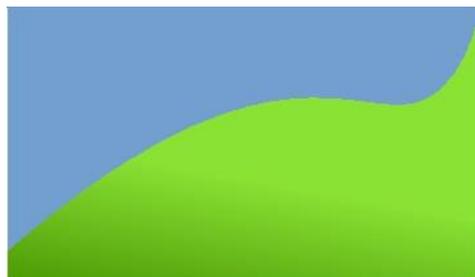


VELD CONDITION ASSESSMENTS AND BURNING MANAGEMENT PLAN FOR THE GREATER CRADLE NATURE RESERVE

June 2025

Report to Malapa Nature Reserve



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Proposed citation:

Short, A.D. 2025. *Veld condition assessments and burning management plan for the Greater Cradle Nature Reserve*. Report to Malapa Nature Reserve. Johannesburg: Themeda Eco Consulting

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Resume of author

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Statement of Independence

Alan Short declares that he has no interest, financial or otherwise, in the outcomes of this study, other than remuneration for services performed.

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1 INTRODUCTION

1.1 Overview

The Greater Cradle Nature Reserve (GCNR) is a privately-owned reserve, built from several smaller reserves that have been amalgamated over several years. The reserve was established to conserve the biodiversity, as well as the paleontological and cultural heritage of the grasslands of the highveld, which are critically endangered as a result of urban expansion in South Africa's most industrialised province.

The GCNR is in the process of applying for gazetting as a Nature Reserve under the National Environmental Management: Protected Areas Act (NEMPA) and as such has drafted a management plan for the reserve. As part of the management plan, a veld management plan is required to ensure that the major vegetation communities, grasslands and savannas, are sustainably managed to preserve and improve the biodiversity and ecological functioning of the ecosystem.

1.2 Objective

Develop a veld management plan for the GCNR, based on field studies of the current condition of the grasslands and savannas of the reserve. The veld management plan will include analysis of, and recommendations for:

- 1) The current condition of the veld, in terms of species composition and ecological functioning;
- 2) The current wildlife stocking densities, and recommendations for the numbers and mix of different major herbivore species in the reserve;
- 3) An assessment of and recommendations for the control and management of the indigenous encroaching tree, *Searsia lancea* (karee).
- 4) A fire management plan for maintaining or improving the condition of the veld.

1.3 Description of the GCNR

Detailed environmental and geographic contexts for the GCNR are contained in the GCNR Management plan, and will be summarized here, with an emphasis on the environmental context relevant to the veld management plan.

The Reserve is 9248ha of contiguous grassland and savanna, with very little significant transformation within the boundaries. It consists of four main units: Three historical private nature reserves, and a fourth recently acquired farm that has been added to the property (Table 1, Map 2)¹.

The reserve is located on the northern boundary of Gauteng province, on the border with North-West province, with a small portion crossing over into North-West. It is wholly contained within the Cradle of Humankind World Heritage Site and must adhere to the standards and guidelines of the Cradle of Humankind (Martindale 2024).

The topography of the GCNR is hilly, with steep valleys and ridges interspersed with flat plateaux. The Skeerpoort river runs through the reserve from west to east at the foot of a long ridge system at the northern end of the reserve, with no other major perennial rivers within the boundaries. The Grootvleispruit and Kleinvleispruit, two tributaries of the Skeerpoort, flow north through Malapa Nature Reserve and join the Skeerpoort just inside the boundaries. One large farm dam is located on the Skeerpoort, with several smaller dams along other unnamed non-perennial streams.

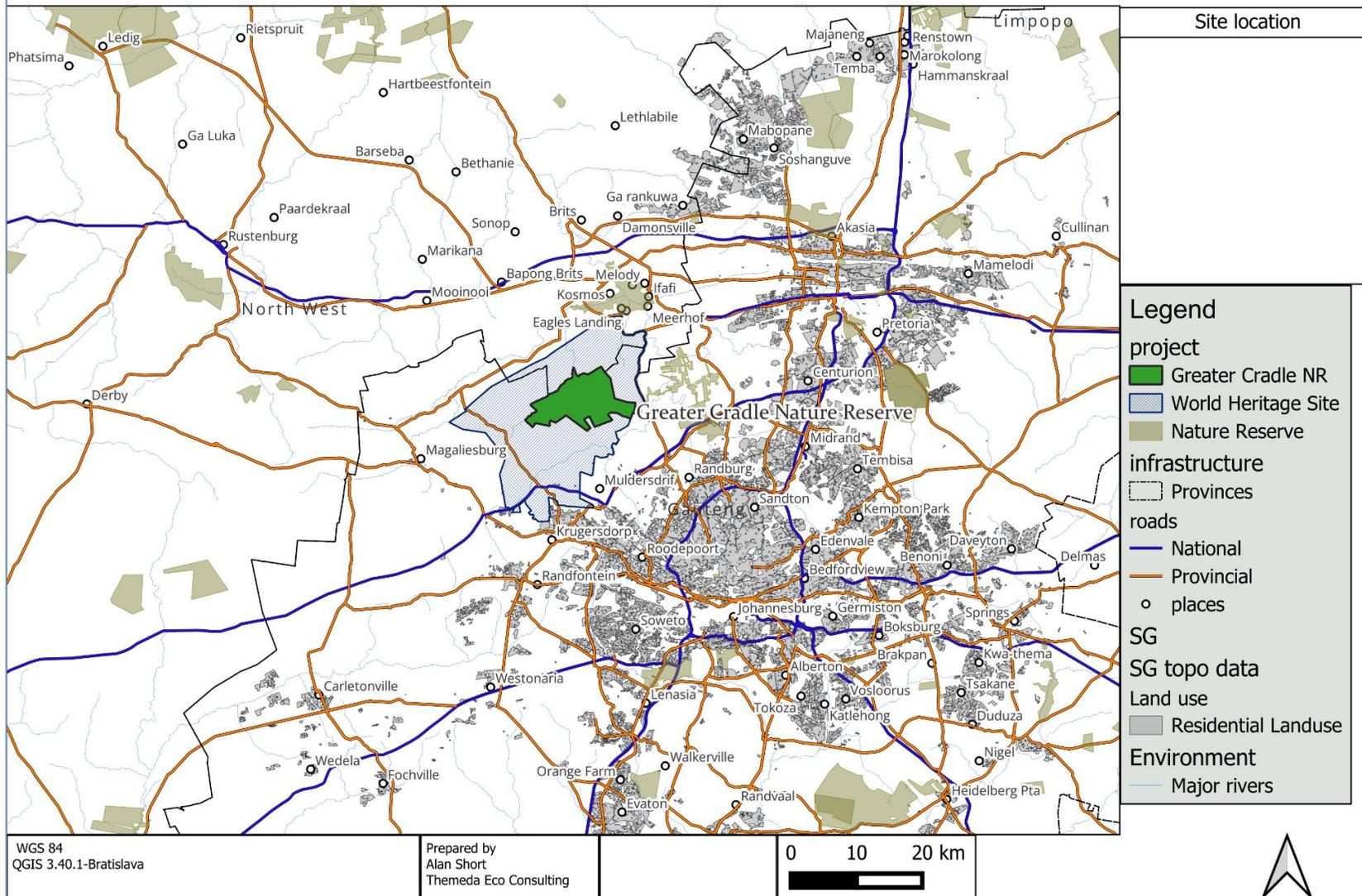
Several named hills are mapped by the surveyor-general, including Eagle Kop, Bushman Kop and Oribi Hill, and many other unnamed peaks at between 1400m and 1580m elevation.

Table 1: Nature reserves and farms making up the Greater Cradle Nature Reserve

Name	Area (ha)
John Nash Nature Reserve	3603
Malapa Nature Reserve	3211
Cradle Nature Reserve	1870
Weltevreden Farm	564
Total area	9248

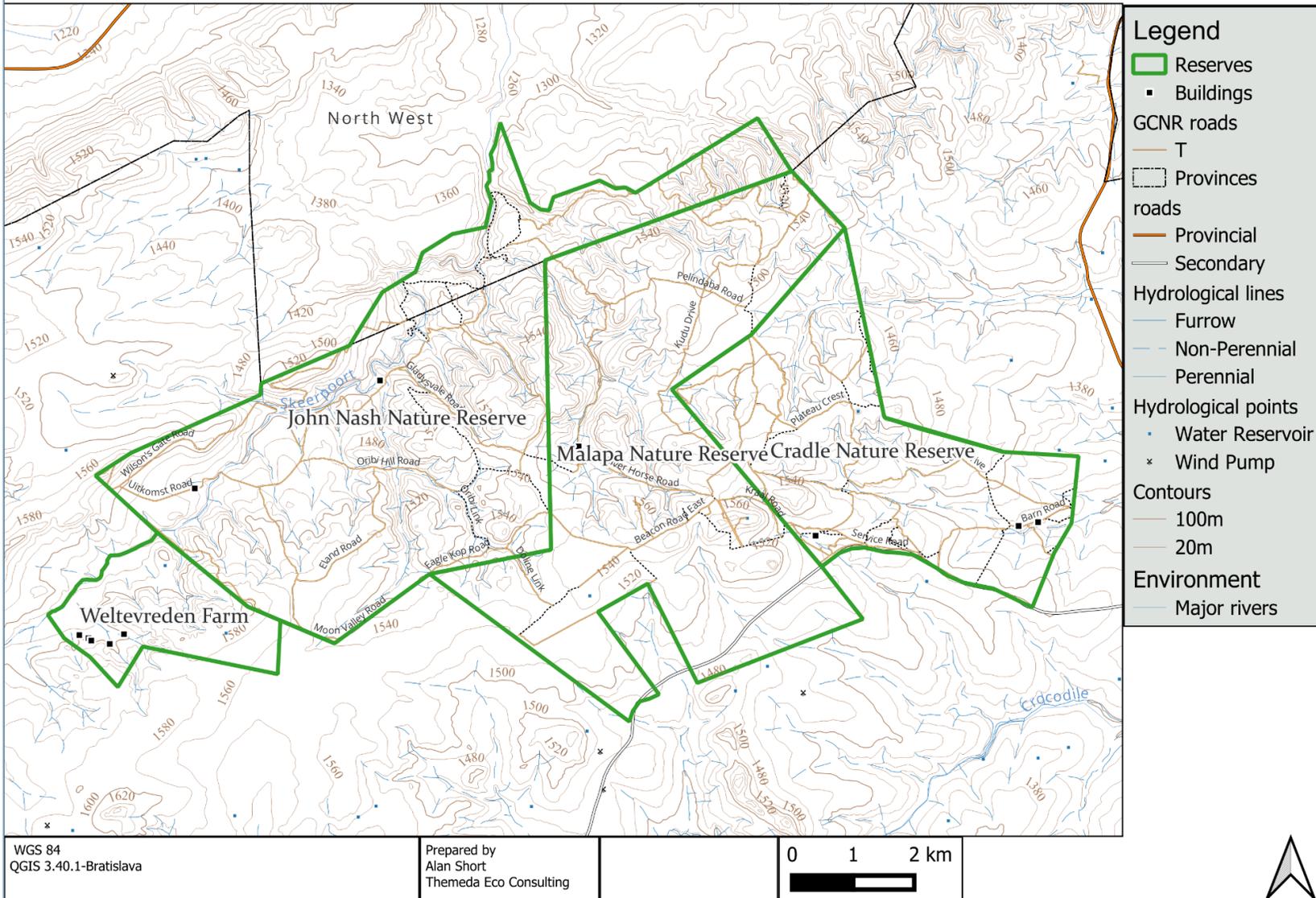
¹ The Surveyor-General topographic map series appears to be incorrect in labelling names of the nature reserves; Cradle Nature Reserve is labelled as “Motsetse Nature Reserve” on the 1:50,000 map series, and John Nash and Malapa Nature Reserves are combined into a single area labelled “John Nash Nature Reserve”. The correct names and boundaries of the GCNR were confirmed with the GCNR Association.

Location of Greater Cradle Nature Reserve



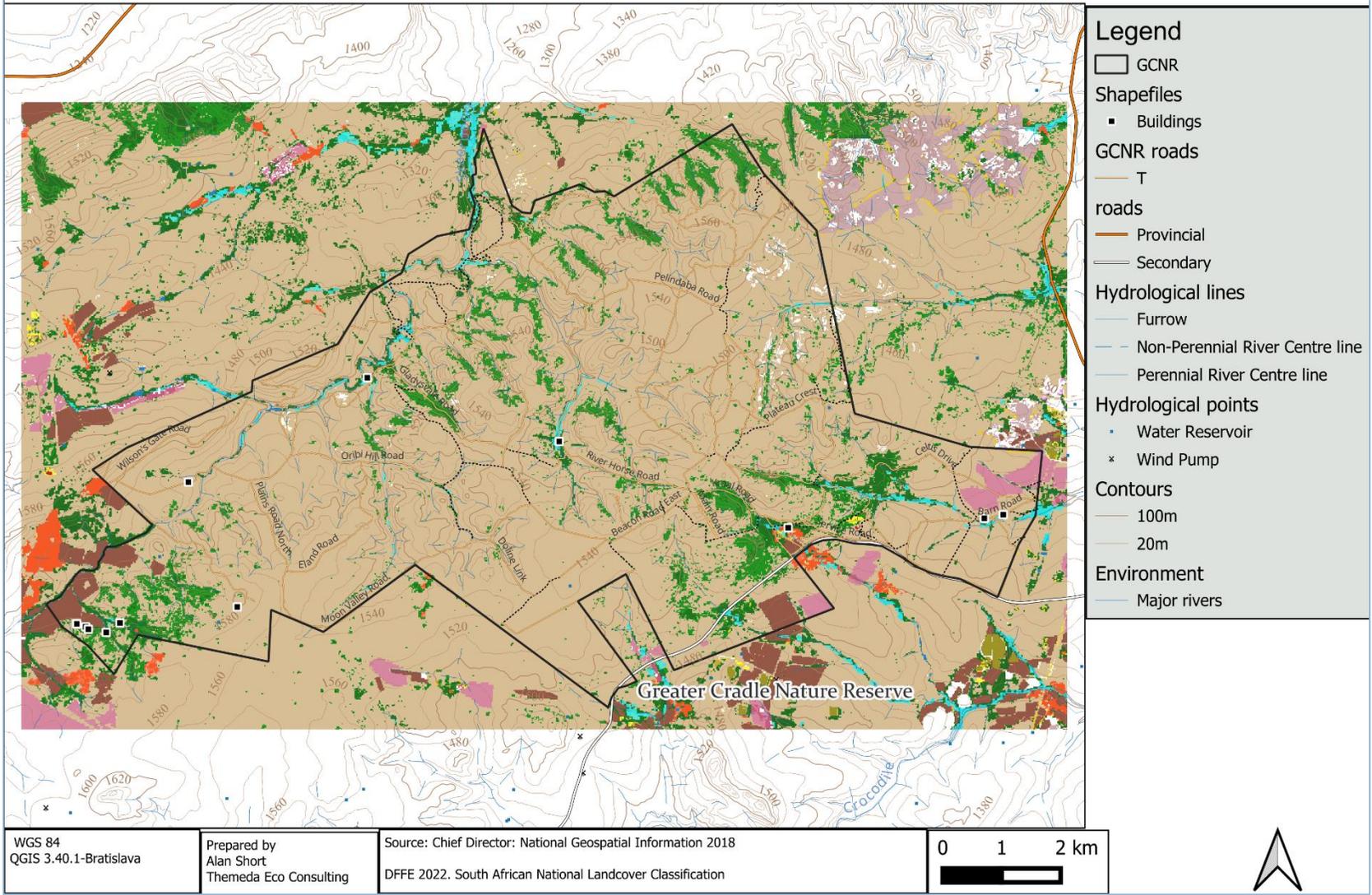
Map 1: Location of the Greater Cradle Nature Reserve within the Cradle of Humankind World Heritage Site

Layout and topography



Map 2: Layout, topography and rivers, and internal roads with some roads labelled.

Landcover



WGS 84
QGIS 3.40.1-Bratislava

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Source: Chief Director: National Geospatial Information 2018
DFFE 2022. South African National Landcover Classification

0 1 2 km



Map 3: Landcover of the Greater Cradle Nature Reserve. See following page for legend key

Legend		
raster	22,Herbaceous Wetlands (currently mapped)	51,Residential Informal (Tree)
landcover_2022	23,Herbaceous Wetlands (previous mapped extent)	55,Village Scattered
Band 1 (Gray)	30,Bare Riverbed Material	58,Smallholdings (Bush)
2,Contiguous Low Forest & Thicket	31,Other Bare	59,Smallholdings (low veg / grass)
3,Dense Forest & Woodland	40,Cultivated Commercial Annuals Non-Pivot / Non-Irrigated	60,Smallholdings (Bare)
4,Open Woodland	42,Fallow Land & Old Fields (Trees)	65,Commercial
5,Contiguous & Dense Planted Forest	44,Fallow Land & Old Fields (Grass)	66,Industrial
6,Open & Sparse Planted Forest	47,Residential Formal (Tree)	67,Roads & Rail (Major Linear)
8,Low Shrubland (other regions)	48,Residential Formal (Bush)	69,Mines: Extraction Sites: Open Cast & Quarries combined
13,Natural Grassland	49,Residential Formal (low veg / grass)	
19,Artificial Dams	50,Residential Formal (Bare)	

1.4 Description of the natural environment

The Greater Cradle Nature Reserve falls largely within the Grassland Biome of southern Africa, with patches of woodland and indigenous forest, in a region of the highveld of South Africa long known by farmers as the Bankenveld (Acocks 1988). The high elevations give rise to cold winters with frosts, with rain falling primarily in the summer months. Three major vegetation types are mapped in the GCNR in the South African vegetation map (Mucina and Rutherford 2006, SANBI 2018): The bulk of the reserve is classified as Carletonville Dolomite Grassland, with a small portion of the Critically Endangered (DFFE 2022) Egoli Granite Grassland in the southern corner of Cradle Nature Reserve, and a long ridge classified as Gauteng Shale Mountain Bushveld along the northern ridges (Map 4).

The vegetation is a mosaic of open grasslands, with patches of open woodland on gentle slopes and some areas of dense woodland and thicket in rocky outcrops and valleys (Photo 1). The veld is characterized as sourveld, meaning that the protein content of grasses rapidly declines in the winter months to below the level required by most grazers.

Soils are derived from dolomitic bedrocks throughout most of the reserve, cut through by igneous dykes (long ridges of igneous intrusions) in many places, as well as ridges of chert (a hard, siliceous sedimentary rock). The northern ridges are underlain by mudstones and quartzite, while the Egoli granite grassland, as the name implies, lies primarily on igneous granites and gneiss. The shales give rise to soils with a higher clay content, while most of the soils are sandy or sandy loam. Igneous rocks give rise to acidic soils while the dolomite-derived soils generally have higher base status. Soils are very shallow, with only a few patches of soils greater than about 400mm depth.



Photo 1: Typical view of the landscape of the GCNR, showing open grassland in the middle distance and dense woodland on the steep, sheltered rocky slopes.

The vast majority of the GCNR is relatively natural, untransformed vegetation, with only a few patches of development and planted areas (Map 3, Table 2). The South African National Landcover Map for 2022 (DFFE 2024) shows some areas classified as cultivated in the south of the GCNR and in the new Weltevreden portion in the west. In the south, the classification could be a false positive if mowing of the veld has been mistaken for cultivation. About 1 000ha is classified as some form of woodland, mostly concentrated in the valleys and steep slopes along ridges and watercourses. By far the largest proportion of the area is natural grassland, with a few hectares of wetlands identified.

Table 2: Areas in ha of different landcover classes identified in the GCNR.

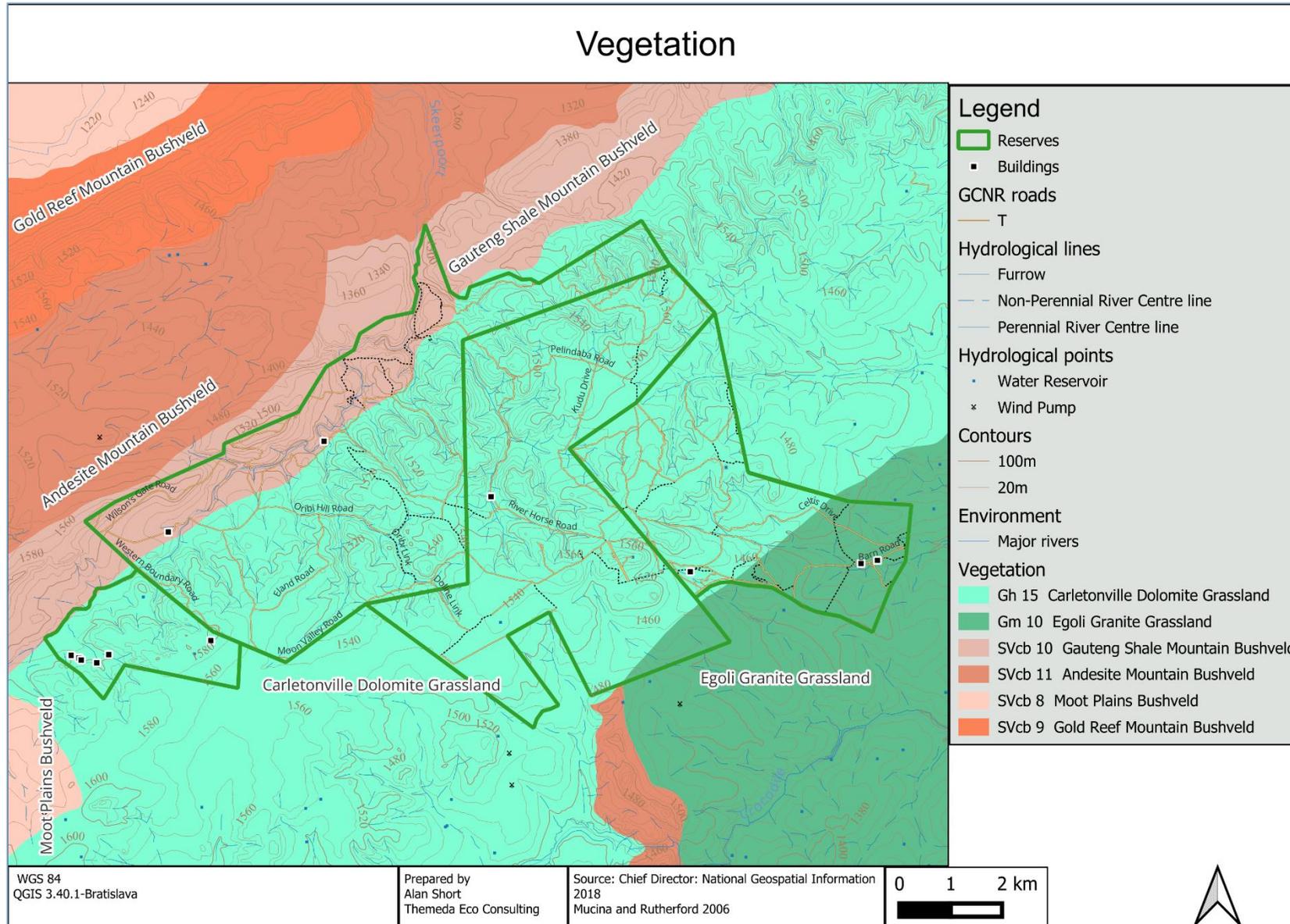
Class	ha	name
2	5	Contiguous Low Forest & Thicket
3	303	Dense Forest & Woodland
4	709	Open Woodland
5	8	Contiguous & Dense Planted Forest
6	1	Open & Sparse Planted Forest
13	7897	Natural Grassland
19	2	Artificial Dams
22	33	Herbaceous Wetlands (currently mapped)
23	48	Herbaceous Wetlands (previous mapped extent)
25	41	Natural Rock Surfaces
31	5	Other Bare
40	105	Cultivated Commercial Annuals Non-Pivot / Non-Irrigated
44	81	Fallow Land & Old Fields (Grass)
47	2	Residential Formal (Tree)
48	1	Residential Formal (Bush)
49	1	Residential Formal (low veg / grass)
55	2	Village Scattered
59	2	Smallholdings (low veg / grass)
67	2	Roads & Rail (Major Linear)
69	1	Mines: Extraction Sites: Open Cast & Quarries combined

1.5 Climate

Rainfall occurs mostly in the summer months, but mean annual rainfall is difficult to determine as different sources provide significantly different values. The source used in the Environmental Management plan provides a mean annual rainfall of 896mm, which is relatively close to the CSIR's Green Book value of about 940mm per year (Le Roux et al. 2019). The general climate description for Carletonville Dolomite Grassland gives annual rainfall of 593mm (Mucina et al. 2006). SamSamWater (samsamwater.com), an online climate tool, gives a mean annual rainfall of 597mm. Eloff (2010) provided one year's worth of rainfall data from two nearby weather stations for 2004, giving a total rainfall of between 658mm and 781mm for that year. The Department of Agriculture rainfall map for South Africa (undated) gives a rainfall range of 600-800mm per year for the area.

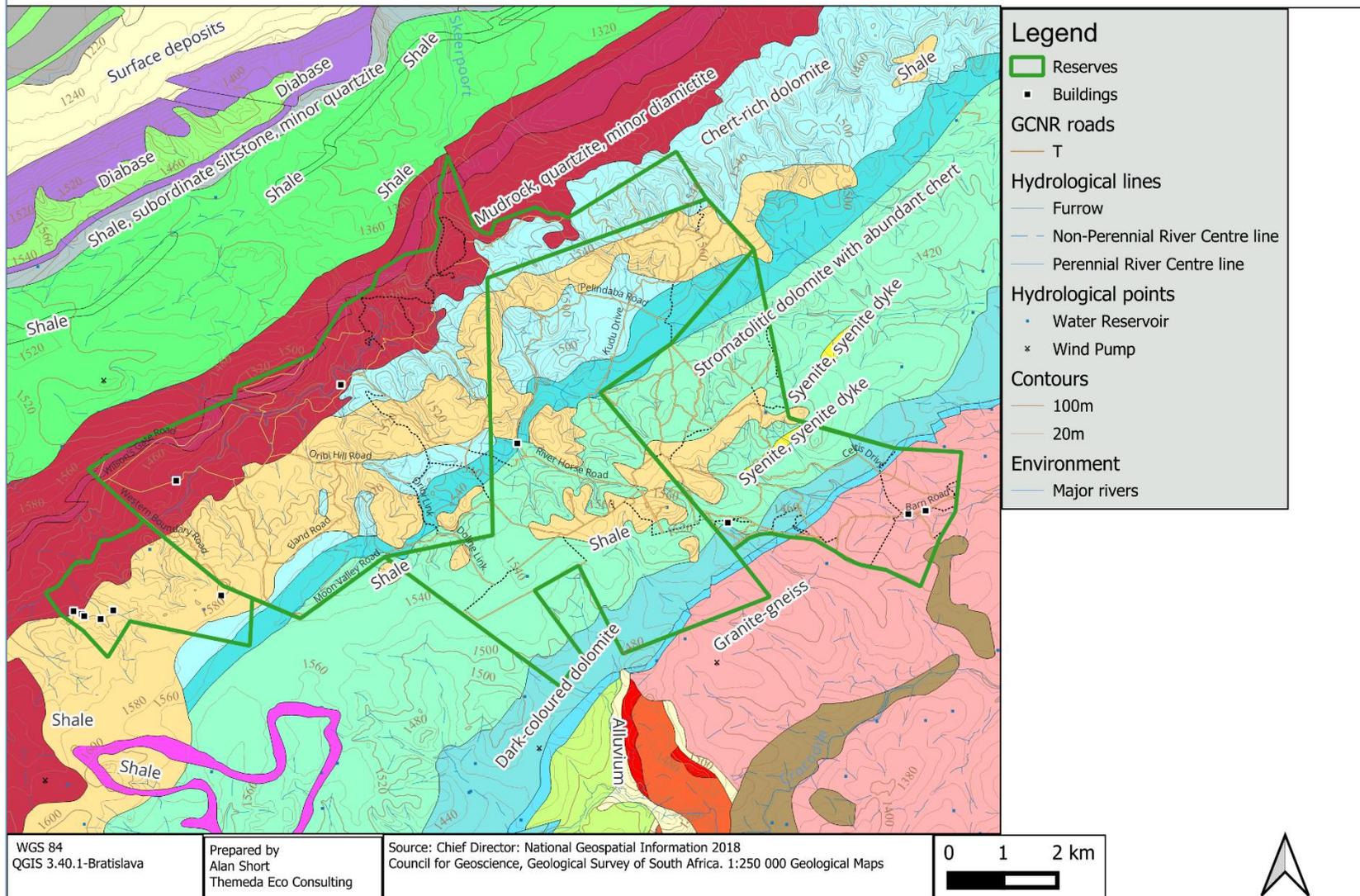
We chose to use the WorldClim V2 dataset (Fick and Hijmans 2017), which falls within the Department of Agriculture range of 600-800mm mean annual rainfall, with a mean for the GCNR of 708mm.

However, the large discrepancy between the lowest and highest reported Mean Annual Precipitation is a significant obstacle to accurately calculating grazing capacity and informed management of the veld. Recommendations to address this shortcoming will be included in section 3.12 Conclusions and recommendations.



Map 4: Vegetation of Greater Cradle Nature Reserve

Geology



Map 5: Major geological groups of Greater Cradle Nature Reserve

1.6 Grass ecological categories

Grasses are subdivided into ecological categories called Increaser and Decreaser, based on their response to grazing and fire.

Decreasers are generally desirable grasses from a veld management perspective that decrease with overgrazing. Rooigras or Redgrass (*Themeda triandra*) is the most important of these species and an excellent indicator of veld condition.

Increaser 1 Species increase when the veld is rested or not burnt. They are generally intolerant of heavy grazing and fire. Some of these species are palatable to animals but many are not. A palatable example, and good veld indicator, is *Tristachya leucothrix*.

Increaser 2 species are species that increase with heavy grazing or disturbance. They are generally moderate to low palatability. They are tolerant of heavy grazing and frequent fire, and may be important to protect the soil surface under conditions of very heavy grazing. Many of the *Eragostis* (lovegrass) species fall into this category

Increaser 3 species are grasses that are thought to increaser under selective grazing pressure. They are generally unpalatable and intolerant of grazing, but with some kind of defense against being grazed (such as chemicals, or very hard leaves). Ngongoni (*Aristida junciformis*) is a major Increaser 3 species in the midlands.

2 METHODS

2.1 Field surveys

Twelve veld condition assessment sites were surveyed in April 2025, with as much environmental variation as possible being covered by sampling. Details of the methodology used are provided in the Appendix. In summary, a nearest-plant survey with 100 points was used for grass species composition, and a belt transect on some transects for woody species density, cover and biomass. A rapid visual assessment, which visually scores the veld on 5 to 7 criteria, was used on all sites.

Soil depth and texture was sampled in the topsoil, and other abiotic factors including landscape position, a visual estimate of current grazing intensity on a scale from “none” to “Very heavy”, and a general description of the site was recorded on all sites.

Most of the veld condition scoring methods require a benchmark, that is, an “ideal” species composition, against which to compare the surveys. No published benchmark could be found for the Granite and Dolomite grasslands of the reserve, so a generic “sourveld” benchmark was used to calculate veld condition scores and grazing capacities. The sourveld benchmark has a total weighted score (species palatability score out of 10, multiplied by the relative abundance of each species) of 750. This number is more realistic as a comparison for surveyed sites than the theoretical maximum score of 1000 that can only be achieved when 100% of grasses have a palatability score of 10.

A general comparison of grass species composition was created by the author by reviewing a botanical study done in the Cradle of Humankind World Heritage Site by Eloff (Eloff 2010).

2.2 Stocking densities and carrying capacities

Game count data was provided for the nature reserves as far back as 1987 (Figure 1). These counts are based on varying techniques including ground and aerial counts. Two estimates were provided in 2010 and the minimum of the two was used for that year’s number.

The game numbers were converted to Animal Units based on the typical masses of game animals provided in Bothma (1996), chapter 17, and the proportion of grass and browse in the diet (Chapter 21, supplemented by other literature).

One Animal Unit (AU) is equivalent to a 450kg steer grazing 10kg per day. The term is synonymous with Large Stock Unit (LSU), also widely used in southern Africa.

Herbivores were first converted to AU, then partitioned into browsers and grazers according to the proportion of grass and browse in each species’ diets (Table 3).

The carrying capacity of the grass portion of the veld was determined according to agricultural norms based on veld condition, slope, and rainfall. However, this does not take into account two factors: the differing behaviour of species (for example, territorial requirements during the breeding season) and the need for sufficient high-quality winter forage. Therefore the carrying capacity was reduced to 70% of the agricultural norms to reflect ecological carrying capacity (Jdu P. Bothma et al. 2004).

Browse capacity is more difficult to determine. It depends on the quantity and quality of leaves available within reach of different species ranging from duiker to giraffe, and varies considerably through the season. One of the most abundant trees in the reserve, *Searsia lancea* (karee), has very low nutritional value and is rarely browsed except in winter. Our sample sites were predominantly concentrated in the relatively open grasslands of the park, while examination of aerial images shows that much of the woodland areas of the reserve are heavily concentrated in valleys and steeper slopes, meaning that woodland areas are undersampled.

Therefore a different approach was used to estimate browse capacity. The woodland cover of the 2022 South African National Landcover Map (DFFE 2020) was used to calculate the total area available to browsers, with a range of estimates for browse capacity based on the range of estimated cover and tree height in each woodland class of the national landcover map. An additional factor was added in for shrubby vegetation in the grassland landcover class, since scattered shrubs are not detected by the landcover classification methodology. It is our experience that the landcover classification is reasonably accurate at the scales of thousands of hectares, albeit with some false positives and negatives. However, the woodland classification for the map appears to closely match the satellite and high-resolution aerial imagery for the GCNR, and is therefore considered a reasonable estimate of woody distribution and cover.

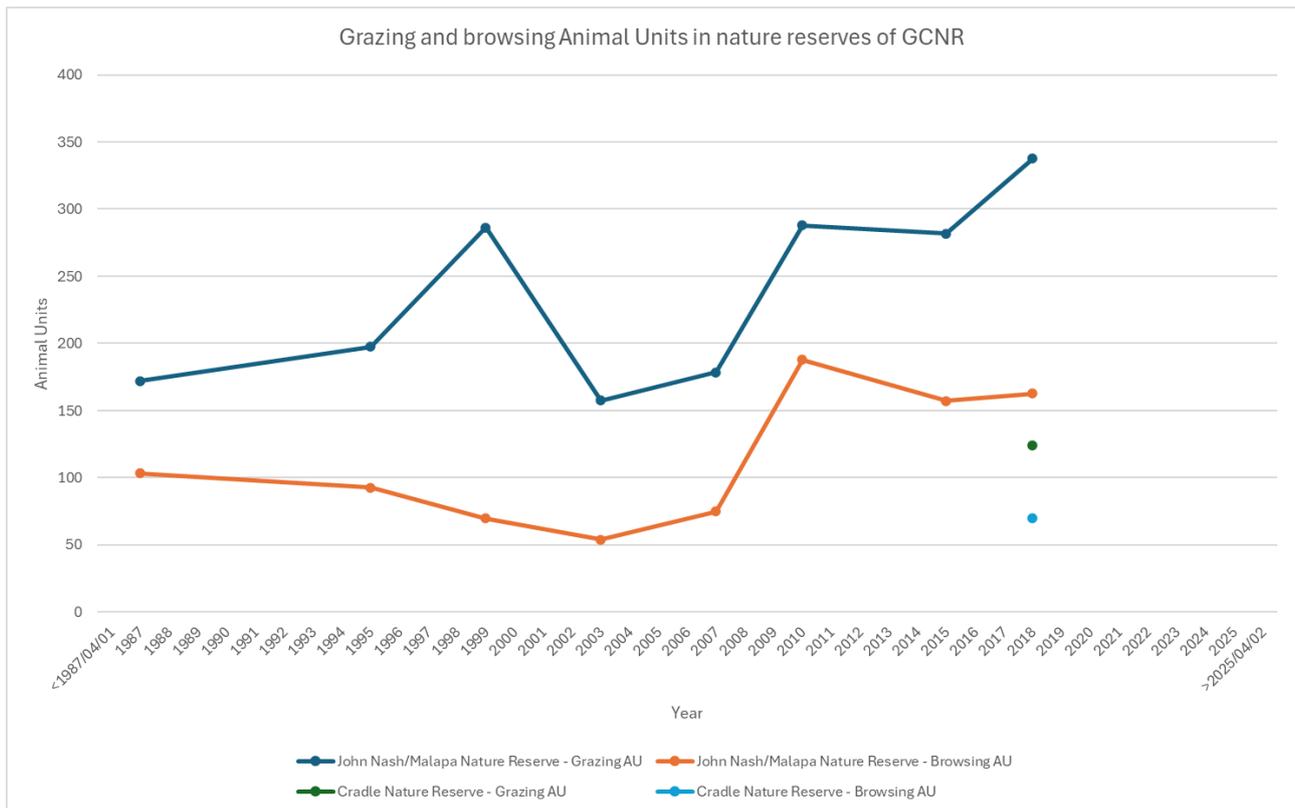


Figure 1: Wildlife stocking rates converted to AU for grazers and browsers in the three component Nature Reserves of GCNR. Mixed feeders have been partitioned into grazer and browser according to the proportion of grass in their diets

Table 3: Conversions from wildlife species to animal units, partitioned into grazing and browsing, over time in GCNR Nature Reserves

NR Name	Taxon	Animal Unit	1987		1995		1999		2003		2007		2010		2015		2018		1987	
			Proportion Grass	Grazing AU	Browsing AU	Grazing AU	Browsing AU	Grazing AU	Browsing AU	Grazing AU	Browsing AU	Grazing AU	Browsing AU	Grazing AU	Browsing AU	Grazing AU	Browsing AU	Grazing AU	Browsing AU	
John Nash/Malapa Nature Reserve	Blesbok	0.22	1	85.8	0	100.98	0	181.5	0	85.8	0	88	0	81.62	0	68.42	0	101.86	0	
	Blue wildebeest	0.5	1	2	0	18	0	35.5	0	17	0	20	0	75	0	63.5	0	76.5	0	
	Buffalo	1.47	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Burchell's Zebra	0.77	1	19.25	0	24.64	0	23.1	0	17.71	0	19.25	0	12.32	0	40.04	0	49.28	0	
	Bushbuck	0.13	0	0	0.52	0	0	0	0	0	0	0	0.65	0	0	0	0	0	0	0
	Common duiker	0.08	0	0	0	0	0	0	0	0	0	0	0	0	0.56	0	0	0	0	0.24
	Eland	1.02	0.3	18.36	42.84	17.44	40.69	10.09	23.56	15.6	36.41	16.83	39.27	47.43	110.67	48.96	114.24	52.93	123.52	
	Gemsbok	0.56	0.75	16.38	5.46	12.18	4.06	6.72	2.24	3.78	1.26	10.5	3.5	33.6	11.2	30.66	10.22	30.24	10.08	
	Giraffe	1.58	0	0	18.96	0	18.96	0	11.06	0	7.9	0	12.64	0	12.64	0	6.32	0	12.64	
	Impala	0.16	0.35	8.4	15.6	6.83	12.68			1.28	2.39	1.12	2.08	0.39	0.72	0.39	0.72	0.22	0.41	
	Impala: black-faced	0.2	0.35					5.6	10.4											
	Kudu	0.54	0.2	3.24	12.96	3.24	12.96	4.64	18.57	0.97	3.88	3.24	12.96	11.77	47.08	5.18	20.73	2.91	11.66	
	Mountain reedbuck	0.12	1	7.2	0	0.48	0	1.08	0	0.96	0	2.4	0	2.52	0	0	0	0	0.96	0
	Nyala	0.23	0.2	0.04	0.18	0	0	0	0	0.04	0.18	0.23	0.92	0	0	0	0	0	0	0
	Oribi	0.07	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Red hartebeest	0.37	0.7	4.14	1.77	1.81	0.77	3.36	1.44	0	0	2.07	0.88	6.47	2.77	4.66	1.99	7.25	3.1	
	Sable	0.56	0.85	3.33	0.58															
	Sable antelope	0.56	0.85			6.18	1.09	8.09	1.42	11.9	2.1	11.9	2.1	11.9	2.1	17.61	3.1	5.71	1	
	Springbok	0.15	0.3	1.8	4.2	0.63	1.47	0.45	1.05	0	0	0	0	0	0	0	0	0	0	0
	Steenbok	0.06	0	0	0.24	0	0	0	0	0	0	0	0	0	0.18	0	0	0	0	0.06
Warthog	0.25	1	0	0	0	0	0	0	0	0	0	0	0.75	0	2.5	0	9.75	0		
Waterbuck	0.5	1	2	0	5	0	6	0	2.5	0	3	0	4	0	0	0	0	0	0	
Total			171.94	103.31	197.41	92.68	286.13	69.74	157.54	54.12	178.54	75	287.77	187.92	281.92	157.32	337.61	162.71		
Cradle Nature Reserve	Blesbok	0.22	1															9.46	0	
	Blue wildebeest	0.5	1															45.5	0	

Veld condition assessments and burning management plan for the Greater Cradle Nature Reserve

NR Name	Taxon	Animal Unit	Proportion on Grass	1987	1995	1999	2003	2007	2010	2015	2018	1987							
				Grazing AU	Browsing AU	Grazing AU	Browsing AU	Grazing AU	Browsing AU	Grazing AU	Browsing AU	Grazing AU	Browsing AU						
	Buffalo	1.47	1								0	0							
	Burchell's Zebra	0.77	1								14.63	0							
	Bushbuck	0.13	0								0	0							
	Common duiker	0.08	0								0	0							
	Eland	1.02	0.3								21.11	49.26							
	Gemsbok	0.56	0.75								6.3	2.1							
	Giraffe	1.58	0								0	7.9							
	Impala	0.16	0.35								0.67	1.24							
	Kudu	0.54	0.2								2.05	8.2							
	Mountain reedbuck	0.12	1								0	0							
	Nyala	0.23	0.2								0	0							
	Oribi	0.07	1								0	0							
	Red hartebeest	0.37	0.7								2.84	1.22							
	Sable antelope	0.56	0.85								0	0							
	Springbok	0.15	0.3								0.09	0.21							
	Steenbok	0.06	0								0	0							
	Warthog	0.25	1								3.25	0							
	Waterbuck	0.5	1								18	0							
Cradle Nature Reserve	Total										123.9	70.13							
Grand Total				171.94	103.31	197.41	92.68	286.13	69.74	157.54	54.12	178.54	75	287.77	187.92	281.92	157.32	461.51	232.84

3 RESULTS

3.1 Veld condition

Detailed descriptions of each site are given in the sections below. Veld condition scores ranged from poor to moderate in both the formal veld condition scoring method (based on the species composition) and the rapid assessment which is based on multiple visual criteria of the veld. Seven sites were surveyed in the Carletonville Dolomite Grasslands, one in the Egoli Granite Grassland, and three in the Gauteng Shale Mountain Bushveld, for a total of 12 sites. A good mix of landscape positions and geology was covered by the survey.

The fuel load in kg/ha (phytomass) was generally high, ranging from 3 to 6 tonnes per hectare, reflecting the generally low stocking densities and infrequent burning in most areas of the reserve.

In general, the crests and upper slopes of the reserve had somewhat lower veld condition than midslopes and footslopes. We saw some areas of significant grazing on crests and topslopes by blesbuck, and topslopes and crests generally have shallow soils and therefore can be more sensitive to high grazing pressure than deeper soils lower down the landscape.

Table 4: Summary of average results for the main measures of veld condition in GCNR. Veld condition scores were calculated according to (Camp and Hardy 1999) for the formal assessments van Oudtshoorn (undated) for the rapid assessments

Vegtype	Geology	Topography	No of sites	Number of formal surveys	veld condition score %	rapid veld score	Basal cover %	Rainfall mm	phytomass (kg/ha)
Gh15									
Carletonville Dolomite Grassland									
	Dolomite	Crest	1	1	33	41	13	719	2980
		Midslope	2	2	45	57	10	714	3835
	Shale	Crest	1	1	39	40	9	707	1932
		Topslope	1	1	44	41	12	716	2010
	Syenite Dolomite; Chert	Footslope	1	1	51	62	10	714	4262
		Topslope	1	1	39	48	9	700	5038
Gm10 Egoli Granite Grassland									
	GRANITE	Footslope	1	1	51	54	7	695	
		Topslope	1	1	29	58	12	702	5466
SVcb10 Gauteng Shale Mountain Bushveld									
	Quartzite Quartzite; mudrock Quartzite; mudrock	Midslope	1	1	42	44	14	714	3408
		Footslope	1			46		705	
		Topslope	1	1	51	54	11	692	3796
Grand Total			12	11	43	50	11	708	3656

One issue of concern was the amount of moribund grass on areas unburnt for many years. Highveld grasslands require relatively frequent fires to remove old, dead grass material and stimulate new growth in both grasses, and in many other wildflowers of the grasslands and savannas. In the absence of fire for very long periods, dead plant material accumulates and begins to shade out the growing apices of new shoots.

3.2 Carrying capacity

3.2.1 Grazing capacity

The grazing capacity of the veld, after adjustment for slope and landcover, was calculated from the mean of three grazing capacity estimation models. Each model was, in turn, reduced by 30% to adjust for the ecological carrying capacity of wildlife rather than the economic carrying capacity of livestock.

The total grazing capacity of the reserve is estimated at 1200 AU, or an average of 7.5 ha/AU. However, there is considerable variation across the reserve caused by topography and landcover (Map 6). The northern ridges and heavily wooded areas have much lower grazing capacities than the gentle rolling grasslands of the centre of the reserve. Some areas also had better veld condition scores, such as around Site 4, which increased the relative grazing capacity.

The current stocking density of the reserve, based on the last game count data in 2018, is estimated to be 461 AU of grazing wildlife, plus another 45 cattle for a grazing pressure of at least 507 AU in 2025 (Table 5). The current grazing density, ignoring the types of animals, therefore appears to be well within the capacity of the GCNR. The mix of animals will be examined in a later section.

The increase in grazing Animal Units and Browsing animal Units, respectively, has historically averaged approximately 2-3% per year on John Nash/Malapa Nature Reserve, although with considerable fluctuations making an accurate population growth model difficult. Using the same conservative 2% per annum growth rate, the current total population on Greater Cradle Nature Reserve, based on the last game counts, should be about 575 AU for grazers and 267 AU for browsers.

Table 5: Summary of historical game count estimates converted to animal units (AU). The wildlife numbers for 2025 are minimums, copied from the last survey in 2018

Row Labels	Sum of Grazing AU	Sum of browsing AU
1987	172	103
1995	197	93
1999	286	70
2003	158	54
2007	179	75
2010	288	188
2015	282	157
2018	462	233
2025	<i>Cattle</i>	45
	<i>Wildlife (No interpolation)</i>	462
	<i>Wildlife (2% annual growth)</i>	530
	<i>Total 2025 (no interpolation)</i>	507
	<i>Total 2025 (interpolated)</i>	575
		267
		233
		267

3.2.2 Browsing capacity

The browsing capacity was determined by modelling a range of minimum and maximum Tree Equivalents per hectare based on the cover classes in the landcover map, and assumptions about the possible average heights and canopy diameters (which determines density) of trees in each land cover class. A tree equivalent is a simple calculation of canopy volume available, calculated by dividing the total heights of trees within a sample plot by 1.5m (van Oudtshoorn 2015). However, as with grazing capacity, the palatability of the different species needs to be taken into account, as well as the feeding behaviour of different game species.

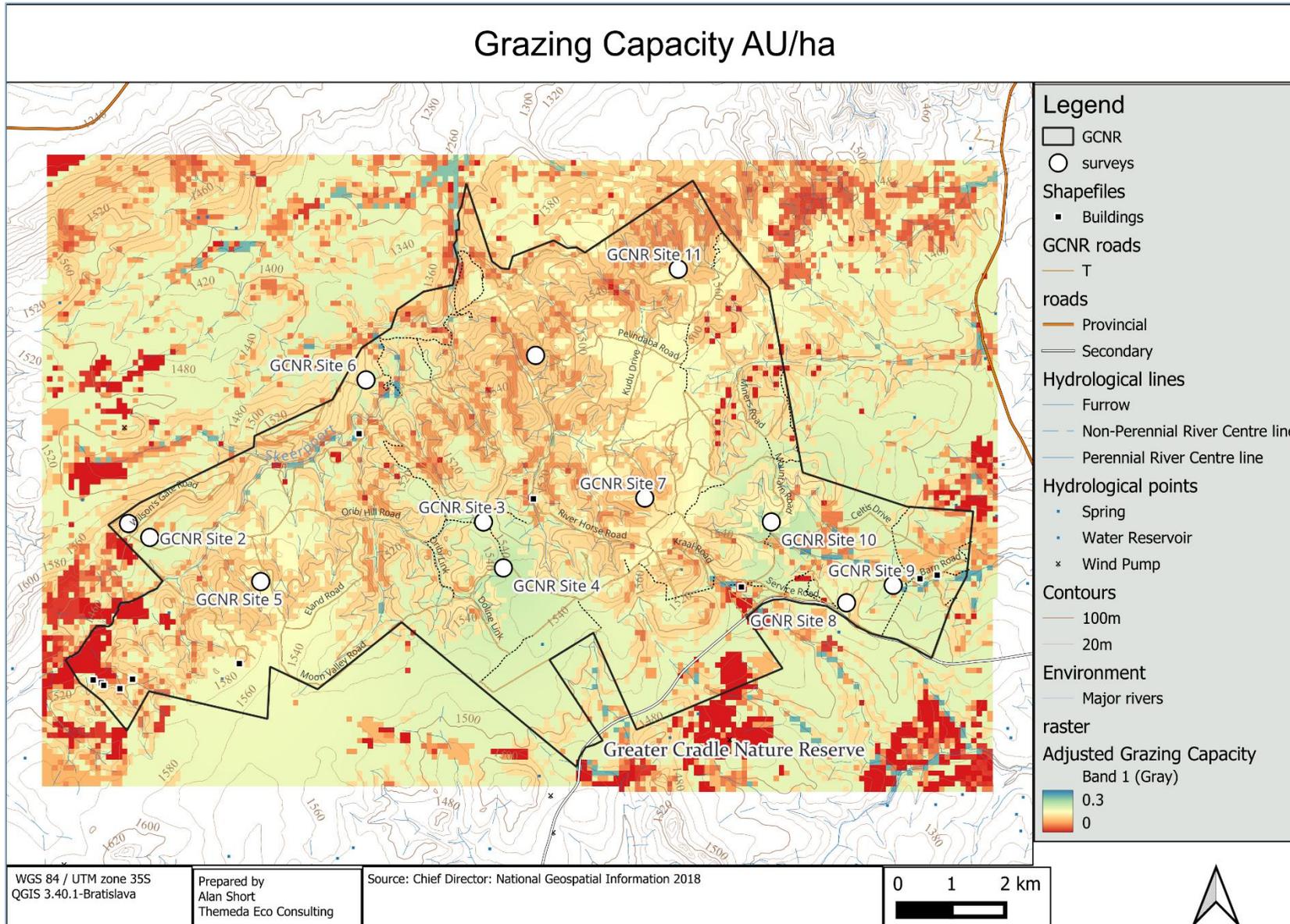
One kudu is approximately 0.4 Animal units, requiring about 4300 Tree Equivalents (TE) per year (van Oudtshoorn 2015)². Therefore a browsing Animal Unit requires about 10,200 TE/year.

Based on this approach, the total browse capacity of the reserve is estimated at a maximum of 477AU. However, the true capacity is likely to be lower as a large proportion of the woody vegetation consists of unpalatable species. Surprisingly, the grassland areas of the reserve provide the bulk of the browsing capacity under the maximum assumptions, simply due to the sheer size of the grassland areas. Scattered trees and shrubs are present throughout the grassland landcover class, but many of them have low browsing value.

Table 6: Description of land cover classes (DFFE 2024) relevant to browsers, with broad estimates of a range of browsing capacity for each type

Class	ha	Name	Description	Min TE /ha	Max TE /ha	Min AU	Max AU
2	5	Contiguous Low Forest & Thicket	Natural tall woody vegetation communities, with 75% or more canopy cover, and canopy heights ranging between 2.5 - 6 metres. Typically representative of low, indigenous forests and dense thicket communities.	127	50930	0	24
3	303	Dense Forest & Woodland	Natural tall woody vegetation communities, with canopy cover ranging between 35 - 75%, and canopy heights exceeding 2.5 metres. Typically represented by dense bush, dense woodland and thicket communities.	153	2829	5	84
4	709	Open Woodland	Natural tall woody vegetation communities, with canopy cover ranging between 10 - 35%, and canopy heights exceeding 2.5 metres. Typically represented by open bush and woodland communities.	212	1132	15	78
13	7897	Natural Grassland	Natural and/or semi-natural indigenous grasslands, typically devoid of any significant tree or bush cover, and where the grassland component is typically dominant over any adjacent bare ground exposure. Typically representative of low, grass-dominated vegetation communities in the Grassland and Savanna Biomes.	1	377	1	291
Total AU browsing capacity						20	477

² Van Oudtshoorn's Table 4.14 provides estimates of TE/year requirements for different browsers. In Van Oudtshoorn the term Browse Unit is used to refer to a 1.5m tree; this report uses the term Tree Equivalents (Smith and Hardy 1999) to avoid confusion with the animals



Map 6: Mean grazing capacity calculated from three different methods, adjusted for slope and landcover. Grazing capacity in AU/ha

3.3 GCNR Site 1 2025



Verbatim Site Name	GCNR Site 1
Sub location	None
Latitude	-25.90938
Longitude	27.721267
Transect direction (degrees true)	None
Elevation (m)	1531.6
Survey Date	2025-04-08 00:00:00
Veld condition score % (Camp and Hardy)	42
Rapid veld condition score (max. 80)	44.0
Vegetation Type	SVcb10 Gauteng Shale Mountain Bushveld
Benchmark veld used for comparison	None
Basal cover %	14.0
Visual basal cover class	15-20%
Grass biomass (kg/ha)	3408.0
Vegetation structure	Short closed grassland
Recorders	Alan Short; Thabiso Ndlovu
Weed or bush encroachment	verbena; bankrotbos;pompom
Type of survey	Visual&Formal
Fire regime	None
Grazing system	Continuous
Geology	Quartzite
Soil texture	sandy clay loam
Soil depth (mm or depth class)	70
Soil wetness class (W0 = no signs of wetness, W4= permanently wet)	None
Rockiness	20 - 30 %
Landscape position	Midslope
Type and severity of soil erosion	Slight terrace
Notes	Mixed short and tall grassland with abundant Cymbopogon, Hyparrhenia, Themeda and Schizachyrium sanguinum. Old dead protea nearby. Selectively grazed. Large patch of disturbed bare area with pompom and pioneer plant. Scatterd diospyros shrubs in disturbed area

3.3.1 Rapid veld assessment

Biomass score	15 - High grass biomass
Species composition	7 - Mostly undesirables; Moderate and poor grazing grasses mixed
Vigour of palatable plants	6 - Satisfactory; Good grasses moderately grazed with medium sized tufts
Soil surface condition	6 - Erosion around tufts, little organic material; Slight levels of topsoil loss; Moderate to light erosion around grass tufts
Bush encroachment	9 - Only light bush encroachment is present
Soil texture	10 - Clay loam
Soil depth	-3 - Less than 300mm
Gravel	-5 - Gravelly soil
Veld condition	45 - Moderate

3.3.2 Species composition

Category	Species	common_name_en	Grazing value	Total
Increaser 1	<i>Alloteropsis semialata</i>	Black Seed Grass	3	1.0
	<i>Cymbopogon caesius</i>	Common turpentine grass	1	1.0
	<i>Cymbopogon pospischilii</i>	Narrow-leaved turpentine grass	0	1.0
	<i>Schizachyrium sanguineum</i>	Red autumn grass	1	27.0
	<i>Tristachya rehmannii</i>	Broom grass	1	4.0
Increaser 1 Total				34.0
Decreaser	<i>Brachiaria serrata</i>	Velvet signal grass	3	4.0
	<i>Diheteropogon amplexans</i>	Broadleaved bluestem	7	5.0
	<i>Melinis nerviglumis</i>	Bristle-leaved redtop	2	7.0
	<i>Themeda triandra</i>	Redgrass	10	9.0
Decreaser Total				25.0
Increaser 2	<i>Eragrostis curvula</i>	Weeping lovegrass	5	13.0
	<i>Hyparrhenia hirta</i>	Common thatchgrass	6	4.0
	<i>Melinis repens</i>	Natal redtop	1	6.0
	<i>Setaria sphacelata var. torta</i>	Creeping setaria	2	18.0
Increaser 2 Total				41.0
Grand Total				100.0
	Forbs			2

3.4 GCNR Site 2 2025



Verbatim Site Name	GCNR Site 2
Sub location	None
Latitude	-25.911683
Longitude	27.725245
Transect direction (degrees true)	None
Elevation (m)	1484.3
Survey Date	2025-04-08 00:00:00
Veld condition score % (Camp and Hardy)	None
Rapid veld condition score (max. 80)	46.0
Vegetation Type	SVcb10 Gauteng Shale Mountain Bushveld
Benchmark veld used for comparison	None
Basal cover %	None
Visual basal cover class	15-20%
Grass biomass (kg/ha)	None
Vegetation structure	Short closed grassland
Recorders	Alan Short; Thabiso Ndlovu
Weed or bush encroachment	pompom
Type of survey	Visual
Fire regime	None
Grazing system	None
Geology	Quartzite;mudrock
Soil texture	clay loam
Soil depth (mm or depth class)	1399
Soil wetness class (W0 = no signs of wetness, W4= permanently wet)	W0
Rockiness	No rocks
Landscape position	Footslope
Type and severity of soil erosion	Insignificant
Notes	Probably secondary grassland, most likely ploughed decades ago. Check historical maps and photos. Soil is deep red well drained and only slightly layered in top 1500mm.

3.4.1 Rapid veld assessment

Biomass score	20 - Very high grass biomass
Species composition	3 - Only undesirables; Mainly poor grazing grasses present
Vigour of palatable plants	8 - Very good; Good grasses are strong with large tufts
Soil surface condition	8 - No soil loss, sufficient organic material; Topsoil not well covered but with no visible soil loss; No erosion and good cover at ground level
Bush encroachment	9 - Only light bush encroachment is present
Soil texture	10 - Clay loam
Soil depth	0 - > 300mm
Gravel	0 - No gravel
Veld condition	58 - Moderate

3.4.2 Species composition

No formal survey was conducted. Dominant species are listed below.

Species	Common name (English)
<i>Cymbopogon caesius</i>	Common turpentine grass
<i>Cynodon dactylon</i>	Couch grass
<i>Eragrostis chloromelas</i>	Curly leaf
<i>Eragrostis curvula</i>	Weeping lovegrass
<i>Eragrostis gummiflua</i>	Gumgrass
<i>Melinis repens</i>	Natal redtop
<i>Schizachyrium sanguineum</i>	Red autumn grass
<i>Setaria sphacelata</i> var. <i>torta</i>	Creeping setaria
<i>Campuloclinum macrocephalum</i>	Pompom

3.5 GCNR Site 3 2025



Verbatim Site Name	GCNR Site 3
Sub location	None
Latitude	-25.908782
Longitude	27.787308
Transect direction (degrees true)	15.0
Elevation (m)	1513.8
Survey Date	2025-04-09 00:00:00
Veld condition score % (Camp and Hardy)	38
Rapid veld condition score (max. 80)	54.0
Vegetation Type	Gh15 Carletonville Dolomite Grassland
Benchmark veld used for comparison	None
Basal cover %	9.0
Visual basal cover class	15-20%
Grass biomass (kg/ha)	4572.0
Vegetation structure	Grassy short open shrubland
Recorders	Alan Short; Thabiso Ndlovu
Weed or bush encroachment	Blackjack;pompom;khakibos;richardia
Type of survey	Visual&Formal
Fire regime	None
Grazing system	None
Geology	Dolomite
Soil texture	sandy loam
Soil depth (mm or depth class)	150
Soil wetness class (W0 = no signs of wetness, W4= permanently wet)	W0
Rockiness	10 - 20 %
Landscape position	Midslope
Type and severity of soil erosion	insignificant
Notes	50m from lick site. Heavily grazed. Dense erogrostis chloromulas with dyospyris ziziphus and searsa shrubs. Several alian invasive weeds present

3.5.1 Rapid veld assessment

Biomass score	15 - High grass biomass
Species composition	7 - Mostly undesirables; Moderate and poor grazing grasses mixed
Vigour of palatable plants	8 - Very good; Good grasses are strong with large tufts
Soil surface condition	8 - No soil loss, sufficient organic material; Topsoil not well covered but with no visible soil loss; No erosion and good cover at ground level
Bush encroachment	7 - Medium to light bush encroachment is present
Soil texture	6 - Sandy loam
Soil depth	-3 - Less than 300mm
Gravel	0 - No gravel
Veld condition	48 - Moderate

3.5.2 Species composition

Category	Species	common_name_en	Grazing value	Total
Increaser 1	<i>Schizachyrium sanguineum</i>	Red autumn grass	1	1.0
	<i>Trachypogon spicatus</i>	Giant spear grass	3	2.0
Increaser 1 Total				3.0
Decreaser	<i>Chrysopogon serrulatus</i>	Golden beard grass	10	2.0
	<i>Diheteropogon amplexens</i>	Broadleaved bluestem	7	8.0
	<i>Themeda triandra</i>	Redgrass	10	2.0
Decreaser Total				12.0
Increaser 2	<i>Cynodon dactylon</i>	Couch grass	3	1.0
	<i>Eragrostis chloromelas</i>	Curly leaf	2	44.0
	<i>Eragrostis curvula</i>	Weeping lovegrass	5	7.0
	<i>Eragrostis gummiflua</i>	Gumgrass	2	15.0
	<i>Eragrostis plana</i>	Fan lovegrass	3	1.0
	<i>Eragrostis sp.</i>	(blank)	4	1.0
	<i>Heteropogon contortus</i>	Speargrass	6	1.0
	<i>Melinis repens</i>	Natal redtop	1	8.0
	<i>Microchloa caffra</i>	Pincushion grass	1	2.0
	<i>Pogonarthria squarrosa</i>	Herringbone grass	0	1.0
	<i>Sporobolus stapfianus</i>	Fibrous dropseed	1	1.0
	<i>Stipagrostis zeyheri subsp. zeyheri</i>	Cape Bushman grass	1	1.0
	<i>Trichoneura grandiglumis</i>	Small rolling grass	0	2.0
Increaser 2 Total				85.0
Grand Total				100.0
Non-grasses	<i>Parinari capensis</i>	Dwarf mobola	0	1.0
	<i>Richardia brasiliensis</i>	(blank)	0	7.0
Total				8.0

3.6 GCNR Site 4 2025



Verbatim Site Name	GCNR Site 4
Sub location	None
Latitude	-25.916433
Longitude	27.791062
Transect direction (degrees true)	350.0
Elevation (m)	1528.3
Survey Date	2025-04-09 00:00:00
Veld condition score % (Camp and Hardy)	51
Rapid veld condition score (max. 80)	59.0
Vegetation Type	Gh15 Carletonville Dolomite Grassland
Benchmark veld used for comparison	None
Basal cover %	10.0
Visual basal cover class	20-25%
Grass biomass (kg/ha)	3097.0
Vegetation structure	Shrubby short continuous grassland
Recorders	Alan Short; Thabiso Ndlovu
Weed or bush encroachment	pompom
Type of survey	Visual&Formal
Fire regime	None
Grazing system	None
Geology	Dolomite
Soil texture	sandy loam
Soil depth (mm or depth class)	110
Soil wetness class (W0 = no signs of wetness, W4= permanently wet)	W0
Rockiness	> 30 %
Landscape position	Midslope
Type and severity of soil erosion	insignificant
Notes	Rocky unburnt grassland with scattered trees and shrubs. Generally good health but lots of grass. Some pompom

3.6.1 Rapid veld assessment

Biomass score	15 - High grass biomass
Species composition	11 - Desirable and undesirable species mixed; Mainly moderate grazing grasses present
Vigour of palatable plants	8 - Very good; Good grasses are strong with large tufts
Soil surface condition	8 - No soil loss, sufficient organic material; Topsoil not well covered but with no visible soil loss; No erosion and good cover at ground level
Bush encroachment	7 - Medium to light bush encroachment is present
Soil texture	6 - Sandy loam
Soil depth	-3 - Less than 300mm
Gravel	0 - No gravel
Veld condition	52 - Moderate

3.6.2 Species composition

Category	Species	common_name_en	Grazing value	Total
Increaser 1	<i>Andropogon chinensis</i>	Hairy blue grass	4	1.0
	<i>Bewisia biflora</i>	False love grass	2	5.0
	<i>Digitaria tricholaenoides</i>	Purple fingergrass	6	5.0
	<i>Schizachyrium sanguineum</i>	Red autumn grass	1	1.0
	<i>Trachypogon spicatus</i>	Giant spear grass	3	2.0
Increaser 1 Total				14.0
Decreaser	<i>Brachiaria serrata</i>	Velvet signal grass	3	7.0
	<i>Diheteropogon amplexens</i>	Broadleaved bluestem	7	18.0
	<i>Melinis nerviglumis</i>	Bristle-leaved redtop	2	7.0
	<i>Themeda triandra</i>	Redgrass	10	2.0
Decreaser Total				34.0
Increaser 2	<i>Digitaria monodactyla</i>	One-finger grass	1	4.0
	<i>Eragrostis chloromelas</i>	Curly leaf	2	3.0
	<i>Eragrostis curvula</i>	Weeping lovegrass	5	1.0
	<i>Eragrostis racemosa</i>	Narrow-heart lovegrass	2	8.0
	<i>Heteropogon contortus</i>	Speargrass	6	1.0
	<i>Melinis repens</i>	Natal redtop	1	7.0
	<i>Setaria sphacelata</i>	Golden setaria	6	14.0
	<i>Setaria sphacelata var. torta</i>	Creeping setaria	2	12.0
	<i>Trichoneura grandiglumis</i>	Small rolling grass	0	1.0
Increaser 2 Total				51.0
(blank)	<i>Unknown</i>	(blank)	1	1.0
(blank) Total				1.0
Grand Total				100.0
Non-grasses	Forbs			1.0
	<i>Cyperaceae</i>	Sedges	0	2.0
Total				3.0

3.7 GCNR Site 5 2025



Verbatim Site Name	GCNR Site 5
Sub location	None
Latitude	-25.918946
Longitude	27.745928
Transect direction (degrees true)	240.0
Elevation (m)	1508.8
Survey Date	2025-04-09 00:00:00
Veld condition score % (Camp and Hardy)	44
Rapid veld condition score (max. 80)	41.0
Vegetation Type	Gh15 Carletonville Dolomite Grassland
Benchmark veld used for comparison	None
Basal cover %	12.0
Visual basal cover class	15-20%
Grass biomass (kg/ha)	2010.0
Vegetation structure	Shrubby low sub-continuous grassland
Recorders	Alan Short; Thabiso Ndlovu
Weed or bush encroachment	pompom
Type of survey	Visual&Formal
Fire regime	None
Grazing system	None
Geology	Shale
Soil texture	sandy clay
Soil depth (mm or depth class)	None
Soil wetness class (W0 = no signs of wetness, W4= permanently wet)	W0
Rockiness	> 30 %
Landscape position	Topslope
Type and severity of soil erosion	moderate sheet
Notes	Gravel rock grassland, burnt, frequently grazed.Large bare gravel areas, some shrubs and scattered pompom

3.7.1 Rapid veld assessment

Biomass score	7 - Low grass biomass
Species composition	7 - Mostly undesirables; Moderate and poor grazing grasses mixed
Vigour of palatable plants	6 - Satisfactory; Good grasses moderately grazed with medium sized tufts
Soil surface condition	6 - Erosion around tufts, little organic material; Slight levels of topsoil loss; Moderate to light erosion around grass tufts
Bush encroachment	9 - Only light bush encroachment is present
Soil texture	4 - Sand
Soil depth	-3 - Less than 300mm
Gravel	-5 - Gravelly soil
Veld condition	31 - Poor

3.7.2 Species composition

Category	Species	common_name_en	Grazing value	Total
Increaser 1	<i>Andropogon chinensis</i>	Hairy blue grass	4	3.0
	<i>Bewisia biflora</i>	False love grass	2	1.0
	<i>Eulalia villosa</i>	Golden velvet grass	3	24.0
	<i>Trachypogon spicatus</i>	Giant spear grass	3	1.0
Increaser 1 Total				29.0
Decreaser	<i>Brachiaria serrata</i>	Velvet signal grass	3	1.0
	<i>Diheteropogon amplexans</i>	Broadleaved bluestem	7	3.0
	<i>Melinis nerviglumis</i>	Bristle-leaved redtop	2	2.0
	<i>Monocymbium ceresiiforme</i>	Wild oats grass	6	18.0
	<i>Themeda triandra</i>	Redgrass	10	3.0
Decreaser Total				27.0
Increaser 2	<i>Eragrostis chloromelas</i>	Curly leaf	2	7.0
	<i>Eragrostis racemosa</i>	Narrow-heart lovegrass	2	17.0
	<i>Eragrostis rigidior</i>	(Broad) Curly Leaf	4	2.0
	<i>Loudetia simplex</i>	Russet grass	1	9.0
	<i>Melinis repens</i>	Natal redtop	1	1.0
	<i>Setaria sphacelata var. torta</i>	Creeping setaria	2	2.0
	<i>Sporobolus pectinatus</i>	Fringed dropseed	1	6.0
Increaser 2 Total				44.0
Grand Total				100.0
Non-grasses	Cyperaceae	Sedges		10.0
	<i>Parinari capensis</i>	Dwarf mobola	0	1.0
Total				11.0

3.8 GCNR Site 6 2025



Verbatim Site Name	GCNR Site 6
Sub location	None
Latitude	-25.885159
Longitude	27.765303
Transect direction (degrees true)	140.0
Elevation (m)	1412
Survey Date	2025-04-10 00:00:00
Veld condition score % (Camp and Hardy)	51
Rapid veld condition score (max. 80)	54.0
Vegetation Type	SVcb10 Gauteng Shale Mountain Bushveld
Benchmark veld used for comparison	None
Basal cover %	11.0
Visual basal cover class	5-15%
Grass biomass (kg/ha)	3796.0
Vegetation structure	Shrubby low continuous grassland
Recorders	Alan Short; Thabiso Ndlovu
Weed or bush encroachment	pompom;solonum spp;cex
Type of survey	Visual&Formal
Fire regime	None
Grazing system	None
Geology	Quartzite; mudrock
Soil texture	sandy clay loam
Soil depth (mm or depth class)	40
Soil wetness class (W0 = no signs of wetness, W4= permanently wet)	W0
Rockiness	20 - 30 %
Landscape position	Topslope
Type and severity of soil erosion	slight sheet
Notes	Rocky shallow shale soil. Setaria grassland with scattered ziziphus shrubs below a band of caff woodland. CEX appears to be encroaching/ large patches present. Some scattered bare areas

3.8.1 Rapid veld assessment

Biomass score	11 - Moderate grass biomass
Species composition	15 - Mostly desirables; Good and moderate grazing grasses mixed
Vigour of palatable plants	8 - Very good; Good grasses are strong with large tufts
Soil surface condition	7 - Little soil loss, some organic material
Bush encroachment	7 - Medium to light bush encroachment is present
Soil texture	10 - Clay loam
Soil depth	-3 - Less than 300mm
Gravel	-5 - Gravelly soil
Veld condition	50 - Moderate

3.8.2 Species composition

Category	Species	common_name_en	Grazing value	Total
Increaser 1	<i>Andropogon chinensis</i>	Hairy blue grass	4	0.9
	<i>Digitaria diagonalis</i>	Brown-seed finger grass	2	0.9
	<i>Schizachyrium sanguineum</i>	Red autumn grass	1	8.8
	<i>Trachypogon spicatus</i>	Giant spear grass	3	5.3
Increaser 1 Total				15.8
Decreaser	<i>Brachiaria serrata</i>	Velvet signal grass	3	10.5
	<i>Diheteropogon amplexans</i>	Broadleaved bluestem	7	2.6
	<i>Melinis nerviglumis</i>	Bristle-leaved redtop	2	1.8
	<i>Panicum natalense</i>	Natal panic	2	0.9
	<i>Themeda triandra</i>	Redgrass	10	16.7
Decreaser Total				32.5
Increaser 2	<i>Cynodon dactylon</i>	Couch grass	3	1.8
	<i>Eragrostis curvula</i>	Weeping lovegrass	5	4.4
	<i>Eragrostis racemosa</i>	Narrow-heart lovegrass	2	7.9
	<i>Heteropogon contortus</i>	Speargrass	6	0.9
	<i>Melinis repens</i>	Natal redtop	1	1.8
	<i>Paspalum scrobiculatum</i>	Veld paspalum	3	0.9
	<i>Setaria sphacelata</i>	Golden setaria	6	2.6
	<i>Setaria sphacelata var. torta</i>	Creeping setaria	2	30.7
Increaser 2 Total				50.9
(blank)	<i>Unknown</i>	(blank)	1	0.9
(blank) Total				0.9
Grand Total				100.0
	<i>Forbs</i>		0	12.3

3.9 GCNR Site 7 2025



Verbatim Site Name	GCNR Site 7
Sub location	None
Latitude	-25.904617
Longitude	27.817294
Transect direction (degrees true)	135.0
Elevation (m)	1527.8
Survey Date	2025-04-10 00:00:00
Veld condition score % (Camp and Hardy)	33
Rapid veld condition score (max. 80)	41.0
Vegetation Type	Gh15 Carletonville Dolomite Grassland
Benchmark veld used for comparison	None
Basal cover %	13.0
Visual basal cover class	20-25%
Grass biomass (kg/ha)	2980.0
Vegetation structure	Shrubby low sub-continuous grassland
Recorders	Alan Short; Thabiso Ndlovu
Weed or bush encroachment	pompom
Type of survey	Visual&Formal
Fire regime	None
Grazing system	None
Geology	Dolomite
Soil texture	sandy clay
Soil depth (mm or depth class)	20
Soil wetness class (W0 = no signs of wetness, W4= permanently wet)	W0
Rockiness	> 30 %
Landscape position	Crest
Type and severity of soil erosion	moderate sheet
Notes	Heavily grazed dolomite crest with terretorial middens, very shallow soil

3.9.1 Rapid veld assessment

Biomass score	7 - Low grass biomass
Species composition	7 - Mostly undesirables; Moderate and poor grazing grasses mixed
Vigour of palatable plants	4 - Poor; Good grasses heavily grazed with small tufts
Soil surface condition	6 - Erosion around tufts, little organic material; Slight levels of topsoil loss; Moderate to light erosion around grass tufts
Bush encroachment	5 - Medium bush encroachment is present
Soil texture	6 - Sandy loam
Soil depth	-3 - Less than 300mm
Gravel	-5 - Gravelly soil
Veld condition	27 - Very poor

3.9.2 Species composition

Category	Species	common_name_en	Grazing value	Total
Increaser 1	<i>Schizachyrium sanguineum</i>	Red autumn grass	1	3.0
Increaser 1 Total				3.0
Decreaser	<i>Melinis nerviglumis</i>	Bristle-leaved redtop	2	1.0
	<i>Themeda triandra</i>	Redgrass	10	2.0
Decreaser Total				3.0
Increaser 2	<i>Aristida transvaalensis</i>	(blank)	0	2.0
	<i>Cynodon dactylon</i>	Couch grass	3	18.0
	<i>Eragrostis chloromelas</i>	Curly leaf	2	24.0
	<i>Eragrostis curvula</i>	Weeping lovegrass	5	2.0
	<i>Eragrostis gummiflua</i>	Gumgrass	2	10.0
	<i>Eragrostis lehmanniana</i>	Lehmann's love grass	4	13.0
	<i>Heteropogon contortus</i>	Speargrass	6	1.0
	<i>Hyparrhenia hirta</i>	Common thatchgrass	6	3.0
	<i>Melinis repens</i>	Natal redtop	1	5.0
	<i>Pogonarthria squarrosa</i>	Herringbone grass	0	9.0
	<i>Sporobolus stapfianus</i>	Fibrous dropseed	1	4.0
	<i>Stipagrostis zeyheri subsp. zeyheri</i>	Cape Bushman grass	1	3.0
Increaser 2 Total				94.0
Grand Total				100.0
Non-grasses	<i>Forbs</i>	(blank)	0	1.0

3.10 GCNR Site 8 2025



Verbatim Site Name	GCNR Site 8
Sub location	None
Latitude	-25.921899
Longitude	27.854944
Transect direction (degrees true)	60.0
Elevation (m)	1429.1
Survey Date	2025-04-11 00:00:00
Veld condition score % (Camp and Hardy)	29
Rapid veld condition score (max. 80)	58.0
Vegetation Type	Gm10 Egoli Granite Grassland
Benchmark veld used for comparison	None
Basal cover %	12.0
Visual basal cover class	15-20%
Grass biomass (kg/ha)	5466.0
Vegetation structure	Grassy Low Open Shrubland
Recorders	Alan Short; Thabiso Ndlovu
Weed or bush encroachment	pompom; karee; bankrot bos
Type of survey	Visual&Formal
Fire regime	None
Grazing system	None
Geology	Granite
Soil texture	sandy loam
Soil depth (mm or depth class)	110
Soil wetness class (W0 = no signs of wetness, W4= permanently wet)	W0
Rockiness	2 - 10 %
Landscape position	Topslope
Type and severity of soil erosion	slight sheet

Notes unburnt seterra- erogrostis grassland on shallow sandy soil, with seriphium encroachment and s.lancea encroachment. Good litter cover from several years of not burning. Wetland patch (perched water) near bottom of transect.

Moved coordinates from GPS location (near road) to start of transect using GIS.

3.10.1 Rapid veld assessment

Biomass score	15 - High grass biomass
Species composition	11 - Desirable and undesirable species mixed; Mainly moderate grazing grasses present
Vigour of palatable plants	8 - Very good; Good grasses are strong with large tufts
Soil surface condition	7 - Little soil loss, some organic material
Bush encroachment	5 - Medium bush encroachment is present
Soil texture	6 - Sandy loam
Soil depth	-3 - Less than 300mm
Gravel	0 - No gravel
Veld condition	49 - Moderate

3.10.2 Species composition

Category	Species	common_name_en	Grazing value	Total
Increaser 1	<i>Bewsia biflora</i>	False love grass	2	4.0
	<i>Cymbopogon caesius</i>	Common turpentine grass	1	1.0
	<i>Schizachyrium sanguineum</i>	Red autumn grass	1	15.2
	<i>Trachypogon spicatus</i>	Giant spear grass	3	10.1
Increaser 1 Total				30.3
Decreaser	<i>Diheteropogon amplexans</i>	Broadleaved bluestem	7	2.0
	<i>Panicum natalense</i>	Natal panic	2	7.1
Decreaser Total				9.1
Increaser 2	<i>Eragrostis chloromelas</i>	Curly leaf	2	20.2
	<i>Eragrostis curvula</i>	Weeping lovegrass	5	4.0
	<i>Eragrostis gummiflua</i>	Gumgrass	2	9.1
	<i>Eragrostis racemosa</i>	Narrow-heart lovegrass	2	2.0
	<i>Setaria sphacelata var. torta</i>	Creeping setaria	2	23.2
	<i>Sporobolus africanus</i>	Ratstail dropseed	3	2.0
Increaser 2 Total				60.6
Grand Total				100.0
Non-grasses	<i>Cyperaceae</i>	Sedges	0	5.1
	<i>Forbs</i>	(blank)	0	4.0
	<i>Seriphium plumosum</i>	Bankruptbush	(blank)	1.0
Total				10.1

3.11 GCNR Site 9 2025

Verbatim Site Name	GCNR Site 9
Sub location	None
Latitude	-25.91892
Longitude	27.863606
Transect direction (degrees true)	125.0
Elevation (m)	1376.8
Survey Date	2025-04-11 00:00:00
Veld condition score % (Camp and Hardy)	51
Rapid veld condition score (max. 80)	54.0
Vegetation Type	Gm10 Egoli Granite Grassland
Benchmark veld used for comparison	None
Basal cover %	7.0
Visual basal cover class	5-15%
Grass biomass (kg/ha)	None
Vegetation structure	Grassy short open shrubland
Recorders	Alan Short; Thabiso Ndlovu
Weed or bush encroachment	Verbena;pompom;richardia
Type of survey	Visual&Formal
Fire regime	None
Grazing system	None
Geology	Granite
Soil texture	sandy
Soil depth (mm or depth class)	100
Soil wetness class (W0 = no signs of wetness, W4= permanently wet)	W0
Rockiness	No rocks
Landscape position	Footslope
Type and severity of soil erosion	slight sheet
Notes	unburned moribund grassland. Karree encroachment. Very shallow soils. Just above the dam.

3.11.1 Rapid veld assessment

Biomass score	20 - Very high grass biomass
Species composition	7 - Mostly undesirables; Moderate and poor grazing grasses mixed
Vigour of palatable plants	6 - Satisfactory; Good grasses moderately grazed with medium sized tufts
Soil surface condition	8 - No soil loss, sufficient organic material; Topsoil not well covered but with no visible soil loss; No erosion and good cover at ground level
Bush encroachment	3 - Heavy to medium bush encroachment present
Soil texture	4 - Sand
Soil depth	-3 - Less than 300mm
Gravel	-
Veld condition	-

3.11.2 Species composition

Category	Species	common_name_en	Grazing value	Total
Increaser 1	<i>Schizachyrium sanguineum</i>	Red autumn grass	1	2.0
Increaser 1 Total				2.0
Decreaser	<i>Setaria incrassata</i>	(blank)	7	13.0
Decreaser Total				13.0
Increaser 2	<i>Cynodon dactylon</i>	Couch grass	3	7.0
	<i>Eragrostis chloromelas</i>	Curly leaf	2	35.0
	<i>Eragrostis curvula</i>	Weeping lovegrass	5	32.0
	<i>Paspalum notatum</i>	Lawn paspalum	4	5.0
	<i>Paspalum scrobiculatum</i>	Veld paspalum	3	1.0
	<i>Sporobolus africanus</i>	Ratstail dropseed	3	3.0
	<i>Sporobolus pyramidalis</i>	Catstail dropseed	2	2.0
Increaser 2 Total				85.0
Non-grasses	<i>Richardia brasiliensis</i>	(blank)	0	5.0
	<i>Forbs</i>	(blank)	0	21.0
	<i>Campuloclinium macrocephalum</i>	Pom-pom weed	0	1.0
	<i>Seriphium plumosum</i>	Bankruptbush	(blank)	3.0
Total				30.0

3.12GCNR Site 10 2025



Verbatim Site Name	GCNR Site 10
Sub location	None
Latitude	-25.908471
Longitude	27.840856
Transect direction (degrees true)	220.0
Elevation (m)	1468.4
Survey Date	2025-04-11 00:00:00
Veld condition score % (Camp and Hardy)	51
Rapid veld condition score (max. 80)	62.0
Vegetation Type	Gh15 Carletonville Dolomite Grassland
Benchmark veld used for comparison	None
Basal cover %	10.0
Visual basal cover class	5-15%
Grass biomass (kg/ha)	4262.0
Vegetation structure	Grassy Low bushland
Recorders	Alan Short; Thabiso Ndlovu
Weed or bush encroachment	S.lancea;pompom
Type of survey	Visual&Formal
Fire regime	None
Grazing system	None
Geology	Syenite
Soil texture	clay loam
Soil depth (mm or depth class)	100
Soil wetness class (W0 = no signs of wetness, W4= permanently wet)	W0
Rockiness	20 - 30 %
Landscape position	Footslope
Type and severity of soil erosion	slight terracing
Notes	Unburnt woody grassland on syenite ridge, Karee encroachment. Considerable moribund material. Transect ends in deep soil bottom land

3.12.1 Rapid veld assessment

Biomass score	15 - High grass biomass
Species composition	15 - Mostly desirables; Good and moderate grazing grasses mixed
Vigour of palatable plants	7 - Good; Good grasses are lightly grazed with medium to large tufts
Soil surface condition	7 - Little soil loss, some organic material
Bush encroachment	3 - Heavy to medium bush encroachment present
Soil texture	10 - Clay loam
Soil depth	-3 - Less than 300mm
Gravel	0 - No gravel
Veld condition	54 - Moderate

3.12.2 Species composition

Category	Species	common_name_en	Grazing value	Total
Increaser 1	<i>Cymbopogon caesius</i>	Common turpentine grass	1	3.0
	<i>Digitaria diagonalis</i>	Brown-seed finger grass	2	7.0
	<i>Setaria nigrirostris</i>	Large seed setaria	5	27.0
	<i>Trachypogon spicatus</i>	Giant spear grass	3	15.0
Increaser 1 Total				52.0
Decreaser	<i>Brachiaria serrata</i>	Velvet signal grass	3	3.0
	<i>Diheteropogon amplexans</i>	Broadleaved bluestem	7	7.0
	<i>Themeda triandra</i>	Redgrass	10	2.0
Decreaser Total				12.0
Increaser 2	<i>Cynodon dactylon</i>	Couch grass	3	3.0
	<i>Eragrostis chloromelas</i>	Curly leaf	2	9.0
	<i>Eragrostis curvula</i>	Weeping lovegrass	5	7.0
	<i>Heteropogon contortus</i>	Speargrass	6	2.0
	<i>Setaria sphacelata var. torta</i>	Creeping setaria	2	13.0
	<i>Sporobolus africanus</i>	Ratstail dropseed	3	2.0
Increaser 2 Total				36.0
Grand Total				100.0
Non-grasses	<i>Cyperaceae</i>	Sedges	0	3.0
	<i>Forbs</i>	(blank)	0	11.0
Total				14.0

3.13GCNR Site 11 2025



Verbatim Site Name	GCNR Site 11
Sub location	None
Latitude	-25.866331
Longitude	27.823258
Transect direction (degrees true)	360.0
Elevation (m)	1555.4
Survey Date	2025-04-12 00:00:00
Veld condition score % (Camp and Hardy)	39
Rapid veld condition score (max. 80)	40.0
Vegetation Type	Gh15 Carletonville Dolomite Grassland
Benchmark veld used for comparison	None
Basal cover %	9.0
Visual basal cover class	5-15%
Grass biomass (kg/ha)	1932.0
Vegetation structure	Low moderately closed grassland
Recorders	Alan Short; Thabiso Ndlovu
Weed or bush encroachment	bankrotbos
Type of survey	Visual&Formal
Fire regime	None
Grazing system	None
Geology	Shale
Soil texture	Sandy
Soil depth (mm or depth class)	50
Soil wetness class (W0 = no signs of wetness, W4= permanently wet)	W0
Rockiness	> 30 %
Landscape position	Crest
Type and severity of soil erosion	severe sheet
Notes	Stony quartzite ridge frequently burnt by wildfires. Little grazing pressure in this area due to poaching. Basal cover is sparse and soil eroding

3.13.1 Rapid veld assessment

Biomass score	7 - Low grass biomass
Species composition	7 - Mostly undesirables; Moderate and poor grazing grasses mixed
Vigour of palatable plants	7 - Good; Good grasses are lightly grazed with medium to large tufts
Soil surface condition	4 - Severe erosion around tufts, no organic material; Moderate levels of topsoil loss; Distinct erosion around grass tufts
Bush encroachment	10 - No Bush encroachment present
Soil texture	4 - Sand
Soil depth	-3 - Less than 300mm
Gravel	0 - No gravel
Veld condition	36 - Poor

3.13.2 Species composition

Category	Species	common_name_en	Grazing value	Total
Increaser 1	<i>Andropogon chinensis</i>	Hairy blue grass	4	2.0
	<i>Digitaria tricholaenoides</i>	Purple fingergrass	6	5.0
	<i>Eulalia villosa</i>	Golden velvet grass	3	16.0
	<i>Schizachyrium sanguineum</i>	Red autumn grass	1	4.0
	<i>Trachypogon spicatus</i>	Giant spear grass	3	3.0
	<i>Tristachya leucothrix</i>	Trident grass	9	3.0
	<i>Tristachya rehmannii</i>	Broom grass	1	1.0
	<i>Urelytrum agropyroides</i>	Quinine grass	0	1.0
Increaser 1 Total			35.0	
Decreaser	<i>Brachiaria serrata</i>	Velvet signal grass	3	2.0
	<i>Diheteropogon amplexans</i>	Broadleaved bluestem	7	11.0
	<i>Melinis nerviglumis</i>	Bristle-leaved redtop	2	1.0
	<i>Panicum natalense</i>	Natal panic	2	1.0
Decreaser Total			15.0	
Increaser 2	<i>Aristida scabrivalvis</i>	Purple three-awn	1	8.0
	<i>Aristida transvaalensis</i>	(blank)	0	1.0
	<i>Eragrostis capensis</i>	Heartseed lovegrass	2	1.0
	<i>Eragrostis racemosa</i>	Narrow-heart lovegrass	2	15.0
	<i>Heteropogon contortus</i>	Speargrass	6	3.0
	<i>Loudetia simplex</i>	Russet grass	1	3.0
	<i>Melinis repens</i>	Natal redtop	1	9.0
	<i>Pogonarthria squarrosa</i>	Herringbone grass	0	2.0
	<i>Sporobolus pectinatus</i>	Fringed dropseed	1	8.0
Increaser 2 Total			50.0	
Grand Total			100.0	
Non-grasses	<i>Cyperaceae</i>	Sedges	0	20.0
	<i>Forbs</i>	(blank)	0	3.0
	<i>Parinari capensis</i>	Dwarf mobola	0	12.0
Total			35.0	

3.14 GCNR Site 12 2025



Verbatim Site Name	GCNR Site 12
Sub location	None
Latitude	-25.880887
Longitude	27.796816
Transect direction (degrees true)	200.0
Elevation (m)	1491.7
Survey Date	2025-04-12 00:00:00
Veld condition score % (Camp and Hardy)	39
Rapid veld condition score (max. 80)	48.0
Vegetation Type	Gh15 Carletonville Dolomite Grassland
Benchmark veld used for comparison	None
Basal cover %	9.0
Visual basal cover class	5-15%
Grass biomass (kg/ha)	5038.0
Vegetation structure	Grassy short closed shrubland
Recorders	Alan Short; Thabiso Ndlovu
Weed or bush encroachment	None
Type of survey	Visual&Formal
Fire regime	None
Grazing system	None
Geology	Dolomite; Chert
Soil texture	sandy loam
Soil depth (mm or depth class)	50
Soil wetness class (W0 = no signs of wetness, W4= permanently wet)	W0
Rockiness	> 30 %
Landscape position	Topslope
Type and severity of soil erosion	slight gully
Notes	Start of transect appears to be in igneous dyke. Last fire was wildfire in 2015, bush slowly returning since then. Significant moribund material is starting to shade out grasses. Little to no grazing. Steep gravelly slope

3.14.1 Rapid veld assessment

Biomass score	15 - High grass biomass
Species composition	7 - Mostly undesirables; Moderate and poor grazing grasses mixed
Vigour of palatable plants	4 - Poor; Good grasses heavily grazed with small tufts
Soil surface condition	6 - Erosion around tufts, little organic material; Slight levels of topsoil loss; Moderate to light erosion around grass tufts
Bush encroachment	5 - Medium bush encroachment is present
Soil texture	6 - Sandy loam
Soil depth	-3 - Less than 300mm
Gravel	-5 - Gravelly soil
Veld condition	35 - Poor

3.14.2 Species composition

Category	Species	common_name_en	Grazing value	Total
Increaser 1	<i>Andropogon chinensis</i>	Hairy blue grass	4	9.0
	<i>Digitaria tricholaenoides</i>	Purple fingergrass	6	3.0
	<i>Eulalia villosa</i>	Golden velvet grass	3	1.0
	<i>Schizachyrium sanguineum</i>	Red autumn grass	1	30.0
Increaser 1 Total				43.0
Decreaser	<i>Andropogon schirensis</i>	Stab grass	6	4.0
	<i>Brachiaria serrata</i>	Velvet signal grass	3	4.0
	<i>Diheteropogon amplexans</i>	Broadleaved bluestem	7	6.0
	<i>Melinis nerviglumis</i>	Bristle-leaved redtop	2	1.0
	<i>Panicum natalense</i>	Natal panic	2	1.0
	<i>Themeda triandra</i>	Redgrass	10	5.0
Decreaser Total				21.0
Increaser 2	<i>Aristida transvaalensis</i>	(blank)	0	3.0
	<i>Eragrostis chloromelas</i>	Curly leaf	2	1.0
	<i>Eragrostis racemosa</i>	Narrow-heart lovegrass	2	26.0
	<i>Setaria sphacelata</i>	Golden setaria	6	2.0
	<i>Setaria sphacelata var. torta</i>	Creeping setaria	2	3.0
	<i>Trichoneura grandiglumis</i>	Small rolling grass	0	1.0
Increaser 2 Total				36.0
Grand Total				100.0
Non-grasses	<i>Forbs</i>	(blank)	0	4.0
	<i>Shrubs</i>	(blank)	(blank)	1.0
Total				5.0

4 RECOMMENDATIONS

4.1 Wildlife carrying capacity and population

Currently the mix of foraging classes for grazing is about 50% selective grazers, with 26% non-selective grazers and 20% of grazing coming from mixed feeders (Table 7).

In order to maintain the condition of the veld, the proportion of larger, non-selective grazers relative to the smaller selective grazers should be increased significantly. A ratio of about 50% non-selective grazers is recommended for sourveld and has been shown in livestock experiments to maintain the condition of veld better than a high proportion of selective grazers (e.g. Short 2010).

All herbivores select the best available forage to a greater or lesser extent, but some herbivores, especially larger animals, can tolerate lower quality forage and are able to graze taller, less palatable species. Animals such as cattle, buffalo and zebra will complement smaller, more selective herbivores by utilizing less palatable grass and less selectively focussing on the most palatable individual tufts and species.

Table 7: Animal units by species and foraging class in the Greater Cradle Nature Reserve

Foraging Class	Species	Sum of Grazing AU	Sum of browsing AU
Browser	Bushbuck	0	0
	Common duiker	0	0
	Giraffe	0	21
	Kudu	5	20
	Steenbok	0	0
Browser Total		5	41
Mixed feeder	Eland	74	173
	Gemsbok	37	12
	Impala	1	2
	Nyala	0	0
	Springbok	0	0
Mixed feeder Total		112	187
Non-Selective Grazer	Buffalo	0	0
	Burchell's Zebra	64	0
	Cattle	45	0
	Red hartebeest	10	4
	Warthog	13	0
Non-Selective Grazer Total		132	4
Selective grazer	Blesbok	111	0
	Blue wildebeest	122	0
	Mountain reedbuck	1	0
	Oribi	0	0
	Sable antelope	6	1
	Waterbuck	18	0
Selective grazer Total		258	1
Grand Total		507	233

The ratio of selective to non-selective grazers can be adjusted either by introducing more non-selective grazers (e.g expanding the cattle herd as a veld management tool), or by destocking the selective grazers, or a combination of both. The large herds of blesbok and wildebeest tend to congregate in certain areas of the reserve, especially near lick points and in recently burnt veld, and may need to be reduced to achieve a better ratio of selective to non-selective grazers.

4.1.1 Animal movement

Animals can be encouraged to move from one area of the reserve to another through the seasons by a combination of the following tactics:

- 1) Fire: Burning patches or blocks of the veld in rotation between years will pull many grazers to the recently burnt areas;
- 2) Moving licks or closing and opening water points: mineral licks will attract animals to the area near the lick site. However, they will cause degradation around the lick site, especially in large numbers and over long periods.
- 3) Herding livestock to new areas, especially to encourage grazing of taller grass that is less acceptable to animals that prefer short-grass areas (such as blesbok), or a mosaic of short and tall grass (such as oribi).

4.1.2 Population growth

Grazers have seen a rapid increase in numbers, driven primarily by wildebeest and zebra, with blesbok number fluctuating considerably over the years. It is not known whether the apparent spike in blesbok numbers and subsequent collapse is an artefact of game counting methods, or whether it reflects real population changes. There has been a recent uptick in the population of blesbok recorded on the reserve (Figure 2).

Browser and mixed-feeder populations have also increased in aggregate, driven by eland and gemsbok, with impala declining significantly over the years. Kudu populations are slightly below their level in the 1980s, and giraffe declined in the 2000s but the population has recovered in recent years (Figure 3).

The static kudu population and general population changes of browsers specifically may indicate that the reserve is approaching its carrying capacity for browsers.

Annual game counts will need to be conducted to monitor the populations of animals, especially fast-growing populations of wildebeest, eland, gemsbok and zebra.

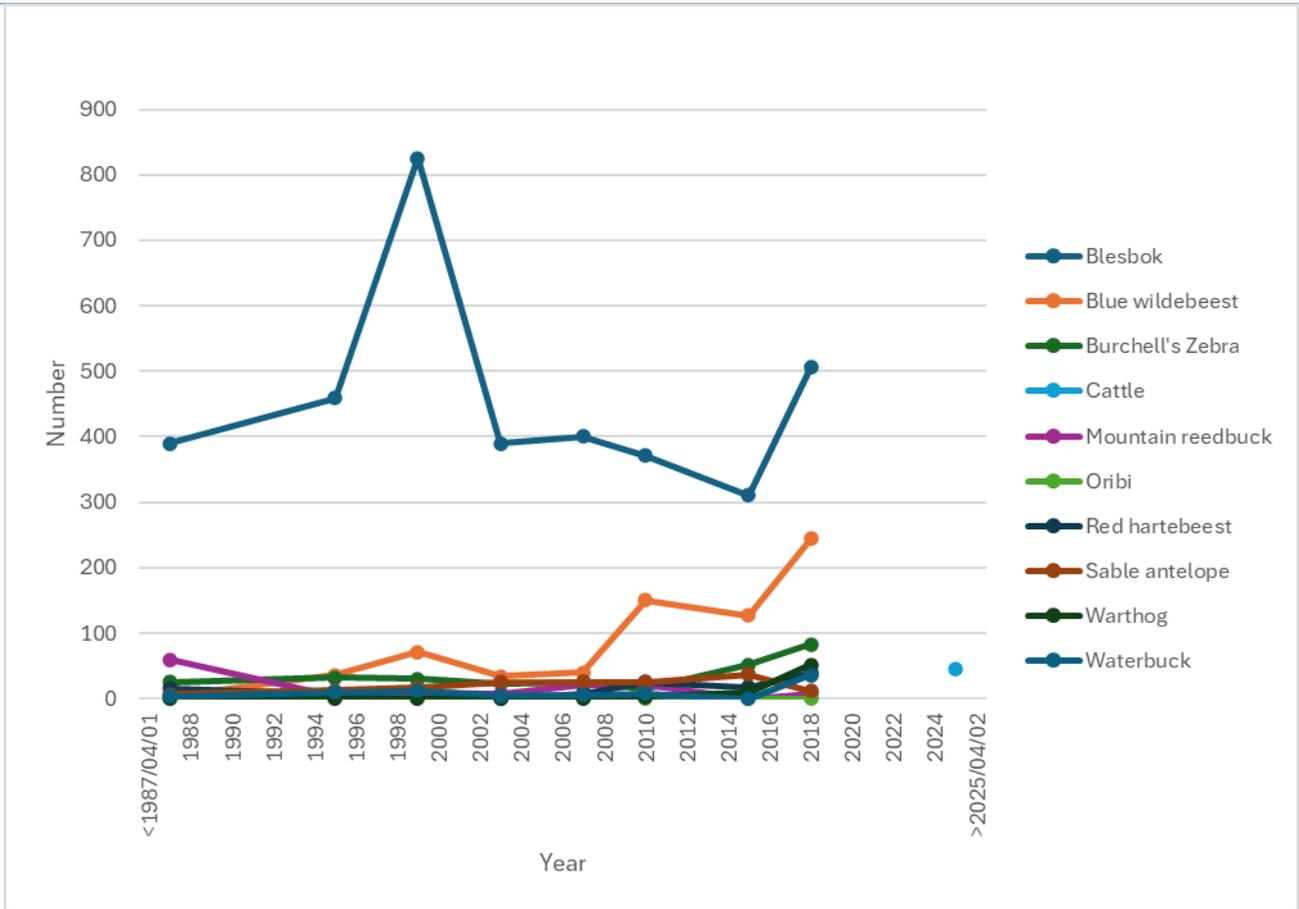


Figure 2: Population change among grazers on GCNR

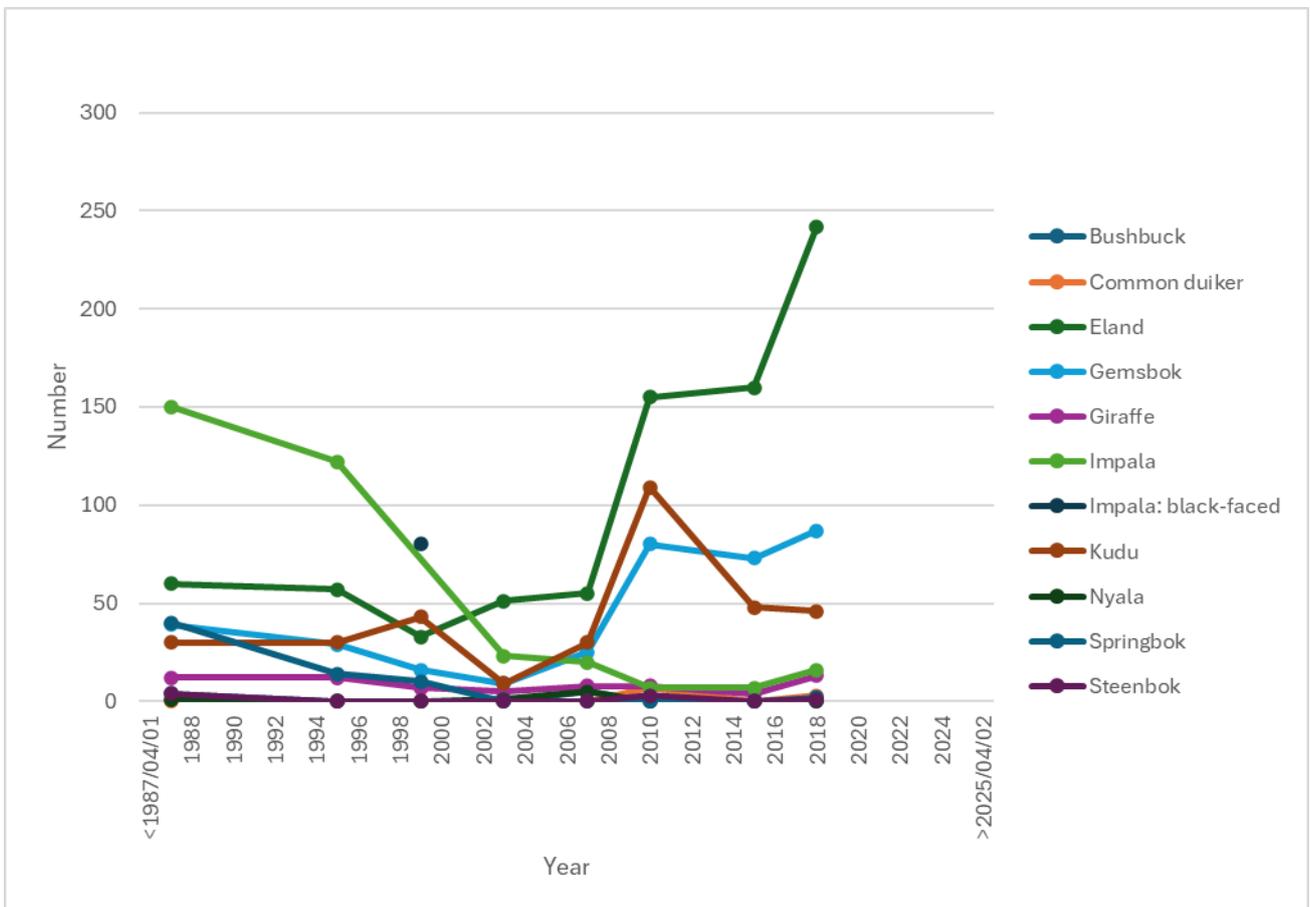


Figure 3: Population changes among browsers and mixed feeders on GCNR

4.1.3 Game counts

Game counts are essential for monitoring the stocking density and population trends of game on the reserve.

No game counts will be entirely accurate, but repeated game counts using repeatable methods will give a good estimate of population trends.

Road-based counting should be conducted using a fixed route, followed each year. Sufficient observers should be present in the vehicle to count on both sides of the road as well as a recorder and driver, or if there are insufficient personnel then only one side of the vehicle is counted.

Game can be sampled within a fixed distance of the vehicle for a strip count to estimate density, or using a laser rangefinder for distance-based measurements, which can be converted to a density estimate (animals/ha).

Aerial counts can be conducted at intervals of a few years to supplement the annual road-based counting.

Whichever method of counting is chosen, it should be documented, standardized and repeated using well-established field methods and standard statistical estimations to be able to estimate trends in populations, especially of the larger animals.

Seasonal observations (summer and winter) can be a useful tool to measure the movements of animals through the year and record which habitats different species use at different times of the year.

4.1.4 Licks

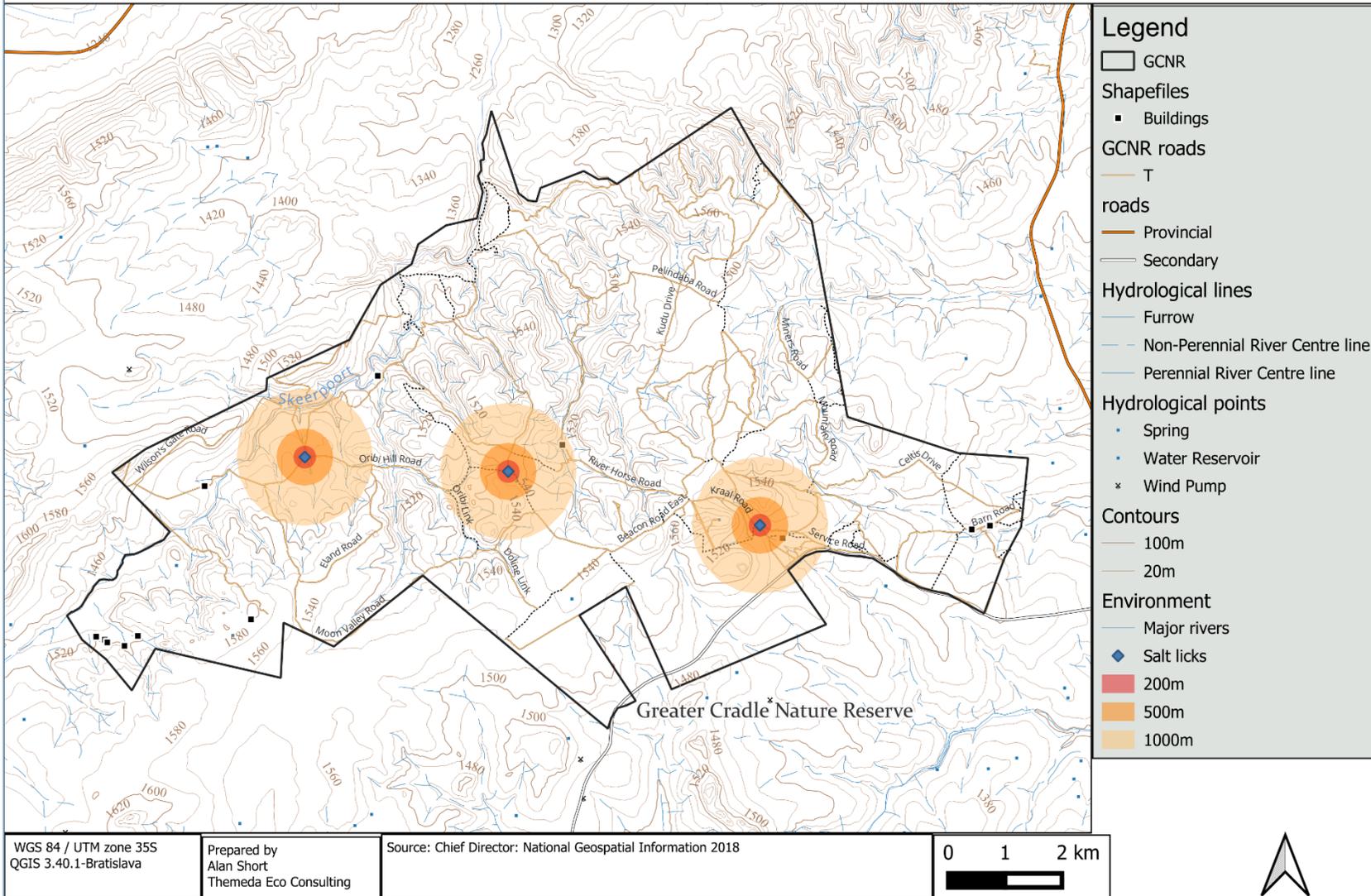
Three lick sites are located on the reserve (Map 7). The potential impact zones of higher grazing pressure on the surrounding grasslands are mapped at 200m, 500m and 1000m, with logarithmically declining impact as the radius increases.

Lick sites and water points are known to have impacts on the surrounding vegetation that can extend for several kilometers (e.g. Brits et al. 2003), but how far the impact zone extends in highveld grasslands at the stocking densities in GCNR is not known. One survey, site 3, was deliberately done near a lick point to gauge the nearby impacts on veld condition. The veld condition score was poor at 38%, with relatively high shrub abundance and a high proportion of increaser 2 species and low basal cover. However, site 4 which was within a kilometer, had moderate condition veld at 51% score, which was equivalent to the best sites in the reserve.

The lick sites appear to be far enough apart that their zones of influence do not overlap. Lick sites should not be moved (although licks can be added or subtracted to the sites to move animals) in order to keep the sacrifice zone of immediate impact at a few locations.

Currently a mineral lick and some energy is provided. A protein lick is likely required for the winter, as the veld loses most of its protein after late summer, and animals cannot move to sweeter areas to the north of Pretoria for the dormant season. A comprehensive review of animal nutrition is recommended to (a) ensure that the correct licks are being provided to maintain animal health and (b) minimize wastage of resources, if incorrect proportions or quantities of minerals, energy and protein are being provided.

Lick sites and potential impact zones



Map 7: Lick sites and potential zones of high impact in GCNR

4.2 Fire

4.2.1 Fire for biodiversity and veld management

In the last five years, less half the reserve has burnt (Table 8). The largest portion was in August and September of 2022 when a quarter of the reserve burnt in two incidents. In 2023 only 10% of the reserve burnt. All of the fires were in the northern to central portion of the reserve, with no areas in the south and west being burnt in the last five years (Map 8).

Fires should be applied on average every three to five years, with about one third to one-fifth of the reserve being burnt with a controlled burn each year.

The block burning can take at least two forms:

- 1) Burn one large contiguous block each year (equivalent to the 2022 fires) or
- 2) Burn many smaller areas to create a mosaic of burnt and unburnt grassland.

Which approach is applied will depend on practical considerations including fire safety and the direction and magnitude of unplanned fires; some areas may need to be burned more regularly as large blocks to prevent unplanned fires encroaching on other portions, which in turn can have a more flexible fire regime. The southern and western areas could have a patch mosaic burning program where controlled burns are started at a point and allowed to burn out naturally under supervision to create a variety of burnt and unburnt areas, while the fire-prone areas of the north and east boundaries are burned more regularly to control and prevent unplanned fires from spreading into the reserve.

Alternate firebreaks wherever possible, on either side of roads, rivers, ridges or other suitable internal boundaries. Firebreaks are typically burnt annually and often have much higher grazing pressure as animals move onto the green flush in winter and early spring.

The exact configuration of major burning blocks should be decided by the management team, taking into account practical and safety considerations. Four to five major blocks, which can be subdivided into smaller units if necessary, are recommended.

Table 8: Area burnt and percentage of total reserve

Date	Area (ha)	Percent burnt
Aug 2020	335	4
Aug 2021	600	6
Aug 2022	1997	22
Sept 2022	305	3
Sept 2023	934	10

4.2.2 Fire for bush control

Fire can be a useful tool in the battle against bush control, when used in conjunction with other control methods.

The objective of using fire to assist with bush control is not to eliminate or clear the bush, but to thin out young saplings and shrubs. More mature trees may be damaged, but will often simply coppice from the base in the following spring.

In contrast to controlled block burning for veld management, bush control requires hot, high-intensity fires.

A fuel load of 4000kg per ha is generally recommended for a hot fire (Trollope and Dondofema 2003). Currently much of the reserve is at or near this level of grass. Hot fires require additional fire safety precautions and may require an earlier block burn or large firebreak around the target area to minimize the chance of the fire escaping the target zone.

Drone technology has significantly increased the options and tools available for fire managers, as controlled ignitions can be done along preplanned routes with multiple ignition points, from a safe distance or at otherwise inaccessible or dangerous terrain.

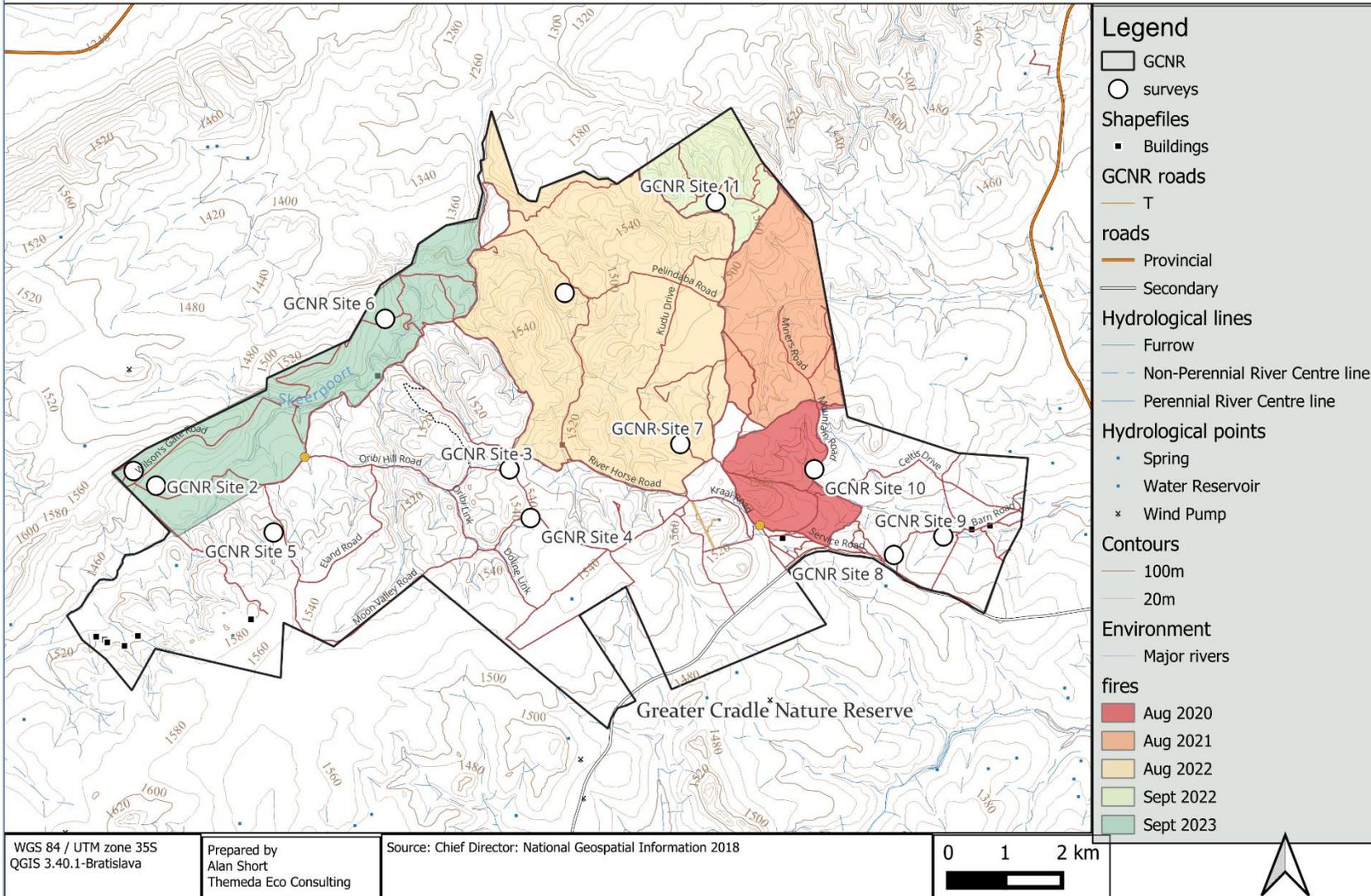
The environmental conditions required for hot and cool fires are listed in Table 9 (Trollope 2007). Hot fires require warm, dry conditions with a high fuel load to achieve sufficient fire intensity (measured as the amount of energy released per second per meter of fire front) to damage and topkill small trees and shrubs.

Head fires do little damage to grasses as the fire passes over quickly and has little effect on the growing points of grass tufts. Back fires, in contrast, do considerably more damage to grasses as the fire intensity is closer to the ground for a longer period.

Table 9: Environmental conditions required for hot fires and cool fires. In both cases head fires are used for the main burn to minimise damage to grass tufts (Trollope 2007)

Type of fire	Cool fires	Hot fires
Objective	Remove moribund material, manage biodiversity by creating mosaic of unburnt and burnt grassland; reduce fuel for fire safety, improve grazing for the season	Topkill of shrubs and trees, removes moribund grass
Air Temperature	<20s° C	>25° C
Wind speed	<20 km/h	<20 km/h
Relative humidity	>50%	<30%
Fuel load (kg/ha of grass)		>4000kg/ha
Fire intensity (kJ/s/m)	<1000	>2000

Fire reports



WGS 84 / UTM zone 35S
QGIS 3.40.1-Bratislava

Prepared by
Alan Short
Themeda Eco Consulting

Source: Chief Director: National Geospatial Information 2018

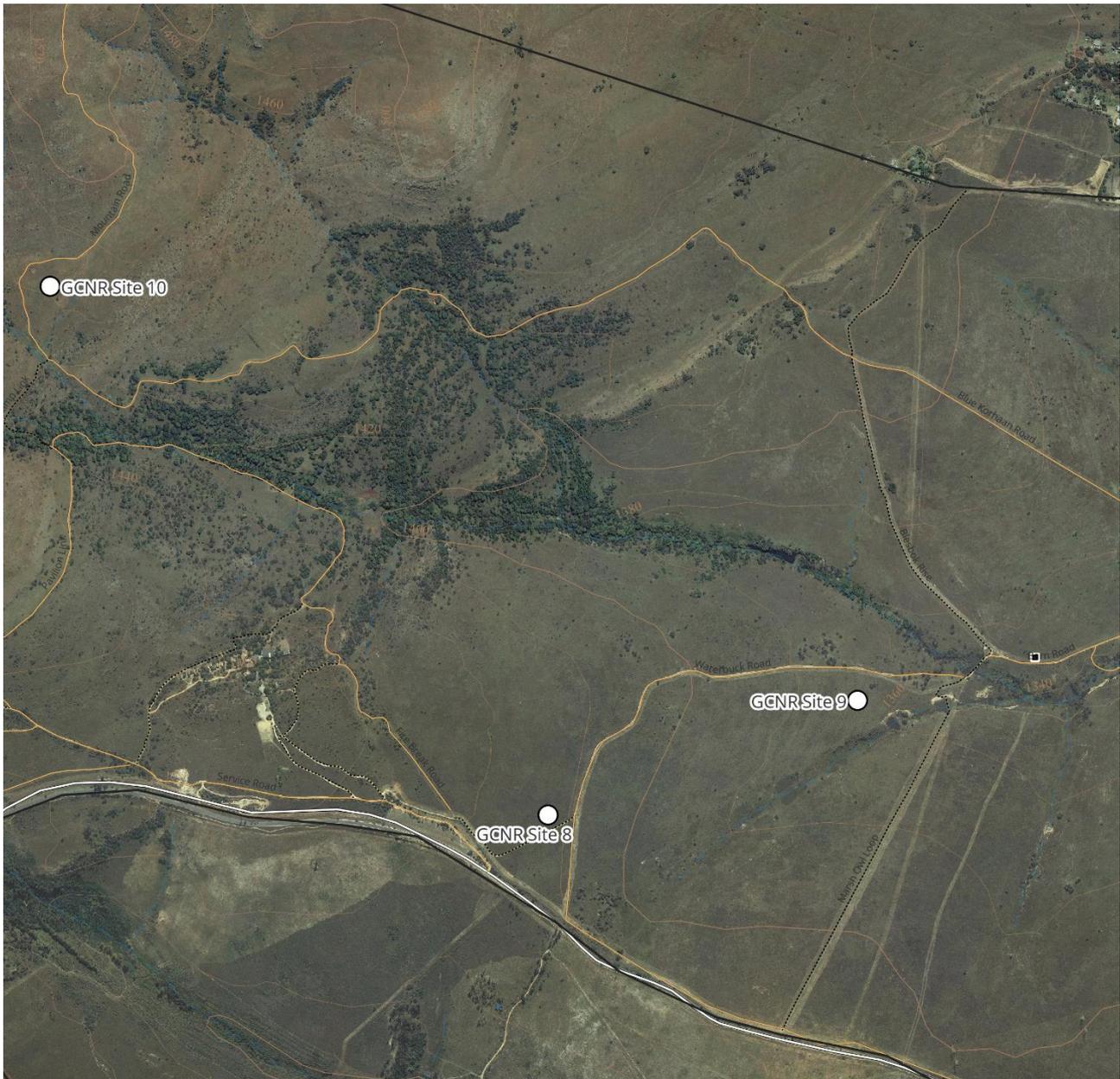
0 1 2 km

Map 8: Mapped fire incidents, 2020 - 2023

4.3 Bush control

The major bush control concern in the Greater Cradle Nature Reserve is karee (*Searsia lancea*), an indigenous bush widespread in highveld grasslands. In recent decades karee has increased exponentially, transforming significant areas of the reserve from open grasslands and sparse woodlands to dense woodlands. The karee has little palatability and is rarely used by browsers except in winter. *Searsia lancea* is not currently listed as an indicator of bush encroachment by the Department of Agriculture, and therefore support for control is less likely to be available.

Karee is found concentrated on southern slopes and in valleys and along drainage lines. Several areas of dense infestation are visible on satellite and aerial images throughout the reserve, but particularly in the south and eastern portions of the Cradle Nature Reserve (e.g. Map 9). Google Earth images 20 years apart show clear bush thickening in places (Map 10).



Map 9: Dense karee encroachment in the Egoli granite grassland. Note the thickets along drainage lines and south-facing slopes. Image: 2018 50cm photo mosaic, Chief Directorate: National Geospatial Information.



Map 10: Close-up view of Egoli Granite Grasslands in 2004 (top) and 2025 (bottom) showing thickening of Karee on slopes. Image: Google Earth

4.4 Main principles of bush control

The main principles of bush (and often alien plant) control are

- 1) Work from the outside in. In other words, start with areas of low infestation to eliminate saplings before they become mature enough to propagate. In these low infestation areas, fire can be a potentially cheap and quick tool to suppress tree encroachment into grassland areas;
- 2) Do not try to clear the entire area when the bush is very thick; The objective is to thin out trees and open up the woodland to allow grass production and to allow large trees to suppress the growth of saplings;
- 3) Constantly monitor and follow up. A significant amount of effort is wasted when a bush control program is not followed up for several years, often resulting in coppicing and increased recruitment;
- 4) Combine multiple methods to achieve best results, including mechanical control, biological control where possible, strategic use of herbicides, and fire.

No specific recommendations for karee control were found, so general recommendations for woody plant control are included.

4.4.1 Selective thinning

Selective thinning of trees can be done by hand or a machine such as a rotary saw. For smaller saplings and shrubs hand cutting or pulling can be effective. For larger stems a herbicide should be immediately applied to the cut stump, preferably within 30 minutes of cutting.

Soil applied granules such as tebuthiuron are not recommended as they are non-selective and very long lasting. Du Toit (2012) investigated the effects of tebuthiuron applied to grasslands to control bankruptbush (*Seriphium plumosum*) and found that 8 years after applications bare patches, which appeared to be larger than the original plant, were still present, and that seedlings planted into the bare patches had nearly 100% mortality, compared to low mortality to seedlings planted into nearby untreated patches.

The effectiveness of foliar application on karee trees and shrubs does not appear to be documented. Foliar application can be effective for some shrubs and trees but requires large amounts of herbicide to be liberally applied to all the leaves. Foliar herbicides can be applied to coppice, after the main stem has been cut.

4.4.2 Mechanical clearing

Mechanical clearing, using large machines such as bullozers, is not recommended for the GCNR, as significant damage to soils and other non-target vegetation is likely to occur, and rehabilitation in highveld grasslands is difficult and uncertain.

4.4.3 Fire

Karee is said to be fire-resistant, and fire may not be effective for dense stands. If fire is used, it should be to suppress young growth, and in conjunction with other forms of control such as herbicide application to coppice, or selective thinning to increase grass fuel loads in dense stands. The recommendations for hot fires in the previous section should be followed when attempting to suppress karee growth and recruitment.

4.5 General recommendations

Veld management is a process of continual learning and adaptive management. It requires monitoring and record-keeping in order to track trends over time, and to ensure that gradual changes over time do not go unnoticed. Grass species composition is one of the main indicators of veld condition and can change gradually, especially in sourveld, and warning signs of degradation can go unnoticed for years until the change is too great to reverse.

Continue monitoring the condition of the veld using a combination of rapid assessments (for example, using the bushveld rapid assessment shown in Table 11), and fixed-point photography to track progress and change over time. The rapid assessment approach, or one similar to it, is easy to apply and can be done to inform burning and game number decisions.

Ideally, several people should do the monitoring together so that consensus can be achieved on the scoring of different areas.

Maintain a spatial database of all natural resource data including animal numbers, plant species composition, specimen photos, fire incidents, and studies and reports that can be easily accessed in future. Many open-source platforms exist such as spatialite, PostGIS, and others which can be configured to maintain all the spatial and non-spatial data relevant to the natural resources of the reserve in one central location, backed up regularly.

Establish written Standard Operating Procedures for fire management, game counts, veld assessments, bush control and alien plant control, erosion control and road maintenance, all of which impact on the condition of the veld in various ways.

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6 APPENDIX A: METHODS

6.1 Sampling strategy

6.1.1 Site selection

Sites were selected to represent as much variation as possible in the landscape, taking into account time and accessibility. A range of sites on bottomlands, midslopes and crests were surveyed, as well as different underlying geology.

6.1.2 Field survey methods

6.1.2.1 NEAREST-PLANT SURVEYS

The nearest-plant method, as used by de Wet, is as follows:

- 1) Two parallel 50m tapes are laid out from the starting point, using historical photographs or the bearing recorded in historical data to determine the location and direction of the transects;
- 2) At each meter, a spike is lowered to the ground and the nearest herbaceous grass to the point is recorded to species. If the nearest plant is not a grass (that is, a forb or a sedge), it is recorded in a second column in addition to the grass;
- 3) The distance in cm from the spike to the edge of the grass tuft is recorded and the diameter of the grass tuft in cm.

Grass composition is expressed as a percentage relative abundance for each species. Forbs and sedges are likewise recorded as a percentage.

The relative abundance is converted to a veld condition score and grazing capacity by one of several methods, to give a range of veld condition scores from different models. These scores are, in turn, converted into a range of grazing capacity estimates. The range of estimates of grazing capacity is then used to calculate a mean grazing capacity from all of the results, under the assumption that several different models will likely converge to a reasonable estimate of veld condition and grazing capacity.

Increaser/decreaser categories were applied according to the KZN veld guidelines (Hardy et al. 1999), Van Oudtshoorn's guide to the grasses of Southern Africa (van Oudtshoorn 2006), and other sources from the literature where required. In some cases where no published classification for a particular species could be found, or where different sources provided contradictory classifications, the author's experience was used to classify a species into an ecological category, and to assign it a grazing value out of 10.

6.1.2.2 RAPID ASSESSMENT

At each site, an additional series of observations, called a rapid assessment, was performed.

A number of criteria are scored by the observer on a sliding scale from "bad" to "very good". The scores are numeric values applied based on experience and training, and are used to quickly calculate a veld condition score according to two different methods. The first was a scoring system developed for highveld grasslands by Fourie and Roberts (Fourie and Roberts 1977), which evaluates six criteria such as species composition (based on a subjective evaluation of the dominant grasses), cover, production and soil condition (state of erosion), among others.

The second is a method adapted from the Fourie and Roberts method by van Oudtshoorn (van Oudtshoorn no date) for the bushveld, which uses a similar approach but with some slightly different criteria, such as including a score for the level of bush encroachment seen on site.

Both sets of scores are then aggregated to a veld condition score based on a formula. For Fourie and Roberts, the formula is a regression equation with several terms, while for van Oudtshoorn the veld condition score is a simple sum of the scores for each criterion. Both methods then use a lookup table to compare veld condition scores to rainfall to derive a grazing capacity estimate.

The rapid assessment is used on all sites, including sites where a step-point survey has been conducted, as well as on some additional sites alone to fill in gaps in the area surveyed.

6.1.2.3 PHYTOMASS

Phytomass (above-ground living plant material) is estimated for grasses by use of a disc pasture meter (Bransby and Tainton 1977) with 50 readings per plot. The mean disc height in cm is converted to phytomass in kg/ha by using one of several published calibration equations, with the appropriate equation selected for the region being surveyed.

In most cases, the conversion formula used is either Trollope and Potgieter (1986) for bushveld regions or Little et al (2015) for moist grasslands.

6.1.2.4 WOODY DENSITY AND COVER

For some transects where woody plant density was sufficient to warrant additional measurements, a belt transect was surveyed on either side of the grass transect. The belt transect was typically 2m wide on each side, for a total of 4m x 50m or 200m². In sparse shrublands or woodlands a wider belt was used.

All woody trees and shrubs are identified in the transect, and their height and canopy diameter recorded in m, as well as the height of the first leaves of the canopy. For larger trees and shrubs, an additional parameter, the shape of the canopy volume, was also recorded according to Melville et al (1999). They simply described the volumetric shape of the canopy according to one of 7 three-dimensional shapes such as cylinder, sphere, or cone, and used the three measured dimensions and the formula for the volume of that shape to estimate canopy volume in m³. This method is less accurate than more detailed measurements with 7 or 8 canopy measurements, but much faster and sufficient for comparative purposes.

6.1.2.5 FIXED-POINT PHOTOS

At each transect a fixed-point photo was taken. The standard procedure is a DSLR with a 55mm lens at normal eye level, and the horizon framed at one-third below the top of the frame. A small blackboard with the site name and date is included in the photo in a position that is legible but does not obstruct the scene. On occasion, a cellphone camera with a 2x or 3x zoom is used instead.

All photos are geotagged, either by a built-in GPS if the camera contains one, or after returning from the field by interpolating from GPS tracks on a separate device to the timestamps on the photographs. It is essential for the camera's clock to be set to the correct local time, and for the computer's clock to be set correctly, for the interpolation between the timestamps on the GPS track and the timestamps on the photos to be accurate. If GPS data is missing or corrupted, photos are manually geotagged using photo editing software. Additional metadata including keywords are added to all photos, and fixed-point photos are renamed using the convention [site name] [number] [year].jpg, for example GCNR Site 3 2025.jpg. A suffix is added automatically for multiple photos when there are several site photos, with the suffix varying depending on the software being used; for example, GCNR Site 3 2025-001.jpg is the standard in some software platforms when batch renaming images.



Photo 2: Example of a fixed-point photo taken from the top of the transect using a 55mm focal length

6.1.2.6 VELD CONDITION SCORE

Veld condition score is calculated as follows:

- 1) Calculate the relative abundance as a percentage for each species in the survey;
- 2) Sum the products of the relative abundance of each species and its grazing value out of 10, where 10 is highly palatable and productive grasses. Grazing values for grasses were obtained from the KZN Veld Guidelines (Hardy et al. 1999), or estimated from palatability ratings in van Oudsthoorn (2006), or from the author's experience.
- 3) Do the same for a benchmark (ideal) veld composition for that vegetation type. Benchmarks were extracted from the KZN Veld Guidelines, and where necessary extrapolated to comparable vegetation types outside the borders of KwaZulu-Natal. Where no benchmark was available, a generic score of 750 was used for the benchmark term.
- 4) The veld score is then the site score divided by the benchmark score expressed as a percentage.

$$[\text{Site_score}] / [\text{Benchmark_score}] * 100$$

Very good sites can exceed the benchmark score. Note that benchmarks include non-grasses; while these surveys exclude non-grasses. Therefore the site score will be somewhat higher than if non-grasses were included.

6.1.2.7 VISUAL ASSESSMENT

On all sites, an additional visual assessment was conducted. Two different approaches were combined: a method developed in the highveld by Fourie and Roberts (1977) and a variation for the bushveld by van Oudsthoorn (no date).

Both approaches involve visually scoring five to seven different attributes and inserting the scores into a formula to calculate veld condition scores.

The attributes and the scoring for each attribute in the Fourie and Roberts method are shown in the table below (Table 10).

The scores are then plugged into the following formula to calculate a veld condition score (terms separated for clarity):

$$\begin{aligned}
 &[\text{Plant_Cover}] * 3 + \\
 &[\text{Species_composition}] * 3 + \\
 &[\text{Vigour}] * 0.05 + \\
 &[\text{Soil_condition}] + \\
 &[\text{Insects}] * 0.5 + \\
 &[\text{Plant_cover}] * [\text{Species_composition}] * 0.02
 \end{aligned}$$

Veld scores are described as follows:

Veld condition	Minimum score
Very good	76
Good	65
Moderate	45
Poor	35
Very poor	0

The veld condition score is out of a maximum of 78 and can be converted to a percentage.

To calculate grazing capacity in AU/ha, the following procedure was used:

- 1) Calculate max_rain as the rainfall of the area up to a maximum of 800mm:

If(rainfall>800, 800, rainfall)

- 2) Plug the veld score (not the percentage) and max_rain into the following multiple regression equation (terms separated for clarity):

-0.1535+

[Veld_score]*-0.002412+

[max_rain]*0.0005595+

[Veld_score]^2*0.0000012+

[max_rain]^2*-0.0000005+

[Veld_score]*[max_rain]*0.0000107

Invert the result to obtain ha/AU.

Table 10: Scoring for the Fourie and Roberts visual veld condition assessment method

Plant cover	Score	
Excellent	9	Plant cover is simply the percentage of soil surface covered by the living parts of herbaceous plants and low shrubs.
Very good	7	
Good	6	
Satisfactory	5	
Poor with bare patches	4	
Very poor with bare patches	3	
Species composition	Score	
Only desirable	8	A quick assessment of the dominant species in the veld. Some knowledge of important species and their palatability is required.
Mostly desirable	6	
Both desirable and undesirable	5	
Mostly undesirable	4	
Only undesirable	3	
Vigour of palatables	Score	
Excellent	9	How productive or healthy the palatable grasses in the veld are. Overgrazing will lead to declining production of individual grasses. This metric is very subjective and changes through the season.
Very good	7	
Good	6	
Satisfactory	5	
Poor	4	
Very poor	2	
Soil surface condition	Score	
Organic material covering the soil surface	9	Description of soil loss
No soil loss and sufficient organic material	7	
Little soil loss with some organic material	6	
Erosion around tufts with little organic material	5	
Severe erosion around tufts with no organic material	4	
Severe erosion with no organic material	1	
Insect/rodent damage	Score	
None	9	A controversial inclusion, but may be related to the assumption that molerats, termites and mole crickets cause significant damage to the veld in the highveld. Only scored highly when termite "cities" (clusters of termite mounds) were observed.
Insignificant	7	
Little	6	
Medium	5	
Severe	3	
Very severe	1	

Table 11: Scoring for the Van Oudtshoorn visual veld condition assessment method

VISUAL VELD CONDITION ASSESSMENT

A MULTI-CRITERIA METHOD

Grazing area: _____ District: _____

Observers: _____ Date: _____

Coordinates: S: _____ E: _____ Elevation: _____

Site description

Terrain unit ?	Crest		Midslope		Foothslope		Valley bottom	
Slope ?	Level (0° - 2°)		Gentle (3° -10°)		Moderate (11° - 45°)		Steep (> 45°)	
Aspect ?	N	S	W	E	NE	NW	SE	SW
Soil type	Sandy	Loam	Clay	Black turf	Humus	Gravelly/rocky		

Comments

Evaluation

Apply scores to the following criteria (A – F):

A. How much grass biomass is present? (quantity grazing)						
1	Very low levels of grass biomass	2	0 – 3	Score A: ↓		
2	Low levels of grass biomass	5	4 – 7			
3	Moderate levels of grass biomass	9	8 – 11			
4	High levels of grass biomass	13	12 – 15			
5	Very high levels of grass biomass	18	16 – 20			
B. How many good grazing grasses are present? (quality grazing)						
1	Mainly poor grazing grasses present	2	0 – 3	Score B: ↓		
2	Moderate and poor grazing grasses mixed	5	4 – 7			
3	Mainly moderate grazing grasses present	9	8 – 11			
4	Good and moderate grazing grasses mixed	13	12 – 15			
5	Mainly good grazing grasses present	18	16 – 20			
C. How is the grass vitality?						
1	Good grasses heavily grazed with very small weak tufts	1	1 – 2	Score C: ↓		
2	Good grasses heavily grazed with small tufts	3	3 – 4			
3	Good grasses moderately grazed with medium sized tufts	5	5 – 6			
4	Good grasses are strong with large tufts	7	7 – 8			
5	Good grasses are very strong with large vigorous tufts	9	9 – 10			
D. How much encroachment by unwanted plants is present?						
1	Heavy encroachment is present	1	1	Score D: ↓		
2	Heavy to medium encroachment present	2	2 – 3			
3	Medium encroachment is present	4	4 – 5			
4	Medium to light encroachment is present	6	6 – 7			
5	Only light encroachment is present	8	8 – 9			
6	No encroachment present	10	10			
E. How is the soil surface condition? (erosion)						
1	Distinct erosion with few vegetation patches	1	1 – 2	Score E: ↓		
2	Distinct erosion around grass tufts	3	3 – 4			
3	Moderate to light erosion around grass tufts	5	5 – 6			
4	No erosion and good cover at ground level	7	7 – 8			
5	No erosion with dense cover and good organic mulch	9	9 – 10			
F. What is the soil type? (agric potential)						
	Texture ↓	Soil depth →	Deep	Shallow	Gravelly	Score F: ↓
1	Sandy soil (< 10% clay)		3 2 – 4	-3	-5	
2	Sandy loam soil (10 – 15% clay)		5 5 – 6	-3	-5	
3	Loam soil (15 – 25% clay)		7 7 – 8	-3	-5	
4	Clay loam soil (25 – 35% clay)		9 9 – 10	-3	-5	
5	Clay soil (35 – 50% clay)		7 7 – 8	-3	-5	
6	Heavy clay soil (>50% clay)		5 5 – 6	-3	-5	

Add below all the scores together to get the Veld Condition Score (VCS):

$$VCS = A + B + C + D + E + F = \underline{\quad} + \underline{\quad} + \underline{\quad} + \underline{\quad} + \underline{\quad} + \underline{\quad} = VCS = \underline{\quad}$$

Use now the Veld Condition Score (VCS), and long-term average rainfall for the area, to get the estimated grazing capacity in ha/LSU or AU from the table below:

VCS	Veld Condition	SEASONAL RAINFALL (mm/annum)																			
		350	375	400	425	450	475	500	525	550	575	600	625	650	675	700	725	750	800	850	900
		ha/LSU																			
20	Very poor	52.6	35.7	28.6	23.6	20.3	18.0	16.2	14.8	13.7	12.7	12.0	11.3	10.7	10.2	9.8	9.4	9.1	8.7	8.4	8.1
25		42.1	29.3	22.5	18.9	16.3	14.4	13.0	11.8	10.9	10.2	9.6	9.0	8.6	8.2	7.8	7.5	7.2	6.9	6.6	6.4
30	Poor	35.1	24.4	19.0	15.8	13.6	12.0	10.8	9.9	9.1	8.5	8.0	7.5	7.2	6.8	6.5	6.3	6.0	5.8	5.5	5.3
35		30.1	20.9	16.3	13.5	11.6	10.3	9.3	8.4	7.8	7.3	6.8	6.5	6.1	5.8	5.6	5.4	5.2	5.0	4.8	4.6
40		29.3	15.3	14.3	11.8	10.2	9.0	8.1	7.4	6.8	6.4	6.0	5.5	5.4	5.1	4.9	4.7	4.5	4.3	4.1	4.0
45	Moderate	24.4	16.3	12.7	10.5	9.0	8.0	7.2	6.6	6.1	5.7	5.3	5.0	4.8	4.5	4.4	4.2	4.0	3.8	3.7	3.5
50		21.0	14.7	11.4	9.5	8.1	7.2	6.5	5.9	5.5	5.1	4.8	4.5	4.3	4.1	3.9	3.8	3.6	3.5	3.3	3.2
55		19.1	13.3	10.4	8.6	7.4	6.5	5.9	5.4	5.0	4.6	4.3	4.1	3.9	3.7	3.6	3.4	3.3	3.2	3.0	2.9
60	Good	17.5	12.2	9.5	7.9	6.8	6.0	5.4	4.9	4.6	4.2	4.0	3.8	3.6	3.4	3.3	3.1	3.0	2.9	2.8	2.7
65		16.2	11.3	8.5	7.3	6.3	5.5	5.0	4.5	4.2	3.9	3.7	3.5	3.3	3.1	3.0	2.9	2.8	2.7	2.6	2.5
70		15.0	10.5	8.2	6.8	5.8	5.1	4.6	4.2	3.9	3.6	3.4	3.2	3.1	2.9	2.8	2.7	2.6	2.5	2.4	2.3
75	Very good	14.0	9.8	7.6	6.3	5.4	4.8	4.3	3.9	3.6	3.4	3.2	3.0	2.9	2.7	2.6	2.5	2.4	2.3	2.2	2.1
80		11.2	9.2	7.1	5.9	5.1	4.5	4.0	3.7	3.5	3.2	3.0	2.8	2.7	2.6	2.4	2.4	2.3	2.2	2.1	2.0