a).

The similarity in appearance of sheetrock seep wetlands to terrestrial habitat, especially during the dry season, creates a challenge to map these habitats accurately.

Four different types of wetlands in BMU5 are classified according to HGM types and are assessed in terms of their PES, EIS, and ecosystems services. There are several more wetlands present, but these assessments are only intended to provide an overview of the ecological condition and services associated with different types of wetlands in the study area. The study area contains few disturbances, meaning that little variation is expected in the condition of different wetlands within HGM classes and habitat types.

All four of the assessed wetlands are natural, unmodified wetlands with PES categories that fall in class A. Impacts were so negligible in the four wetlands that they did not even register in the assessments. Negligible impacts include an access road to the communications tower that borders HGM unit 1 and a few remnant trees of a plantation of *Eucalyptus* spp. that have been cut back adjacent to HGM unit 2. The only impact that registered in the scoring system is the presence of patches of *Pennisetum clandestinum* (kikuyu grass) in HGM unit 4. It is estimated that these alien patches occupy less than 5 % of the seep at present and were introduced into the area by livestock grazing and transportation on hooves. Future biodiversity management actions are, however, required to keep these wetlands in a pristine condition, specifically with regards to alien plant control. De Castro and Brits (2021b) mentions the risk of the invasive alien tree species, and recorded *Acacia dealbata* and *Populus* x *canescens,* to have invaded and transformed significant areas of valley bottom and seep wetland habitat at elevations above ca. 1 600 m.a.s.l., outside of the study area. Alien control interventions have already been implemented, and large sections of *Eucalyptus* spp. plantations have subsequently been removed through initial control. Continued alien control will be required to keep HGM unit 2, and other wetlands in the study area, in a natural condition. The implementation and updating of the existing alien control plan must therefore be prioritised as a critical feature for successful biodiversity management in BMU5, as well as in BMU7.

The two peatlands, HGM units 1 and 2, can perform (supply) various ecosystem services at a very high level, specifically biodiversity maintenance, stream flow regulation, carbon storage, water for human use, and cultural and spiritual services. Cultural and spiritual services have a very high supply score, but no demand score in both peatlands. This is due to the exceptional aesthetical beauty of the two HGM units (high supply score) and lack of use by the public at present (demand score). This is expected to change once the study area becomes established as a nature reserve. Biodiversity maintenance and carbon storage are the two most important ecosystem services in both HGM unit 1 and 2, as they are the only two that score high for both supply and demand.

Unsurprisingly, HGM unit 3, the sheetrock seep wetland, scores highest for biodiversity maintenance, for both supply and demand, due to the presence of plant SCC and unique habitat. The prominent supply score for cultivated foods in HGM unit 3 is regarded as a mistake due to a quirk in the algorithm used in the method developed by Kotze *et al*., (2020), as SRSWs present exceptions to assumptions that are used in the model, such as the expected presence of deep and organically enriched soils that can be used for cultivation.

HGM unit 4 also scores very high for biodiversity maintenance, for both supply and demand, while it possesses favourable grazing habitat for livestock (high supply score), even though livestock have a restricted presence within the study area (low demand score). Biodiversity maintenance is the most important ecosystem services in HGM unit 4, as it is the only wetland function that scores high for both supply and demand.

General recommendations for the management of wetlands in BMU's 5, 7, and 11:

- Wetlands in BMU5 are at risk of specific alien invasive species, such as *Acacia dealbata, A. mearnsii, Populus* x *canescens*, and *Eucalyptus* spp. The latter occurs as plantations that are in the process of being removed. Mountain streams in BMU7 are more at risk of plant alien invasive species, such as *Acacia dealbata, A. mearnsii, Pinus* cf. *elliotii*, and *P. patula* (De Castro & Brits, 2021b). Continued alien control will be required to keep BMU's 5 and 7 in a natural condition (class A PES). The implementation and updating of the existing alien control plan developed by De Castro and Brits (2021b) must therefore be prioritised as a critical feature for successful biodiversity management in BMU's 5 and 7.
- Erosion features in wetlands and mountain streams are often targeted for rehabilitation intervention in order to reduce the risk of habitat loss through erosion and/or to improve desiccated habitat along eroded gullies through the implementation of structures that can help to rewet affected areas. Care should be taken not to simply attempt to stabilise all erosion features in watercourses within the study area as natural erosion associated with the development of the drainage network is expected in this largely untransformed landscape. The study area is also located in a headwater catchment setting with steep slopes where erosion is to be expected. Erosion features that lack clear signs of anthropogenic origin/modification should ideally be left as natural erosion features unless clear motivation can be provided to intervene. Monitoring can also help to inform decisions regarding the need to stabilise erosion features, which will require expertise for the selection, design, and implementation of site specific rehabilitation structures. Erosion features that may develop in peatlands should be of a higher concern and require urgent consideration, as these low energy adapted wetlands with soft peat substrates can erode rapidly in a single storm event.
- Sheetrock seep wetlands, which also form part of BMU5, have a highly inconspicuous nature that can appear very similar to adjoining terrestrial habitat. They provide habitat for several plant SCC, but these species are minute and can be inconspicuous themselves, especially when not in flower. Sheetrock seep wetlands can therefore easily be missed, resulting in irreplaceable biodiversity loss as these areas can intuitively be incorrectly regarded as non-sensitive outcrops with a low sensitivity for biodiversity. Efforts to effectively communicate and raise awareness of the exceptional importance of these wetlands for biodiversity is recommended, especially for contractors or other visitors to the area, in order to help avoid impacts.
- Future field surveys can further refine delineated watercourses that form part of BMU's 5 and 7 as delineated in the wetland report (De Castro & Brits, 2022b), but any additional accuracy in terms of the presence and extent of watercourse boundaries are not regarded to be required for the purposes of managing biodiversity. It should, however, be noted that wetlands and other watercourses that form part of BMU's 5, 7, and 11 are protected water resources in South African legislation and this should also be considered in their management and conservation. The National Water Act (Act No. 36 of 1998) specifies water use activities that can only be allowed through an approved Water Use License (WUL) or General Authorisation (GA), irrespective of the condition of the affected watercourse. Section 21 of the NWA defines different types of water use activities in a watercourse. Section 21 water use activities listed in the NWA that pertain to watercourses (all BMU's 5, 7, and 11), which are commonly triggered in development and even certain rehabilitation activities, include the following:

(c) impeding or diverting the flow of water in a watercourse

(i) altering the bed, banks, course or characteristics of a watercourse.

- Development or rehabilitation actions that involve excavation, construction, or other works consistent with Section 21 (c) and (i) water use activities that are located within a 500 m radius of any wetland, requires authorisation for the Department of Water and Sanitation, as either a Water Use Licence or a General Authorisation.
- The National Environmental Management Act (Act Nr. 107 of 1998) (NEMA) specify listed activities that also require authorisation when located within 32 m of a watercourse (BMU's 5, 7, and 11).
- It is recommended that any possible development within 100 m of any BMU's 5, 7 and 11, should be avoided. It follows that the necessary authorisation from different pieces of legislation will need to be obtained before any such development can proceed.

The following references can be consulted for more detail regarding the vegetation (floristics, alien vegetation) of the DBPRN and greater Northam Booysendal Mine study area:

- De CASTRO & BRITS. (2020). Northam Booysendal Platinum Mine Biodiversity Management Plan (BMP): Initial literature review for the Botanical Biodiversity Baseline study. Report to Clean Stream Biological Services, Buttonshope Trust and Northam Booysendal Platinum Mine.
- De CASTRO & BRITS. (2021a). Botanical biodiversity baseline report for 12 950ha Northam Booysendal Mine Surface Rights Area. Report to Clean Stream Biological Services, Buttonshope Trust and Northam Booysendal Platinum Mine.
- De CASTRO & BRITS. (2021b). Survey of the Alien Invasive Plant Species occurring within the 12 950ha Northam Booysendal Mine Surface Rights Area. Report to Clean Stream Biological Services, Buttonshope Trust and Northam Booysendal Platinum Mine.
- De CASTRO & BRITS. (2022a). Botanical biodiversity survey report for 2 127ha De Berg Private Nature Reserve (Roossenekal, Mpumalanga Province). Report to Clean Stream Biological Services and Buttonshope Trust.
- De CASTRO & BRITS. (2022b). Wetland Biodiversity Management Plan for the proposed De Berg Private Nature Reserve (DBPNR) (Mpumalanga Province). Report to Clean Stream Biological Services and Buttonshope Trust.

8.2 TERRESTRIAL VERTEBRATE FAUNA (frogs, reptiles, birds and mammals)

A detailed desktop study on all faunal species recorded in the past was completed and includes a description of red data and protected status according to the IUCN Red Data list and the National Environmental Management Biodiversity Act (TOPS list). All applicable literature was reviewed and extensive background studies regarding species distributions, -habitat preferences, and -status were updated accordingly. The potential occurrence of threatened species was also evaluated from historical records, available literature, habitat availability, and personal experience. The fauna species lists thus represent the majority of species occurring in the study area and provide a solid basis from which the project can continue to develop a comprehensive species list (Deacon, 2020; Deacon, 2021).

After analysing the fauna distribution data and habitat availability a total of **641 animal species** that includes **18 frog species, 71 reptile species, 432 bird species and 120 mammal species** can be expected to occur in the DBPNR project area. The presence of these different faunal groups is dependent on availability of potential habitats in each distinct biotope. Several of these animal species are considered to be species of conservation concern (SCC).

Amphibians (Frogs)

The frog fauna of Mpumalanga and Limpopo provinces is a product of the diversity of the region's topography, climate, and habitats. Frogs have adapted to almost every type of environment and many species are highly specialized to suit conditions in a particular locality. This, however, can leave a species vulnerable when a habitat itself degrades or changes (Du Preez & Carruthers, 2009). It was proven that amphibian species worldwide are declining. Whereas habitat loss remains the primary threat to amphibian species worldwide, habitat conservation must remain a priority for amphibians because their usually small areas of occupancy make them more susceptible to extinction from habitat loss and degradation than other vertebrates. Suitable environmental conditions, especially breeding sites, are critically important to frogs, and species are often very specific to those habitats.

The amphibian populations in Mpumalanga are faced with several environmental threats. Habitat destruction and alien vegetation resulting in fragmentation of populations is probably the major threats facing all frog species. Forestry and agriculture have already resulted in the rapid destruction and fragmentation of the habitat of populations of the species discussed here. Overgrazing and severe fires in the grassland catchment areas result in extensive silting up of streams and wetlands, threatening the breeding habitat of these frogs.

Frogs of the Booysendal study area

- According to the 2004 Frog Atlas (Minter *et al.*, 2004), the DBPNR is situated in the Sour Grassland Assemblage. The frog distribution maps assessed, confirms that **18 frog species are expected to occur in the study area**. Of the 18 frog species that are expected to occur within the study area, it is anticipated that all the species may be found in the project area based on the availability of the potential habitat. The Sour Grassland Assemblage has relatively moderate species richness (11-20 species per grid cell), decreasing westwards, but is low in endemic species (four to six species) (Minter *et al.*, 2004). During surveys of the frog species (November 2021 and February 2022), the following **ten of the 18 expected species were encountered in the DBPNR**:
    1. Mozambique rain frog (*Breviceps mossambicus*)
    2. African common toad (*Sclerophrys gutturalis*)

3. African split-skin toad (*Schismaderma carens)*
4. Bubbling kassina (*Kassina senegalensis*)
5. Natal dwarf puddle frog (*Phrynobatrachus natalensis*)
6. African clawed frog (*Xenopus laevis)*
7. Boettger's dainty frog (*Cacosternum boettgeri)*
8. Delalande's river frog (*Amietia delalandii*).
9. Cape river frog (*Amietia fuscigula*)
10. Striped stream frog (*Strongylopus fasciatus*)

Most of the expected species were found in the natural wetlands and streams, as well as the artificial dam habitats.

According to Mr Marius Kruger (Land Manager), he received a report of a sighting which could possibly be that of the Natal ghost frog (*Hadromophryne natalensis*) lower down in the valley. Although this rare frog is not Red Listed according to Du Preez and Caruthers (2009), it is threatened by introduced trout and habitat destruction. Although the frog has not been recorded in the area before and its distribution map does not indicate its expected presence, the fast-flowing mountain streams in the lower valleys of the DBPNR are ideal habitat for this species.

Frog Species of Conservation Concern

Due to their limited distribution and range in South Africa, endemic species was also included as species of special interest. An endemic species has a global distribution restricted (or nearly so: >90%) to the atlas region.

According to the South African Frog Atlas map (Minter *et al.*, 2004) regarding richness of endemic frog species, the Sour Grassland Assemblage contains four to six endemic species. Using distribution maps and habitat quality as guidelines, **two endemic species (possibly three)** are expected to occur in the DBPNR.

The following frogs that are expected to be found in the study area are endemic to South Africa (SA endemic - Including Lesotho and Eswatini):

- Raucous toad (*Sclerophrys capensis*)
- Gray's stream frog (*Strongylopus grayii*)
- Natal ghost frog (*Hadromophryne natalensis*) – possibly

In determining the threatened status of frog species, the most recent listings of the IUCN Red Data (IUCN, 2022) and NEM:BA 2007 (National Environmental Management: Biodiversity Act) have been consulted and the South African component of frogs has been updated.

No frog species considered as "Red Data species", are expected to occur in the area (range and habitat).

Refer to

Table 8 for detail regarding the primary habitat requirements of the endemic frog species and BMU's of importance to the species.

Table 8: **Frog 'species of conservation concern' in the study area, indicating habitat requirements and BMU's with appropriate habitat.**

Frog species	BMU's with appropriate habitat - suitability for the species:
Raucous toad (*Sclerophrys capensis*): Endemic 	BMU5 Valley-bottom wetlands and seeps: Optimal BMU7 Mountain Streams: Optimal **Habitat preference**: Mesic temperate areas: Grassland biome. Breeds in rivers (pools along slow-flowing streams), streams, and ponds in grassland or woodland. Suburban gardens and farmland. Favour running water sources.
Gray's stream frog (*Strongylopus grayii*): Endemic 	BMU5 Valley-bottom wetlands and seeps: Optimal BMU7 Mountain Streams: Optimal BMU11 Dams. Good **Habitat preference**: It inhabits all biomes of South Africa, excluding the arid areas, such as forest, fynbos heath land, thicket, savanna and grassland, as well as modified habitats. It breeds in almost any well vegetated shallow body of water, such as pools, dams, ponds, ditches, and brackish pools along the coast within the spray zone, and shallow seeps. It can also tolerate polluted waters. It lays eggs out of the water in moist situations, and the tadpoles enter the water to complete their development. Breeds in almost any shallow body of water which is well provided with vegetation.

Reptiles

Current knowledge of the reptiles of Mpumalanga and Limpopo provinces derives from the information available in the "Atlas and Red List of the Reptiles of South Africa, Lesotho and Swaziland" (Bates *et al*., 2014). The bulk of the data in the atlas came from museums and nature conservation agencies, including data that was obtained from surveys done by N.H.G. Jacobsen (1989) providing a detailed account of all reptiles in the then Transvaal province. Other data were obtained from private collections, academic institutions, published literature, SARCA field surveys, and members of the general public via an online Virtual Museum (Bates *et al*, 2014).

In compiling the expected reptile lists, the detailed distribution records by Jacobsen (1989) of the herpetofauna of the old Transvaal were used with its interpreted distribution maps, as well as the reptile atlas project data from the Animal Demographic Unit (ADU, 2010).

According to the distribution of reptiles in South Africa, 71 species have distribution ranges extending into the region. All **71 of these reptile species are expected to occur in the DBPNR** (Jacobsen, 1989; Animal Demographic Unit, 2010) as adequate habitat is available. During the surveys of reptile species (November 2021 and February 2022), the following **16 of the 71**

expected species were encountered in the DBPNR (Deacon, 2022). Species in red font are listed as SCC:

1. Spotted dwarf gecko *(Lygodactylus ocellatus ocellatus)*
2. Common tropical house gecko *(Hemidactylus mabouia)*
3. Common dwarf gecko *(Lygodactylus capensis capensis)*
4. Southern African rock python (*Python natalensis*)
5. Snouted night adder (*Causus defilippii*).
6. Speckled rock skink *(Trachylepis punctatissima)*
7. Variable skink (*Trachylepis varia)*
8. Wahlberg's snake-eyed skink (*Panaspis wahlbergi*)
9. Spotted sand lizard (*Pedioplanis lineoocellata)*
10. Yellow-throated plated lizard *(Gerrhosaurus flavigularis)*
11. Van Dam's girdled lizard (*Smaug vandami*)
12. Common girdled lizard *(Cordylus vittifer)*
13. Sekhukhune flat lizard *(Platysaurus orientalis orientalis)*
14. Common crag lizard (*Pseudocordylus melanotus melanotus*)
15. Common flap-necked chameleon (*Chamaeleo dilepis dilepis*)
16. Southern rock agama *(Agama atra atra)*

Species of Conservation Concern: Reptiles

Threatened reptile species are rated by standards established by the **International Union for Conservation of Nature (IUCN 2022),** National Environmental Management: Biodiversity Act of 2004 (NEM:BA, 2004), and the SA Red List (Bates, *et al.*, 2014). Due to their limited distribution and range in South Africa, endemic species are included as species of conservation concern listed below. There are more endemic reptiles in southern Africa than any other vertebrates, and new species are being discovered regularly. According to the South African Reptile Atlas (ADU, 2010), the following **12 endemic reptile species are expected to be found in the DBPNR study area** (SA endemic - Including Lesotho & Eswatini):

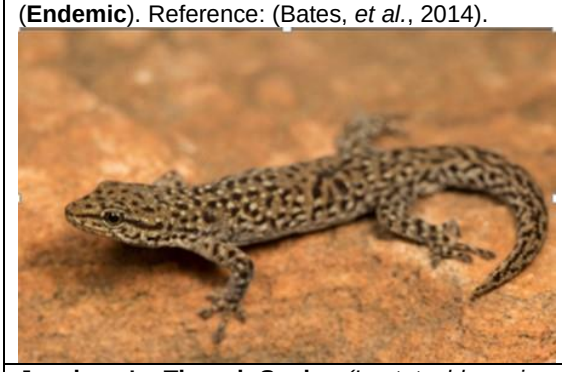
1. Spotted dwarf gecko *(Lygodactylus ocellatus ocellatus)*
2. Jacobsen's thread Snake *(Leptotyphlops jacobseni)*
3. Eastern Cape thread snake *(Leptotyphlops scutifrons conjunctus)*
4. Olive house snake *(Lycodonomorphus inornatus)*
5. Aurora house snake *(Lamprophis aurora)*
6. Western Natal green snake *(Philothamnus occidentalis)*
7. Montane dwarf burrowing skink (*Scelotes mirus*)
8. Van Dam's girdled lizard (*Smaug vandami*)
9. Sekukhune flat lizard *(Platysaurus orientalis orientalis)*
10. Common crag lizard (*Pseudocordylus melanotus melanotus*)
11. Distant's ground agama (*Agama aculeata distanti*)
12. Wolkberg dwarf chameleon (*Bradypodion transvaalense*)

There is **one threatened reptile species** expected to occur in the area (including MTPA conservation status):

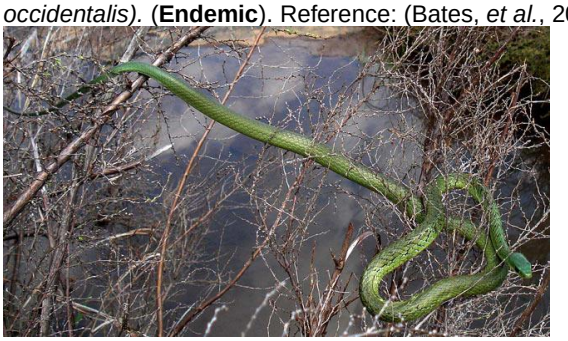
- Southern African rock python (*Python natalensis*) - NEMA TOPS 2007: Protected;

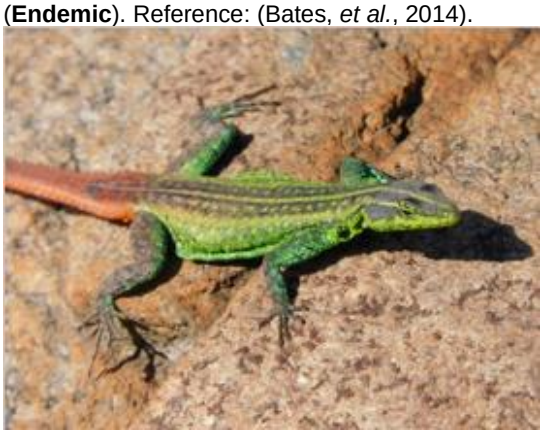
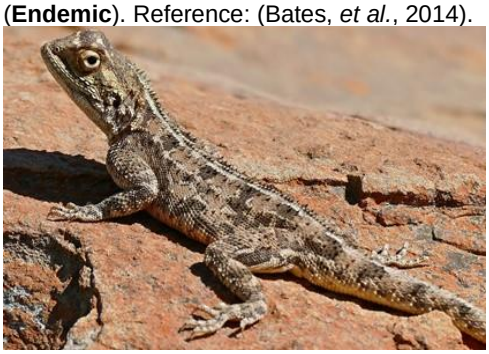
Refer to Table 9 for detail regarding the primary habitat requirements of the reptile SCC, BMU's of importance to the species, and recommended species-specific biodiversity management actions.

Table 9: **Habitat availability for reptile 'species of conservation concern' in the study area, indicating habitat requirements, and BMU's with appropriate habitat.**

Reptile species	Habitat requirements, BMU's of concern & Species-specific management actions
Spotted dwarf gecko *(Lygodactylus ocellatus ocellatus):* (**Endemic**). Reference: (Bates, *et al.*, 2014). 	Rocky hillsides. Exclusive rupiculous; among rocks and stones on exposed hillsides. BMU's with the appropriate habitat and suitability for the species: BMU1 Sekhukhune Mountain Bushveld: **Optimal** BMU2 Sekhukhune Montane Grassland: **Optimal** BMU3 Steenkampsberg Montane Grassland: **Optimal** **Species-specific biodiversity actions**: The population is suspected to be stable in the absence of evidence for any declines or substantial threats. Rocky outcrops should not be impacted
Jacobsen's Thread Snake *(Leptotyphlops jacobsenii).* (**Endemic**). Reference: (Bates, *et al*., 2014). 	**Habitat preference: Grassland and moist Savanna** at an altitude of between 1300 and 1700 m.a.s.l. Found under stones and in deserted termite mounds. BMU1 Sekhukhune Mountain Bushveld: **Good** BMU2 Sekhukhune Montane Grassland: **Optimal** BMU3 Steenkampsberg Montane Grassland: **Medium** **Species-specific biodiversity actions**: The population is suspected to be stable in the absence of evidence for any declines or substantial threats. Manage grassland appropriately.
Eastern Cape thread snake *(Leptotyphlops scutifrons conjunctus).* (**Endemic**). Reference: (Bates, *et al.*, 2014). 	**Habitat preference:** Varied; **grassland, mesic Savanna. Fossorial:** under stones, among roots of grass tussocks; moribund termitaria. BMU1 Sekhukhune Mountain Bushveld: **Optimal** BMU2 Sekhukhune Montane Grassland: **Optimal** BMU3 Steenkampsberg Montane Grassland: **Optimal** BMU4 Northern Afrotemperate Forest: **Medium** BMU9 Secondary vegetation: **Medium** **Species-specific biodiversity actions**: The population is suspected to be stable in the absence of evidence for any declines or substantial threats. Manage grassland appropriately.

Reptile species	Habitat requirements, BMU's of concern & Species-specific management actions
Southern African python (*Python natalensis*). (NEMA TOPS 2007: **Protected**). Reference: (Bates, *et al*., 2014). 	**Habitat preference:** Open Savanna regions, particularly rocky areas and riverine scrub. Moist, rocky, well-wooded valleys, reed-beds or even bush country, seldom venture far from permanent water. BMU1 Sekhukhune Mountain Bushveld: **Optimal** BMU5 Valley-bottom wetlands and seeps: **Medium** BMU7 Mountain Streams: **Good** BMU11 Dams: **Good** **Species-specific biodiversity actions**: The population is suspected to be stable in the absence of evidence for any declines or substantial threats. Threats: Habitat transformation and fragmentation. Persecution by human
Olive snake *(Lycodonomorphus inornatus).* (**Endemic**). Reference: (Bates*, et al.*, 2014). 	**Habitat preference:** Moist bushveld extending into grassveld. Moister habitats. BMU1 Sekhukhune Mountain Bushveld: **Optimal** BMU2 Sekhukhune Montane Grassland: **Optimal** BMU5 Valley-bottom wetlands and seeps: **Optimal** **Species-specific biodiversity actions**: The population is suspected to be stable in the absence of evidence for any declines or substantial threats. Manage grassland appropriately.
Aurora house snake *(Lamprophis aurora):* (**Endemic**). Reference: (Bates, *et al*., 2014). 	**Habitat preference:** Grasslands. Terrestrial. Favours damp localities in grasslands, moist Savanna, lowland forest and fynbos. BMU1 Sekhukhune Mountain Bushveld: **Optimal** BMU2 Sekhukhune Montane Grassland: **Optimal** BMU3 Steenkampsberg Montane Grassland: **Low** BMU5 Valley-bottom wetlands and seeps: **Optimal** BMU7 Mountain Streams: **Good** **Species-specific biodiversity actions**: The population is suspected to be stable in the absence of evidence for any declines or substantial threats Manage grassland and wetlands appropriately

Reptile species	Habitat requirements, BMU's of concern & Species-specific management actions
Western Natal green snake *(Philothamnus natalensis occidentalis).* (**Endemic**). Reference: (Bates, *et al.*, 2014). 	**Habitat preference:** Varied: Wet montane, **woodland** and dry forest. In shrubs or trees **close to water**. Home near water bodies where it hunts for frogs, frequenting marshes, ponds, rivers, reedbeds, pans, vleis and streams. BMU1 Sekhukhune Mountain Bushveld: **Good** BMU5 Valley-bottom wetlands and seeps: **Optimal** BMU7 Mountain Streams: **Optimal** **Species-specific biodiversity actions**: The population is suspected to be stable in the absence of evidence for any declines or substantial threats. Manage grassland and wetlands appropriately.
Montane dwarf burrowing skink (*Scelotes mirus*). (**Endemic**). Reference: (Bates, *et al.,* 2014). 	**Habitat preference: Rocky montane grassland**. Live in grass among rocks on upper mountain slopes and summits. BMU3 Steenkampsberg Montane Grassland: **Optimal** BMU9 Secondary vegetation: **Optimal** **Species-specific biodiversity actions**: The population is suspected to be stable in the absence of evidence for any declines or substantial threats. Manage grassland appropriately.
Van Dam's girdled lizard (*Smaug vandami*). (**Endemic**). Reference: (Bates, *et al*., 2014). 	**Habitat preference:** A **montane form, living amongst rocks on rocky outcrops**, cliffs and rocky hillsides in bushveld up to 1600 m.a.s.l. Shelters in crevices between rocks or under rock on rock. Do not go far from shelter, retire into crevices when disturbed. BMU1 Sekhukhune Mountain Bushveld: **Good** BMU2 Sekhukhune Montane Grassland: **Optimal** BMU3 Steenkampsberg Montane Grassland: **Optimal** **Species-specific biodiversity actions**: The population is suspected to be stable in the absence of evidence for any declines or substantial threats. Rocky outcrops should not be impacted.

Reptile species	Habitat requirements, BMU's of concern & Species-specific management actions
Sekukhune flat lizard *(Platysaurus orientalis orientalis).* (**Endemic**). Reference: (Bates, *et al.*, 2014). 	**Habitat preference: Mesic Savanna**: Mpumalanga escarpment. Restricted to eastern Sekhukhuneland. BMU1 Sekhukhune Mountain Bushveld: **Optimal** BMU2 Sekhukhune Montane Grassland: **Optimal** BMU3 Steenkampsberg Montane Grassland: **Good** **Species-specific biodiversity actions**: The population is suspected to be stable in the absence of evidence for any declines or substantial threats. Rocky outcrops should not be impacted.
Common crag lizard (*Pseudocordylus melanotus melanotus*). (**Endemic**). Reference: (Bates, *et al*., 2014). 	**Habitat preference: Grassland Biome - Mesic Highveld Grassland** and Sub-Escarpment Grassland. Rock outcrops on mountain plateaus and in rolling grassland. Slope and foothill specialists. In rock cracks, narrow crevices between rocks. BMU1 Sekhukhune Mountain Bushveld: **Good** BMU2 Sekhukhune Montane Grassland: **Optimal** BMU3 Steenkampsberg Montane Grassland: **Optimal** **Species-specific biodiversity actions**: The population is suspected to be stable in the absence of evidence for any declines or substantial threats. Rocky outcrops should not be impacted.
Distant's ground agama (*Agama aculeata distanti*). (**Endemic**). Reference: (Bates, *et al.*, 2014). 	**Habitat preference:** Semi-desert and **Savanna: Open highveld (Grassland) and sandy thornbush (woodland)** country with suitable rodent and other small animal burrows for shelter. BMU1 Sekhukhune Mountain Bushveld: **Medium** BMU2 Sekhukhune Montane Grassland: **Optimal** BMU9 Secondary vegetation: **Medium** **Species-specific biodiversity actions**: The population is suspected to be stable in the absence of evidence for any declines or substantial threats. Manage grassland appropriately

Reptile species	Habitat requirements, BMU's of concern & Species-specific management actions
Wolkberg dwarf chameleon (*Bradypodion transvaalense*). (**Endemic**). Reference: (Bates, *et al*., 2014). 	**Habitat preference: Prefers forested or thick, bushy habitats**, usually with closed canopy. Not found in Savanna areas outside forest fragments. BMU4 Northern Afrotemperate Forest: **Optimal** **Species-specific biodiversity actions**: The population is suspected to be stable in the absence of evidence for any declines or substantial threats. Forest patches should not be impacted.

Birds (avifauna)

The Bird Atlas (Harrison *et al.*, 1997, Volumes 1 & 2) formed the basis of the distribution data used in this report since these are currently the most updated printed information sources on South African birds available. The Roberts Birds of southern Africa (Hockey *et al*., 2005) was also consulted for habitat and bird data.

Of the bird species expected to be found in the study area, certain birds were resident and thus remain in the area throughout the year. Nomadic species periodically move to other areas further away from the study area for feeding or breeding purposes. Of the expected migratory bird species, some North African visitors will only appear during the warmer seasons where they will feed and likely breed. The Palaearctic migrants spend our winters in Eurasia and are summer visitors to the warm south during the cold winters up north, however very few breed in southern Africa.

It is important to note that the project area is very close to the Steenkampsberg Important Bird Area (IBA) (Birdlife South Africa website), specifically related to the presence of many pans as a crucial habitat for water birds. A portion of DBPNR is situated in this IBA.

A total of 450 bird species were observed in this region during the Bird Atlas project (Harrison *et al.* 1997) and various studies conducted for the area. Based on bird distribution and local habitat availability, it is estimated that a total of **432 bird species** are likely to utilize the different biotopes of the study area. Two of these bird species are alien exotics:

- House Sparrow (*Passer domesticus*)
- Common Myna (*Acridotheres tristis*)

The surveys at DBPNR and adjacent areas produced **127 bird species** across all transects in the project area. The following bird species were recorded (Red = "Species of Conservation Concern"):

Little Grebe *(Tachybaptus ruficollis)*
Reed cormorant (*Microcarbo africanus*)
Western Cattle egret (*Bubulcus ibis*)
Blue Crane *(Anthropoides paradiseus)*
Hadeda Ibis (*Bostrychia hagedash*)
Southern Bald Ibis *(Geronticus calvus)*
Hamerkop (*Scopus umbretta*)
African black duck (*Anas sparsa*)
Secretary bird (*Sagittarius serpentarius*)
Black-winged Kite *(Elanus caeruleus)*
Yellow-billed Kite (*Milvus parasitus*)
African Harrier-Hawk *(Polyboroides typus)*
Common Buzzard *(Buteo buteo)*
Jackal Buzzard *(Buteo rufofuscus)*
Verreaux's Eagle *(Aquila verreauxii)*
Rock Kestrel *(Falco rupicolus)*
Red-winged Francolin *(Scleroptila levaillantii)*
Natal spurfowl (*Pternistis natalensis*)
Harlequin Quail *(Coturnix delegorguei)*
Red-knobbed coot (*Fulica cristata*)
Blacksmith plover (*Vanellus armatus*)
African Wattled plover (*Vanellus senegallus*)
Crowned Lapwing *(Vanellus coronatus)*
Speckled Pigeon (*Columba guinea)*
Laughing dove (*Spilopelia senegalensis*)
Ring-necked Dove (*Streptopelia capicola*)
Red-eyed Dove (*Streptopelia semitorquata*)
Purple-crested Turaco (*Gallirex porphyreolophus*)
Diederik Cuckoo (*Chrysococcyx caprius*)
Red-chested Cuckoo (*Cuculus solitarius*)
Freckled nightjar (*Caprimulgus tristigma*)
Common Swift *(Apus apus)*
African Black Swift *(Apus barbatus)*
White-rumped Swift (*Apus caffer*)
Speckled mousebird *(Colius striatus)*
Red-faced Mousebird *(Urocolius indicus)*
Brown-hooded Kingfisher (*Halcyon albiventris*)
Striped Kingfisher (*Halcyon chelicuti*)
European Bee-eater (*Merops apiaster*)
Yellow-fronted Tinkerbird (*Pogoniulus chrysoconus*)
Black-collared Barbet (*Lybius torquatus*)
Crested Barbet (*Trachyphonus vaillantii*)
Greater Honeyguide (*Indicator indicator*)
Golden-tailed Woodpecker (*Campethera abingoni*)
Ground Woodpecker *(Geocolaptes olivaceus)*
Cardinal Woodpecker (*Dendropicos fuscescens*)
Red-throated Wryneck *(Jynx ruficollis)*
Rufous-naped Lark (*Mirafra africana*)
Banded Martin *(Neophedina cincta)*
Barn Swallow (*Hirundo rustica*)
White-throated Swallow *(Hirundo albigularis*)
Greater Striped Swallow *(Cecropis cucullata)*
Lesser Striped Swallow *(Cecropis abyssinica*)
Common House-Martin *(Delichon urbicum)*
Black Cuckooshrike (*Campephaga flava*)
Fork-tailed Drongo (*Dicrurus adsimilis*)
Black-headed Oriole (*Oriolus larvatus*)
Cape Crow *(Corvus capensis)*
Pied Crow (*Corvus albus*)
White-necked Raven *(Corvus albicollis)*
Dark-capped Bulbul (*Pycnonotus tricolor)*
Sombre Greenbul *(Andropadus importunus)*
Pied Crow (*Corvus albus*)
Cape Rock Thrush *(Monticola rupestris)*
Groundscraper thrush *(Psophocichla litsitsirupa*)
Karoo thrush (*Turdus smithi*)
African Stonechat *(Saxicola torquatus)*
Buff-streaked Chat *(Campicoloides bifasciata)*
Mountain Wheatear *(Myrmecocichla monticola)*
Familiar Chat *(Oenanthe familiaris)*
Ant-eating Chat *(Myrmecocichla formicivora)*
Mocking Cliff Chat (*Thamnolaea cinnamomeiventris*)
Cape Robin-Chat *(Dessonornis caffra)*
Cape Grassbird *(Sphenoeacus afer)*
Dark-capped Yellow Warbler *(Iduna natalensis)*
Willow Warbler *(Phylloscopus trochilus)*
Yellow-breasted Apalis *(Apalis flavida)*
Green-backed Camaroptera *(Camaroptera brachyura)*
Lazy Cisticola *(Cisticola aberrans)*
Rattling Cisticola (*Cisticola chiniana*)
Levaillant's cisticola (*Cisticola tinniens*)
Neddicky (*Cisticola fulvicapilla*)
Zitting Cisticola *(Cisticola juncidis)*
Desert Cisticola *(Cisticola aridulus)*
Wing-snapping Cisticola (*Cisticola ayresii)*
Tawny-flanked prinia (*Prinia subflava*)
Drakensberg Prinia *(Prinia hypoxantha)*
African Paradise Flycatcher (*Terpsiphone viridis*)
Fiscal Flycatcher *(Melaenornis silens)*
Spotted Flycatcher *(Muscicapa striata)*
Cape Batis *(Batis capensis)*
Chinspot Batis *(Batis molitor)*
Cape wagtail *(Motacilla capensis)*
Cape Longclaw *(Macronyx capensis)*
African Pipit *(Anthus cinnamomeus)*
Long-billed Pipit *(Anthus similis)*
Common Fiscal *(Lanius collaris)*
Black-backed puffback (*Dryoscopus cubla*)

Black-crowned Tchagra (*Tchagra senegalus*)
Southern Boubou *(Laniarius ferrugineus)*
Bokmakierie *(Telophorus zeylonus)*
Red-winged Starling *(Onychognathus morio)*
Pied Starling *(Lamprotornis bicolor)*
Common Myna *(Acridotheres tristis)*
Gurney's Sugarbird *(Promerops gurneyi)*
Amethyst Sunbird *(Chalcomitra amethystina)*
Malachite Sunbird *(Nectarinia famosa)*
Greater Double-collared Sunbird *(Cinnyris afer)*
Cape white-eye *(Zosterops virens)*
House Sparrow *(Passer domesticus)*
Spectacled Weaver (*Ploceus ocularis*)
Cape weaver (*Ploceus capensis*)
Thick-billed weaver *(Amblyospiza albifrons)*
Red-billed Quelea *(Quelea quelea)*
White-winged Widowbird *(Euplectes albonotatus)*
Red-collared Widowbird *(Euplectes ardens)*
Long-tailed Widowbird *(Euplectes progne)*
Yellow-crowned bishop (*Euplectes afer*)
Southern red bishop *(Euplectes orix)*
African Quail-finch *(Ortygospiza fuscocrissa)*
Common Waxbill (*Estrilda astrild*)
Pin-tailed Whydah (*Vidua macroura*)
Cape Canary *(Serinus canicollis)*
Yellow-fronted Canary *(Crithagra mozambica*)
Brimstone Canary *(Crithagra sulphurata)*
Streaky-headed Seedeater *(Crithagra gularis)*
Cinnamon-breasted Bunting *(Emberiza tahapisi)*

Species of Conservation Concern: Birds

In this document, the category “Species of Conservation Concern” is considered to include all threatened taxa listed by South African Red Data lists, and all South African endemic taxa. If bird distribution and local habitat are evaluated, a total of **42 bird Species of Conservation Concern** are likely to utilize the different biotopes of the study area.

Of all the Species of Conservation Concern which are expected to occur in the study area, 15 species are endemic to South Africa (including Lesotho and Eswatini) and these are listed below (six of these are also threatened species):

1. Southern Bald Ibis *(Geronticus calvus)*
2. Knysna Turaco *(Tauraco corythaix)*
3. Grey-winged Francolin *(Scleroptila afra)*
4. Ground Woodpecker *(Geocolaptes olivaceus)*
5. Rudd's Lark *(Heteromirafra ruddi)*
6. Eastern Long-billed Lark (*Certhilauda semitorquata*)
7. Cape Rock Thrush *(Monticola rupestris)*
8. Sentinel Rock Thrush *(Monticola explorator)*
9. Melodious Lark *(Mirafra cheniana)*
10. Buff-streaked Chat *(Campicoloides bifasciata)*
11. Chorister Robin-Chat *(Cossypha dichroa)*
12. Yellow-breasted Pipit *(Hemimacronyx chloris)*
13. Pied Starling *(Lamprotornis bicolor)*
14. Gurney's Sugarbird *(Promerops gurneyi)*
15. Greater Double-collared Sunbird *(Cinnyris afer)*

The following **33 threatened bird species** are expected to occur in the DBPNR area (IUCN**, 2022**; NEM:BA, 2014; Red Data Book, 2015):

1. Abdim’s stork (*Ciconia abdimii*) - IUCN 2016 Status: Least concern. SA Red Data (Taylor, 2015): Near Threatened.
2. African Crowned Eagle *(Stephanoaetus coronatus)* - IUCN 2018 Status: Near Threatened. SA Red Data (Taylor, 2015): Vulnerable.

3. African Finfoot *(Podica senegalensis)* - IUCN 2016 Status: Least concern; SA Red Data (Taylor, 2015): Vulnerable.
4. African Grass-owl *(Tyto capensis)* - IUCN 2016: Least Concern; SA Red Data (Taylor, 2015): Vulnerable.
5. African marsh harrier (*Circus ranivorus*) – IUCN 2016: Least concern; SA Red Data (Taylor, 2015): Endangered
6. African White-backed Vulture *(Gyps africanus)* - IUCN 2021: Critically Endangered; SA Red Data (Taylor, 2015): Critically Endangered. Common nomadic.
7. Black stork (*Ciconia nigra*) - IUCN 2017 Status: Least concern. SA Red Data (Taylor, 2015): Vulnerable.
8. Black Harrier *(Circus maurus)* - IUCN 2021 Status: Endangered; SA Red Data (Taylor, 2015): Endangered.
9. Blue Crane *(Anthropoides paradiseus)* – IUCN 2021 Status: Vulnerable; SA Red Data (Taylor, 2015): Near Threatened.
10. Cape Vulture *(Gyps coprotheres)* - IUCN 2021 Status: Vulnerable; SA Red Data (Taylor, 2015): Endangered.
11. Denham's Bustard *(Neotis denhami)* - IUCN 2016 Status: Near Threatened. SA Red Data (Taylor, 2015): Vulnerable.
12. European Roller (*Coracias garrulus*) - IUCN 2019 Status: Least concern; SA Red Data (Taylor, 2015): Near Threatened.
13. Greater Painted snipe (*Rostratula benghalensis*) - IUCN 2016 Status: Least concern; SA Red Data (Taylor, 2015): Near Threatened.
14. Grey Crowned Crane *(Balearica regulorum)* - IUCN 2016 Status: Endangered. SA Red Data (Taylor, 2015): Endangered.
15. Ground Woodpecker *(Geocolaptes olivaceus)* - IUCN 2021 Status: Near Threatened. SA Red Data (Taylor, 2015): Least Concern, SA Endemic.
16. Gurney's Sugarbird *(Promerops gurneyi)* - IUCN 2017 Status: Near Threatened. SA Red Data (Taylor, 2015): Unknown, SA Endemic.
17. Half-collared Kingfisher *(Alcedo semitorquata)* - IUCN 2016 Status: Least concern. SA Red Data (Taylor, 2015): Near Threatened.
18. Lanner Falcon *(Falco biarmicus)* - IUCN 2017 Status: Least concern (Global). SA Red Data (Taylor, 2015): Vulnerable
19. Martial Eagle *(Polemaetus bellicosus)* - IUCN 2020 Status: Endangered; SA Red Data (Taylor, 2015): Endangered.
20. Melodious Lark (*Mirafra cheniana*) – IUCN 2017 Status: Least Concern; SA Red Data (Taylor, 2015): Near Threatened, Endemic.
21. Pallid Harrier *(Circus macrourus)* - IUCN 2021 Status: Near Threatened; SA Red Data (Taylor, 2015): Near Threatened.
22. Red-footed Falcon *(Falco vespertinus)* - IUCN 2021 Status: Vulnerable; SA Red Data (Taylor, 2015): Near Threatened.
23. Rudd's Lark *(Heteromirafra ruddi)* - IUCN 2021 Status: Endangered; SA Red Data (Taylor, 2015): Endangered, Endemic.
24. Secretary bird (*Sagittarius serpentarius*) - IUCN 2020 Status: Endangered; SA Red Data (Taylor, 2015): Vulnerable.
25. Sentinel Rock Thrush *(Monticola explorator)* - IUCN 2021 Status: Near Threatened. SA Red Data (Taylor, 2015): Least concern, SA Endemic.
26. Short-tailed Pipit *(Anthus brachyurus)* - IUCN 2018 Status: Least concern. SA Red Data (Taylor, 2015): Vulnerable.
27. Southern Bald Ibis *(Geronticus calvus)* – IUCN 2016 Status: Vulnerable; SA Red Data (Taylor, 2015): Vulnerable, SA endemic.
28. Tawny Eagle (*Aquila rapax*) – IUCN 2021. Status: Vulnerable. SA Red Data (Taylor, 2015): Endangered.
29. Verreauxs' eagle (*Aquila verreauxii*) - IUCN 2016 Status: Least concern. SA Red Data (Taylor, 2015): Vulnerable.

30. Wattled Crane (*Bugeranus carunculatus*) - IUCN 2018 Status: Vulnerable; SA Red Data (Taylor, 2015): Critically endangered.
31. White-bellied korhaan (*Eupodotis senegalensis*) – IUCN 2016 Status: Least concern; SA Red Data (Taylor, 2015): Vulnerable.
32. Yellow-billed stork (*Mycteria ibis*) - IUCN 2016 Status: Least concern. SA Red Data (Taylor, 2015): Endangered.
33. Yellow-breasted Pipit (*Hemimacronyx chloris*) - IUCN 2021 Status: Vulnerable. SA Red Data (Taylor, 2015): Vulnerable, SA endemic.

Refer to Table 10 for detail regarding the primary habitat requirements of the bird SCC, BMU's of importance to the species and recommended species-specific biodiversity management actions.

Table 10: **Habitat availability for bird 'species of conservation concern' in the study area, indicating habitat requirements, BMU's with appropriate habitat and recommended species-specific biodiversity management actions.**

Bird species	**Habitat requirements, BMU's of concern & Species-specific management actions**
Yellow-billed stork (*Mycteria ibis*): (SA Red Data: **Endangered**). Reference: (Taylor, 2015). 	Habitat: Dams, large marshes, swamps, estuaries, margins of lakes and rivers, seasonal wetlands. Wetlands, including alkaline and freshwater lakes, rivers, pans, flood plains, flooded grasslands, small pools or streams. BMU's with the appropriate habitat and suitability for the species: BMU5. Valley-bottom wetlands and seeps - Suitability: Low **Species-specific biodiversity actions**: Prevent wetland disturbance and destruction.
Black stork (*Ciconia nigra*). (SA Red Data: **Vulnerable**). Reference: (Taylor, 2015). 	Habitat: Shallow water: streams, rivers, marshes, floodplains, flooded grassland; large and small dams; dry land. Shallows of rivers, pools in dry riverbeds. Nest up cliff above water: 10-100m. BMU's with the appropriate habitat and suitability for the species: BMU5. Valley-bottom wetlands and seeps - Suitability: Medium **Species-specific biodiversity actions**: Minimise disturbance to nesting sites. Reduce environmental impacts on the flow of perennial rivers.
Abdim's stork (*Ciconia abdimii*). (SA Red Data: **Near Threatened**). Reference: (Taylor, 2015).	Grasslands, pastures and cultivated fields. BMU's with the appropriate habitat and suitability for the species: BMU2. Sekhukhune Montane Grassland - Suitability: Optimal BMU3. Steenkampsberg Montane Grassland - Suitability: Low

Bird species	Habitat requirements, BMU's of concern & Species-specific management actions
	BMU9. Secondary vegetation (historical cultivation) - Suitability: Optimal **Species-specific biodiversity actions**: Prevent habitat degradation - agricultural activities (such as maize farming). Responsible control of insects – insecticides.
Blue Crane *(Anthropoides paradiseus).* (SA Red Data: **Vulnerable**). Reference: (Taylor, 2015). 	Karoo and grassland biome. Croplands. BMU's with the appropriate habitat and suitability for the species: BMU2. Sekhukhune Montane Grassland - Suitability: Good BMU3. Steenkampsberg Montane Grassland - Suitability: Optimal BMU5. Valley-bottom wetlands and seeps - Suitability: Optimal BMU9. Secondary vegetation (historical cultivation) - Suitability: Medium **Species-specific biodiversity actions**: Mitigate power-line collisions (make hazardous powerlines more visible), addressing illegal trade, encourage more responsible use of agrochemicals, focus awareness campaigns on the farming community, reduce deliberate poisoning of cranes for food.
Grey Crowned Crane *(Balearica regulorum).* (SA Red Data: **Endangered**). Reference: (Taylor, 2015). 	Associated with wetlands: forage in dryland habitat – grassland, open savannah, agricultural fields. High altitude temperate wetlands. BMU's with the appropriate habitat and suitability for the species: BMU2. Sekhukhune Montane Grassland - Suitability: Good BMU3. Steenkampsberg Montane Grassland - Suitability: Optimal BMU5. Valley-bottom wetlands and seeps - Suitability: Optimal BMU9. Secondary vegetation (historical cultivation) - Suitability: Medium **Species-specific biodiversity actions**: Habitat loss and degradation - attempt to restore habitat. Raise awareness of this species and land use practices. Discourage hunting and irresponsible pesticide use through awareness campaigns.

Bird species	Habitat requirements, BMU's of concern & Species-specific management actions
Wattled Crane *(Bugenarus carunculatus).* (SA Red Data: **Vulnerable**). Reference: (Taylor, 2015). 	Wetlands (sponges): permanently inundated, fairly small, high altitude (>1500 m.a.s.l.) of upper catchment regions in high-rainfall sour grasslands. BMU's with the appropriate habitat and suitability for the species: BMU5. Valley-bottom wetlands and seeps - Suitability: Optimal BMU7. Mountain Streams - Suitability: Medium **Species-specific biodiversity actions**: Increase educational campaigns - work with farming communities to conserve natural grasslands that surround wetlands.
Southern Bald Ibis *(Geronticus calvus).* (SA Red Data: **Vulnerable**). Reference: (Taylor, 2015). 	High rainfall, sour and alpine grasslands – absence of trees, short dense grass sward. Montane grassland of Eastern Transvaal escarpment. Cliffs for breeding. BMU's with the appropriate habitat and suitability for the species: BMU2. Sekhukhune Montane Grassland - Suitability: Good BMU3. Steenkampsberg Montane Grassland - Suitability: Good BMU5. Valley-bottom wetlands and seeps - Suitability: Optimal BMU7. Mountain Streams - Suitability: Good BMU9. Secondary vegetation (historical cultivation) - Suitability: Good **Species-specific biodiversity actions:** Managing the two most significant grassland drivers, namely fire frequency and grazing intensity, are one of the most significant and often challenging management objectives for any protected area within the Grassland Biome. Extensive over-grazing and annual fires will have a severe impact upon a host of invertebrate and vertebrate species inhabiting these ecosystems.
African Finfoot *(Podica senegalensis).* (SA Red Data: **Vulnerable**). Reference: (Taylor, 2015). 	Quiet wooded streams and rivers flanked by thick riparian vegetation and overhanging trees. Forest and woodland areas: Streams and rivers lined with reeds, overhanging trees and shrubs. Avoids stagnant and fast flowing water. Perennial watercourses, clear water. BMU's with the appropriate habitat and suitability for the species: BMU7. Mountain Streams - Suitability: Low **Species-specific biodiversity actions**: Effective management of rivers and riverine vegetation

Bird species	Habitat requirements, BMU's of concern & Species-specific management actions
African White-backed Vulture *(Gyps africanus).* (SA Red Data: **Critically Endangered**). Reference: (Taylor, 2015). 	Drier woodlands, tall trees for roosting and nesting. BMU with the appropriate habitat, suitability for the species: BMU1. Sekhukhune Mountain Bushveld - Suitability: Low BMU2. Sekhukhune Montane Grassland - Suitability: Low BMU3. Steenkampsberg Montane Grassland - Suitability: Low **Species-specific biodiversity actions**: Threats from infrastructure (collisions and electrocution). Training of rapid response units and communication. Prevent the use of vulture-toxic NSAIDs in livestock and substitute them for vulture-friendly alternatives.
Cape Vulture *(Gyps coprotheres).* (SA Red Data: **Endangered**). Reference: (Taylor, 2015). 	Both open country (grasslands) and woodland. Reliant on tall cliffs for breeding and roosting. Wanders widely. BMU's with the appropriate habitat and suitability for the species: BMU1. Sekhukhune Mountain Bushveld - Suitability: Medium BMU2. Sekhukhune Montane Grassland - Suitability: Optimal BMU3. Steenkampsberg Montane Grassland - Suitability: Optimal **Species-specific biodiversity actions**: Develop conservation partnerships with the farming community. Threats from infrastructure (collisions and electrocution). Training of rapid response units and communication. Prevent the use of vulture-toxic NSAIDs in livestock and substitute them for vulture-friendly alternatives.
Secretary bird (*Sagittarius serpentarius*). (SA Red Data: **Vulnerable**). Reference: (Taylor, 2015). 	Open country: Savanna, open woodland, grassland and dwarf shrubland. Avoids mountain fynbos, forests, dense woodland and very rocky or hilly or mountainous areas. BMU's with the appropriate habitat and suitability for the species: BMU1. Sekhukhune Mountain Bushveld - Suitability: Good BMU2. Sekhukhune Montane Grassland - Suitability: Medium BMU3. Steenkampsberg Montane Grassland - Suitability: Optimal BMU9. Secondary vegetation (historical cultivation) - Suitability: Good **Species-specific biodiversity actions**: The excessive burning of grasslands may suppress populations of prey species, whilst the intensive grazing of livestock is also probably degrading otherwise suitable habitat. Collisions with fence lines and electric cables. Disturbance by humans, probably most often herders, is likely to negatively affect breeding; raise awareness of threats amongst local people, particularly livestock herders. Join biodiversity stewardship initiatives.

Bird species	Habitat requirements, BMU's of concern & Species-specific management actions
African marsh harrier (*Circus ranivorus*). (SA Red Data: **Critically Endangered**). Reference: (Taylor, 2015). 	Nests in extensive reedbeds; forage over reeds, lake margins, floodplains and woodland. BMU's with the appropriate habitat and suitability for the species: BMU11. Dams - Suitability: Good **Species-specific biodiversity actions**: Prevent the drainage, burning and grazing of wetlands.
Black Harrier *(Circus maurus).* (SA Red Data: **Endangered**). Reference: (Taylor, 2015). 	Grassland, mountain fynbos cultivated lands, subalpine vegetation. BMU's with the appropriate habitat and suitability for the species: BMU2. Sekhukhune Montane Grassland - Suitability: Optimal BMU3. Steenkampsberg Montane Grassland - Suitability: Optimal BMU9. Secondary vegetation (historical cultivation) - Suitability: Good **Species-specific biodiversity actions**: Habitat is primarily lost to agriculture: uncontrolled burning of grassland which renders these habitats unsuitable for breeding for about five years. Drainage, impoundment and inappropriate management of vleis, marshes or streams near breeding grounds could prove detrimental to the availability of rodent prey around habitat fragments. Low hatching rates, possibly as a result of high pesticide residues, is an increasing threat now that many remaining breeding habitats are surrounded by agricultural areas; the ingestion of herbicides and pesticides may account for the death of some adults. Raise awareness of the value of this species.
Pallid Harrier *(Circus macrourus).* (SA Red Data: **Near Threatened**). Reference: (Taylor, 2015). 	Open grassveld, cultivated fields, less commonly in open semi-arid savannah. BMU's with the appropriate habitat and suitability for the species: BMU2. Sekhukhune Montane Grassland - Suitability: Optimal BMU3. Steenkampsberg Montane Grassland - Suitability: Optimal BMU9. Secondary vegetation (historical cultivation) - Suitability: Good **Species-specific biodiversity actions**: Encourage conservation of wetlands and ponds in grassland and prevent the use harmful pesticides. Support moderate grazing and conservation of grasslands.

Bird species	Habitat requirements, BMU's of concern & Species-specific management actions
Tawny Eagle *(Aquila rapax).* (SA Red Data: **Endangered**). Reference: (Taylor, 2015). 	Woodlands, lightly wooded areas; needs trees. BMU's with the appropriate habitat and suitability for the species: BMU1. Sekhukhune Mountain Bushveld - Suitability: Optimal BMU2. Sekhukhune Montane Grassland - Suitability: Good **Species-specific biodiversity actions**: Awareness campaigns are underway to reduce the number of poisoning incidents. Install bird-friendly structures to prevent electrocution.
Verreaux's Eagle *(Aquila verreauxii).* (SA Red Data: **Vulnerable**). Reference: (Taylor, 2015). 	Rocky habitats in hills and mountains with nest sites; vegetation types associated with mountainous regions - Alpine grasslands. Need dassies as food. BMU's with the appropriate habitat and suitability for the species: BMU2. Sekhukhune Montane Grassland - Suitability: Optimal BMU3. Steenkampsberg Montane Grassland - Suitability: Optimal **Species-specific biodiversity actions**: Locally persecuted where it coincides with livestock farms. Where hyraxes are hunted for food and skins, eagle populations have declined.
Martial Eagle *(Polemaetus bellicosus).* (SA Red Data: **Endangered**). Reference: (Taylor, 2015). 	Open grassland and scrub. Large trees for nests. Wide range of vegetation types: deserts, densely wooded and forested areas. BMU's with the appropriate habitat and suitability for the species: BMU1. Sekhukhune Mountain Bushveld - Suitability: Optimal BMU2. Sekhukhune Montane Grassland - Suitability: Medium BMU4. Northern Afrotemperate Forest - Suitability: Good **Species-specific biodiversity actions**: Install anti-electrocution devices on electricity pylons. Implement education and awareness campaigns across its range to reduce the use of poisoned baits.

Bird species	Habitat requirements, BMU's of concern & Species-specific management actions
African Crowned Eagle *(Stephanoaetus coronatus).* (SA Red Data: **Vulnerable**). Reference: (Taylor, 2015). 	Dense indigenous forest, including riverine gallery forest; may range far from forest to hunt. BMU's with the appropriate habitat and suitability for the species: BMU4. Northern Afrotemperate Forest - Suitability: Optimal **Species-specific biodiversity actions**: Increase the total area of suitable habitat that is protected. Conduct education activities to reduce direct persecution and hunting pressure on prey species. Upgrade electrical networks to raptor safe designs.
Red-footed Falcon *(Falco vespertinus).* (SA Red Data: **Near Threatened**). Reference: (Taylor, 2015). 	Open grassveld to semi-arid savannah; also cultivated lands. BMU's with the appropriate habitat and suitability for the species: BMU1. Sekhukhune Mountain Bushveld - Suitability: Good BMU2. Sekhukhune Montane Grassland - Suitability: Optimal BMU9. Secondary vegetation (historical cultivation) - Suitability: Medium **Species-specific biodiversity actions**: Deter the killing of this species, prevent hunting in problem areas, support awareness campaigns.
Lanner Falcon *(Falco biarmicus).* (SA Red Data: **Vulnerable**). Reference: (Taylor, 2015). 	Open habitats. Most frequent in open grassland, open or cleared woodland, and agricultural areas. Cliff-nester, also in old nests in trees or electricity pylons and buildings. BMU's with the appropriate habitat and suitability for the species: BMU1. Sekhukhune Mountain Bushveld - Suitability: Good BMU2. Sekhukhune Montane Grassland - Suitability: Optimal BMU9. Secondary vegetation (historical cultivation) - Suitability: Medium **Species-specific biodiversity actions**: The overall effects of pesticides are unknown, they have been shown to have negative impacts locally. Local declines in southern Africa have possibly been associated with seed dressings (antimicrobial or fungicidal treatment) which kills seed-eating birds and secondarily poisoned many raptors.

Bird species	Habitat requirements, BMU's of concern & Species-specific management actions
Grey-winged Francolin *(Scleroptila africanus).* (**Endemic**). Reference: (Birdlife International, 2021). 	Montane scrub and grassland (especially on tops of shelves and ridges), karoo, stunted fynbos. BMU's with the appropriate habitat and suitability for the species: BMU1. Sekhukhune Mountain Bushveld - Suitability: Medium BMU2. Sekhukhune Montane Grassland - Suitability: Good BMU3. Steenkampsberg Montane Grassland - Suitability: Optimal **Species-specific biodiversity actions**: The population is suspected to be stable in the absence of evidence for any declines or substantial threats.
Denham's Bustard *(Neotis denhami).* (SA Red Data: **Vulnerable**). Reference: (Taylor, 2015). 	Breeding: High rainfall sour grassveld, fairly high altitudes. Also cultivated pastures. Non-breeding: Lower-lying regions, grassland and woodland, savannah, karoo scrub BMU's with the appropriate habitat and suitability for the species: BMU2. Sekhukhune Montane Grassland - Suitability: Optimal BMU3. Steenkampsberg Montane Grassland - Suitability: Good **Species-specific biodiversity actions** Hunting is a cause of declines. Protect habitat and enforce hunting bans in reserves. Reduce power-line collisions.
White-bellied korhaan (*Eupodotis senegalensis*). (SA Red Data: **Vulnerable**). Reference: (Taylor, 2015). 	Open grassland and lightly wooded savannah; prefer taller grass. BMU's with the appropriate habitat and suitability for the species: BMU1. Sekhukhune Mountain Bushveld - Suitability: Optimal BMU2. Sekhukhune Montane Grassland - Suitability: Optimal **Species-specific biodiversity actions**: Decline owing to ongoing habitat destruction

Bird species	**Habitat requirements, BMU's of concern & Species-specific management actions**
Greater Painted snipe (*Rostratula benghalensis*). (SA Red Data: **Near Threatened**). Reference: (Taylor, 2015). 	Pans and marshy river flood plains. Exposed mud adjacent to cover. Marshes, muddy edges of swamps, lake edges, and riverbanks with thick vegetation cover. Favours waterside habitats with substantial cover and receding water levels with exposed mud among vegetation. BMU's with the appropriate habitat and suitability for the species: BMU5. Valley-bottom wetlands and seeps - Suitability: Good BMU11. Dams - Suitability: Medium **Species-specific biodiversity actions** Conserve wetlands.
Knysna Turaco *(Tauraco corythaix).* (**Endemic**). Reference: (Birdlife International, 2021). 	Evergreen and riverine forest, dense thickets. BMU's with the appropriate habitat and suitability for the species: BMU4. Northern Afrotemperate Forest - Suitability: Optimal **Species-specific biodiversity actions**: Decline due to habitat loss; conserve forest patches and riparian corridors.

Bird species	**Habitat requirements, BMU's of concern & Species-specific management actions**
African Grass-owl *(Tyto capensis).* (SA Red Data: **Vulnerable**). Reference: (Taylor, 2015). 	Rank grass and marshes are the preferred habitat. Usually in open habitat at fairly high altitudes. BMU's with the appropriate habitat and suitability for the species: BMU2. Sekhukhune Montane Grassland - Suitability: Good BMU3. Steenkampsberg Montane Grassland - Suitability: Good BMU5. Valley-bottom wetlands and seeps - Suitability: Optimal **Species-specific biodiversity actions**: Prevent ongoing habitat destruction.
Half-collared Kingfisher *(Alcedo semitorquata).* (SA Red Data: **Near Threatened**). Reference: (Taylor, 2015). 	Clear fast flowing perennial streams, rivers and estuaries; clear water and well-wooded banks; often near rapids; narrow and secluded with dense marginal vegetation. BMU's with the appropriate habitat and suitability for the species: BMU7. Mountain Streams - Suitability: Low **Species-specific biodiversity actions**: The species has declined locally owing to pollution, river siltation and habitat destruction.

Bird species	Habitat requirements, BMU's of concern & Species-specific management actions
European Roller (*Coracias garrulus*). (SA Red Data: **Near Threatened**). Reference: (Taylor, 2015). 	Woodlands, bushveld and grasslands. Open woodland. BMU's with the appropriate habitat and suitability for the species: BMU1. Sekhukhune Mountain Bushveld - Suitability: Optimal BMU2. Sekhukhune Montane Grassland - Suitability: Optimal **Species-specific biodiversity actions**: Conserve and manage existing habitat. Promote native tree planting to reduce deforestation and encourage agro-environmental schemes and biodiversity-friendly farming. Reduce illegal killing and trapping of birds.
Ground Woodpecker *(Geocolaptes olivaceus).* IUCN 2021 Status: **Near Threatened**. SA Red Data (Taylor, 2015): South Africa **endemic**. 	Steep boulder strewn slopes of buttes, or cave sandstone regions – Alpine grasslands. Avoid dense vegetation. Mountains, rocky hillsides, dongas. BMU's with the appropriate habitat and suitability for the species: BMU2. Sekhukhune Montane Grassland - Suitability: Optimal BMU3. Steenkampsberg Montane Grassland - Suitability: Good **Species-specific biodiversity actions**: Afforestation. This species has also been considered to be potentially under threat from climate change.
Melodious Lark *(Mirafra cheniana).* (**Endemic**). Reference: (Birdlife International, 2021). 	Open climax grassland, especially *Themeda triandra*. Rocky outcrops, termite mounds or sparse bushes; also cultivated fields. BMU's with the appropriate habitat and suitability for the species: BMU2. Sekhukhune Montane Grassland - Suitability: Optimal BMU3. Steenkampsberg Montane Grassland - Suitability: Good **Species-specific biodiversity actions**: Overgrazing of its favoured grassland habitat is a threat. Encourage grassland management that favours the species.

Bird species	**Habitat requirements, BMU's of concern & Species-specific management actions**
Rudd's Lark *(Heteromirafra ruddi).* (SA Red Data: **Endangered**). Reference: (Taylor, 2015). 	High-altitude and montane grassveld above about 1700m, usually on crowns and ridges without rocks and with dense grass cover up to 50cm tall. BMU's with the appropriate habitat and suitability for the species: BMU2. Sekhukhune Montane Grassland - Suitability: Optimal BMU3. Steenkampsberg Montane Grassland - Suitability: Optimal **Species-specific biodiversity actions**: Manage grassland appropriately.
Eastern Long-billed Lark *(Certhilauda semitorquata):* (**Endemic**). Reference: (Birdlife International, 2021). 	Upland grassland and mixed shrubland and grassland, usually on rocky ridges. BMU's with the appropriate habitat and suitability for the species: BMU2. Sekhukhune Montane Grassland - Suitability: Optimal BMU3. Steenkampsberg Montane Grassland - Suitability: Good **Species-specific biodiversity actions**: The population is suspected to be in decline owing to habitat conversion.
Cape Rock Thrush *(Monticola rupestris).* (**Endemic**). Reference: (Birdlife International, 2021). 	Rocky, mountainous habitats in relatively high-rainfall areas; gorges, incised river valleys, foothills & lowlands adjacent to mountains. BMU's with the appropriate habitat and suitability for the species: BMU2. Sekhukhune Montane Grassland - Suitability: Optimal BMU3. Steenkampsberg Montane Grassland - Suitability: Good **Species-specific biodiversity actions**: Declining or fluctuating range size.

Bird species	Habitat requirements, BMU's of concern & Species-specific management actions
Sentinel Rock Thrush *(Monticola explorator).* IUCN 2021 Status: **Near Threatened**. SA Red Data (Taylor, 2015): South Africa endemic. 	Rocky uplands in grassland biome. High rolling grasslands, rocky slopes, burnt areas, felled plantations. BMU's with the appropriate habitat and suitability for the species: BMU2. Sekhukhune Montane Grassland - Suitability: Optimal BMU3. Steenkampsberg Montane Grassland - Suitability: Good **Species-specific biodiversity actions**: Afforestation could potentially be a threat to the species.
Buff-streaked Chat *(Oenanthe bifasciata).* (**Endemic**). Reference: (Birdlife International, 2021). 	Sour grasslands – rocky habitat on mountains, hills, ridges and escarpments (1500-1700). Avoids woodlands, including aliens. BMU's with the appropriate habitat and suitability for the species: BMU2. Sekhukhune Montane Grassland - Suitability: Optimal BMU3. Steenkampsberg Montane Grassland - Suitability: Optimal **Species-specific biodiversity actions**: Declining or fluctuating range size, habitat extent/quality.
Chorister Robin-Chat *(Cossypha dichroa).* (**Endemic**). Reference: (Birdlife International, 2021). 	Evergreen forest, especially in mist belt. BMU's with the appropriate habitat and suitability for the species: BMU4. Northern Afrotemperate Forest - Suitability: Optimal **Species-specific biodiversity actions**: Ongoing habitat destruction and fragmentation.

Bird species	Habitat requirements, BMU's of concern & Species-specific management actions
Yellow-breasted Pipit *(Anthus chloris).* (SA Red Data: **Vulnerable**). Reference: (Taylor, 2015). 	Submontane undulating grasslands. Lush meadowlike conditions. Pasture and fallow lands. Flat to gently rolling lush montane grassland when breeding; lowland grassland to bushveld in winter. BMU's with the appropriate habitat and suitability for the species: BMU2. Sekhukhune Montane Grassland - Suitability: Optimal BMU3. Steenkampsberg Montane Grassland - Suitability: Good **Species-specific biodiversity actions**: Promote better grazing and burning practices. Start awareness campaigns and incentive programmes. Identify uses of grassland with fewer negative impacts than forestry.
Short-tailed Pipit *(Anthus brachyurus).* (SA Red Data: **Vulnerable**). Reference: (Taylor, 2015). SA Endemic. 	Grassy hillsides or flats. BMU's with the appropriate habitat and suitability for the species: BMU2. Sekhukhune Montane Grassland - Suitability: Optimal BMU3. Steenkampsberg Montane Grassland - Suitability: Good **Species-specific biodiversity actions**: Maintain suitable breeding habitat; grazing pressure and timing of burns.
Pied Starling *(Lamprotornis bicolor).* (**Endemic**). Reference: (Birdlife International, 2021). 	Open Karoo and grassland habitats. Open fields. Not found in wooded areas. Areas of broken ground. BMU's with the appropriate habitat and suitability for the species: BMU2. Sekhukhune Montane Grassland - Suitability: Optimal BMU3. Steenkampsberg Montane Grassland - Suitability: Good **Species-specific biodiversity actions**: None - Common to abundant.

Bird species	Habitat requirements, BMU's of concern & Species-specific management actions
Gurney's Sugarbird *(Promerops gurneyi).* IUCN 2021 Status: **Near Threatened**. SA Red Data (Taylor, 2015): South Africa **endemic**. 	Montane scrub with Protea and Aloe (mostly Mountain Sourveld); also gardens and Protea nurseries; may move into suburban gardens in winter. BMU's with the appropriate habitat and suitability for the species: BMU2. Sekhukhune Montane Grassland - Suitability: Optimal BMU3. Steenkampsberg Montane Grassland - Suitability: Good **Species-specific biodiversity actions**: Appropriate habitat management.
Greater Double-collared Sunbird *(Cinnyris afer).* (**Endemic**). Reference: (Birdlife International, 2021). 	Moist habitats with trees, montane and riverine scrub, *Protea* savannah. Mountainous or hilly country. Afromontane and Valley Bushveld. BMU's with the appropriate habitat and suitability for the species: BMU1. Sekhukhune Mountain Bushveld - Suitability: Optimal BMU2. Sekhukhune Montane Grassland - Suitability: Optimal BMU4. Northern Afrotemperate Forest - Suitability: Good BMU7. Mountain Streams - Suitability: Good **Species-specific biodiversity actions**: None - Common to abundant.

Mammals

The grassland biome sustains many endemic and red data mammal species. In the DBPNR, wetlands, pans, and a mosaic of short- and tall grassland are habitats that significantly contribute towards the ecological requirements of certain mammal species. The sour grasslands occur in the higher rainfall regions on acidic (leached) soils and are characterized by being shorter and denser in structure, having a high fibre content and a tendency to withdraw nutrients from the leaves to the roots during the winter, rendering the grazing largely unpalatable to stock during this time.

Of all the **mammal species** that have distribution ranges in the region, **129** coincide with the De Berg project area (Friedman & Daly, 2004). Under natural conditions the area has the potential to accommodate all these species. However, due to persecution by humans and habitat loss, the following larger game species are most likely lost to the DBPNR:

1. South central black rhinoceros (*Diceros bicornis minor*)
2. Southern white rhinoceros (*Ceratotherium simum simum*)

3. Black wildebeest (*Connochaetes gnou*)
4. Blue wildebeest (*Connochaetes taurinus*)
5. Red hartebeest (*Alcelaphus buselaphus caama*)
6. Sable antelope (*Hippotragus niger niger)*
7. Cape buffalo (*Syncerus caffer*)
8. Common eland (*Tragelaphus oryx*)
9. Common waterbuck (*Kobus ellipsiprymnus ellipsiprymnus*)

Some larger game species (including eland and zebra) are kept under controlled conditions on properties in the surrounding area. Evaluating distribution and available habitat, **120 of the medium- to small mammal species are expected to occur in the DBPNR area**.

During the 2021-2022 surveys, signs and/or sights (or reports by locals) of **23 mammal species** were recorded. Species in red font are listed SCC:

1. Forest shrew (*Myosorex varius*)
2. Little free-tailed bat *(Chaerephon pumilus)*
3. Egyptian free-tailed bat (*Tadarida aegyptiaca*)
4. Chacma baboon (*Papio ursinus*)
5. Vervet monkey (*Chlorocebus pygerythrus*)
6. Yellow mongoose *(Cynictis penicillata*)
7. Slender mongoose (*Herpestes sanguineus*)
8. Leopard (*Panthera pardus*)
9. Black-footed cat (*Felis nigripes*)
10. Rock hyrax (*Procavia capensis*)
11. Greater kudu (*Tragelaphus strepsiceros*)
12. Southern bushbuck (*Tragelaphus scriptus sylvaticus*)
13. Klipspringer (*Oreotragus oreotragus*)
14. Blesbok (*Damaliscus pygargus phillipsi*)
15. Grey rhebok (*Pelea capreolus*)
16. Reedbuck (*Redunca arundinum*)
17. Southern mountain reedbuck (*Redunca fulvorufula*)
18. Cape porcupine *(Hystrix africaeaustralis)*
19. Common molerat *(Cryptomys hottentotus)*
20. Bushveld Namaqua rockmouse *(Micaelamys namaquensis subsp. alborarius)*
21. House Mouse *(Mus musculus)*
22. Hewitt's red rock rabbit (*Pronolagus saundersiae*)
23. Eastern rock sengi/elephant shrew (*Elephantulus myurus*)

Species of Conservation Concern: Mammals

The category "Species of Conservation Concern" is considered to include all threatened taxa listed by South African Red Data lists, and all South African (including Lesotho and Eswatini) endemic taxa. South Africa has the highest number of endemic mammals and is regarded as the most important centre of endemism in the southern African sub-region. **Twenty-five species are listed as 'species of conservation concern' (SCC),** most of which are considered threatened. **Seven of the mammal SCC were encountered** or reported on during the DBPNR study. The following **nine endemic mammals** are listed for the DBPNR area [(Mammal Red List (Child, 2016)]:

1. Cohen's horseshoe bat *(Rhinolophus cohenae)*
2. Grey rhebok *(Pelea capreolus)*
3. Common molerat *(Cryptomys hottentotus)*
4. Hewitt's red rock rabbit *(Pronolagus saundersiae)*

5. Dark-footed forest shrew (*Myosorex cafer*)
6. Robust golden mole (*Amblysomus robustus*)
7. Laminate Vlei Rat *(Otomys laminatus)*
8. African marsh rat (*Dasymys incomtus*)
9. White-tailed mouse (*Mystromys albicaudatus*)

Since nine of the larger mammals no longer occur here, they are not listed or discussed further as SCC for DBPNR. The following 25 mammal species which are expected to occur in the area, and are considered threatened, are listed below (Mammal Red List, 2016; IUCN**, 2022**; NEM:BA, 2007):

1. Dark-footed forest shrew (*Myosorex cafer*) - IUCN 2020 Status: Least concern. Mammal Red List (Child, 2016): Vulnerable, Endemic. NEMBA TOPS (2007): None.
2. Swamp musk shrew (*Crocidura mariquensis*) - IUCN 2016 Status: Least concern. Mammal Red List (Child, 2016): Near Threatened. NEM:BA (TOPS 2007): None.
3. South African hedgehog (*Atelerix frontalis*) - IUCN 2016 Status: Least Concern. Mammal Red List (Child, 2016): Near Threatened. NEM:BA TOPS (2007): Protected species.
4. Robust golden mole (*Amblysomus robustus*) - IUCN 2015 Status: Vulnerable. Mammal Red List (Child, 2016): Vulnerable, Endemic. NEM:BA TOPS (2007): Endangered.
5. Percival's short-eared trident bat *(Cloeotis percivali)* - IUCN 2016 Status: Least concern. Mammal Red List, 2016: Endangered. NEM:BA TOPS (2007): None.
6. Striped leaf-nosed bat *(Macronycteris vittatus)* - IUCN 2020 Status: Near Threatened. Mammal Red List (Child, 2016): Least concern. NEM:BA TOPS (2007): None
7. Cohen's horseshoe bat *(Rhinolophus cohenae)* - IUCN 2017 Status: Vulnerable. Mammal Red List (Child, 2016): Vulnerable, Endemic. NEM:BA TOPS (2007): None.
8. Blasius horseshoe bat (*Rhinolophus blasii*) - IUCN 2016 Status: Least concern. Mammal Red List (Child, 2016): Near Threatened. NEM:BA TOPS (2007): None.
9. Brown hyaena (*Parahyaena brunnea*) - IUCN 2015 Status: Near Threatened; Mammal Red List (Child, 2016): Near Threatened; NEM:BA (TOPS 2007): Protected species.
10. Leopard (*Panthera pardus*) - IUCN 2016 Status: Vulnerable. Mammal Red List (Child, 2016): Vulnerable. NEM:BA (TOPS 2007): Vulnerable.
11. Black-footed cat (*Felis nigripes*) - IUCN 2016 Status: Vulnerable; Mammal Red List (Child, 2016): Vulnerable; NEM:BA (TOPS 2007): Protected species.
12. Serval (*Leptailurus serval*) - IUCN 2019 Status: Least concern. Mammal Red List (Child, 2016): Near Threatened; NEM:BA (TOPS 2015): Protected species.
13. Cape fox (*Vulpes chama)* - IUCN 2014 Status: Least Concern. Mammal Red List (Child, 2016): Least Concern. NEM:BA (TOPS 2007): Protected species.
14. Cape clawless otter (*Aonyx capensis*) - IUCN 2021 Status: Near Threatened; Mammal Red List (Child, 2016): Near Threatened; NEMBA (TOPS 2007): Protected species.
15. Spotted-necked otter (*Hydrictis maculicollis*) - IUCN 2021 Status: Near Threatened Mammal Red List (Child, 2016): Vulnerable; NEM:BA (TOPS 2007): Protected species.
16. African striped weasel (*Poecilogale albinucha*) - IUCN 2015 Status: Least concern. Mammal Red List (Child, 2016): Near Threatened. NEM:BA (TOPS 2007): None.
17. Honey badger (*Mellivora capensis*) - IUCN 2016 Status: Least Concern. Mammal Red List (Child, 2016): Least Concern; NEM:BA (TOPS) 2007: Protected species.
18. Oribi (*Ourebia ourebi*) - IUCN 2016 Status: Least Concern. Mammal Red List (Child, 2016): Endangered. TOPS NEMA: Endangered species.
19. Grey rhebok (*Pelea capreolus*) - IUCN 2017 Status: Least concern. Mammal Red List (Child, 2016): Near Threatened, Endemic. NEM:BA (TOPS 2007): None.
20. Southern reedbuck (*Redunca arundinum*) - IUCN 2016 Status: Least concern; Mammal Red List (Child, 2016): Least concern; NEM:BA (TOPS 2007): Protected species.

21. Southern mountain reedbuck (*Redunca fulvorufula fulvorufula*) - IUCN 2017 Status: Endangered. Mammal Red List (Child, 2016): Endangered. NEM:BA (TOPS 2007): None.
22. Temminck's ground Pangolin (*Smutsia temminckii*) - IUCN 2019 Status: Vulnerable. Mammal Red List (Child, 2016): Vulnerable. NEM:BA (TOPS 2015): Vulnerable species.
23. Laminate Vlei Rat *(Otomys laminatus)* - IUCN 2019 Status: Near Threatened. Mammal Red List (Child, 2016): Near Threatened, Endemic. NEM:BA TOPS (2007): None.
24. African marsh rat (*Dasymys incomtus*) - IUCN 2016 Status: Least concern. Mammal Red List (Child, 2016): Near Threatened, Endemic. NEM:BA TOPS (2007): None.
25. White-tailed mouse (*Mystromys albicaudatus*) - IUCN 2019 Status: Vulnerable; Mammal Red List (Child, 2016): Vulnerable, Endemic. NEM:BA (TOPS 2007): None.

Refer to Table 11 for detail regarding the primary habitat requirements of the mammal SCC, BMU's of importance to the species and recommended species-specific biodiversity management actions.

Table 11: **Habitat availability for mammal 'species of conservation concern' in the study area, indicating habitat requirements, BMU's with appropriate habitat and recommended species-specific biodiversity management actions.**

Mammal species	**Habitat requirements, BMU's of concern & Species-specific management actions.**
Dark-footed forest shrew (*Myosorex cafer*) (SA Red Data: **Vulnerable**). Reference: (Child, 2016). 	Montane grasslands; wet sponges in mist belt. Dense scrub and grass in damp areas fringing mountain streams. Moist densely vegetated habitat, mountainous country. BMU's with the appropriate habitat and suitability for the species. BMU5. Valley-bottom wetlands and seeps - Suitability: Optimal BMU7. Mountain Streams - Suitability: Optimal **Species-specific biodiversity actions**: The main intervention for this species is the protection and restoration of wetlands and grasslands within and around forest patches. Small mammal diversity and abundance is also higher in more complex or heterogeneous landscapes, where periodic burning is an important tool to achieve this. Removing alien vegetation from watersheds, watercourses and wetlands is also an important intervention to improve flow and water quality, and thus habitat quality, for shrews.
Swamp musk shrew (*Crocidura mariquensis.* (SA Red Data: **Near Threatened**). Reference: (Child, 2016). 	Moist habitats, thick grass along riverbanks, in reedbeds and in swamp. Tangled masses of semi-aquatic grasses along fringes of water. BMU's with the appropriate habitat and suitability for the species. BMU5. Valley-bottom wetlands and seeps - Suitability: Optimal BMU7. Mountain Streams - Suitability: Optimal **Species-specific biodiversity actions**: The main intervention for this species is thus the protection and restoration of rank vegetation around wetlands. Retaining ground cover is the most important management tool to increase small mammal diversity and abundance. This can be achieved through lowering grazing pressure, or by maintaining buffer strips of natural vegetation around wetlands. Small mammal diversity and abundance is also higher in more complex or heterogeneous landscapes, where periodic burning is an important tool to achieve this. Removing alien vegetation from watersheds, watercourses and wetlands is also an important intervention to improve flow and water quality, and thus habitat quality, for shrews.

South African hedgehog (*Atelerix frontalis*). (SA Red Data: **Near Threatened**). Reference: (Child, 2016). 	Temperate: Vegetable debris in shady places; dry cover. Dry habitats with ground cover for nesting. BMU's with the appropriate habitat and suitability for the species. BMU1. Sekhukhune Mountain Bushveld - Suitability: Optimal BMU2. Sekhukhune Montane Grassland - Suitability: Optimal **Species-specific biodiversity actions**: The species is also illegally harvested for the muti market and bush meat trade. Hedgehogs appear to prefer dense vegetation habitats, which would provide suitable nesting sites and food availability. These habitats should be restored and protected by land managers and conservation managers
Robust golden mole (*Amblysomus robustus*). (SA Red Data: Vulnerable). Reference: (Child, 2016). 	Montane grasslands and marshes in Moist Sandy Highveld Grassland in Eastern Mpumalanga, South Africa. Prefers friable soils, from sands to quite heavy clays. Avoid shallow substrates along rocky ridges (which may act as dispersal barriers) and waterlogged areas. They also survive well in disturbed agricultural land and gardens if soil is not too rocky. BMU's with the appropriate habitat and suitability for the species. BMU2. Sekhukhune Montane Grassland - Suitability: Optimal BMU3. Steenkampsberg Montane Grassland - Suitability: Good BMU5. Valley-bottom wetlands and seeps - Suitability: Good **Species-specific biodiversity actions** This species would benefit from protected area expansion and land management practices that reduce overgrazing and degradation. Incentivise landowners to de-stock to reduce overgrazing impacts and to stop cattle grazing in vleiland refugia during winter
Percival's short-eared trident bat *(Cloeotis percivali).* (SA Red Data: **Endangered**) Reference: (Child, 2016). 	Habitat preference: Savanna woodland. Rest in caves. Sufficient cover in the form of caves and mine tunnels for day roosting. Roost in narrow crevices. A clutter forage (in vegetation). BMU1. Sekhukhune Mountain Bushveld - Suitability: Good BMU2. Sekhukhune Montane Grassland - Suitability: Medium **Species-specific biodiversity actions:** Limit disturbance to roost sites. These bats are highly sensitive to roost disturbance and regular roost disturbance may lead to abandonment or dissuade breeding.
Striped leaf-nosed bat *(Hipposideros vittatus).* (IUCN, 2008: **Near Threatened**). Reference: (Child, 2016). 	Dependent on large caves for breeding. Variety of woodland and savanna habitats - arid to moist. BMU's with the appropriate habitat and suitability for the species. BMU1. Sekhukhune Mountain Bushveld - Suitability: Good **Species-specific biodiversity actions**: This species is sensitive to disturbance of its cavernicolous roosts (especially by guano mining). It is also a popular target of bushmeat hunters within its distribution.

Cohen's horseshoe bat *(Rhinolophus cohenae).* (SA Red Data: **Vulnerable**). Reference: (Child, 2016). 	Savanna close to grassland at 690 - 900 m. Mpumalanga escarpment from Mariepskop to Machadodorp, its distribution falls within an elevational range of 457 to 1698 m.a.s.l. BMU's with the appropriate habitat and suitability for the species. BMU2. Sekhukhune Montane Grassland - Suitability: Good BMU3. Steenkampsberg Montane Grassland - Suitability: Medium **Species-specific biodiversity actions**: Expand national protected area network through provincial stewardship programmes. Landowners should implement best landuse management practices to maintain sustainability and limit disturbance at roosting sites.
Blasius horseshoe bat (*Rhinolophus blasii*). (SA Red Data: **Near Threatened**). Reference: (Child, 2016). 	Woodland; savanna: It roosts in caves and subterranean habitats (mine adits) in small groups. BMU's with the appropriate habitat and suitability for the species. BMU1. Sekhukhune Mountain Bushveld - Suitability: Good BMU2. Sekhukhune Montane Grassland - Suitability: Low **Species-specific biodiversity actions**: Protection of caves and monitoring of subpopulations is required. Minimise disturbance to caves when visiting.
Brown hyaena *(Parahyaena brunnea*). (SA Red Data: **Near Threatened**). Reference: (Child, 2016). 	Semi-desert, open scrub and open woodland savanna. Nocturnal, holes in ground. BMU's with the appropriate habitat and suitability for the species. BMU1. Sekhukhune Mountain Bushveld - Suitability: Optimal BMU2. Sekhukhune Montane Grassland - Suitability: Good **Species-specific biodiversity actions**: Landowners should conduct regular snare sweeps and improve anti-poaching measures on their properties.

Leopard (*Panthera pardus*). (IUCN: **Vulnerable**). Reference: (Child, 2016). 	Widespread. Broken country or forests. Nocturnal & solitary. BMU's with the appropriate habitat and suitability for the species. BMU1. Sekhukhune Mountain Bushveld - Suitability: Good BMU2. Sekhukhune Montane Grassland - Suitability: Medium **Species-specific biodiversity actions**: Landowners should conduct regular snare sweeps and improve anti-poaching measures on their properties
Serval *(Leptailurus serval*). (IUCN: **Vulnerable**). Reference: (Child, 2016). 	Proximity to water essential requirement, coupled with availability of adequate cover; tall grass, underbrush or reed beds - during day. Wet grassland, vleis and reed beds. BMU's with the appropriate habitat and suitability for the species. BMU5. Valley-bottom wetlands and seeps - Suitability: Optimal BMU7. Mountain Streams - Suitability: Good **Species-specific biodiversity actions**: Effective conservation of serval populations demands sufficient viable native habitat, particularly wetlands in fragmented landscapes. Conserve small remnant habitat patches such as shrubby areas and scattered semi-natural grasslands to sustain murid diversity. Conservation managers should thus enhance heterogeneity by protecting diverse habitats including wetlands and other indigenous habitats. Habitat management to conserve prime habitat. Managers and landowners must avoid draining wetlands and ensure good veld condition as servals forage away from wetlands too in woodlands with good grass cover
Cape fox (*Vulpes chama).* (NEM:BA TOPS 2007: **Protected**). Reference: (Child, 2016). 	Widespread. Open country, open grassland. Nocturnal & solitary. Holes in ground, in cover, underbrush. BMU's with the appropriate habitat and suitability for the species. BMU1. Sekhukhune Mountain Bushveld - Suitability: Good BMU2. Sekhukhune Montane Grassland - Suitability: Optimal **Species-specific biodiversity actions**: Cape Foxes are hunted and poisoned, directly and as bycatch, throughout most of their range in South Africa. Persecution (hunting, trapping, and poisoning), either directly or as bycatch. The impacts and extent of persecution, both direct and as bycatch from snares, and use in traditional medicine. Education and awareness campaigns.

Cape clawless otter (*Aonyx capensis*). (IUCN: **Near Threatened**). Reference: (Child, 2016). 	Predominantly aquatic; freshwater an essential requirement: Rivers, lakes, swamps and dams. Widespread. Tributaries of rivers into small streams - habitat with food. BMU's with the appropriate habitat and suitability for the species. BMU5. Valley-bottom wetlands and seeps - Suitability: Low BMU11. Dams - Suitability: Good **Species-specific biodiversity actions**: The main interventions revolve around riparian protection. Reduce development along rivers, implement veld management, improve agricultural practices and river care. Prevent the removal of necessary vegetation types. Otters will still frequent areas with moderate vegetation removal but only if human activity is not present as there is not enough cover to remain concealed from human detection. Landowners should be encouraged to reduce stocking rates and take down fences, as, due to the large home range of the species, it can cover large distances when searching for freshwater and fences will only fragment their habitat.
Spotted-necked otter (*Hydrictis maculicollis*). (SA Red Data: **Near Threatened**). Reference: (Child, 2016). 	Aquatic, confined to larger rivers, lakes, swamps and dams with extensive areas of open water. Stay close to water edge. Lie up in holes of river banks, in rock crevices or in dense reed. BMU's with the appropriate habitat and suitability for the species. BMU5. Valley-bottom wetlands and seeps - Suitability: Low BMU11. Dams - Suitability: Medium **Species-specific biodiversity actions**: The main interventions revolve around riparian protection and enforcement of existing legislation, and indirectly by the controls on the number of fishermen permitted on reserves. Monitoring and mitigation of pollution (chemical and physical) of rivers needs to be implemented or increased. Similarly, persecution should also be reduced through education and awareness campaigns, especially with the angling and trout farming industries. For all rivers, good land-use practices, such as keeping natural vegetation intact along river banks, can make a vital difference to their ecological integrity. Thus, rivers should be carefully managed to increase flow and reduce turbidity, and development on banks should be restricted.
African striped weasel (*Poecilogale albinucha*). (SA Red Data: **Near Threatened**). Reference: (Child, 2016). 	Savannah: Moist grassland. Litters born in burrows. BMU's with the appropriate habitat and suitability for the species. BMU1. Sekhukhune Mountain Bushveld - Suitability: Optimal BMU2. Sekhukhune Montane Grassland - Suitability: Good BMU5. Valley-bottom wetlands and seeps - Suitability: Optimal BMU7. Mountain Streams - Suitability: Medium **Species-specific biodiversity actions**: Conserve grassland habitats through protected area expansion and conservancy formation or stewardship schemes. Reducing agricultural intensification to conserve grassland habitats. By reducing overgrazing in communal lands, ground cover will be retained and therefore sustain natural prey diversity.

Honey badger (*Mellivora capensis*). (NEMBA TOPS 2007: **Protected**). Reference: (Child, 2016). 	Widespread. Use crevices in rocky areas, will also dig refuges. Rocky koppies, scrub sandveld, open grassland, open woodland, riverine woodland and floodplain grassland. BMU's with the appropriate habitat and suitability for the species. BMU1. Sekhukhune Mountain Bushveld - Suitability: Optimal BMU2. Sekhukhune Montane Grassland - Suitability: Good BMU5. Valley-bottom wetlands and seeps - Suitability: Good BMU7. Mountain Streams - Suitability: Medium BMU9. Secondary vegetation (historical cultivation) - Suitability: Medium BMU10. Alien trees - Suitability: Medium **Species-specific biodiversity actions**: Honey Badgers are persecuted by apiculturists for the damage caused to commercial honey production. Continue to encourage beehive protection methods.
Oribi (*Ourebia ourebi*). (SA Red Data: **Endangered**). Reference: (Child, 2016). 	Open habitat. Open grassland, flood plain; sparse scattering of trees and bushes. BMU's with the appropriate habitat and suitability for the species. BMU2. Sekhukhune Montane Grassland - Suitability: Optimal BMU3. Steenkampsberg Montane Grassland - Suitability: Good **Species-specific biodiversity actions**: Combat the ongoing illegal hunting and emerging threat of organised dog hunting as a gambling practice. Habitat management - revision of burning regimes in some areas (for example, fire breaks and use of mosaic burning), summer mowing of grass, use of cattle to generate heterogeneity of grass height, monitoring. Public awareness - intensive public education programmes. The formal proclamation of key habitats through the biodiversity stewardship schemes should continue.
Reedbuck (*Redunca arundinum*). (NEM:BA TOPS 2007: **Protected**). Reference: (Child, 2016). 	Open water with cover; stands of tall grass or reed beds. BMU's with the appropriate habitat and suitability for the species. BMU1. Sekhukhune Mountain Bushveld - Suitability: Medium BMU2. Sekhukhune Montane Grassland - Suitability: Medium BMU7. Mountain Streams - Suitability: Good **Species-specific biodiversity actions**: Management should be encouraged to protect the habitats on which this species relies and to help mitigate the threat of poaching through cooperative security measures. Biodiversity stewardship for this species should also be promoted. Create conservancies to protect vital wetland and tall grassland habitats. Fire management is possibly a key tool in ensuring persistence of Southern Reedbuck in the landscape, where fires should be patchy enough to conserve areas of tall grass or reed beds but extensive enough to prevent bush encroachment. Regulate translocation to avoid hybridisation between ecotypes and to regulate offtake.

Grey rhebok (*Pelea capreolus*). (SA Red Data: **Vulnerable**). Reference: (Child, 2016). 	Associated with rocky hills, grassy mountain slopes, and plateau grasslands in the eastern extent of their distribution. BMU's with the appropriate habitat and suitability for the species. BMU2. Sekhukhune Montane Grassland - Suitability: Optimal BMU3. Steenkampsberg Montane Grassland - Suitability: Good **Species-specific biodiversity actions**: The most important immediate intervention is to combat illegal dog hunting through enforcement in affected areas and education/awareness campaigns in local communities to encourage alternative forms of recreations
Southern mountain reedbuck (*Redunca fulvorufula fulvorufula*). (SA Red Data: **Vulnerable**). Reference: (Child, 2016). 	Live on grass-covered ridges and hillsides in broken rocky country and high-altitude grasslands often with some tree or bush cover. BMU's with the appropriate habitat and suitability for the species. BMU1. Sekhukhune Mountain Bushveld - Suitability: Good BMU2. Sekhukhune Montane Grassland - Suitability: Optimal BMU3. Steenkampsberg Montane Grassland - Suitability: Optimal **Species-specific biodiversity actions**: Private landowners should also be encouraged to continue to form conservancies to reduce the edge effects of small areas of natural habitat, such that vulnerability to poaching is lessened. Patrols of private land for the purposes of apprehending would-be hunter trespassers, and snare removals must be regularly performed
Temminck's ground Pangolin (*Smutsia temminckii*). (SA Red Data: **Vulnerable**). Reference: (Child, 2016). 	Wide habitat tolerance, absent from forests. Day – piles of leaves or other vegetable debris, holes in the ground. BMU's with the appropriate habitat and suitability for the species. BMU1. Sekhukhune Mountain Bushveld - Suitability: Good BMU2. Sekhukhune Montane Grassland - Suitability: Good **Species-specific biodiversity actions**: Fence electrocutions - fitted with a three-strand tripwire; reduce the need for internal electric fences. Reintroduction of rehabilitated or rescued pangolins. Monitor the distribution of this species through ongoing field research and citizen-science-based monitoring protocols.

Laminate Vlei Rat *(Otomys laminatus).* (SA Red Data: **Near Threatened**). Reference: (Child, 2016). 	Tied to moist habitats - grasslands in submontane and coastal areas. BMU's with the appropriate habitat and suitability for the species. BMU5. Valley-bottom wetlands and seeps - Suitability: Optimal BMU7. Mountain Streams - Suitability: Optimal **Species-specific biodiversity actions**: Wetland conservation and restoration of ranch lands: land managers should maintain a vegetation buffer to reduce impacts of land-use practices; de-stocking, rotational grazing and buffering wetland vegetation; prioritising previously cultivated "old lands" for development.
African marsh rat (*Dasymys incomtus/ robertsii*). (SA Red Data: **Near Threatened**). Reference: (Child, 2016). 	Wet habitat: Streams, rivers, reed beds, swamps and is partially aquatic. Long grass close to water, semi-aquatic grasses, in swampy areas along rivers and streams, or in grassy or bracken covered areas close to water. Ground bordering the swampy edge of the river. BMU's with the appropriate habitat and suitability for the species. BMU5. Valley-bottom wetlands and seeps - Suitability: Good BMU7. Mountain Streams - Suitability: Optimal **Species-specific biodiversity actions**: Conserve and create wetland clusters and corridors. Biodiversity stewardship schemes should be promoted if landowners possess wetlands close to core protected areas or remaining habitat patches. Conserve or restore riparian vegetation around wetlands. Retaining ground cover and rank vegetation is the most important management tool to increase small mammal diversity and abundance around wetlands. Lowering grazing pressure; maintain a buffer strip of natural vegetation around wetlands; periodic burning - Small mammal diversity and abundance is also higher in more complex or heterogeneous landscapes; Removing alien vegetation from watersheds; stock livestock or wildlife at ecological carrying capacity.
White-tailed mouse (*Mystromys albicaudatus*). (SA Red Data: **Vulnerable**). Reference: (Child, 2016). 	Highveld and montane grassland. Nocturnal – lives in burrows or cracks in the ground. Sandy soil with good cover. BMU's with the appropriate habitat and suitability for the species. BMU2. Sekhukhune Montane Grassland - Suitability: Medium BMU3. Steenkampsberg Montane Grassland - Suitability: Medium **Species-specific biodiversity actions** Conservation of grasslands through protected area expansion and biodiversity stewardship schemes is suspected to be the most important intervention for this species. Grassland condition must also be conserved through correct grazing and fire management. Landscapes that burn occasionally are suspected to have greater conservation value. Thus, mosaic burning, within the natural fire frequency.
Common molerat *(Cryptomys hottentotus).* (SA Red Data: **Endemic**). Reference: (Child, 2016).	Habitat preference: Generally, the subterranean Cryptomys spp. occur across a wide range of soil types from fine to medium grained clays and loams. They are often located within humanmodified environments, such as lawns, golf courses and gardens. BMU1. Sekhukhune Mountain Bushveld - Suitability: Good BMU2. Sekhukhune Montane Grassland - Suitability: Optimal BMU3. Steenkampsberg Montane Grassland - Suitability: Good BMU9. Secondary vegetation - Suitability: Optimal **Species-specific biodiversity actions:** No major threats have been identified for these species. However, they are occasionally persecuted as an agricultural pest.

	
Hewitt's red rock rabbit *(Pronolagus saundersiae).* (SA Red Data: **Endemic**). Reference: (Child, 2016) 	Habitat preference: All species of *Pronolagus* seem to have similar habitat requirements in that they are confined to rocky areas that provide shelter and occur in krantzes, rocky hillsides, boulder-strewn koppies, rocky ravines and amongst rocks in dry river beds. Such areas must provide palatable grasses (they are grazers) and some cover of scrub bushes. BMU1. Sekhukhune Mountain Bushveld - Suitability: Optimal BMU2. Sekhukhune Montane Grassland - Suitability: Optimal BMU3. Steenkampsberg Montane Grassland - Suitability: Good **Species-specific biodiversity actions:** The main threat to rock hares is hunting, both for bushmeat and for sport. Sport hunting with dogs may also be impacting these species. Additionally, agricultural and rural settlement expansion may be increasing incidental predation on rock hares by domestic dogs.

8.3 AQUATIC FAUNA (fish, aquatic macroinvertebrates, and diatoms)

The study area falls within the Olifants (B) Water Management Area (WMA) and specifically quaternary catchments B41G (Groot Dwars River and Everest tributary), B41C (Klip River), and B42F (Potspruit). The current study concluded that the DBPNR study area contains areas of **high to very high aquatic biodiversity conservation importance**. The present ecological status of most of the aquatic ecosystems falling within the DBPNR study area is **largely natural to slightly modified (ecological category A to B)** with **high to very high ecological importance and sensitivity**. The Groot Dwars River reaches within the study area is furthermore classified as a **National Freshwater Ecosystem Priority Areas** (NFEPAs) which elevates their conservation importance. The Groot Dwars River (sub-quaternary reach B41G-00721) is considered by the Mpumalanga Biodiversity Conservation Plan (MBSP 2014) to be a **"Critical Biodiversity Areas"** (FEPA River), while the various tributaries draining these sub-catchments (Everest Tributary, etc.) are classified as "Ecological Support Areas: Important sub-catchments" (FEPA sub-catchments) (Lötter *et al*., 2014). The National Environmental Screening Tool indicated that the **aquatic biodiversity sensitivity** of the majority of the DBPNR study area was ***Very High***. The two most important aquatic biodiversity management units of concern within the DBPNR study area are BMU5: Valley-bottom wetlands and seeps and BMU7: Mountain Streams, while limited artificially created systems (BMU11: Dams) are also present. Biodiversity management recommendations pertaining to the aquatic ecosystems of the study area is provided in **Table 15** while SCC-specific recommendations are provided in the fish section.

According to Hermoso *et al. (*2016), declaring protected areas (PAs) (such as the proposed De Berg Private Nature Reserve) stands out as one of the main conservation strategies worldwide, and there are clear commitments to expand their extent under the auspices of the Convention on Biological Diversity. This conservation strategy has also received increasing attention in a freshwater context in the last two decades. Despite increasing conservation efforts, the effectiveness of PAs for freshwater purposes is questioned and freshwater biodiversity continues to decline. There are many reasons for this poor effectiveness: a lack of consideration of freshwater needs when designing and declaring protected areas, fewer resources devoted to freshwater conservation management than to other actions, and poor understanding of complex management problems beyond the limits of the protected area. Hermoso *et al.* (2016) advocate better monitoring programmes to assess the effectiveness of PAs for freshwater biodiversity, in which the unique characteristics of freshwater systems, such as the important role of connectivity and the close links with the rest of the landscape they drain, are considered. There are new conservation opportunities to enhance the value of PAs for freshwater biodiversity under the new conservation paradigm of 'people and nature'. The imperative of finding solutions that generate co-benefits alongside biodiversity conservation and the clear reliance of human communities on freshwater services have created an environment that may be more favourable to PAs focused in whole or part on fresh waters. The DBPNR as a proposed future protected area can therefore play an integral part in freshwater biodiversity conservation on a local, provincial, and national scale.

Fish

No previous fish information was available for the DBPNR study area and hence the current status and distribution of fish within this area is based on the surveys conducted on selected sites by Clean Stream Biological Services between 2020 and 2022 (CSBS, 2020, 2021, and 2022). These surveys confirmed the absence of fish from all rivers and streams (Groot Dwars River, Everest tributary, and Klip River tributary) within the original DBPNR study area (farms De Berg, Triangle, and Sterkfontein). The absence of indigenous fish from these upper catchment streams inside DBPNR is thought to be a natural phenomenon as a result of the abundance of natural migration barriers (waterfalls, cascades, large boulders) that occurs

within the mountain stream (BMU7) zone. It was promising that no alien fish species were present in the two dams on the farm De Berg (previously thought to potentially contain alien Rainbow trout).

Limited fish sampling and visual observations performed at selected sites of the new section (farm Goedehoop) during the end of March 2022 confirmed the presence of one indigenous fish species, namely *Enteromius cf. anoplus/motebensis* within the Potspruit river system on this farm (Plate 6). The presence of the alien Rainbow trout (*Oncorhynchus mykiss*) was also confirmed (visual observation) in the larger dam on the property. The small barb (Plate 6) sampled in the Potspruit on the farm Goedehoop closely resembles *E. motebensis* (the Marico barb) and *E. anoplus* (Chubbyhead barb). The identification of this species remains uncertain and can only be confirmed by further detailed (including genetic) analyses. If this species is not *E. motebensis* or *E. anoplus*, it is likely to be a unique genetic linage of the complex Chubbyhead Barb group of species currently under review in South Africa. It must further also be mentioned that many records currently ascribed to *E. motebensis* and *E. anoplus* in the eastern Lowveld of Mpumalanga may be synonymous with a potential new species *Enteromius sp.nov. "Ohrigstad"* proposed by Engelbrecht and Van Der Bank (1996). A recent study of *E. motebensis* within the Groot Marico catchment found unique haplotypes in two tributaries that required conservation (van der Walt *et al*., 2017). Previous genetic (unpublished) studies of the *Enteromius* species within the Northam Booysendal study area (Groot Dwars River: BMU8) downstream of DBPNR suggest that this population is genetically unique, as a result of its isolated distribution, and still needs to be described (Dr. Francois Roux, MTPA, *pers. comm.).* The taxonomy of the *Enteromius* species in the Goedehoop (and greater Northam Booysendal) area remains uncertain and should be confirmed by further studies (that includes genetic analyses).

Until the identification of this species has been clarified, it will be referred to as *Enteromius cf. anoplus/motebensis* and considered to potentially be a fish 'species of conservation concern'. *Enteromius motebensis* is listed by the International Union for Conservation of Nature (IUCN) as near-Threatened (NT) [B1b(ii,iii,iv)+2b(ii,iii,iv)](Table 12) while *E. anoplus* is currently listed as Least concern (LC) (IUCN, 2021). Previously, all records from the Eastern Lowveld catchments were recognised as *E. anoplus* for the purpose of the IUCN Red List Assessment, accepting that a taxonomic revision of this group is required (Woodford, 2017). The IUCN assessment only considered records from the western Limpopo River Catchment as *E. motebensis* being listed as Near-Threatened. *Enteromius motebensis* typically occurs in headwater streams where it prefers slow-flowing pools. Headwater stream fish communities are increasingly becoming isolated in headwater refugia as a result of direct and indirect threats further downstream (e.g. predatory fish species such as alien bass and rainbow trout, pollution, flow changes due to abstraction, and habitat degradation). This range restriction and isolation gives rise to a high degree of genetic variation and endemism, thus making them vulnerable to extinction. Globally and locally, headwater ecosystems are under increasing threat from human disturbance.

Plate 6: *Enteromius cf. anoplus/motebensis* sampled in Potspruit (Goedehoop, 2022-03).

Table 12: Conservation status of fish species of concern.

SCIENTIFIC NAME	IUCN Red list status[1]	TOPS[2]	Notes
Enteromius cf. motebensis *(Enteromius cf. anoplus)*	NearThreatened B1b(ii,iii,iv)+2b(ii,iii,iv)	Not listed	Endemic SA. Complex of genetic unique species & populations *E. motebensis* (North West/Croc East system).

1 – IUCN (2016-3: Version 3.1): LC-Least concern, 2- NEM:BA (10 of 2004): TOPS (RSA Threatened or protected species).

Alien fish species

The presence of one alien invasive fish species (Government Gazette No. 40166: 29 July 2016), namely the Rainbow trout (*Oncorhynchus mykiss*) (Plate 7) was confirmed (visual observation) within the Potspruit system on the farm Goedehoop (newly added section of DBPNR). This aggressive alien predator threatens biodiversity through predation on indigenous fish and invertebrate populations. Ideally it should be aimed to remove or control any alien fish species occurring within nature reserves or areas of high biodiversity conservation importance. It was however promising to note that the only indigenous fish species sampled in the Goedehoop section of the study area (*E. cf. anoplus/motebensis*) was abundant both upstream and downstream of the dam that housed the trout, and the indigenous fish was also present along the edges of the dam where the trout occurred. It therefore seems that the trout is not currently an immediate threat to the occurrence of this indigenous fish in the upper Potspruit system. Should the land owners decide to maintain the Rainbow Trout population within this dam, the status of the indigenous fish should be closely monitored.

Plate 7: Rainbow trout (*Oncorhynchus mykiss*)

Aquatic macroinvertebrates

Aquatic macroinvertebrate diversity of the study area was primarily assessed on family level through the application of the South African Scoring System (version 5) (SASS5) protocol. A once-off survey was also performed by Dr. R. Palmer to collect primary data on aquatic macroinvertebrate species at selected sites (NEPID, 2022).

Species of Conservation Concern

Distribution maps provided by the IUCN Redlist (https://www.iucnredlist.org/) indicate the potential presence of **one species of aquatic macroinvertebrate of conservation concern** that could be expected within the DBPNR study area, namely, *Pseudagrion newtoni* (VU: Vulnerable). *Pseudagrion newtoni (*common name: Harlequin sprite) is a species of **damselfly** in the family Coenagrionidae. The presence of this species was not confirmed during the surveys conducted for this BMP, but there is a high probability that this species may be present within the DBPNR. The field survey for this report found no threatened aquatic macroinvertebrate species in the Study Area. However, the following rare, endemic or range-restricted aquatic invertebrate taxa were recorded:

- *Mesostoma sp.* (Typhloplanidae)
- *Afronemoura stuckenbergi* (Notonemouridae)
- *Demoreptus cf. monticola* (Baetidae)
- *Elporia marieps* (Blepariceridae)
- *Simulium debegene* (Simuliidae)

Invertebrate species composition

The most diverse aquatic macroinvertebrate group were true flies (21 taxa), beetles (nine taxa), and bugs (six taxa). The diversity of mayflies was low (five taxa) and included the most hardy and widespread of all mayflies in southern Africa, *Baetis harrisoni.* One species of crab was recorded, namely the Natal river crab *Potamonautes sidneyi*. This species is the most widespread of all crabs in Southern Africa (Hart *et al.*, 2001). Aquatic snails were absent, although they are expected to be presented in the lower-lying portions of the study area. Functional feeding in all zones was dominated by shredders, except downstream of De Berg Dam 1, where there was a high abundance of filterers. The change in functional feeding downstream of the dam is attributed to the release of plankton from the dam.

Invertebrate families (SASS5)

A total of forty-seven (47) macroinvertebrate families were sampled in the valley- bottom wetlands and seeps (BMU5) and mountain streams (BMU7) within the DBPNR study area between 2020 and 2022 (Table 13). This reflects a relatively high diversity of aquatic macroinvertebrate families and is a reflection of highly diverse aquatic habitats as well as areas with very good water quality. Limited sampling (one site) within BMU5 (wetlands and seeps) indicated the presence of 18 macroinvertebrate taxa, while 47 taxa was sampled within BMU7 (Mountain streams) (Table 13).

Five taxa/groups with a high requirement for unmodified water quality were sampled in the study area, namely Blepharoceridae (Net-winged midges) (Plate 8), Notonemouridae (Stoneflies) (Plate 9), Perlidae (Stoneflies) (Plate 10), >2spp. Baetidae (Small minnow flies) and Pyralidae (Aquatic caterpillars) (Table 13). A further 11 taxa with a moderate requirement for unmodified water quality, such as Psephenidae: Water pennies (Plate 11), was also sampled in the study area (Table 13). The presence of these intolerant taxa at specific sites indicates excellent water quality prevailing at present in most reaches of the DBPNR study area. Special mention must be made of the presence of Blepharoceridae (Net-winged midges) (Plate 8) sampled at various sites in the upper reaches of the Groot Dwars River and Everest tributary (BMU7: Mountain stream). This taxon attains the highest possible SASS5 sensitivity score/intolerance rating of 15, indicating that it is only found in the most pristine sites with unmodified water and habitat quality (SASS5 taxa are rated from 1 for the most tolerant taxa to 15 for the most intolerant taxa). The presence is a certain indication that the upper Groot Dwars River catchment (including upper Everest tributary) falling mostly within the DBPNR is currently maintaining very good water quality and plays an important role in sustaining this river in a good ecological condition. It is therefore strongly recommended that these areas should be conserved, and no activities should be allowed that may jeopardise the water quality and overall ecological integrity of these source streams.

The macroinvertebrate taxa sampled in the study area vary in their requirement for flow/velocities as well as cover features (Table 13). It is therefore essential to maintain a diversity of habitats, together with good water quality, in an attempt to conserve the aquatic macroinvertebrate diversity of the DBPNR. Most of the taxa with a high and moderate requirement for unmodified water quality generally prefers fast flowing water (>0.3 m/s) with cobble as substrate, a general feature of the mountain streams (BMU7) (Table 13). It therefore furthermore emphasises the importance of maintaining good flow (high velocities) (no damming, limit abstraction and evaporation), good water quality (prevent pollution), and clear stone habitat (prevent erosion, sedimentation) in an attempt to conserve these intolerant taxa and overall diversity of the study area.

Plate 8: Blepharoceridae (Net-winged midges) (Dr. R. Palmer)

Plate 9: Notonemouridae (Stoneflies) (Dr. R. Palmer)

Plate 10: Perlidae (Stoneflies)

Plate 11: Psephenidae (Water penny beetles)

Table 13: Aquatic macroinvertebrate taxa (families) sampled in the different BMU's of the DBPNR study area (2020 to 2022) indicating their requirement for unmodified water quality, flow and cover preferences.

Taxon	Common name	BMU5	BMU7	Flow (in m/s) preference				Cover preference				
		Wetlands & seeps	Mountain streams	<0.1	0.1-0.3	0.3-0.6	>0.6	BEDROCK	COBBLES	VEG	GSM	WATER COLUMN
Blepharoceridae	Net-winged midges	-	X	0	0	3	4	2	3	0	0	0
Notonemouridae	Stoneflies	X	X	1	1	2	4	1	4	1	0	0
Perlidae	Stoneflies	-	X	1	1	1	5	1	4	1	0	0
Baetidae > 2 spp.	Small minnow flies	-	X									
Pyralidae	Aquatic caterpillars	-	X	1	1	3	2	0	2	3	0	0
Platycnemidae	Damselflies	-	X	2	3	1	1	0	2	3	0	0
Philopotamidae	Caseless caddisflies	-	X	0	1	2	3	1	4	1	1	0
Psephenidae	Water penny beetles	-	X	0	1	3	4	1	4	1	0	0
Athericidae	Snipe flies	-	X	0	1	2	2	1	4	1	1	0
Leptophlebiidae	Prongills	X	X	3	2	2	1	1	3	2	0	0
Tricorythidae	Stout crawlers	-	X	0	1	1	4	1	4	1	0	0
HYDRACARINA	Water mites	-	X	0	2	2	0	1	1	2	3	1
Chlorolestidae	Damselflies	X	X	3	2	1	0	0	1	4	0	0
Lestidae	Damselflies	-	X	4	1	0	0	0	1	4	1	0
Aeshnidae	Dragonflies	X	X	1	2	2	2	0	3	2	0	0
Ecnomidae	Caseless caddisflies	-	X	1	5	0	0	2	3	2	0	0
Naucoridae*	Creeping water bugs	-	X	2	2	3	0	1	1	1	1	4
Baetidae 2 spp.	Small minnow flies	X	X									
Caenidae	Cainflies	-	X	3	2	1	1	0	2	1	3	0
Gomphidae	Dragonflies	-	X	0	2	3	0	0	1	0	5	0
Hydropsychidae 2 spp.	Caseless caddisflies	-	X									
Hydroptilidae	Micro caddisflies	-	X	0	3	2	2	1	2	3	1	0
Leptoceridae	Cased caddisflies	X	X	0	1	3	2	2	2	2	2	0
Ancylidae	Limpets	-	X	1	2	2	1	3	2	1	0	0
Gerridae*	Pond skater	X	X	4	1	0	0	0	0	0	0	5
Veliidae*	Broad-shouldered water strid	X	X	5	1	1	0	0	0	0	0	5
Dytiscidae (adults*)	Predacious diving beetles	X	X	4	2	1	0	1	2	3	1	2
Gyrinidae (adults*)	Whirligig beetles	X	X	1	2	2	3	0	0	0	0	5
Hydrophilidae (adults*)	Water scavenger beetles	-	X	0	2	2	0	0	0	3	2	2
Ceratopogonidae	Biting midges	X	X	2	2	2	4	2	3	2	2	0
Simuliidae	Black flies	X	X	0	2	2	4	2	3	2	0	0
Tabanidae	Horseflies	-	X	2	3	1	0	0	2	0	3	0
Tipulidae	Crane flies	-	X	3	4	1	1	1	2	0	3	0
Baetidae 1 sp.	Small minnow flies	X	X	2	2	2	2	2	2	2	2	1
Coenagrionidae	Damselflies	X	X	1	2	3	1	0	1	4	1	0
Libelludae	Dragonflies	-	X	1	2	3	1	1	4	0	1	0
Hydropsychidae 1sp.	Caseless caddisflies	-	X	0	1	2	4	2	3	1	0	0
TURBELLARIA	Flatworms	X	X	1	2	3	4	1	4	0	0	0
Leeches	Leaches	-	X	2	2	1	1	0	4	1	1	0
Potamonautidae*	Crabs	-	X	1	1	3	2	0	3	1	1	0
Corixidae*	Water boatmen	-	X	2	3	1	0	1	1	1	1	4
Nepidae*	Water scorpions	X	X	4	1	0	0	0	0	5	0	0
Notonectidae*	Back swimmers	X	X	4	1	0	0	0	0	2	0	4
Chironomidae	Midges	X	X	1	3	2	2	2	2	2	2	0
Oligochaeta	Aquatic earthworms	-	X	2	2	2	1	0	1	0	4	0
Culicidae*	Mosquitoes	X	X	3	1	0	0	0	0	0	0	5
Muscidae	House flies	-	X	4	2	2	0	1	1	1	1	4

High requirement for unmodified water quality
Moderate requirement for unmodified water quality
Low requirement for unmodified water quality
Very low requirement for unmodified water quality

Key: Preference
0 - No preference (does not occur)
1 - Very low preference Coincidental
2 - Low preference
3 - Moderate preference
4 - High preference
5 - Very high preference

Diatoms

Diatoms are of great ecological importance because of their role as primary producers, and they form the base of the aquatic food web. Diatoms have been shown to be reliable indicators of specific water quality problems such as organic pollution, eutrophication, acidification and metal pollution, as well as for general water quality. This information, however, also provides preliminary data on the diversity of diatom species in an area. Representative sites were sampled within the proposed DBPNR study area to gain some baseline diatom results of the area during the February 2022 aquatic survey (CSBS, 2022; Koekemoer, 2022).

Fifty-nine (59) diatom species were identified (first 400 counted per sample) at the five sampling sites assessed in DBPNR during February 2022 (Table 14). Four of the five sites in the proposed De Berg Nature Reserve were characterised by **high biological water quality** reflecting near pristine conditions, while the remaining site was rated as having moderate biological water quality (upper Groot Dwars River). Endemic species with a preference for high biological water quality were observed at sites in the Klip River, Everest tributary, and upper Groot Dwars River (BMU7). These species, based on the experience of the diatomologist, are scarce and have only been observed in the upper reaches of high-altitude streams or the upper reaches near the origins of streams where anthropogenic activity is limited (Koekemoer, 2022).

Table 14: List of diatom species collected during February 2022 (Endemic species are shaded) (KR = Klip River; GD = Groot Dwars River).

Species	US DAM 1	KR1	EVEREST 2	EVEREST 3	GD NTRIB
Achnanthes standeri Cholnoky		175	166	162	
Achnanthes subaffinis Cholnoky			61	29	
Achnanthes subsaxonica Cholnoky			88	42	10
Achnanthidium crassum (Hustedt) Potapova & Ponader	10	8			
ACHNANTHIDIUM F.T. Kützing	7				
Achnanthidium macrocephalum (Hustedt) Round & Bukhtiyarova	2				3
Achnanthidium minutissimum (Kützing) Czarnecki	9	16	37	26	102
Achnanthidium subatomoides (Hustedt) Monnier, Lange-Bertalot et	1				
ADLAFIA Moser Lange-Bertalot & Metzeltin					3
AULACOSEIRA G.H.K. Thwaites				14	
Brachysira brebissonii Ross in Hartley	1			3	1
Brachysira neoexilis Lange-Bertalot	1				38
Caloneis bacillum (Grunow) Cleve					2
Chamaepinnularia mediocris (Krasske) Lange-Bertalot	2				1
Cymbella naviculiformis Auerswald					3
CYMBELLA C.Agardh	6				
Encyonema minutum (Hilse) D.G. Mann				5	
Encyonema theronii (Cholnoky) Krammer		168	4	18	1
Encyonopsis leei var. *sinensis* Metzeltin & Krammer			1	1	
Encyonopsis microcephala (Grunow) Krammer			2		
Encyonopsis microcephala var. *robusta* (Hustedt) Krammer	3				
EUNOTIA C.G. Ehrenberg	2				
Eunotia bilunaris (Ehr.) Mills	112				14

Species	US DAM 1	KR1	EVEREST 2	EVEREST 3	GD NTRIB
Eunotia exigua (Brebisson ex Kützing) Rabenhorst	11	6		4	1
Eunotia flexuosa (Brebisson) Kützing	3				1
Eunotia hugenottarum Cholnoky				12	3
Eunotia incisa Gregory	1				2
Eunotia minor (Kützing) Grunow	26		1	4	36
Eunotia muscicola Krasske	5				
Eunotia paludosa Grunow	4				
Eunotia rhomboidea Hustedt	21			2	2
FRUSTULIA L. Rabenhorst	2				
Frustulia crassinervia (Brebison) Lange-Bertalot et Krammer	6				
Frustulia rhomboides (Ehrenberg) De Toni					3
Frustulia rhomboides var. *amphipleuroides* (Grunow) De Toni	1				
Frustulia saxonica Rabenhorst	1				
Frustulia vulgaris (Thwaites) De Toni	7				5
GOMPHONEMA C.G. Ehrenberg	2		37	14	
Gomphonema acidoclinatum Lange-Bertalot & Reichardt					1
Gomphonema acuminatum Ehrenberg					2
Gomphonema affine Kützing					6
Gomphonema angustatum (Kützing) Rabenhorst					3
Gomphonema gracile Ehrenberg					11
Gomphonema lagenula Kützing	3				100
Gomphonema parvulum (Kützing)				1	
NAVICULA J.B.M. Bory de St. Vincent	1				1
Navicula angusta Grunow		2			
Navicula arvensis var. *maior* Lange-Bertalot					1
Navicula veneta Kützing					1
NITZSCHIA A.H. Hassall	1			1	9
NUPELA W. Vyverman & P. Compere				60	
PINNULARIA C.G. Ehrenberg	1				
Rhopalodia operculata (Agardh) Hakånsson					2
Sellaphora seminulum (Grunow) D.G. Mann					1
STAURONEIS C.G. Ehrenberg					1
Stenopterobia delicatissima (Lewis) Brebisson ex Van Heurck	1	21	2	2	2
Synedra rumpens Kützing	1		1		9
Tabellaria flocculosa (Roth) Kützing	146	4			2
Ulnaria biceps (Kützing) Compere					17
Total count	**400**	**400**	**400**	**400**	**400**

Table 15: Broad overview of potential impacts and threats to aquatic fauna biodiversity of the study area, relevant BMU's and species/aspects of concern, as well as recommended management actions.

IMPACT/THREAT	DESCRIPTION OF IMPACT/THREAT	RELEVANCE TO BMU's	SPECIES/ASPECTS OF CONCERN	RECOMMENDED MANAGEMENT ACTIONS
Impact 1: Altered hydrological regimes (increased or decreased flows/water levels)	Dams (BMU11), weirs, bridges, pipeline crossings: These activities may result in flow alteration (storage/pooling of water, delay in floods/flushes/freshets, increased evaporation) and often abstraction (loss of water from system). The construction of buildings and roads also alter natural drainage patterns Excavations/trenches/canals may cut-off of or alter surface flow and underground seepage. DBPNR specific impacts: De Berg Dams 1 and 2 and Goedehoop Dams 1 and 2.	5, 7	All aquatic biota will be impacted by altered flow regime, but especially flow intolerant invertebrates.	Determine flow requirements and comply with ecological reserve (quality and quantity). Remove any redundant dams and bridges and rehabilitate these areas (removal should be done through formal process to minimise any potential environmental impacts, such as increased sedimentation of downstream reaches, spreading of alien fish species, etc.). Prevent the construction of additional in-stream dams/bridges/pipelines across aquatic ecosystems. No development should occur within the 1: 100-year flood line of any watercourse. Make sure that the natural flow of all drainage lines is kept intact and prevent erosion at all cost. It is important that the natural diversity of habitats must be maintained to cater for the diversity of aquatic fauna in the study area.
Impact 2: Fragmentation / migration barriers	Dam walls as well as poorly constructed bridges and pipeline crossings create migration barriers that hinder the free movement of fish. Pollution/release of water of poor quality may cause "chemical migration barriers", especially to intolerant aquatic biota. Due to the absence of fish from the most upper reaches (mountain streams) the dams in these areas will have no/minimal migration impacts. Goedehoop dam 2 limited and not significant impact on movement of *E. cf. anoplus/motebensis*.	5, 7	Most fish species require free movement within or between reaches (includes NT[1] *E. cf. anoplus/motebensis*) to complete life-cycle.	Refrain from building any further in-stream dams, weirs, river crossings. Remove redundant dams/structures to restore the natural river continuum. No dams or weirs, other than those specifically designed for erosion control, may be constructed in wetlands. Unnecessary damming of the river, tributaries, wetlands and seepages should not be allowed. Prevent any pollution/areas of poor water quality as to not create chemical migration barriers.

[1] Near Threatened (IUCN)

IMPACT/THREAT	DESCRIPTION OF IMPACT/THREAT	RELEVANCE TO BMU's	SPECIES/ASPECTS OF CONCERN	RECOMMENDED MANAGEMENT ACTIONS
Impact 3: Water quality deterioration	Alterations to **water quality** (such as eutrophication, increased salinity, increased turbidity) through effluents, storm water runoff, and seepage into streams. Reduced water quality related to potential seepage from infrastructure (such as offices, accommodation) which could have impacts on the aquatic biota. Flushed-out pesticides, detergents, and other poisonous substances.	5, 7	Most aquatic fauna, but especially water quality intolerant species/taxa (including NT *E. cf. anoplus/motebensis*).	Prevent surface, ground water, or effluents with poor quality from entering the aquatic ecosystems. Oil and other hydrocarbons must be strictly controlled (limit storage of fuels on site, no servicing/repairs of vehicles, etc.). Implement water quality monitoring program on DBPNR and ensure compliance to water quality guidelines. Implement aquatic biomonitoring programme to monitor any changes in the ecological integrity of the aquatic ecosystem. Identify potential areas where seepage and spills can occur into the natural environment and take preventative measures (such as from infrastructure, sewage treatment facilities). Determine and comply with ecological reserve (quality and quantity). If pesticides or herbicides are used (such as during alien plant control, weed control, firebreaks), products should be chosen responsibly to act in accordance with the sensitive environment and associated ecology. Storage, administration, and disposal must be done according to the prescribed methods. Care should be taken to prevent any of the pollutants from ending up in the wetlands or river. Educate farmers about the importance of invertebrate conservation and encourage use of integrated pest management (IPM) strategies with reduced reliance on pesticides. No dumping of wet or dry material and, in particular, no waste disposal of any kind may be permitted in or near a wetland or stream.
Impact 4: Aquatic habitat deterioration	**Increased siltation/embeddedness of bottom substrates and loss of depth in pools** as a result of sediment inflow. This is the end product of catchment erosion (human activities responsible for removal of vegetation, such as clearing for infrastructure, roads, etc.). Also includes grading of fire breaks, grading of roads through untransformed land and uprooting of alien vegetation. **Removal of riverine vegetation**: The structural habitat of aquatic systems can be	5, 7	All aquatic species.	Limit surface soil disturbance and manage erosion (especially dirt roads and previously disturbed areas). No development or disturbance should occur within the 1:100-year flood line of any drainage line (including perennial and non-perennial streams) in accordance with the National Water Act (no. 36 of 1998). Demarcate all wetland and riverine boundaries and associated buffer zones No dumping of waste or any other materials is allowed within or close proximity to aquatic ecosystems. Implement all possible erosion control measures. Ensure adequate storm water drainage (infrastructure, roads).

IMPACT/THREAT	DESCRIPTION OF IMPACT/THREAT	RELEVANCE TO BMU's	SPECIES/ASPECTS OF CONCERN	RECOMMENDED MANAGEMENT ACTIONS
	significantly degraded by alteration of the riparian zones. **Accelerated** flows downstream of outlets, bridges, and canals cause erosion, scouring banks and reducing the availability of marginal vegetation habitats. Erosion will also **increase the turbidity** of the water, affecting species with a high requirement for clear water. Where sediments settle out (sedimentation), substrates will be altered, affecting those species that prefer clear, cobbled substrates. Pool depth will also be reduced, affecting species that prefer deep pools. Bridges, dams, river crossings cause pooling upstream. The **inundation** upstream of the bridge may also create favourable habitats for unfavourable species and change the overall fish assemblage of this area. DBPNR: The spillway of De Berg Dam 1 is eroding and it may fail in the near future. Failure of the Dam would have detrimental ecological impacts on the downstream Groot-Dwars River because of elevated sediments. The upper reaches of the Groot-Dwars River supports range-restricted aquatic biota that are sensitive to elevated sediments. Seepage downstream of De Berg Dam 1 was characterised by dense growth of the protobacterium, *Leptothrix ochracea*. This bacterium clogs interstitial spaces and created conditions that were unsuitable for aquatic macroinvertebrates. This bacterium species is typically associated with oxidation of iron. Spillage from the dam also created conditions suitable for filter-feeding macroinvertebrates, particularly the blackfly *Simulium medusaeforme* and therefore had			Specialist aquatic assessments should be conducted before, and monitoring conducted after disturbance of riverine habitats. It is important to maintain good vegetative cover (overhanging vegetation, undercut banks, and substrates). Do not allow removal of vegetation along banks, erosion and alien vegetation encroachment, or sedimentation of rocky substrates. Promote sustainable use of vegetation by local community. Carrying capacity should not be exceeded (conduct grazing capacity assessment, implement veld management plan). Trampling at watering areas should be minimized. No activities are to infringe upon the wetland and riverine boundaries or associated buffer zones. Should it be absolutely unavoidable that activities occur within these areas, relevant authorisation should be obtained according to the National Environmental Management Act (NEMA) 107 of 1998 and Section 21 c and i of the National Water Act 36 of 1998.

IMPACT/THREAT	DESCRIPTION OF IMPACT/THREAT	RELEVANCE TO BMU's	SPECIES/ASPECTS OF CONCERN	RECOMMENDED MANAGEMENT ACTIONS
	a measurable impact on the ecological functioning of the Dwars River directly downstream of the dam. Active bank and rill erosion was observed in some areas on DBPNR (such as Everest tributary catchment).			
Impact 6: Invasion by alien plants (especially in riparian zones)	Results in **decreased water levels** (see impact 1: altered hydrological regime). **Compete with indigenous** riparian plant species, altering natural marginal zone vegetation as cover for aquatic fauna. **Floating alien/exotic vegetation** prevent sunlight from penetrating into the water column, thus interfering with photosynthesizing algae in the water column, which could lead to oxygen depletion in the water.	5,7	Most aquatic species, but especially species with preference for marginal vegetation as cover.	Implement an alien plant control programme (conducted as part of current BMP study). Alien plant removal should be emphasised in the natural biotopes. Promote use of alien trees by local communities for firewood and construction activities.
Impact 7: Presence of exotic/alien fish	Presence of exotic fish species impact on indigenous fish through predation, disturbance of bottom substrates, competition for food and habitat, transfer of parasites. Dams (BMU11) especially create artificial habitats for proliferation of alien species. Presence of alien Rainbow trout in Goedehoop Dam is a potential threat to conservation of NT. *E. cf.anoplus/ motebensis.*	7, 8	Most aquatic species but especially small species (such as NT *E. cf. anoplus/motebensis*) are preyed upon by predatory alien fish.	Prohibit stocking of exotic fish and invertebrate species or translocation of indigenous fish species in any dams (BMU11) or rivers within the study area. Educate surrounding farmers/landowners about the threat of alien species. Promote conservation of indigenous species and removal of alien species The presence of the alien predatory Rainbow trout in GH Dam 1 is a potential threat to the indigenous fish of the Potspruit system (farm Goedehoop). It was, however, promising to note that the indigenous barb (*E. anoplus/motobensis*) also occurred in the marginal vegetation of GH Dam 2, and this species was abundant both upstream (GH Dam1) and downstream (site PS1) at the time of sampling in March 2022. It therefore seems that the trout is not currently an immediate threat to the occurrence of this indigenous fish in the upper Potspruit system. Should the land owners decide to maintain the Rainbow Trout population within this dam, the status of the indigenous fish should be monitored closely through an aquatic biomonitoring programme.
Impact 8: Poaching	Using of destructive methods such as gill nets, piscicides, or fish traps can seriously impact on the fish population of the area	7, 11	All indigenous fish species.	No poaching was observed or are known to occur currently within DBPNR study area. This is predominantly prevented by

IMPACT/THREAT	DESCRIPTION OF IMPACT/THREAT	RELEVANCE TO BMU's	SPECIES/ASPECTS OF CONCERN	RECOMMENDED MANAGEMENT ACTIONS
	(reduced abundance and even loss of species).			access control and patrols by security and should be maintained. Dams (BMU11) are often targeted by poachers and should especially be monitored for any signs of poaching activity.

8.3 TERRESTRIAL INVERTEBARTES

Dung Beetles

A total of 35 dung beetle taxa were captured during the pitfall trapping sessions at De Berg Private Nature Reserve (Table 16) (De Castro & Brits, 2022c). Three of these species (*Caccobius obtusus, Onthophagus asperulus,* and *Cyptochirus ambiguus)* were widespread on the DBPNR which occurred in nearly all the terrestrial BMU's (with a frequency of occurrence of 88.89% of all trap sites). These three species, along with *Onthophagus parumnotatus*, were also numerically dominant on the DBPNR. Other widespread and co-dominant species include generalist taxa such as *Copris cf. denticulatus, Onthophagus cribripennis, Cleptocaccobius viridicollis*, and *Sisyphus cf. costatus*. The highest number of beetles were captured from BMU2 (Sekhukuneland Montane Grassland), BMU1 (Sekhukhuneland Montane Bushveld) and BMU3 (Steenkampsberg Montane Grassland) where livestock were prominent. However, the highest richness (number of species) was from *Protea*-dominated BMU's represented by BMU2 and BMU3 which ranged from 17-20 species. Afromontane forest habitat (BMU4) was poor in species richness (Table 16). Most of the species composition attained relatively small-body sizes and represents predominantly endocoprids that remove dung from underneath the dung pads or are small telecoprids that role small dung pellets (e.g. fresh hare or rabbit's dung) from the dung source before it is buried. The majority of the beetles are also highveld and high-altitude species with a propensity to occur in grasslands as opposed to bushveld habitat. One large-bodied and widespread species, namely *Heliocopris hamadryas*, which was uncommon on the DBPNR, was probably attracted to the occasional presence of large-coarse fibred dung from monogastric mammals such as horses.

It appears that grassland BMU's contained the highest richness as well as the highest number of beetle individuals when compared to the other terrestrial BMU's. Species richness in the Grassland BMU's is as follows: BMU2 (Sekhukhuneland Montane Grassland) has an average richness of 18 species, and BMU3 (Steenkampsberg Montane Grassland) has an average richness of 14.74 species. Moderate richness values were recorded from bushveld-dominated habitat (e.g. BMU1 - Sekhukhuneland Montane Bushveld) (Table 17). The Northern Afrotemperate Forest habitat (BMU4) sustained low numbers of beetles, with only two species captured during the survey (Table 16).

Table 16: The captured dung beetle composition and relative abundance obtained from nine pitfall trap sites represented by four terrestrial BMU's.

Taxon	BMU2	BMU3	BMU3	BMU3	BMU4	BMU3	BMU2	BMU1	BMU1	Abundance	Frequency of occurrence
	P1	P2	P3	P4	P5	P6	P7	P8	P9		
Caccobius obtusus	20	16	5	7		10	36	24	14	132	88.89%
Chalconotus convexus								1		1	11.11%
Copris cf. corniger						1	1			2	22.22%
Copris cf. denticulatus	15	4	4	18		5	48			94	66.67%
Copris cf. obesus	1	1								2	22.22%
Cyptochirus ambiguus	10	18	4	3		1	4	1	1	42	88.89%
Drepanocerus kirbyi	1						6		2	9	33.33%
Eodrepanus fastiditus	1									1	11.11%
Euoniticellus africanus				1			16			17	22.22%
Garreta unicolor	1	1				6				8	33.33%

Taxon	BMU2 P1	BMU3 P2	BMU3 P3	BMU3 P4	BMU4 P5	BMU3 P6	BMU2 P7	BMU1 P8	BMU1 P9	Abundance	Frequency of occurrence
Heliocopris hamadryas							1			1	11.11%
Liatongus militaris	1					8	4			13	33.33%
Neosisyphus cf. barbarossa				2						2	11.11%
Neosisyphus cf. calcaratus						1	2			3	22.22%
Odontoloma cf. obscurum	1							4		5	22.22%
Oniticellus planatus							1			1	11.11%
Onitis cf. caffer					1		1			2	22.22%
Onthophagus asperulus	39	14	14	1		65	260	24	4	421	88.89%
Onthophagus cf. "pilosus group")	1									1	11.11%
Onthophagus cf. binodis	4		5	3		12				24	44.44%
Onthophagus cribripennis	17	13	25	2		12		24	2	95	77.78%
Onthophagus parumnotatus						24	16	56	40	136	44.44%
Onthophagus pauxillus	7	4		1						12	33.33%
Cleptocaccobius viridicollis		6				5	2	6	5	24	55.56%
Onthophagus pilosus	1	4				2			6	13	44.44%
Onthophagus producticollis		1							1	2	22.22%
Onthophagus rasipennis	5	3								8	22.22%
Pedaria cf. picea	14	3				1				18	33.33%
Proagoderus chalcostolus		1		1					5	7	33.33%
Sarophorus cf. "carinatus"					18					18	11.11%
Sarophorus costatus								5	14	19	22.22%
Scarabaeus cf. rusticus	4	1				1	1	3	4	14	66.67%
Sisyphus cf. "brown"	12	5		1						18	33.33%
Sisyphus cf. costatus	21	6				10	11	12	1	61	66.67%
Total relative abundance:	**176**	**101**	**57**	**40**	**19**	**164**	**410**	**160**	**99**	**1226**	
Total richness:	**20**	**17**	**6**	**11**	**2**	**16**	**16**	**11**	**13**		

Table 17: The mean relative beetle abundance and mean dung beetle richness obtained from four terrestrial BMU's on DBPNR.

Taxon	BMU1	BMU2	BMU3	BMU4
Caccobius obtusus	19.00	28.00	12.75	0.00
Chalconotus convexus	0.50	0.00	0.00	0.00
Copris cf. corniger	0.00	0.50	0.13	0.00
Copris cf. denticulatus	0.00	31.50	5.88	0.00
Copris cf. obesus	0.00	0.50	0.63	0.00
Cyptochirus ambiguus	1.00	7.00	12.25	0.00
Drepanocerus kirbyi	1.00	3.50	0.00	0.00
Eodrepanus fastiditus	0.00	0.50	0.00	0.00
Euoniticellus africanus	0.00	8.00	0.13	0.00
Garreta unicolor	0.00	0.50	1.38	0.00
Heliocopris hamadryas	0.00	0.50	0.00	0.00
Liatongus militaris	0.00	2.50	1.00	0.00
Neosisyphus cf. barbarossa	0.00	0.00	0.25	0.00
Neosisyphus cf. calcaratus	0.00	1.00	0.13	0.00
Odontoloma cf. obscurum	2.00	0.50	0.00	0.00
Oniticellus planatus	0.00	0.50	0.00	0.00
Onitis cf. caffer	0.00	0.50	0.00	1.00
Onthophagus asperulus	14.00	149.50	18.75	0.00
Onthophagus cf. "pilosus group"	0.00	0.50	0.00	0.00
Onthophagus cf. binodis	0.00	2.00	2.50	0.00
Onthophagus cribripennis	13.00	8.50	13.00	0.00
Onthophagus parumnotatus	48.00	8.00	3.00	0.00
Onthophagus pauxillus	0.00	3.50	2.63	0.00
Cleptocaccobius viridicollis	5.50	1.00	4.38	0.00
Onthophagus pilosus	3.00	0.50	2.75	0.00
Onthophagus producticollis	0.50	0.00	0.63	0.00
Onthophagus rasipennis	0.00	2.50	1.88	0.00
Pedaria cf. picea	0.00	7.00	2.00	0.00
Proagoderus chalcostolus	2.50	0.00	0.75	0.00
Sarophorus cf. "carinatus"	0.00	0.00	0.00	18.00
Sarophorus costatus	9.50	0.00	0.00	0.00
Scarabaeus cf. rusticus	3.50	2.50	0.75	0.00
Sisyphus cf. "brown"	0.00	6.00	3.25	0.00
Sisyphus cf. costatus	6.50	16.00	5.00	0.00
Average abundance:	**129.50**	**293.00**	**95.75**	**19.00**
Average richness:	**12.00**	**18.00**	**14.75**	**2.00**

Species such as *Neosisyphus cf. barbarossa* (confined to BMU3), *Odontoloma cf. obscurum* (BMU1 and BMU2), *Sarophorus cf. "carinatus*" (BMU4), and *Sisyphus cf. "brown*" (BMU2 and BMU3) are all highland **endemics** that are restricted to the Afrotropical Highlands region. These species are therefore restricted to the Drakensberg Escarpment. In addition, *Sarophorus cf. "carinatus*" was only sampled from leaf litter in upland habitat, and it is currently only known from two localities in the Lydenburg region. It is therefore listed as Data Deficient (Davis *et al*., 2020). However, *Sarophorus cf. "carinatus*" was restricted to Afrotemperate forest habitat on the DBPNR, for which it is regarded as a **highly specialised species** which feed on detritus as opposed to dung.

It is highly likely that the aforementioned taxa (*Sarophorus cf. "carinatus*", *Odontoloma cf. obscurum, Neosisyphus cf. barbarossa, Sisyphus cf. "brown*", including *Onthophagus cf. "pilosus group"*) may represent undescribed cryptic taxa awaiting formal descriptions. For example, the nearest locality where *Odontoloma cf. obscurum* occurs is from high-altitude habitat on the Drakensberg Mountains along the Lesotho border. It is possible that the collected specimens from BMU1 and BMU2 represent **new species** to science, or they represent a range-extension northwards along the Drakensberg Escarpment which was previously overlooked (due to undersampling).

Butterflies

A total of **55 butterfly species was observed** on the DBPNR during the current study, with the highest number of species recorded from BMU7 (Mountain streams) and BMU2 (Sekhukhune Montane Grassland) (Table 18). *Catopsilia florella* was observed in all the BMU's, while *Papilio demodocus demodocus, Vanessa cardui*, and *Danaus chrysippus orientis* were present in at least five of the BMU's.

None of the observed butterfly species was Threatened or Near Threatened (sensu Mecenero *et al.,* 2013). Most of the butterfly species were widespread, although *Chrysoritis aethon* and *Dingana alticola* are **endemic** to the Lydenburg region.

In addition, results of the Environmental Screening Tool also showed that the study area does not overlap with the known distribution range of any threatened or restricted-range butterfly species. The Screening Tool is intended to allow for pre-screening of sensitivities relative to Animal Species Protocol which *inter alia* includes butterflies in a particular landscape, with the intention to be assessed during the EA process. However, the outcome of the Screening Tool report should be interpreted with caution since, as the Screening Tool contains datasets that are mapped at a national scale, there may be areas where the Screening Tool erroneously assignsor misses environmental sensitivities because of mapping resolution and a high paucity of available and accurate data. Broad-scale site investigations will provide for an augmented and site-specific evaluation of the accuracy and 'infilling' of obvious and large-scale inaccuracies. Information extracted from the National Web-based Environmental Screening Tool (Department of Environmental Affairs, 2020) indicated that the DBPNR does not contain any Threatened or SCC butterfly species, and holds a Medium to High sensitivity with respect to bird and mammalian taxa only (report generated 09/09/2021).

Odonata

A total of 21 Odonata species was observed on the DBPNR during the current study, with the highest number of species recorded from BMU7 (Mountain streams). *Orthetrum caffrum* was widespread and occurred in nearly all the BMU's. *Phaon iridipennis* was restricted to BMU4 (Afrotemperate forests) (Table 19).

None of the observed Odonata species was Threatened or Near Threatened (sensu IUCN, 2022). However, *Chlorolestes fasciatus* and *Pinheyschna subpupillata* are **endemic** to the Drakensberg escarpment. Both these species are sensitive to stream-flow modification and sedimentation of mountain streams (BMU7) and will be the first species to disappear when erosion and damming of the mountain streams occur.

Table 18: The butterfly species observed on the DBPNR.

Taxon	BMU1 Sekhukhune Mountain Bushveld	BMU2 Sekhukhune Montane Grassland	BMU3 Steenkampsberg Montane Grassland	BMU4 Northern Afrotemperate Forest	BMU5 Valley-bottom wetlands & Seeps	BMU7 Mountain Rivers	BMU11 Dams	Frequency of occurrence
HESPERIIDAE								
Coeliades pisistratus				X				1
Gegenes sp.		X						1
Kedestes barberae barberae				X		X		2
Kedestes mohozutza		X	X			X		3
Spialia diomus ferax	X							1
LYCAENIDAE								
Actizera lucida	X							1
Aloeides henningi		X	X			X		3
Anthene definita definita	X	X	X			X		4
Axiocerses tjoane tjoane	X							1
Azanus jesous	X							1
Cacyreus marshalli		X	X			X		3
Capys alpheus extentus		X	X					2
Chilades trochylus		X	X					2
Chrysoritis aethon		X	X					2
Crudaria leroma	X							1
Cupidopsis cissus cissus		X	X		X	X		4
Harpendyreus noquasa					X			1
Hypolycaena philippus philippus	X							1
Lampides boeticus	X	X	X			X		4
Leptomyrina gorgias gorgias		X						1
Leptotes pirithous pirithous		X			X			2
Tarucus sybaris sybaris	X							1
Zizeeria knysna knysna		X	X		X			3
Zizula hylax	X							1
NYMPHALIDAE								
Acraea horta				X		X		2

Taxon	BMU1 Sekhukhune Mountain Bushveld	BMU2 Sekhukhune Montane Grassland	BMU3 Steenkampsberg Montane Grassland	BMU4 Northern Afrotemperate Forest	BMU5 Valley-bottom wetlands & Seeps	BMU7 Mountain Rivers	BMU11 Dams	Frequency of occurrence
Acraea natalica	X							1
Acraea neobule neobule	X							1
Aeropetes tulbaghia			X		X	X		3
Byblia ilithyia		X	X			X		3
Cassionympha cassius				X				1
Catacroptera cloanthe cloanthe					X	X	X	3
Danaus chrysippus orientis	X	X	X			X	X	5
Dingana alticola			X					1
Eurema brigitta brigitta	X	X	X			X		4
Eurytela hiarbas angustata	X							1
Heteropsis perspicua perspicua	X							1
Hypolimnas misippus	X							1
Junonia hierta cebrene	X	X	X			X		4
Junonia oenone oenone		X	X			X		3
Junonia orithya madagascariensis		X	X			X		3
Phalanta phalantha aethiopica						X		1
Precis archesia archesia		X	X			X		3
Precis ceryne ceryne					X	X		2
Prescis octavia sesamus		X	X			X		3
Pseudonympha magoides					X			1
Stygionympha wichgrafi wichgrafi	X	X						2
Telchinia anacreon					X			1
Telchinia rahira rahira					X			1
Vanessa cardui	X	X	X			X	X	5
PAPILIONIDAE								
Papilio demodocus demodocus	X	X	X	X		X		5
Papilio nireus lyaeus				X		X		2
PIERIDAE								
Belenois aurota	X					X		2
Belenois creona severina		X	X			X		3

Taxon	BMU1 Sekhukhune Mountain Bushveld	BMU2 Sekhukhune Montane Grassland	BMU3 Steenkampsberg Montane Grassland	BMU4 Northern Afrotemperate Forest	BMU5 Valley-bottom wetlands & Seeps	BMU7 Mountain Rivers	BMU11 Dams	Frequency of occurrence
Catopsilia florella	X	X	X	X	X	X	X	7
Pontia helice helice					X	X	X	3
Totals:	**23**	**26**	**24**	**7**	**12**	**27**	**5**	

Table 19: The dragonfly and damselfly species observed on the DBPNR.

Taxon	BMU1	BMU2	BMU3	BMU4	BMU5	BMU7	BMU11	Frequency of occurrence
	Sekhukhune Mountain Bushveld	Sekhukhune Montane Grassland	Steenkampsberg Montane Grassland	Northern Afrotemperate Forest	Valley-bottom wetlands & Seeps	Mountain Rivers	Dams	
AESHNIDAE								
Anax imperator					X	X	X	3
Anax speratus						X		1
Pinheyschna subpupillata						X		1
CHLOROCYPHIDAE								
Phaon iridipennis				X				1
Platycypha caligata						X		1
COENAGRIONIDAE								
Africallagma glaucum					X		X	2
Africallagma sapphirinum					X		X	2
Pseudagrion citricola						X		1
Pseudagrion kersteni					X	X		2
Pseudagrion spernatum						X		1
LESTIDAE								0
Lestes plagiatus						X		1
LIBELLULIDAE								
Crocothemis erythraea						X	X	2
Crocothemis sanguinolenta							X	1
Orthetrum caffrum					X	X	X	3
Orthetrum chrysostigma							X	1
Pantala flavescens					X		X	2

Taxon	BMU1	BMU2	BMU3	BMU4	BMU5	BMU7	BMU11	Frequency of occurrence
	Sekhukhune Mountain Bushveld	Sekhukhune Montane Grassland	Steenkampsberg Montane Grassland	Northern Afrotemperate Forest	Valley-bottom wetlands & Seeps	Mountain Rivers	Dams	
Sympetrum fonscolombii					X		X	2
Trithemis dorsalis						X		1
Trithemis furva						X		1
PLATYCNEMIDIDAE								
Allocnemis leucosticta					X	X		2
SYNLESTIDAE								
Chlorolestes fasciatus						X		1
Totals:	**0**	**0**	**0**	**1**	**7**	**11**	**8**	

Millipedes

Millipede taxa were mainly restricted to BMU4 (Northern Afrotemperate Forests), with three taxa confined to the moist humus rich soils of certain forest enclaves, apart from a *Doratogonus* species that was observed from Sekhukhuneland Montane Grassland (BMU2). Searching in some of the forest enclaves did not detect any millipede taxa, which were ominously absent for no apparent reason. A potentially undescribed species of the genus cf. *Gnomeskelus* (a keeled millipede) was sampled from an Afrotemperate forest patch on the farm Sterkspruit, as well as two species pertaining to the genus *Sphaerotherium* (pill millipedes) (Plate 12). Another potentially undescribed species or aberrant form of *Doratogonus cf. flavifilis* was observed from the Sekhukhuneland Montane Grassland (Plate 13).

(a) cf. *Gnomeskelus sp.* (potentially undescribed) (b) *Sphaerotherium spp.*

Plate 12: Millipede taxa collected from BMU4 (Northern Afrotemperate Forest), including potentially undescribed species.

Plate 13: An example of *Doratogonus cf. flavifilis* observed from the BMU2 (Sekhukhuneland Montane Grassland), a potential undescribed species.

Hymenoptera: Formicidae - ants

Previous surveys within the Booysendal project area have identified seven undescribed ant species, but most studies did not focus on this group to a significant degree and no detailed information is available for any areas below 1600 m.a.s.l. or above 1800 m.a.s.l. altitude (Afribugs, 2021). Ant diversity in the region is known to be exceptionally high, and many undescribed species have been discovered; two ant genera previously not recorded in South Africa have also been found in the region. Of the 69 ant species so far identified from the 2020/2021 samples, at least 11 are undescribed. Seven of these had not previously been recorded from the Booysendal project area and four have never previously been recorded, having been collected for the first time during the present study. Two of these (*Myrmicaria* afrc-za01 and *Tetramorium* afrc-za47) were recorded only from high altitudes (above 2200 m.a.s.l.) in BMU3 at the De Berg portion of the proposed De Berg Private Nature Reserve, one was recorded only from Northern Afrotemperate forest (BMU4) and another from BMU3 and BMU2, the latter both at De Berg and Pietersburg/Hebron (Afribugs, 2021).

A preliminary scan of the pitfall and subterranean trap samples collected for the greater Northam Booysendal study area in February 2021 on the farms Pietersburg, Hebron and De Berg yielded a total of 54 species at the lower altitude sites (*c.* 1900–2000 m.a.s.l. on Pietersburg and Hebron) and 35 species at higher altitude sites (*c*. 2200–2300 m.a.s.l.) on De Berg. The lower observed diversity at higher altitudes is expected and follows a general pattern common to ants and other invertebrates worldwide. Despite the high altitude, even of the lower sites, overall diversity is high and the De Berg sites had a combined diversity nearly 50% higher than the mean reported by Braschler *et al*. (2012) for sites in the Fynbos and Succulent Karoo biomes. Six species were found only at the higher altitude sites, while 25 were found only at the lower altitude sites. Due to overlap in species in these areas, 60 species in total have been identified to date from these samples, but detailed processing is still to be completed.

In addition, three more ant species have to date been identified from *ad hoc* sampling in the Sterkfontein portion of the proposed De Berg PNR, but many more samples remain to be inspected from here as well as from De Berg, Pietersburg, and various sites at lower altitudes within the project area in the Dwars River valley. Six additional species have so far been identified from these samples; several additional genera and many more species are likely to be identified.

Of the six ant species found only at the higher altitude sites on De Berg, one is as yet unidentified but is likely to be a species previously found in the Klein Dwars River valley and another is a widespread species that, with further sampling, is very likely to appear at the lower altitude sites as well. The remaining four of these six species are of interest as potential indicators of climate and habitat conditions within the proposed reserve, and two of these are of special significance from a conservation perspective:

- *Streblognathus peetersi*, in the Sekhukhuneland area at least, appears to be a high-altitude specialist, with samples having been collected from the Sterkspruit Nature Reserve and near Haenertsburg, but not at altitudes below 1800 m.a.s.l. in the Klein or Groot Dwars River region despite many intensive ant surveys in this area.
- *Tetramorium bevisi* was described from specimens collected at 2560 m.a.s.l. altitude in Lesotho and apart from some dubious records (probably misidentifications) at far lower altitudes (200–500 m.a.s.l.) in and near the Karoo, the specimens from De Berg appear to be the first record of the species since its description in 1958.
- *Myrmicaria* afrc-za01 (Plate 14) is an undescribed species and builds distinctive mound nests that allow for relatively easy survey; the apparent absence of the species from Pietersburg and other sites previously surveyed in the Booysendal project area suggests that it is also a high-altitude specialist. *Myrmicaria* afrc-za01 is unusual in that it builds mound nests, constructed of very fine quartz gravel/coarse sand, with chambers both beneath the soil surface and within the mound itself; other African *Myrmicaria* species sometimes create mounds of excavated soil around their nest entrance, giving a large crater-like appearance to the nest, but to the best of the authors' knowledge the central hole of these species leads to underground tunnels and chambers only. Since many (though not all) of the *Myrmicaria* afrc-za01 nests found were in, or adjacent to, seep or valley-bottom wetlands, it is possible that this is an adaptation to allow them to escape flooding if water levels rise too high. This species has so far been found only on De Berg and has not been seen at lower altitudes within the study area. Locations of mound nests recorded during the surveys are shown in Figure 12.
- *Tetramorium* afrc-za47 (Plate 15) is a small but very distinctive and clearly undescribed species, at this stage represented by a single specimen from site 5A (BMU3) in the proposed De Berg PNR. No other African *Tetramorium* species looks similar, and it is unclear at this stage even what species group within the genus it should be assigned to.

If this species is also a high-altitude specialist, it may be very restricted in distribution and hence of high conservation significance.

Plate 14: *Myrmicaria* afrc-za01, first recorded at De Berg, 2020.

Plate 15: *Tetramorium* afrc-za47, first recorded at De Berg, 2021.

Plate 16: Nest of *Myrmicaria* afrc-za01 (left) and workers of the species on the surface of the nest (right).

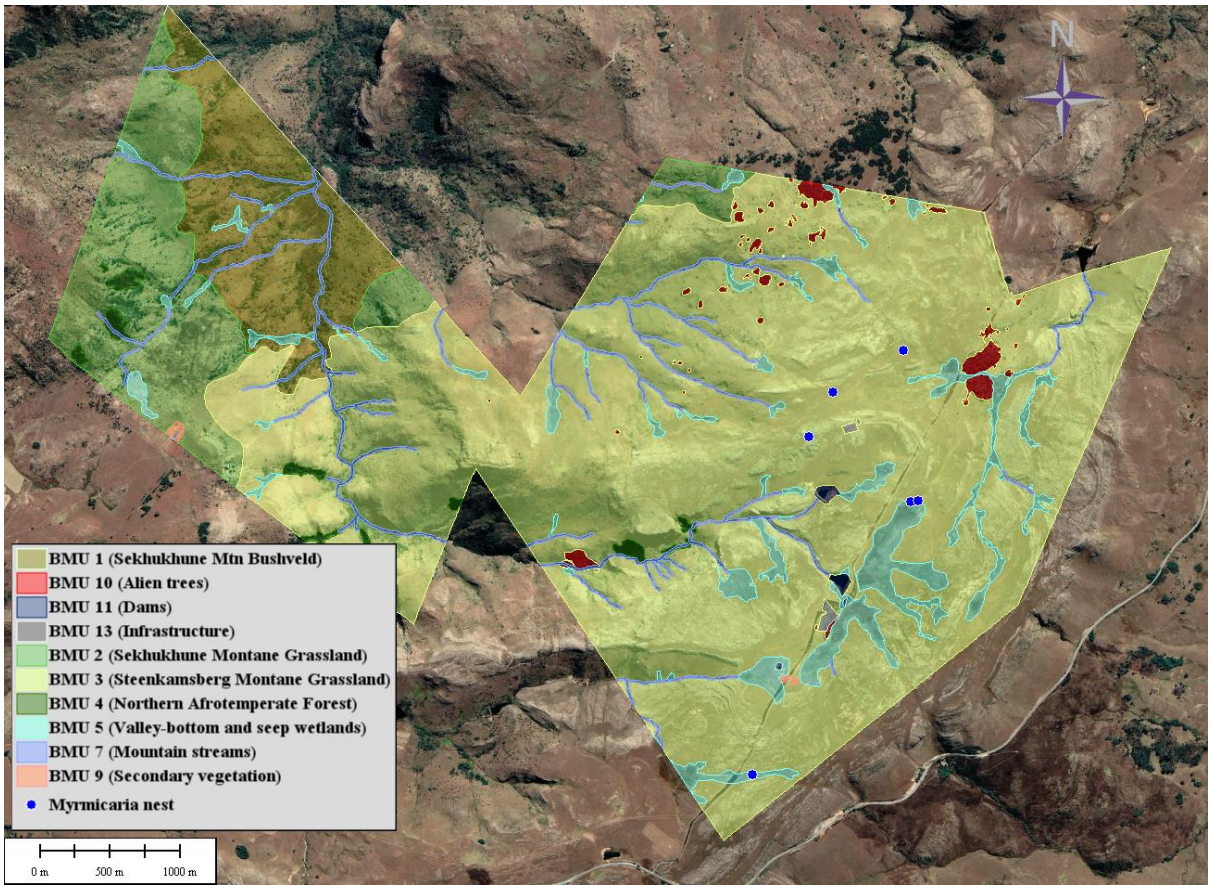


Figure 12: Proposed De Berg PNR showing Biodiversity Management Units and locations of nests of *Myrmicaria* afrc-za01.

The following references can be consulted for more detail regarding the faunal biodiversity of the DBPNR and greater Northam Booysendal study area:

- AFRIBUGS (2021) Booysendal Platinum Mine Biodiversity Management Plan Phase 1 – Terrestrial Invertebrates. Report to Clean Stream Biological Services, Buttonshope Trust and Northam Booysendal Platinum Mine.
- CLEAN STREAM BIOLOGICAL SERVICES (CSBS) (2020). Northam Booysendal Platinum: Aquatic Fauna Diversity: Literature review report as part of Baseline BMP study). Report to Buttonshope Trust and Northam Booysendal Platinum Mine.
- CLEAN STREAM BIOLOGICAL SERVICES (CSBS) (2021). Northam Booysendal Platinum: Aquatic Fauna Diversity (compiled as part of Baseline BMP study). Report number: CSBS/NB/2021/A.
- CLEAN STREAM BIOLOGICAL SERVICES (CSBS) (2022). Northam Booysendal Platinum/Buttonshope Trust: Aquatic Biodiversity Study (compiled as part of Baseline BMP study for the proposed De Berg Private Nature Reserve). Report number: CSBS/DBPNR/2022/A.
- DE CASTRO AND BRITS (2022c): Management Plan with focus on Invertebrates for the De Berg Private Nature Reserve near Lydenburg, Mpumalanga. Authored by L. Niemand.
- DEACON (2020). Biodiversity assessment of the Booysendal Complex. Specialist study: Terrestrial Fauna: Vertebrates. Literature review report. Report to Clean Stream Biological Services, Buttonshope Trust and Northam Booysendal Platinum Mine.
- DEACON (2021). Biodiversity assessment of the Northam Booysendal Complex. Specialist study: Terrestrial Fauna Report. Report to Clean Stream Biological Services, Buttonshope Trust and Northam Booysendal Platinum Mine.
- DEACON (2022). The development of a BMP for the De Berg Private Nature Reserve: Specialist study: A terrestrial vertebrate assessment. Report to Clean Stream Biological Services & Buttonshope Trust.
- KOEKEMOER AQUATIC SERVICES (KAS) (2022). De Berg – Diatom community composition and biological water quality. Authored by S. Koekemoer.
- NEPID (2022) Northam Platinum Holdings Limited Booysendal Mine: De Berg Private Nature Reserve. Preliminary assessment of aquatic macroinvertebrates. Authored by Dr. R. Palmer.

9. RECOMMENDED BIODIVERSITY MANAGEMENT ACTIONS

Recommended biodiversity management actions are **highlighted** throughout the report. This section provides detail on the most important biodiversity management activities recommended for the De Berg Private Nature Reserve study area. Biodiversity management recommendations specific to each Biodiversity Management Unit (BMU-specific) are described in section 7, while species or group specific management recommendations are included in section 8. The current section (section 9) includes an overview of general biodiversity management recommendations that could be consider by the DBPNR.

9.1 General biodiversity management recommendations

Implement BMU-specific biodiversity management recommendations: Various management recommendations were made for each BMU (see section 7) and it is strongly recommended that these should be considered for implementation within each BMU.

Implement species-specific biodiversity management recommendations: Various species/taxa/group specific biodiversity management recommendations (especially for species of conservation concern) were included in the summarised description of each specialist component (see section 8) with the detail being available in the various specialist reports (Addenda). It is strongly recommended that these management recommendations should be implemented.

VEGETATION (BOTANICAL)

1. Northam Booysendal should seek to formalise the DBPNR as a Protected Area where the management priority should be the conservation of plant SCC and their habitats.
2. The recent acquisition of a portion the farm Goedehoop 79JT by Northam Booysendal and its addition to the DBPNR has created a very narrow link between the DBPNR and the Verloren Vallei Nature Reserve. Northam Booysendal should seek to extend this very narrow link into an effective 'biodiversity corridor' by acquiring the farm Wanhoop 79JT (433 ha) which would create an effective biodiversity corridor of approximately 2 km in width. The creation of an effective biodiversity corridor between the two reserves would greatly enhance the biodiversity conservation value and tourist potential of both of these irreplaceable conservation areas.
3. The long-term expansion of the DBPNR so as to incorporate Portions 1 and 2 of the farm Sterkfontein 52, should be considered. This expansion will increase the representation of both Sekhukhune Mountain Bushveld and Sekhukhune Montane Grassland in the DBPNR and incorporate the only portion of Steenkampsberg Montane Grassland occurring within the 12 950 ha Northam Booysendal property that is not currently included in the DBPNR. Such an expansion would also incorporate additional SCC, including a known locality for the Critically Endangered species *Asclepias* sp. nov. (WM 754).
4. DBPNR should focus its biodiversity management effort on the six untransformed BMU's which have **Very High** botanical biodiversity conservation value, namely BMU's 1, 2, 3, 4, 5, and 7. Special focus should be placed on managing the habitats with the highest concentrations of plant SCC, namely habitats included in the high-altitude Steenkampsberg Montane Grassland (BMU 3.1) and the wetlands (BMU5) and mountain streams (BMU7) embedded in these high-altitude grasslands.
5. Any future infrastructure development, such as tourist or staff accommodation facilities, offices, and graded access tracks, should not be constructed within any habitats comprising part of any of the untransformed BMU's (e.g. BMU's 1, 2, 3, 4, 5, and 7). The

footprints of such infrastructure should, where possible, be placed within the historically transformed areas included within BMU's 9, 10, and 13.

6. Any infrastructure development (e.g. graded access roads, offices, workers accommodation, and tourist accommodation facilities) within any of the six untransformed BMU's should be preceded by a thorough search for plant SCC within the footprints of alignments of the proposed development as well as in immediately adjacent areas. Botanical research and conservation institutions (e.g., SANBI and MTPA), should also be afforded an opportunity to search the footprints for species that are of conservation, research, or horticultural interest, prior to commencement of any development.

- Principles and practical recommendations pertaining to the conservation management of the 37 Threatened (CR, EN, and VU), Near Threatened, and Rare species thus far recorded within the DBPNR, are as follows:

    - The most important BMU's for the conservation of Threatened, Near Threatened, and Rare species are, in order of importance: BMU3 (comprises ca. 59.8% of the study area) and BMU 3.1 in particular, BMU5 (comprises only ca. 6.4% of the study area), BMU2 (comprises ca. 21.2% of the study area), and BMU7 (comprises only ca. 2.5% of the study area). High-altitude peat wetlands (mires) situated at elevations above ca. 2 100 m.a.s.l. within BMU5, are regarded as the single most important habitat for Threatened and Near Threatened species within the DBPNR. BMU's 5, 3, and 2 should be the focus of efforts to conserve Threatened, Near Threatened, and Rare species and their habitat within the study area.

    - The 2021 botanical baseline survey of the 12 950 ha Northam Booysendal property (De Castro & Brits, 2021a), which includes the DBPNR, established that the DBPNR contained 35 of the 46 plant SCC then known to occur within the Northam Booysendal property and therefore comprised the most important area for the conservation of Threatened, Near Threatened and Rare plant species within the 12 950 ha property. The 2022 botanical survey confirmed the presence of 42 plant SCC in the DBPNR, with a high probability that future surveys will reveal the presence of additional plant SCC (De Castro & Brits, 2022a). The DBPNR is also regarded by the MTPA as one of the most important biodiversity conservation areas in the Mpumalanga Province (M. Lötter, pers comm.) and the findings of the current survey strongly support this view. The land owners should seek to formalise the DBPNR as a Protected Area where the management priority should be the conservation of plant SCC and their habitats.

    - *In situ* conservation is vital and should be the only option recommended in cases where the conservation of subpopulations of Threatened, Near Threatened, and Rare species is required (Raimondo *et al*., 2009). *Ex situ* conservation, a practice often termed 'search and rescue', is very rarely successful, expensive, and is considered an unacceptable conservation measure (Raimondo *et al*., 2009, Pfab, 2001b and GDARD, 2015). In accordance with the recommendations of Raimondo *et al.* (2009) the general principal to conservation management of Threatened, Near Threatened, and Rare species within the study area should be that no further loss of any subpopulations of such species should be permitted and any impacts to confirmed habitat for such species should be avoided wherever possible. Exceptions include species that qualify as Near Threatened under Criterion B of the IUCN criteria, such as *Lydenburgia cassinoides*, which is widespread within BMU1 and along streams (BMU7) at elevations below 1 600 m.a.s.l. as well as throughout much of the SCPE. The loss of a few individuals or small areas of habitat for such species may in some cases be acceptable (Raimondo *et al*., 2009) but must be authorised by the MTPA based on a specialist assessment.

    - Threatened, Near Threatened, or Rare species have been recorded within all six of the untransformed BMU's identified for the study area and prior to any proposed

development or activity within BMU's 1, 2, 3, 4, 5, and 7, the proposed footprint of development should be subjected to a thorough search for such recorded species (Table 8) as well potentially occurring species. Particular emphasis should be placed on searching footprints within BMU2, BMU 3.1, and in particular BMU5.

- In cases where localities for Threatened, Near Threatened, or Rare species are considered to be at risk from proposed tourism or management infrastructure development (e.g. service tracks, low-water bridges, and tourist accommodation), a species-specific 'management and monitoring plan' for the potentially affected species and its habitat must be developed by a specialist. Such a 'management and monitoring plan' must include the following aspects:

    a. Determination of the 'Area of Occupancy' (AOO) and population size of the species potentially affected by the proposed development or activity.

    b. Determination of the potential impacts of the proposed development or activity on the conservation of the affected species, both at the scale of the study area and at a national scale or population level (where population refers to all known individuals of a species).

    c. Determination of suitable mitigation measures.

    d. Determination of suitable buffer zones for the protection of the species and its habitat (of particular importance in the case of wetland species).

    e. The final monitoring and management programme for the species should be compiled with the input and approval of the MTPA (contact person: Mr Mervyn Lötter).

- In accordance with the general principles for the determination of buffer zones provided by GDARD (Pfab, 2001b; GDARD, 2015), recommended generic buffer zone widths for Threatened, Near Threatened, and Rare species potentially affected by proposed activities are 600 m for all Threatened (CR, EN, and VU) species and 300 m for all Near Threatened and Rare species. These generic buffer zones should be refined and appropriately modified for each potentially affected species in accordance with aspects such as the autecology of the species, habitat characteristics, potential impacts of the proposed development or activity on the species and its habitat, and historical and current land use of the area surrounding the subpopulation.

- All species should be subjected to simple, ongoing informal monitoring by Field Rangers of the reserve management, with specialist input where necessary. Such personnel should receive basic training in the informal monitoring of Threatened, Near Threatened, and Rare species. Training should include identification of such species and areas which hold concentrations of such species, as well as frequency of monitoring and basic reporting format. Harvesting incidents and other observed threats to plant SCC and their habitats (e.g. erosion, sedimentation, or invasion by alien plants) should be reported immediately.

- The five Endangered species recorded within the DBPNR should be subjected to basic monitoring by a specialist at two-year intervals, or more frequently if deemed necessary by the reserve management (mine's Land Management Department). Such monitoring should consist of simply visiting the recorded localities for these species listed in Table 8, counting the number of plants present (where appropriate), noting any signs of harvesting or threats to the plant habitat (e.g. overgrazing, erosion, or invasion by alien plants) and photographing the site.

- The reserve management should invite the MTPA (contact person: M. Lötter of MTPA Scientific Services) to conduct botanical exploration of the study area together with its

research partners such as SANBI and the Plant Specialist Group (PSG). Emphasis should be placed on botanical exploration of the remote areas of the DBPNR situated in the Groot Dwars River valley which have thus far been relatively poorly sampled. Such a collaboration will greatly assist reserve management in terms of continually updating their records of the occurrence, distribution, and utilisation of plant SCC and sensitive habitats within the DBPNR and its immediate surrounds.

- Recommendations pertaining to the five Declining plant species thus far recorded within the DBPNR are as follows:
    - Development at sites where Least Concern - Declining plant species have been recorded should be avoided where possible.
    - Access to sites where Declining plant species occur should be controlled in order to avoid illegal medicinal plant harvesting. This will benefit not only the medicinal plant species but will also facilitate biodiversity conservation within the study area as a whole.
    - The five recorded Declining plant species can be used as indicators of medicinal plant harvesting pressure within the study area. These species should be subjected to simple, ongoing informal monitoring by Field Rangers of the reserve management, with specialist input where necessary. Such personnel should receive basic training in the informal monitoring of Declining species, as well as other SCC and medicinal plants, which should include identification of such species, areas which hold concentrations of such species and should be regularly monitored, as well as reporting of harvesting incidents and other observed threats to plant SCC and their habitats (e.g. erosion, sedimentation, or invasion by alien plants).
    - In the event of any Declining species being recorded within an approved development site, permission for the removal of such species should be obtained from the Permitting Office of the MTPA, and the appropriate *in situ* and/or *ex situ* conservation measures should be developed and implemented with the approval of the MTPA conservation authorities where necessary. Where feasible, the four recorded Declining species that are perennial herbs or geophytes (but not the tree *Ilex mitis*) can be translocated to transformed, degraded, or untransformed parts of the study area which provide potentially suitable habitat, but such translocations will have to be carried out in a way that ensures no ecological degradation of the host habitat occurs, and will have to be briefly evaluated by an ecologist for each species and each potential translocation area. Alternatively, Declining species can be rescued and donated to appropriate conservation and research institutions such as the Walter Sisulu National Botanical Garden or the Pretoria National Botanical Garden of SANBI.

7. In order to expand and verify the plant species list and to search for as yet unrecorded plant SCC such as *Asclepias* sp. nov. aff. *schlechteri* (CR), *Brownlea graminicola* (VU), *Crotalaria monophyla* (VU), *Delosperma delainthoides* (VU), *Drimia altissima* (Declining), *Disa zuluensis* (EN), *Disa rungweensis* (Rare), *Gyymnosporia sekhukhuniensis* (VU), *Monopsis koweyensis* (VU), and *Syncolostemon rugosifolius* (VU), which have a High probability of occurrence within the DBPNR, as well as other potentially occurring SCC, it is recommended that the reserve management should encourage botanical interest groups associated with the MTPA and SANBI [e.g. the 'Plant Specialist Group (PSG)] to conduct field trips to the reserve on a regular basis. These surveys will serve to increase the seasonal coverage of the floristic surveys already conducted for the study area. Visiting botanist should be encouraged to focus on searching for the 10 aforementioned species in potentially suitable habitat within the untransformed BMU's and BMU's 2, 3.1, and 5 in particular. The reserve management should also invite the MTPA Biodiversity Planning Division (contact person: M. Lötter of MTPA Scientific Services) to conduct periodic site visits for the purposes of botanical exploration and reserve management input. In the

event of any additional plant SCC being recorded during these future surveys, the MTPA Biodiversity Planning Division and SANBI's Threatened Species Programme should be informed of such records.

8. The damaging or destruction of plant species that are Protected in terms of the National Forest Act (Act 84 of 1998), NEM:BA (Act 10 of 2004, as amended on the 16th of April 2013) or the Mpumalanga Nature Conservation Act (No.10 of 1998) during any future development (e.g. construction of workers accommodation, offices or tourist facilities) should be avoided wherever possible, and a permit for the removal or destruction of any such protected plant must be obtained from the provincial authorities (Permitting Office of the MTPA) prior to development. It is recommended that where untransformed natural habitats are to be affected by a proposed development, Protected plant species are rescued and placed in a nursery or donated to a research institute (e.g. SANBI botanical gardens) prior to development, rather than simply being destroyed. Where feasible, viable subpopulations of such species should also be translocated to transformed areas (including rehabilitated areas) or untransformed areas within the study area which provide potentially suitable habitat, but such translocations will have to be carried out in a manner that ensures that no ecological degradation of the host habitat occurs and will have to be evaluated by a botanist for each species and each potential translocation area. The 90 Protected species thus far recorded within the study area are listed in Table 7. The aforementioned measures are not applicable to species such as *Alepidea cordifolia* and *Dioscorea sylvatica*, which are also Threatened species and should be conserved *in situ*.

- *Catha edulis* (Khat) has not yet been recorded within the DBPNR, but has been recorded just 3 km to the north of the DBPNR within the Northam Booysendal property and it is quite possible that this species may be present within the reserve in BMU's 1 and 2. Khat is a valuable, illegal narcotic drug in South Africa and if *Catha edulis* is present in the reserve there will inevitably be large-scale poaching of this species and associated impacts such as year-round veld fires and destruction of fences will result. In the event that *Catha edulis* trees are recorded within the DBPNR in future, the ecological impacts associated with the illegal harvesting of Khat and recommendations for the control/management of such impacts are provided in the BMP for the 12 950 ha Northam Booysendal property (De Castro & Brits, 2021a).

- The land owners should implement the existing, integrated alien plant control programme (De Castro & Brits, 2021b) as per the AIS Regulations of the National Environmental Management: Biodiversity Act (Act No 10 of 2014). The alien plant control programme identifies the species that pose the greatest threat, in terms of habitat transformation, within the study area, and considers all appropriate chemical, mechanical, biological, and cultural control methods for all the alien species listed in Appendix 1 of the alien plants control programme (De Castro & Brits, 2021b). Emphasis should be placed on controlling the 14 declared alien invasive species (*sensu* the AIS Regulations) listed in Appendix 1, and in particular the seven priority species or genera (*Eucalyptus*) identified in the current report, namely **Acacia dealbata, *Acacia mearnsii, *Acacia melanoxylon, *Eucalyptus* spp, **Pinus patula, *Pinus* cf. *elliotii,* and **Pennisetum clandestinum.* The alien plant control programme (De Castro & Brits, 2021b), provides a more complete list of all naturalised alien species recorded within the DBPNR and its immediate surrounds, identifies aliens that are priority species in terms of control efforts, and maps areas where control efforts should be focused.

9. The implementation of a simple monitoring programme that focuses on the use of easily repeatable fixed-point photography to monitor representative sensitive habitats (e.g. mires and sheetrock seeps wetlands within BMU5) within the six untransformed BMU's and simple quantitative methods to monitor the size and health of selected subpopulations of Threatened (CR, EN, and VU) plant SCC, is strongly recommended. The dome-shaped, perched peat wetlands mires recorded at Sites xa11, xc70 and xc118 and the sheetrock

seep wetlands recorded at Sites xc77 and xc118 should be included in the monitoring. Monitoring should take place at intervals of two years or more or less frequently, dependant on the outcomes of the ongoing informal monitoring conducted by the Field Rangers of the Department of Land Management. This is regarded as the only practical method of evaluating the impact of current and possible future anthropogenic impacts and management practices on the floristic biodiversity of the study area. A brief evaluation of the success of rehabilitation activities in sensitive habitats should also be included in monitoring. The nature of secondary succession in rehabilitated areas should be evaluated in order to determine whether a favourable successional pathway towards indigenous vegetation cover is occurring and whether the establishment of alien invasive plants is occurring.

10. The reserve management should develop a basic 'veld management plan' based on a 'veld condition and carrying capacity assessment' which includes a 'burning plan', recommendations on the reintroduction of indigenous ungulates (if necessary), and stocking rates for these species. Sustainable grazing is essential in preventing the vegetation from becoming moribund and maintaining good veld condition and floristic diversity. Long-term overgrazing can, however, be detrimental to veld condition and floristic diversity, and the reserve management should therefore establish the veld condition and carrying capacity of the DBPNR on an ongoing basis and ensure that overgrazing is prevented. The DBPNR is regarded as potentially highly sensitive to overstocking with game animals as the area is unlikely to have been subjected to sustained heavy grazing by ungulates under pre-settlement conditions and the highly conservation worthy high-altitude grassland vegetation and wetland embedded within it (BMU's 3.1 and BMU5) are unlikely to be adapted to sustained, year-round heavy grazing. Such overgrazing and trampling as a result of overstocking of ungulates is likely to have a deleterious effect on the highly sensitive and endemic rich high-altitude wetlands (BMU5) which contain the highest concentrations of SCC within the DBPNR and possibly the Mpumalanga Province as a whole. Highly conservative stocking rates should therefore be applied and only species indigenous to the Steenkampsberg should be introduced. The subpopulations of smaller, naturally occurring ungulates such as Mountain Reedbuck, Grey Rhebuck, Klipspringer, and Duiker are, however, still subjected to natural predation within the reserve and population control (i.e. culling) should not be applied to these species.

11. A crucial component of the 'veld management plan' would be the recommendation of an appropriate 'burning plan'. In the Grassland Biome of Africa, fire is a natural environmental phenomenon that does not normally produce serious residual effects. Fire is in fact a natural and beneficial disturbance of the vegetation structure (including species composition), is essential in nutrient recycling and distribution, and, at correct intervals, assists in maintaining high levels of biodiversity (Goldammer & de Ronde, 2004). Recommendation of appropriate burning intervals is an extremely complex subject that is part science and part art. Appropriate burning intervals for areas that are managed for high biodiversity are those that mimic the 'natural' fire regimes of the area. In order to recommend appropriate intervals between prescribed fires, various factors, especially veld condition and fuel load of both fine fuels (grass) and woody fuels, must be assessed. Prescribed burning is usually recommended if an assessment of range condition indicates that the grass sward is not in a pioneer condition dominated by Increaser II grass species and the grass fuel load is $>$ 4000 kg/ha. Though controlled burning is usually carried out in the late dry season, natural fires on the Highveld and mountain grasslands of Mpumalanga usually occur during the lightning season (approximately October to January), and controlled fires in the DBPNR should be carried out during this period if authorised by the provincial Agricultural authorities. In the case of the DBPNR, beneficial burning would normally be in the form of a 'low intensity fire', and precise timing of the burn must be determined on the basis of atmospheric conditions such as humidity and

wind speed and direction. Fire cycles should be varied within the reserve, as uniform annual burning will be detrimental to maintenance and encouragement of high biodiversity and vegetation 'patchiness' which promotes biodiversity. A 'patch mosaic' approach to burning, where intervals between burning are varied in selected areas of the same habitat and records are kept determining the effect on veld condition and biodiversity levels and thus the optimal burning frequency for each broad-scale habitat/vegetation unit (BMU), is recommended. Appropriate fire cycles may vary from approximately two to three years in the high-rainfall grasslands of the study area (BMU's 2 & 3) to two to five years in the relatively high-rainfall (in terms of SCPE bushveld) open woodland (BMU1) of the study area. The need to burn should, however, be determined by factors such as biomass, veld condition, and rainfall in the preceding two years.

12. All watercourses and wetlands within the DBPNR are regarded as highly conservation worthy and sensitive ecosystems, and wherever possible development within 100 m of BMU5 and BMU7 should be avoided. The sensitivity of watercourses in general is reflected by the fact that watercourses are protected by South African legislation including the National Water Act (NWA), Act no. 36 of 1998, and the National Environmental Management Act (NEMA), Act No. 107 of 1998. According to the NWA, water use activities within watercourses as well as Section 21 C and I water use activities within 500 m of any wetland, require authorisation through a Water Use Licence or General Authorisation from the Department of Water and Sanitation. According to the stipulations of the NEMA, the vast majority of activities within 32 m of a watercourse (including its floodplain) or in some cases even within 100 m of a watercourse, require environmental authorisation. Details pertaining to restrictions associated with different listed activities were updated in 2014 under sections 24(5) and 44 of the NEMA, as set out in the Schedule under Government Gazette Notice 38282 of 4 December 2014.

13. Where planting of trees and shrubs around reserve offices, workers accommodation, or tourist facilities is deemed necessary, only trees and shrubs indigenous to the study area and its immediate surrounds should be planted, and these should wherever possible be grown from locally obtained seeds or other propagules. The alien invasive grass *Pennisetum clandestinum** (Kikuyu) should not be used for the establishment of lawns anywhere within the reserve as this species is an aggressive invader and habitat transformer of temporary seeps and riparian habitat within the study area (De Castro & Brits, 2021b). No planting of trees (alien or indigenous) should occur outside of the footprints of the aforementioned reserve infrastructure. More detailed recommendations regarding the introduction of plants are provided in the existing alien plant control programme for the study compiled by Clean Stream Biological Services (De Castro & Brits, 2021b).

14. It is recommended that capacity building among relevant reserve personnel (e.g. Field Rangers of the Department of Land Management), with respect to understanding biodiversity management in the study area, should take place. Consultants study the local ecosystems and identify important aspects of ecosystem functioning and sensitive species, but it is only the personnel that can refine and implement recommended management measures on an ongoing basis. It is therefore recommended that reserve management should 'take ownership' of any approved biodiversity management and monitoring program. It is also recommended that the relevant reserve personnel responsible for biodiversity management should attended a brief workshop to discuss and elucidate the biodiversity management measures recommend in the BMP. The biodiversity managers should also have access to outside specialist input on an ad hoc basis.

FAUNA

The primary approach in the conservation of fauna is to protect their preferred habitat (feeding, breeding) and food sources and to prevent persecution of animals in the study area. The following risks / impacts have been identified as the most prominent in the DBPNR (refer to Addendum C: Deacon, 2022 for detailed description, photographic evidence, and specific recommended management actions):

- Impact 1: Channelling of stormwater
- Impact 2: Overgrazing
- Impact 3: Uncontrolled burning
- Impact 4: Trampling vegetation cover and compacting soil
- Impact 5: Trampling of wetlands
- Impact 6: Utilising natural products
- Impact 7: Human disturbance:
  - Impact 7.1: Hunting and poaching
  - Impact 7.2: Human presence, movement, and noise
  - Impact 7.3: Human settlements in reserve
- Impact 8: Damming of streams
- Impact 9: Linear structures
  - Impact 9.1: Fences
  - Impact 9.2: Power lines
- Impact 10: Alien and invasive biota
  - Impact 10.1: Fish
  - Impact 10.2: Vegetation

The first four impacts have elements of transforming soil cover and resulting in impacts that includes erosion and siltation. Although soil erosion is a natural process, it is often accelerated by human activities, for example by the clearing of vegetation, soil tillage, or overgrazing. Prolonged erosion causes irreversible soil loss over time, reducing the ecological (e.g. biomass production) and hydrological functions (e.g. filtering, infiltration and water holding capacity) of soil.

The increased mobilisation of sediment will cause siltation in the water resource. In the event of washing away loosened soil particles, the eroded surfaces are scoured bare which ultimately leads to a major decrease in ecosystem functioning for many organisms that can no longer live there.

The section below provides an overview of potential impacts and general management measures for specific faunal groups. Refer to Deacon (2022) (Addendum C) for more detail.

Amphibians

Potential impacts: Collecting as food resource, persecution, road kills, and human presence. Destruction of feeding and breeding habitats. Water quality deterioration.

Management: Protect optimal habitats for amphibians with special emphasis on ‘species of conservation concern’ and implement recommended species-specific management actions. Start awareness campaigns on the reserve and in the community to inform the people about the role of these species. Exclude sensitive areas from further development. Leave natural

ground cover intact by preventing the harvesting of firewood and other natural materials on the soil that may act as amphibian habitat.

Reptiles

Potential impacts: Movement during construction, trampling by traffic, persecution of snakes, construction of roads and pipelines, altered fire regimes, overgrazing, covering of soil, vegetation removal, alien plants, removal of habitat aspects such as rocks, shrubs, and dead wood, and saturation of the peripheral soils by seepage.

Management: Protect optimal habitats for reptiles with special emphasis on 'species of conservation concern' and implement recommended species-specific management actions (Table 9). Start awareness campaigns on the reserve and in the community to inform the people about the role of these species. Exclude sensitive areas from further development. The illegal reptile trade is a serious threat to some species and security should be made aware of the fact that this is an ongoing organised crime.

Birds

Potential impacts: Fences across water bodies and wetlands, collision with utility lines, human presence, activities and interference, chemical pollution, alterations to water quality through effluents, storm water runoff and seepage into wetlands/dams, draining wetlands, clearing of riparian vegetation, siltation, erosion, pollution, water extraction, degradation of the clear and fast-flowing rivers fringed with riparian growth, construction of roads and pipelines, loss of natural habitat, habitat destruction or modification, and habitat fragmentation. Changing land-use practices, burning of wetland vegetation, damming, and water abstraction.

Management:

- Protect the habitat of these bird 'species of conservation concern' and implement recommended species-specific management actions (refer to Table 10).
- Emphasize importance of conserving bird species and highlight their endangered status: keep the staff and surrounding community informed.
- Erect road signs warning motorists to take care (especially at night).
- Remove myths relating to birds of prey.
- Exclude sensitive areas from further mining and development.
- Livestock numbers should be controlled to avoid excessive grazing, disturbance of habitat, and trampling of nests.

Mammals

Potential impacts: Persecution: hunting dogs and humans - hunted for their fur, and some for their meat. Use in traditional medicine and rituals, pesticides impacting on prey items, human presence affecting small mammals, poisoning, trampling by traffic, and decline in prey species.

Management: Protect optimal habitats for mammals with special emphasis on 'species of conservation concern' and implement recommended species-specific management actions (refer to Table 11). Inform the staff and surrounding community of importance of these predators and their function in the ecology of the area. Contradict myths relating to some mammals; create awareness towards animals crossing the road.

Aquatic fauna

Detailed impacts/threats to fish and the aquatic biota in general and relevant management measures are provided in Table 15 and CSBS (2022) (Addendum D). The primary impacts/risks and recommended management measures can be summarised as follows:

Potential impacts: Water quality deterioration (spills, seepage, pollution events, pesticides or herbicides, fuel or oil spills), habitat quality deterioration (sedimentation/erosion, increased nutrients causing excessive algal growth, physical disturbance through construction of riverine habitats), altered hydrology (water abstraction, flow modification, damming, exotic vegetation encroachment), migration barriers (dams, weirs, bridges), and alien and extralimital predatory fish species.

Management: Protect optimal habitats for fish with special emphasis on 'species of conservation concern' and implement recommended species-specific management actions. Implement surface, ground and biomonitoring programmes and address any issues of concern detected as a matter of urgency. Ensure that there are no spills/seepage/uncontrolled releases into the natural environment. Do not allow physical disturbance of riverine habitats (instream and riparian zones) and respect buffer zones. Remove redundant dams and do not construct additional migration barriers.

Terrestrial invertebrates

- Game species (e.g. antelope) should be allowed to have unrestricted access to the entire reserve to prevent trampling and overgrazing of BMU's which could result in unequal/skewed distributions of the local dung beetle composition and dung beetle abundance. Dung beetles break down mammal dung pads/droppings which will replenish nutrients back into the topsoil. An absence of dung beetles in a particular area, due to an absence of mammals, may in the long term affect the graminoid composition and structure of grassland BMU's. However, conservative stocking rates should be maintained.
- If livestock (e.g. cattle) is to be introduced, then it is important to fence-off sensitive habitat types to prevent trampling and overgrazing, especially where the palatability of the graminoid layer is high (e.g. wetlands). It is important that BMU4 and BMU5 be fenced to exclude livestock since these BMU's contain endemic invertebrate taxa (e.g. BMU4) and/or provide critical important foraging habitat for many butterfly taxa (which may be affected by trampling).
- The introduction of monogastric mammals (e.g. zebra) into the reserve could elevate the current dung beetle diversity of the reserve since it may attract specialist taxa which utilises (feed) on coarse-fibred dung. However, introduction of monogastric mammal species should only be attempted after thorough evaluation of stocking rates that are applicable to each BMU, where it may be required to fence-off certain BMU's to prevent overutilisation of the herbaceous cover.
- Implement a controlled burning programme [as per recommendations made in the botanical report compiled by De Castro and Brits (2021a)]. Controlled burning of the graminoid layer will allow dung beetles and other detritivore invertebrates access to the soil layer and will facilitate the movement of invertebrates between grass tufts. Moribund grassland will restrict the movement of invertebrates between grass tufts.
- Minimise the use of outside lighting, replace white light with bulbs of longer wave lengths (550nm or preferably 575nm) and make use of low-pressure sodium vapour lights or yellow LEDs. Avoid the use of fluorescent light since these emit significant amounts of UV light which will attract invertebrates or result in the disorientation of nocturnal invertebrates. Apply UV filters to high pressure mercury vapour lamps and

fluorescent light. In addition, outside lights should be deflected downwards, and internal lighting should be shielded by blinds or curtains.

- The reserve management should implement an integrated alien plant control program, as per the AIS Regulations of the National Environmental Management: Biodiversity Act (Act No 10 of 2014), which identifies the plant species that pose the greatest threat, in terms of habitat transformation, especially where it may affect BM2, BMU3, BMU4 and especially BMU5, and considers all appropriate chemical, mechanical, biological, and cultural control methods for the alien species namely *Eucalyptus* spp*.* and *Acacia* spp*.*.
- In order to expand and verify the current list of butterfly species (see Table 18) and forest-dependant taxa (with relevance to BMU4), and to confirm the presence and/or absence of the potentially occurring Threatened and Near Threatened species, it is recommended that additional brief follow-up surveys be conducted during September to October and again during late October to mid-January with emphasis on species of the genera *Aloeides, Lepidochrysops, Orachrysops*, and *Dingana*. These surveys will serve to increase the seasonal coverage of the invertebrate surveys already conducted for the study area. The surveys should focus on searching for *Thestor basutus, Serradinga clarki amissivallis* (IUCN Vulnerable)*,* and *Orachrysops warreni* (extremely rare) in potentially suitable habitat within BMU's 2, 3, and 5 since these species occur in similar habitat in the nearby Verloren Vallei Reserve near Dullstroom.
- The implementation of a simple monitoring programme that focuses on the use of repeatable fixed-point photography to monitor all sensitive BMU's (BMU's 1 to 5 & 7) and simple quantitative methods to monitor for temporal changes of the graminoid and forb composition at each of these BMU's which could alter the extant butterfly, Odonata, and dung beetle sub-population on DBPNR.
- A 'veld management plan' should be implemented for all natural BMU's, and existing grazing capacity studies (if any) should be updated in line with current grazing regimes when game are to be introduced to the DBPNR. The DBPNR should be appropriately managed in preventing the graminoid and forb layers from becoming moribund and maintaining good veld condition and floristic diversity. However, veld condition and carrying capacity surveys of the BMU's are highly recommended on an ongoing basis to ensure that overgrazing is prevented and to ensure "healthy" invertebrate populations.
- An important part of the 'veld management plan' will be the recommendation of an appropriate 'burning plan'. Appropriate burning intervals for areas that are managed for high biodiversity are those that mimic the 'natural' fire regimes of the area. In order to recommend appropriate intervals between prescribed fires various factors, especially veld condition and fuel load of both fine fuels (grass) and woody fuels, must be assessed. Controlled burning is usually carried out in the late dry season, when natural fires usually occur during the lightning season (approximately October to January), and controlled fires on the study area should be carried out during this period if authorised by the provincial authorities. Burning should normally be in the form of a 'low intensity fire', and precise timing of the burn must be determined on the basis of atmospheric conditions such as humidity and wind speed and direction. Fire cycles should be varied between the BMU's (with the exception of BMU4), as uniform annual burning will be detrimental to the maintenance and encouragement of high biodiversity. Appropriate fire cycles may vary from approximately two to eight (or more) years, and should be determined by factors such as biomass, veld condition, and rainfall in the preceding two years. BMU4, which mainly consists of a woody layer, should preferaly not be exposed to controlled/beneficial burns since it could result in the die-off of large canopy emergents (e.g. *Kiggelaria africana*), many being the larval food plants for butterfly species. Die-off could also result in forest gap creation, which may be colonised by non-forest taxa or edge species.

9.2 Conduct follow-up studies and implement biodiversity monitoring programme

The main objective of **biodiversity monitoring** should be to contribute to successful environmental management tools that can prevent the degradation of biodiversity. Focussed biodiversity monitoring can be a powerful tool to inform decision-makers on biodiversity conservation and restoration priorities. Periodical biodiversity monitoring is required in order to assess the success of management activities in meeting legal, regulatory, and policy objectives, including the requirements of sustaining the local use of biodiversity. A long-term biodiversity monitoring plan covering all important aspects and components should therefore be implemented at DBPNR as well as the greater Northam Booysendal surface rights area. The objective of this programme should ideally be as follows:

- Limited verification of the actual presence of many species will be accomplished during detailed once-off ecological assessments. Repeated surveys will vastly improve the database and aid in the updating of biodiversity information of a site. Very reliable species lists will be accomplished when repeat surveys are performed at least every second to third year.
- A biodiversity monitoring programme should aim at early detection (early warning systems) of potential negative trends towards the biodiversity components of the study area, as a result of mining and other human activities. Past surveys will therefore act as a measure (baseline) against which future findings could be compared.
- This programme will also be essential in order to continually upgrade the available information on the suitability of habitats in the identified biodiversity management areas. It is important that BMU's of high conservation importance should especially be monitored to ensure that the management practices are appropriate for these areas.
- The complex nature of ecosystems often necessitates the use of indicator taxa to monitor ecosystem health. It should be endeavoured to identify these taxa of specific relevance to the study area. Assessing the attainment of management objectives related to ecosystem health often requires the monitoring of key indicators, including ecological processes and components of biological diversity. The identification of key biodiversity indicators that represent the important parameters that needs protection may enable the reserve to perform future biodiversity assessments rapidly and accurately.

The follow-up studies / monitoring activities recommended for DBPNR include:

- The implementation of a simple monitoring programme that focuses on the use of repeatable **fixed-point photography** to monitor sensitive habitats within the four untransformed BMU's and simple quantitative methods to monitor the size and health of the recorded subpopulations of plant 'species of conservation concern', is strongly recommended.
- Annual surveys aimed at updating the **alien plant list** and establishing and updating the invasive status of each of the alien species, should be carried out (can be done annually by environmental staff with support from a botanist where required).
- Conduct **terrestrial fauna follow-up surveys** to expand the current faunal data set and monitor potential impacts on preferred habitat of animal 'species of conservation concern'.

Aquatic fauna [Refer to Addendum D: CSBS (2022) for details]:

Focussed aquatic studies and biomonitoring in the De Berg Private Nature Reserve (DBPNR).

Due to the importance of the DBPNR in terms of aquatic biodiversity conservation and its value to conserve these upper catchments (especially the Groot Dwars River) to ensure continued good water quality and flow, it is recommended that aquatic assessments should be continued in this area. The following should be considered:

- Implement a biomonitoring programme (fish, SASS5, diatoms) at selected sites within the DBPNR to expand the spatial and temporal information regarding the aquatic biodiversity of this area and to monitor any potential impacts.
- Conduct more detailed fish assessments of the Potspruit and dams on the farm Goedehoop to verify the fish species composition of this area.

Further studies on *E. cf. motebensis/anoplus*:

The barb species that closely resembles *Enteromius motebensis* (the Marico barb) and *E. anoplus* (Chubbyhead barb) was sampled from the Potspruit on the farm Goedehoop (BMU5 and BMU7). This *Enteromius* species is potentially a unique genetic lineage of the complex "*Enteromius anoplus/motebensis group of species"*. Previous genetic (unpublished) studies of the *Enteromius* species within the Northam Booysendal study area (Groot Dwars River) suggest that this population is genetically unique, as a result of its isolated distribution (Dr. Francois Roux, MTPA, pers. comm.). The taxonomy of this *Enteromius* species in the DBPNR remains uncertain and should be addressed by further studies as a matter of urgency. These studies should aim to verify the taxonomy of this species (including genetic analyses), investigate the current range of distribution and relative abundance within the study area, describe its preferred habitat and water quality, and identify specific threats and impacts. All this information should then be used to compile a detailed management plan if this species is confirmed to be of conservation importance.

Terrestrial invertebrate studies [Refer to Addendum E: De Castro and Brits, (2022c) for details]:

The implementation of a simple monitoring programme that focuses on the use of repeatable fixed-point photography to monitor all sensitive BMU's (BMU's 1 to 5 & 7) and simple quantitative methods to monitor for temporal changes of the graminoid and forb composition at each of these BMU's which could alter the extant butterfly, Odonata, and dung beetle sub-population on DBPNR.

9.3 Promote sustainable use of natural resources

Develop a programme to promote the **sustainable utilisation of natural resources** to benefit the local community. The needs of the local community should be determined in order to evaluate the potential impact they may have on the natural resource base. This may take the form of a social study, which could provide an opportunity to pre-empt social impacts. It will also enable the equitable utilisation of natural resources under the control of the reserve, without necessarily having any negative impact on the conservation of biodiversity. The following aspects could be addressed:

Thatch: Collect from already disturbed/previously cultivated lands, limit removal from areas of high and moderate biodiversity importance.
Wood (fire/building material)*:* Collect from already disturbed/previously cultivated lands, limit within areas of high biodiversity. Promote use of alien species above indigenous vegetation.

Health/spiritual/recreational requirements: Allow for sustainable collection of plants and animals with medicinal/spiritual value (create list of required species used by local community, sangomas, etc.). Sustainable collection should take place within the parameters of the relevant legislation and exclude protected species and 'species of conservation concern' (unless the necessary permits are obtained from the MTPA). Also determine required areas for spiritual activities (water/rivers for baptism, etc.). Use areas of high conservation importance for recreation (game walks/bird watching/fishing), and dams/rivers for angling (catch-and-release).

Grazing: A 'veld management plan' should be implemented for the DBPNR. Grazing is an essential environmental factor in maintaining veld condition and floristic diversity. Overgrazing can, however, be detrimental to the vegetation and the reserve should therefore establish the carrying capacity of the untransformed areas of the property and ensure that overgrazing is prevented.

9.4 Environmental Education Programmes

The reserve management should engage and assist appropriate local government institutions and non-governmental organisations (NGOs) in developing and implementing an 'Environmental Education Programme' that is tailored to address environmental issues that are of relevance within the study area. Such an environmental programme should focus on the environmental education of staff and school children from communities that are more reliant on local natural resources such as fuel wood and medicinal plants. Environmental aspects that should form the focus of such an environmental education programme include:

- Management of waste and control of water pollution.
- Utilisation of alien species rather than indigenous trees as a source of fuel wood and construction timber.
- Sustainable harvesting of medicinal plants.
- Damaging effects of human-induced fires, especially burning during the growing season.
- Killing/poaching/poisoning/collecting of animals (especially 'species of conservation concern')

9.5 Capacity building

It is recommended that capacity building among relevant personnel (e.g., field rangers of the Department of Land Management), with respect to understanding biodiversity management in the study area, should take place. Consultants study the local ecosystems and identify important aspects of ecosystem functioning and sensitive species, but it is only the personnel that can refine and implement recommended management measures on an ongoing basis. It is therefore recommended that mining staff should 'take ownership' of any approved biodiversity management and monitoring programme. It is also recommended that the relevant personnel responsible for biodiversity management should attended a brief workshop to discuss and elucidate the biodiversity management measures recommend in the Biodiversity Management Plan. The biodiversity managers should also have access to outside specialist input on an ongoing basis where necessary.

The capacity of the environmental management personnel, with respect to understanding and managing biodiversity, should be developed. The responsibility of the specialist consultants remains to study and describe the ecology of the area, but it is the personnel who have to manage this. It is therefore recommended that the appropriate environmental management personnel could benefit from this assessment by accompanying the specialists during field surveys. These personnel will then be empowered in terms of aspects such as identification of Threatened species, alien invasive species, medicinal plants, general ecosystem functioning, and the assessment of veld condition. The specialist could provide a short lecture

on the different biodiversity aspects of interest regarding their field of expertise. These skills will greatly facilitate the task of the environmental management personnel and enable them to identify potential areas of concern on an ongoing basis. It will also enable them to contribute to the ongoing improvement of the biodiversity baseline for the reserve. It is again strongly recommended that the relevant personnel responsible for biodiversity management should have access to outside specialist input and support on an ongoing basis.

10. SUMMARY & CONCLUSIONS

The following primary conclusions were drawn from this study:

- All parts of the DBPNR comprise one of two **Threatened terrestrial ecosystems** listed in the 2011 Schedule of the NEM:BA as **Endangered** under Criterion F ('priority areas for meeting biodiversity targets'), namely Sekhukhune Mountainlands (MP9) and Dullstroom Plateau Grasslands (MP4). The 2 127 ha DBPNR also falls entirely within one of **two centres of plant endemism**, namely the Sekhukhuneland Centre of Plant Endemism (SCPE) and the Lydenburg Centre of Plant Endemism (LCPE). The study area also falls within the recently described **Limpopo-Mpumalanga-Eswatini Escarpment (LMEE) centre of plant endemism**, an orographic entity some 53 594 km^2 in extent which encompasses both the SCPE and LCPE. The rugged DBPNR study area **remains in a largely pristine or near-pristine** state and only 2.1% (or ca. 46 ha) of the habitats and vegetation study area has been transformed by the planting of, and invasion by, alien trees, historical cultivation, the damming of wetlands and the establishment of infrastructure such as farm homesteads, a labourer's dwelling and a communications tower complex.
- The 2 127 ha DBPNR falls within the Mpumalanga Province and its biodiversity conservation importance is mapped in the Mpumalanga Biodiversity Sector Plan Version 3 (MBSP 2014). Most (59.6%) of the 2 127 ha DBPNR is categorised in the MBSP 2014 as '**Protected Areas'**. The portion of the DBPNR mapped as 'Protected Areas' comprises the entire extent of the farms De Berg and Triangle as they comprise the previous Davel Nature Reserve which was proclaimed in 1965 and is now included in the Northam Booysendal Mine's larger De Berg Private Nature Reserve. Areas mapped as '**CBA-Irreplaceable'** comprise 9.9% of the DBPNR and areas mapped as '**CBA-Optimal'** comprise 27.3% of the DBPNR. Areas mapped as 'Protected Areas', 'CBA-Irreplaceable' or 'CBA-Optimal', thus together comprise 96.8% of the DBPNR, which is regarded as an accurate reflection of the extreme conservation importance of the DBPNR.
- For the purposes of this study, the study area has been divided into **10 broad-scale vegetation units and land use classes** that was used as **Biodiversity Management Units (BMU's).** Of the ten identified BMU's, six comprise untransformed (and largely pristine or near-pristine) habitats (BMU1: Sekhukhune Mountain Bushveld; BMU2: Sekhukhune Montane Grassland; BMU3: Steenkampsberg Montane Grassland; BMU4: Northern Afrotemperate Forest; BMU5: Valley-bottom wetlands and seeps; BMU7: Mountain streams) and four comprise transformed habitats where the vegetation is secondary or has been cleared (BMU9: Secondary vegetation - historical cultivation; BMU10: Alien trees; BMU11: Dams; BMU13: Infrastructure). The untransformed BMU's together comprise 97.9% (or ca. 2 081 ha) of the study area.
- According to SANBI's online BODATSA database records, the quarter degree grid square within which the study area is situated, namely 2530AA, has been poorly explored botanically, and the database contains herbarium records for less than 533 plant species and infraspecific taxa collected within this grid of 50 000 ha. A total of **930 plant species and infraspecific taxa were recorded within the DBPNR** during the current study, **878 of which are indigenous** taxa and 52 (or 5.6%) of which are

naturalised alien species. **Fourteen** of the 52 recorded alien species are listed as **declared invasive species** in the AIS Regulations. The total of 878 indigenous plant species and infraspecific taxa recorded during the current botanical survey of the 2 127 ha DBPNR alludes to the **exceptionally high plant species richness** (α-diversity) of the study area. This species richness is attributable to the fact that the study area lies within the **ecotone (transition zone) between four vegetation types**, **two Biomes** (the Savanna Biome and the Grassland Biome) and **two centres of plant endemism** (the SCPE and the LCPE) and is also situated within the recently identified LCME centre of endemism which encompasses both the SCPE and LCPE. Furthermore, the **dramatic differences in elevation** within the study area create "**Ecological Diversity Gradients"** which add further to variability in available habitat and species richness.

- The DBPNR study confirmed the presence of **15 plant taxa that are endemic or near endemic to the SCPE** and **17 that are endemic or near endemic to the LCPE** within the 2 127 ha DBPNR. The study also confirmed the **presence of a minimum of 52 LMEE endemics** within the DBPNR.
- The DBPNR study confirmed the presence of **42 plant SCC within the 2 127 ha DBPNR** study area, 17 of which were recorded within the study area for the first time during the current study. The 42 SCC thus far recorded within the study area comprise **19 Threatened plant species** (EN or VU), **11 Near Threatened plant species**, **seven Rare plant species, and five Declining plant species** and it is considered highly probable that additional plant SCC are present. The 30 Threatened and Near Threatened plant taxa thus far recorded within the DBPNR comprise 15% of the 200 Threatened and Near Threatened species known to occur within the Mpumalanga Province in 2017 (MTPA database), a remarkable figure considering that the Mpumalanga Province covers an area of approximately 7 649 460 ha and the 2 127 ha DBPNR therefore comprises less than 0.03% of the province. The high-altitude Steenkampsberg Montane Grassland (BMU 3.1) and the valley-bottom and seep wetlands embedded within them (BMU5), including various large peat wetlands (mires), were identified as the most important habitats for the conservation of plant SCC within the DBPNR. Ninety of the species recorded within the study area are Protected under either the National Forest Act (NFA), the National Environmental Management: Biodiversity Act (NEM:BA), or the Mpumalanga Nature Conservation Act (MNCA).
- The biodiversity conservation importance of the DBPNR is emphasised by the fact that the 5 981 ha **Verloren Vallei Nature Reserve**, which is consistently ranked as one of the three most important biodiversity conservation areas in Mpumalanga in internal assessments conducted by the MTPA (M. Lötter, pers. comm.) and borders directly on the southern boundary of the DBPNR, is known to contain 20 plant SCC whereas 42 plant SCC have thus far been recorded from the far smaller 2 127 ha DBPNR. The formalisation of the DBPNR as a formally legislated Protected Area is strongly supported by the findings of the current study.
- The DBPNR study recorded a strong **correlation between elevation and richness of Threatened, Near Threatened, and Rare plant species** within the DBPNR. The grasslands (BMU 3.1) and wetlands (BMU's 5 and 7) overlying metamorphic or sedimentary geology at elevations of above ca. 2 100 m.a.s.l. contain, by a large margin, the highest diversity of Threatened, Near Threatened, and Rare plant species within the DBPNR and it is considered probable that this pattern is repeated throughout the Mpumalanga Province. The approximately 980 ha of habitat situated above 2 100 m.a.s.l. and with metamorphic or sedimentary geology within the DBPNR comprises approximately 7.3% of all such habitat occurring in the Mpumalanga Province. The exceptional conservation importance of BMU 3.1 is further emphasised by the fact that the DBPNR forms part of the Steenkampsberg 'plateau' which includes by far the largest area of contiguous sandstone and arenite lithology situated above 2 100

m.a.s.l. within the Mpumalanga Province, and therefore is likely to comprise the most important high elevation 'ecological refuge' or 'terrestrial island' within Mpumalanga.

- The DBPNR is not only of exceptionally high biodiversity value and conservation importance, but also an area of **great scenic beauty and tourism potential**. The DBPNR therefore holds great potential as a venue for conservation-compatible, income generating activities such as hiking, birdwatching, wildlife, and wildflower tourism. The development of this tourism potential will greatly enhance the long-term viability and sustainability of the DBPNR as a critical biodiversity conservation area. The linking of the DBPNR with the Verloren Vallei Nature Reserve will not only enhance the conservation value of both reserves but will also strengthen the economic viability and sustainability of both conservation areas.
- Based on faunal distribution data and habitats available within the study area, it is estimated that approximately **641 terrestrial vertebrate animal** species including frogs, reptiles, birds, and mammals can be expected in the study area.
- **Ten of the 18 expected frog species were encountered** in the DBPNR project area as part of the DBPNR study. In terms of frog SCC, two (possibly three) endemic frog species are expected while no red data listed species are estimated to occur in DBPNR.
- **Sixteen of the 71 expected reptile species were encountered** in DBPNR during the DBPNR study. **Twelve endemic reptile species** are expected to be found in the study area, **five** of which were confirmed during the DBPNR study. **One Threatened reptile species** (Southern African python) is also **expected to occur in the area** (including MTPA conservation status).
- The presence of **127 of an estimated 432 species of birds** that could potentially utilize the different biotopes of the DBPNR study area, was confirmed during the DBPNR study. **Forty-two bird 'species of conservation concern'** are likely to utilize the DBPNR study area, with eight of these confirmed to be present during the current study.
- Of all the mammal species that have distribution ranges in the region, 129 coincide with the DBPNR project area while approximately **120 medium to small mammal species** are expected to occur. During the DBPNR study signs and/or sights of 23 mammal species were recorded. **Twenty-five of the mammal species** expected in the study area are 'species of conservation concern' (SCC), with seven of these confirmed during the current study.
- The DBPNR provides **near-pristine montane habitat** for several faunal SCC, including viable subpopulations of Southern Mountain Reedbuck (EN) and Grey Rhebuck (NT) which move freely between the DBPNR and suitable habitat in surrounding private farmland and the largely untransformed Northam Booysendal property. The DBPNR and its immediate surrounds comprise one of the very few areas in Mpumalanga where fauna can disperse over large areas of highly varied untransformed habitats, representing two Biomes (Bushveld and Grassland) and varying in elevation from ca. 1 100 m.a.s.l. to 2 332 m.a.s.l. without any significant barriers for dispersal such as roads, game fencing, security fencing, and human settlements.
- The current study concluded that the DBPNR study area contains areas of **high to very high aquatic biodiversity conservation importance**. The present ecological status of most of the aquatic ecosystems falling within the DBPNR study area is **largely natural to slightly modified (ecological category A to B)** with **high to very high ecological importance and sensitivity**. The Groot Dwars River reaches within the study area is furthermore classified as a **National Freshwater Ecosystem Priority Areas (NFEPAs)** which elevates their conservation importance. The National Environmental Screening Tool indicated that the aquatic **biodiversity sensitivity** of the majority of the DBPNR study area was ***Very High***.

- The study also confirmed the **absence of fish** from all rivers and streams (Groot Dwars **River, Everest tributary,** and **Klip River tributary**) within the original DBPNR study area (farms De Berg, Triangle, and Sterkfontein). The absence of indigenous fish from these upper catchment streams inside DBPNR is thought to be a natural phenomenon as a result of the abundance of natural migration barriers (waterfalls, cascades, large boulders) that occurs within the mountain stream (BMU7) zone. It was promising that no alien fish species were present in the two dams on the farm De Berg. Limited fish sampling and visual observations performed at selected sites of the new section (farm Goedehoop) confirmed the presence of **one indigenous fish species**, namely *Enteromius cf. anoplus/motebensis* within the **Potspruit** river system on this farm. The presence of the **alien Rainbow trout** (*Oncorhynchus mykiss*) was also confirmed (visual observation) in the larger dam on the property. The barb (*E. cf. anoplus/motebensis*) requires further verification (genus currently under review in RSA) and, until verified, it will be considered as potentially being a **fish 'species of conservation concern'** (due to *E. motebensis* (IUCN) listing as Near Threatened (NT).
- The current study also confirmed a **high aquatic macroinvertebrate diversity** present with the DBPNR. At least **one species** of aquatic macroinvertebrate of **conservation concern** could be expected within the DBPNR study area, namely, *Pseudagrion newtoni* (VU: Vulnerable) *(Damselfly:* Harlequin sprite). The presence of various **rare, endemic, or range-restricted macroinvertebrate taxa** were also confirmed. A total of **forty-seven (47) macroinvertebrate families** were also sampled within the DBPNR.
- **Fifty-nine (59) diatom species** were identified at the five sampling sites assessed in DBPNR during February 2022. Four of the five sites were characterised by **high biological water quality** reflecting near pristine conditions, while the remaining site was rated as having moderate biological water quality. **Endemic species** with a preference for high biological water quality were observed.
- During the field surveys conducted as part of the DBPNR study, it was noted that **35 dung beetle taxa** were present, with four taxa (*Neosisyphus cf. barbarossa* - confined to BM3, *Odontoloma cf. obscurum* – BMU1 and BMU2, *Sarophorus cf. "carinatus*" - BMU4 and *Sisyphus cf. "brown*" - BMU2 and BMU3) being highland endemics that were restricted to the Afrotropical Highlands region. It is likely that these taxa, including *Onthophagus cf. "pilosus group*" may represent **undescribed cryptic taxa**.
- Approximately **55 butterfly taxa** were recorded from the DBPNR, the highest number of species were recorded from BMU7 (Mountain streams) and BMU2 (Sekhukhune Montane Grassland). None of the observed butterfly species was Threatened or Near Threatened, although *Chrysoritis aethon* and *Dingana alticola* are endemic to the Lydenburg region.
- A total of **21 Odonata species** were observed on the DBPNR, with the highest number of species recorded from BMU7 (Mountain streams). None of the observed Odonata species was Threatened or Near Threatened, although *Chlorolestes fasciatus* and *Pinheyschna subpupillata* are endemic to the Drakensberg escarpment and sensitive to flow modifications and sedimentation.

Some **impacts** were identified as potentially posing a risk to the biodiversity of the study area. It is strongly recommended that the management actions as stated in the report should be incorporated into the reserve's biodiversity action plan. Various management actions are recommended with the most important being as follows:

- It is recommended that the proposed **management guidelines be implemented** with focus on **maintaining ecological connectivity** between the respective natural BMU's and to adopt a dynamic **grazing and burning management plan** that will benefit invertebrate diversity. The reserve management staff who have access the DBPNR should be trained on how to manage the grazing potential of the study area in an

appropriate manner in conjunction with maintaining conservative stocking rates which will benefit the dung beetle richness of the area, but also preserve current butterfly and dragonfly/damselfly activity patterns.

- The main focus of biodiversity management should be on the **untransformed BMU's** with high to very high biodiversity conservation value.
- Aim to include the relevant **BMU-specific, species/group-specific, and general biodiversity management recommendations into a biodiversity action plan** for the proposed DBPNR.
- Implement an integrated **alien plant control program** (as per the AIS Regulations), with details being outlined in De Castro and Brits (2021b and 2022a).
- Biodiversity-related **follow-up studies and a monitoring programme** should be conducted.
- A programme should be developed to **promote the sustainable utilisation of natural resources** to benefit the local community.
- Engage and assist appropriate local government institutions and non-governmental organisations (NGOs) in developing and implementing an '**Environmental Education Programme'** that is tailored to address environmental issues that are of relevance within the DBPNR study area.
- It is recommended that **capacity building** amongst relevant personnel and landowners and informal tenants (e.g. people utilising the land on the study area), with respect to understanding biodiversity management in the study area, should take place. It is also emphasised that the relevant personnel responsible for biodiversity management, should have access to outside specialist input and support on an ongoing basis.

South Africa is rightly very proud of its rich biodiversity. However, our biodiversity is under threat from climate change, pollution, the excessive use of resources, and invasive plant and animal species. Developers are now under pressure to reduce and report on the impacts on biodiversity. Many of these developers have the opportunity to contribute to biodiversity conservation and management through gaining a better understanding of the ecosystems on their sites, and often through small changes to the way land is managed. Northam Booysendal is fortunate to be in control of the proposed DBPNR, an area that is richly endowed with exciting plant and animal species that needs protection. Declaring protected areas (PAs) (such as the proposed De Berg Private Nature Reserve) stands out as one of the main conservation strategies worldwide and there are clear commitments to expand their extent under the auspices of the Convention on Biological Diversity.

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